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 50 W to 7.5 kW. It supports EtherCAT communication protocol and carries Ethernet communication interfaces to work with the host controller for a networked operation of multiple servo drives.

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

The SV660N series servo drive aims to deliver a 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 troubleshooting. First-time users must read through this user guide. For concerns regarding product functions or performance, contact Inovance for technical support.

Precautions
◆ 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.

Unpacking Inspection

Check the following items upon unpacking.

Items	Description
Check whether the delivered products comply with your order.	Check whether the delivered products comply with the model and specifications shown on the packing box.
Check whether the delivered 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
October 2020	A00	First release

Standards Compliance

SV660N series servo drives and MS1 series servo motors have passed CE certification and comply with the following standards.

Name	Symbol	Directive		Standard	
CE certification	CE	EMC directive	2014/30/EU	Servo drive and servo motor	EN 61800-3 EN55011 EN61000-6-2 EN61000-6-4
		LVD directive	2014/35/EU	Servo drive	EN 61800-5-1
				Servo motor	EN 60034-1
		RoHS directive	2011/65/EU	EN 50581	

NOTE

- ◆ The preceding certification and standards 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 Directives.
- ◆ For more information on product certification, 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 only by professionals. ◆ Installation, wiring, maintenance, inspection, or parts replacement must be performed only by 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 only by 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 cross sectional area 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 enclosure, fan, or resistor for temperature detection. Failure to comply will result in heat injuries.
- Signal detection must be performed only by 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 a contactor. Failure to comply may result in equipment damage.

Maintenance

DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by 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 only by 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.

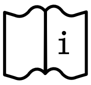
Disposal

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.

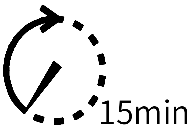

Reliably ground the system and equipment.


Danger!


High temperature!


Prevent personal injuries caused by machines.


High voltage!



Wait 15 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

Code	1R6	2R8	3R5	5R4	5R5	7R6
Rated output current	1.6 A	2.8 A	3.5 A	5.4 A	5.5 A	7.6 A
Code	8R4	012	017	021	026	-
Rated output current	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

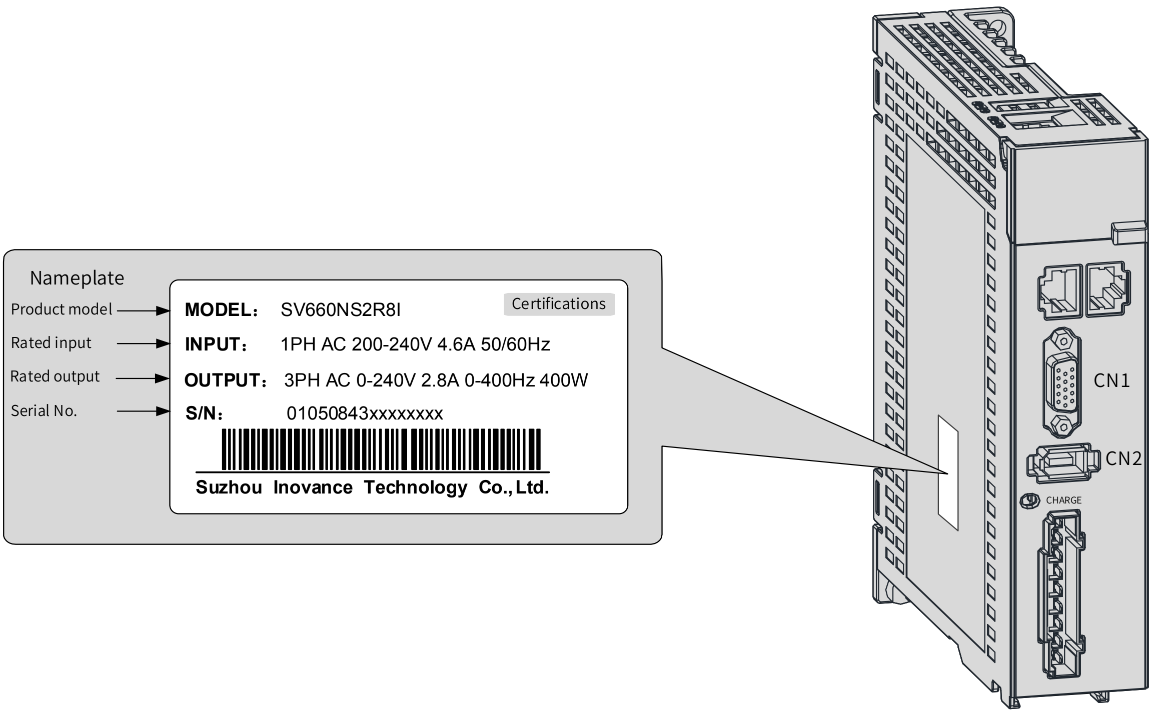


Figure 1-1 Nameplate and model number

01050193 4 H 7 00001

Code	Part No.
01 ******	Internal part number

Code	Manufacturer Code
4	Suzhou Inovance

Code	Year
9	2009
A	2010
B	2011
……	By analogy
Note: Letters I, L, O, or Q are not used.	

Code	Product No.
00001	1st in current month
00002	2nd in current month
00003	3rd in current month
……	Nth in current month
Range: 00001 to 99999	

Code	Month
1	January
2	February
3	March
...	...
A	October
B	November
C	December

Example: The serial number 010501934H700001 indicates the servo drive is manufatured in July 2017.

Figure 1-2 Encryption of the serial number (S/N)

1.1.2 Components

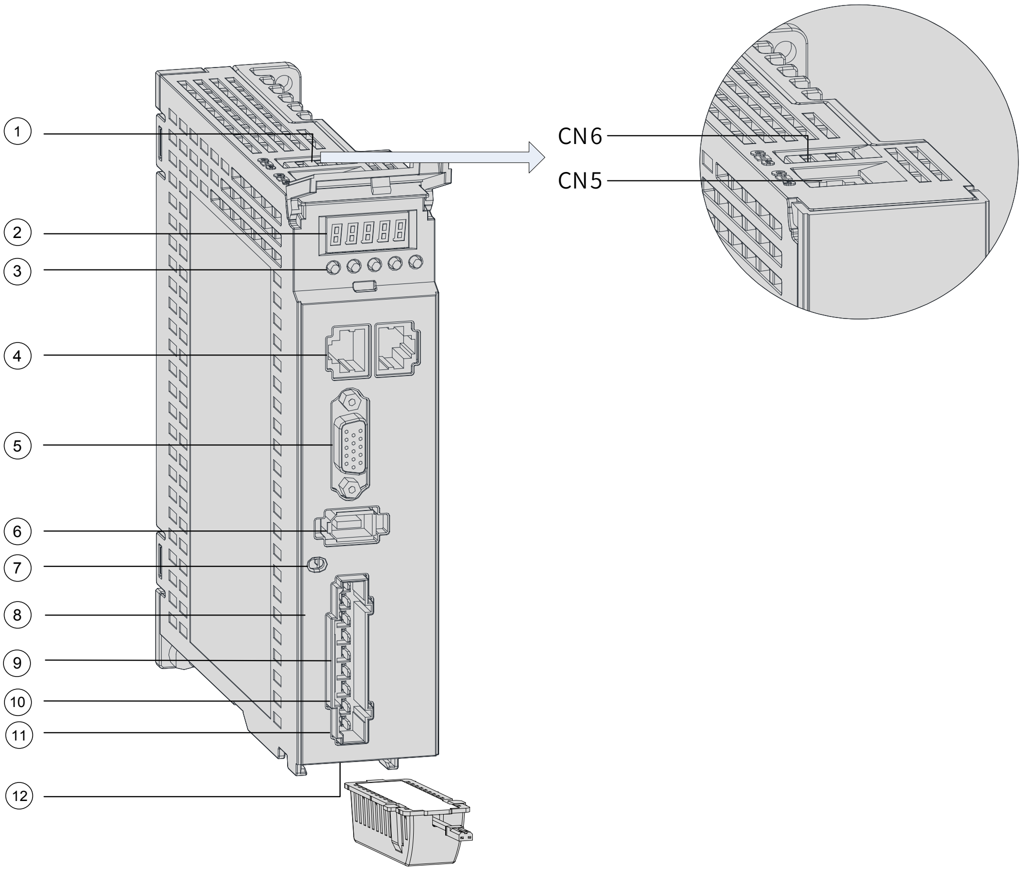


Figure 1-3 Layout of servo drives in size A

No.	Name	Description
1	CN6 and CN5	CN6: Functional safety terminal mainly used for functional safety purpose, connected to the external functional safety signal CN5: Software tool communication terminal

No.	Name	Description
2	LED display (5-digit)	Used to display servo drive operation states and parameter settings.
3	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. (Held down: Used to turn to the next page when the display value is comprised of more than 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. CN4 (OUT): Connected to the next slave.
5	CN1 (control terminal)	Used by reference input signals and other I/O signals.
6	CN2 (terminal for connecting the encoder)	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, electric charge may be still present in the internal capacitor of the servo drive 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 rated voltage of the power supply.
	P, N (DC bus terminals)	Used as the common DC bus for multiple servo drives.
9	P, C (terminals for connecting external regenerative resistor)	When an external regenerative resistor is needed, connect it between terminals P and C.
10	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
11	PE (grounding terminal)	Connected to the power supply ground and the motor grounding terminal.
12	Battery location	Used to hold the battery box of the absolute encoder.

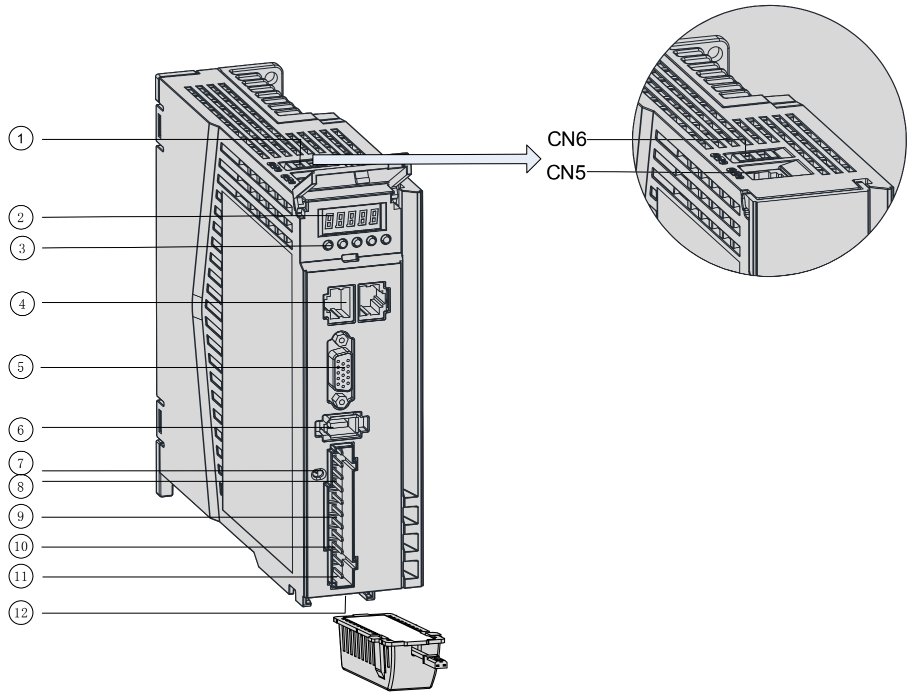


Figure 1-4 Layout of servo drives in size B

No.	Name	Description
1	CN6, CN5	CN6: Functional safety terminal mainly used for functional safety purpose and connected to external functional safety signal CN5: Software tool communication terminal
2	LED display (5-digit)	Used to display servo drive operation states and parameter settings.
3	Buttons	MODE: Used to switch the parameter No. in sequence. △ : Used to increase the set value of the blinking digit. ▽ : Used to decrease the set value of the blinking digit. ◁◁ : Used to shift the blinking digit leftwards. (Held down: Used to turn to the next page when the display value is comprised of more than five digits.) SET: Used to save modifications and enter the next level of menu.
4	CN3, CN4 (EtherCAT communication terminals)	CN3 (IN): Connected to the master or the last slave. CN4 (OUT): Connected to the next slave.
5	CN1 (control terminal)	Used for reference input signal and other I/O signals.
6	CN2 (terminal for connecting the encoder)	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, electric charge may be still present in the internal capacitor of the servo drive 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.

No.	Name	Description
8	L1, L2, L3 (power input terminals)	See the nameplate for the rated voltage of the power supply. Note: S5R5 (750 W) servo drives: Single-phase 220 V input, with 220 V power supply connected to L1 and L2
	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)	Connect the regenerative resistor between terminals P and C as needed. Remove the jumper between terminals P and D before connecting the regenerative resistor
10	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
11	PE (grounding terminal)	Connected to the power supply ground and motor grounding terminal.
12	Battery location	Used to hold the battery box of the 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.

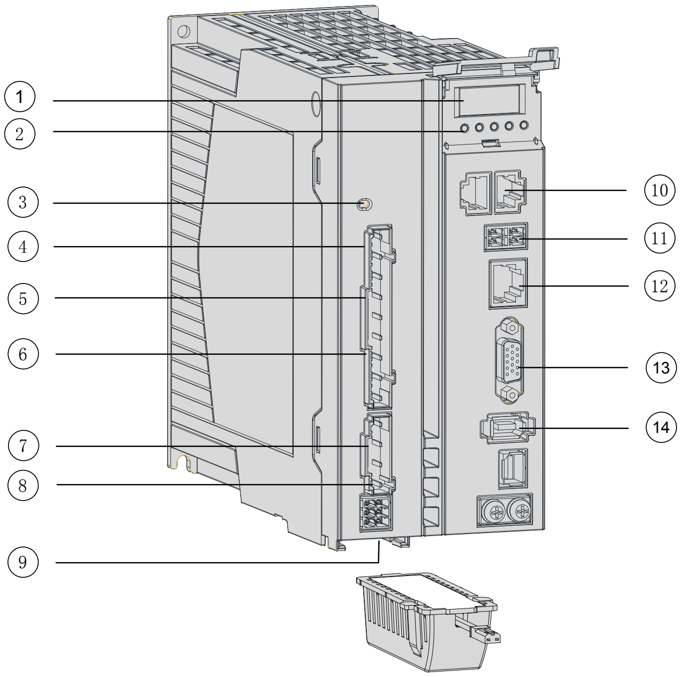


Figure 1-5 Components of servo drives in size C and Size D

No.	Name	Description
1	LED display (5-digit)	Used to display servo drive operation states and parameter settings.

No.	Name	Description
2	Buttons	MODE: Used to switch the parameter No. in sequence. △ : Used to increase the set value of the blinking digit. ▽ : Used to decrease the set value of the blinking digit. ◁◁ : Used to shift the blinking digit leftwards. (Held down: Used to turn to the next page when the display value is comprised of more than five digits.) SET: Used to save modifications and enter the next level of menu.
3	CHARGE (bus voltage indicator)	Used to indicate that the bus capacitor carries electric charge. When this indicator lights up, electric charge may be still present in the internal capacitor of the servo drive 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.
4	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
5	R, S, T (main circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
6	P, D, C (terminals for connecting external regenerative resistor)	Connect the regenerative resistor between P and C as needed. Remove the jumper between terminals P and D before connecting the regenerative resistor
	P, N (DC bus terminals)	Used as the common DC bus for multiple servo drives.
7	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
8	PE (Grounding terminal)	Connected to the power supply ground and motor grounding terminal.
9	Battery location	Used to hold the battery box of the absolute encoder.
10	CN3, CN4 (EtherCAT terminal)	CN3(IN): Connected to the master or the last slave. CN4(OUT): Connected to the next slave.
11	CN6 (STO terminal)	Used to connect the external functional safety signal.
12	CN5	Used as the software tool communication terminal.
13	CN1 (control terminal)	Used by reference input signals and other I/O signals.
14	CN2 (terminal for connecting the encoder)	Connected to motor encoder terminal.

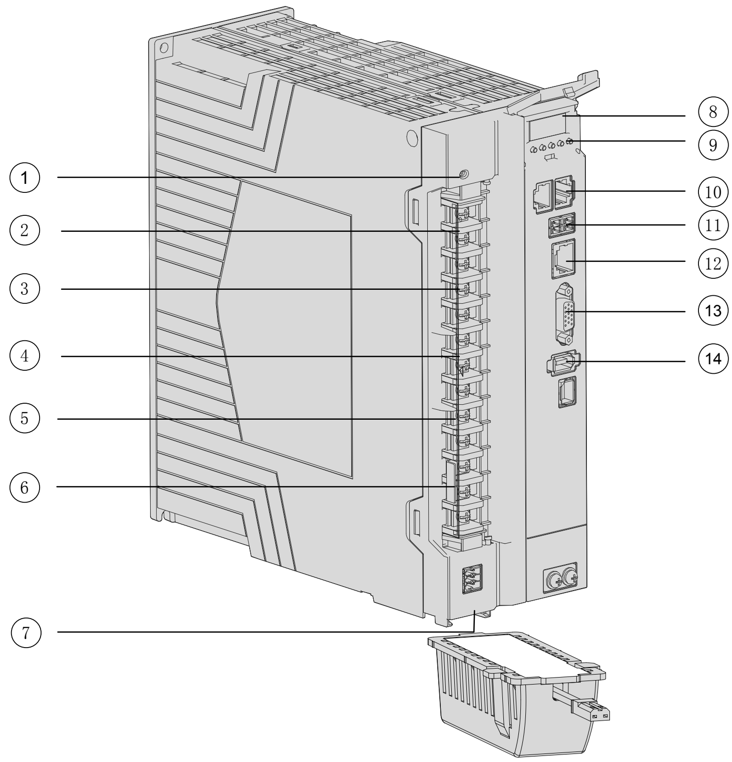


Figure 1-6 Components of servo drives in size E

No.	Name	Description
1	CHARGE (bus voltage indicator)	Used to indicate that the bus capacitor carries electric charge. When this indicator lights up, electric charge may be still present in the internal capacitor of the servo drive 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.
2	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
3	R, S, T (main circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
4	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
5	N2, N1 (terminals for connecting the external reactor)	Terminals N1 and N2 are jumpered by default. Remove the jumper before connecting the external DC reactor between N1 and N2.
6	P, D, C (terminals for connecting external regenerative resistor)	Connect the regenerative resistor between P and C as needed. Remove the jumper between terminals P and D before connecting the regenerative resistor
7	Battery location	Used to hold the battery box of the absolute encoder.
8	LED display (5-digit)	Used to display servo drive operation states and parameter settings.

No.	Name	Description
9	Buttons	MODE: Used to switch the parameter No. in sequence. △ : Used to increase the set value of the blinking digit. ▽ : Used to decrease the set value of the blinking digit. ◁◁ : Used to shift the blinking digit leftwards. (Held down: Used to turn to the next page when the display value is comprised of more than five digits.) SET: Used to save modifications and enter the next level of menu.
10	CN3, CN4 (communication terminal)	Connected in parallel internally. Connected to RS232 and RS485 devices.
11	CN6 (STO terminal)	Used to connect the external functional safety signal.
12	CN5	Used as the software tool communication terminal.
13	CN1 (control terminal)	Used by reference input signals and other I/O signals.
14	CN2 (terminal for connecting the encoder)	Connected to the encoder terminal.

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	5.5
Maximum output current (Arms)	5.8	10.1	16.9
Main circuit power supply	Single-phase 200 VAC to 240 VAC, -10% to +10%, 50/60 Hz		
Control circuit power supply	Single-phase 200 VAC to 240 VAC, -10% to +10%, 50/60 Hz		
Braking function	Servo drives in size A support external regenerative resistors only. Servo drives in size B carries a built-in regenerative resistor as standard.		

■ Three-phase 220 V servo drives

Item	Size C	Size D
Servo drive model: SV660N	S7R6	S012
Continuous output current (Arms)	7.6	11.6
Maximum output current (Arms)	23	32
Main circuit power supply	Three-phase 200 VAC to 240 VAC, -10% to +10%, 50/60 Hz	
Control circuit power supply	Single-phase 200 VAC to 240 VAC, +10 to –10%, 50/60 Hz	
Braking function	A built-in regenerative resistor is included in the standard configuration.	

NOTE

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

■ 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 VAC to 440 VAC, -10% to +10%, 50/60 Hz						
Control circuit power supply	Single-phase 380 VAC to 440 VAC, -10% to +10%, 50/60 Hz						
Braking function	A built-in regenerative resistor is included in the standard configuration.						

2 General specifications

Item			Description
Basic specifications	Control mode		IGBT PWM control, sine wave current drive mode 220 V, 380 V: Single-phase/Three-phase full bridge rectification
	Encoder feedback		23-bit absolute (optional) encoder, which can be used as an incremental encoder in the absence of the battery
	Conditions for use	Ambient/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
		Ambient/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 are excluded, which have a rating of IP00.)
		Pollution degree	PD2
		Altitude	Below 1000 m. Derating is required for altitudes between 1000 m and 2000 m.
Speed/ Torque control mode	Performance	Speed control range	1:6000 (Under the rated torque load, the servo drive keeps running as long as the lower limit of the speed control range is not exceeded.)
		Speed loop bandwidth	3 kHz
		Torque control accuracy (repeatability)	±2%
		Soft startup time	0s to 65s (Acceleration and deceleration can be set separately.)
	Input signals	Speed reference	Source of network-type references: EtherCAT communication Local mode and local multi-speed supported
		Torque reference	

Item			Description
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, EDM output
Built-in functions	Overtravel (OT) prevention		Stopping immediately when P-OT and N-OT activated
	Protective functions		Providing protections against overcurrent, overvoltage, undervoltage, overload, main circuit detection error, heatsink over-temperature, overspeed, encoder error, CPU error, and parameter error
	LED display and CHARGE indicator		CHARGE indicator for the main power supply, 5-digit LED display
	Vibration suppression		Four notches (including two adaptive notches), 50 Hz to 5000 Hz
	Communication functions	Connection protocol	RS232
		Communication protocol	EtherCAT
		Multi-station communication	Maximum number of slaves: 255
		Axis address setting	No physical knob, set to 0...255 through 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

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

3 Technical specifications of EtherCAT communication

Item		Specification
Basic performance of EtherCAT slaves	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 a 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
	Synchronization jitter of two slaves	< 1 µs
	Refresh time	About 30 µs for 1000 DI/DOs About 100 µs for 100 servo axes Different refresh times for different interfaces
	Communication code error rate	10^{-10} Ethernet standard
EtherCAT configuration units	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

4 Basic functions

The servo drive functions are listed below. 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 the positioning control process.
Cyclic synchronous velocity mode	The host controller generates speed references and sends the references cyclically through the bus. The servo drive performs speed control.
Cyclic synchronous torque mode	The host controller generates torque references and sends the references cyclically through the bus. The servo drive performs torque control.
Profile position mode	The host controller sets parameters through the bus, and the servo drive generates position references and performs positioning control process.
Profile velocity mode	The host controller sets parameters through the bus, and the servo drive generates speed references and performs speed control.

Function	Description
Profile torque mode	The host controller sets parameters through the bus, and the servo drive generates torque references and performs torque control.
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 state 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.
Forced output of output signals	Implements forced signal output not related to the servo drive status and detects the wiring of output signals.
Trial run mode	Runs the servo motor directly through the keypad, avoiding 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. By using the software tool, the data is read for further analysis.

1.1.4 Specifications of the Regenerative Resistor

<table>
<tr><th colspan="2" rowspan="2">Servo Drive Model</th><th colspan="2">Specifications of the Built-in Regenerative Resistor</th><th rowspan="2">Min. Allowable Resistance (Ω)</th><th rowspan="2">Max. Braking Energy Absorbed by the Capacitor (J)</th></tr>
<tr><th>Resistance (Ω)</th><th>Power (W)</th></tr>
<tr><td rowspan="3">Single-phase 220 V</td><td>SV660NS1R6I</td><td>-</td><td>-</td><td>50</td><td>13.15</td></tr>
<tr><td>SV660NS2R8I</td><td>-</td><td>-</td><td>45</td><td>26.29</td></tr>
<tr><td>SV660NS5R5I</td><td>50</td><td>50</td><td>40</td><td>22.41</td></tr>
<tr><td rowspan="2">Single-phase/ Three-phase 220 V</td><td>SV660NS7R6I</td><td rowspan="2">25</td><td rowspan="2">60</td><td>20</td><td>26.70</td></tr>
<tr><td>SV660NS012I</td><td>15</td><td>26.70</td></tr>
<tr><td>Three-phase 380 V</td><td>SV660NT3R5I</td><td>100</td><td>60</td><td>80</td><td>34.28</td></tr>
<tr><td rowspan="6">Three-phase 380 V</td><td>SV660NT5R4I</td><td>100</td><td>60</td><td>60</td><td>34.28</td></tr>
<tr><td>SV660NT8R4I</td><td rowspan="2">50</td><td rowspan="2">75</td><td>45</td><td rowspan="2">50.41</td></tr>
<tr><td>SV660NT012I</td><td>40</td></tr>
<tr><td>SV660NT017I</td><td rowspan="3">35</td><td rowspan="3">100</td><td>35</td><td>82.67</td></tr>
<tr><td>SV660NT021I</td><td rowspan="2">25</td><td>100.82</td></tr>
<tr><td>SV660NT026I</td><td>100.82</td></tr>
</table>

NOTE

- ◆ Select the external regenerative resistor according to actual operating conditions.
- ◆ S7R6 and S012 models support single-phase 220 V power supply and derating is not required upon single-phase power input.

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 > rated speed
V	Motor with max. speed = rated speed

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

Code	Rated Power (W)
Comprised of two digits and a letter	
B	x 10
C	x 100
Example: 40B: 400 W	

Code	Rated Speed (RPM)
Comprised of two digits and a letter	
B	x 10
C	x 100
Example: 30C: 3000 RPM	

Code	Sub-series No.
Z	Terminal type, natural cooling
Z-S	Lead-wire type, natural cooling

Code	Brake, Reducer, Oil Seal
0	None
1	Oil seal
2	Brake
4	Oil seal+Brake

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

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

Code	Voltage Class
B	220 V
D	380 V

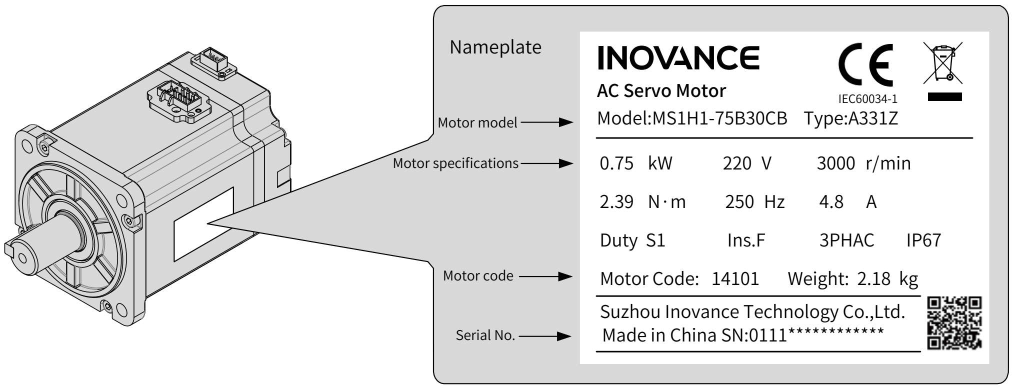


Figure 1-7 Model number and nameplate

NOTE

◆ SV660N series servo drives can work with a motor equipped with a 23-bit single-turn or multi-turn encoder.

1.2.2 Components

■ Components of terminal-type motors

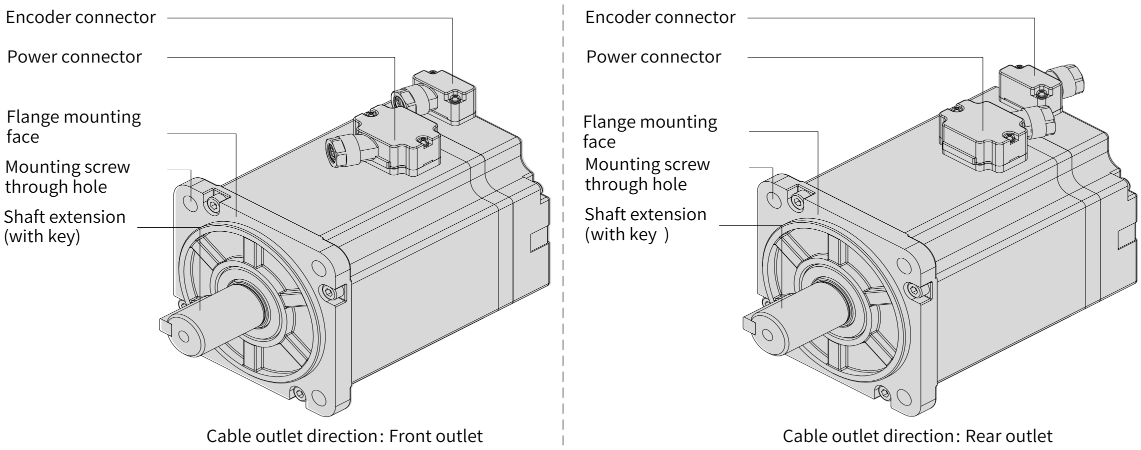


Figure 1-8 Components of MS1 series terminal-type motors

■ Components of lead wire-type motors

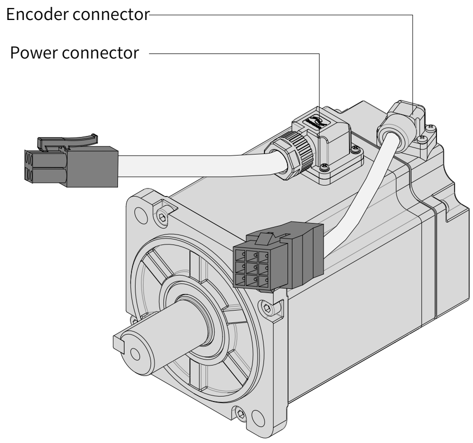


Figure 1-9 Components of MS1 series lead wire-type motors

■ Components of connector-type motors (flange sizes 100/130/180)

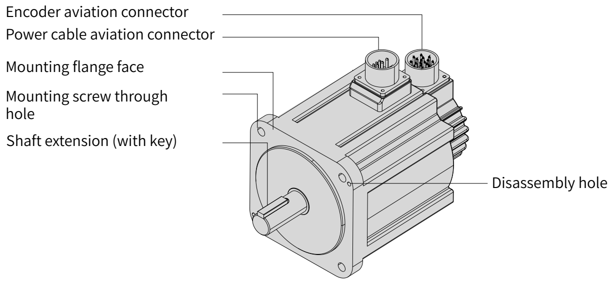


Figure 1-10 Components of MS1 series connector-type motors

1.2.3 Technical Specifications

1 Mechanical specifications of the motor

Item	Description
Duty type	Continuous
Vibration level	V15
Insulation resistance	500 VDC, above 10 MΩ
Ambient temperature	0°C to 40°C
Excitation mode	Permanent magnetic
Installation mode	Flange
Heat resistance level	Level F
Insulation voltage	1500 VAC, 1 min (220 V) 1800 VAC, 1 min (380 V)
IP rating of the enclosure	IP67 (except the shaft opening)
Ambient humidity	20% to 80% (without condensation)
Direction of rotation	Rotates counterclockwise (CCW) when viewed from the load side with a forward run command

2 Motor ratings

<table>
<tr><th>Model</th><th>Rated Output (kW)[1]</th><th>Rated Torque (N·m)</th><th>Max. Torque (N·m)</th><th>Rated Current (Arms)</th><th>Max. Current (Arms)</th><th>Rated Speed (RPM)</th><th>Max. Speed (RPM)</th><th>Torque Specifications (N·m/Arms)</th><th>Rotor Moment of Inertia (10^{-4}kg·m^2)</th><th>Voltage (V)</th></tr>
<tr><td colspan="11">Ratings of MS1H1 (Vn = 3000 RPM, Vmax = 6000 RPM) Series Motors</td></tr>
<tr><td>MS1H1-05B30CB</td><td>0.05</td><td>0.16</td><td>0.56</td><td>1.3</td><td>4.7</td><td rowspan="7">3000</td><td rowspan="7">6000</td><td>0.15</td><td>0.026 (0.028)</td><td rowspan="7">220</td></tr>
<tr><td>MS1H1-10B30CB</td><td>0.1</td><td>0.32</td><td>1.12</td><td>1.3</td><td>4.7</td><td>0.26</td><td>0.041 (0.043)</td></tr>
<tr><td>MS1H1-20B30CB</td><td>0.2</td><td>0.64</td><td>2.24</td><td>1.5</td><td>5.8</td><td>0.46</td><td>0.207 (0.220)</td></tr>
<tr><td>MS1H1-40B30CB</td><td>0.4</td><td>1.27</td><td>4.46</td><td>2.8</td><td>10.1</td><td>0.53</td><td>0.376 (0.390)</td></tr>
<tr><td>MS1H1-55B30CB</td><td>0.55</td><td>1.75</td><td>6.13</td><td>3.8</td><td>15.0</td><td>0.49</td><td>1.06</td></tr>
<tr><td>MS1H1-75B30CB</td><td>0.75</td><td>2.39</td><td>8.36</td><td>4.8</td><td>16.9</td><td>0.58</td><td>1.38 (1.43)</td></tr>
<tr><td>MS1H1-10C30CB</td><td>1.0</td><td>3.18</td><td>11.1</td><td>7.6</td><td>28.0</td><td>0.46</td><td>1.75</td></tr>
<tr><td colspan="11">Ratings of MS1H2 (Vn = 3000 RPM, Vmax = 6000/5000 RPM) Series Motors</td></tr>
<tr><td>MS1H2-10C30CB</td><td>1.0</td><td>3.18</td><td>9.54</td><td>7.5</td><td>23.00</td><td rowspan="9">3000</td><td>6000</td><td>0.47</td><td>1.87 (3.12)</td><td rowspan="2">220</td></tr>
<tr><td>MS1H2-15C30CB</td><td>1.5</td><td>4.90</td><td>14.7</td><td>10.8</td><td>32.00</td><td>5000</td><td>0.54</td><td>2.46 (3.71)</td></tr>
<tr><td>MS1H2-10C30CD</td><td>1.0</td><td>3.18</td><td>9.54</td><td>3.65</td><td>11.00</td><td>6000</td><td>0.89</td><td>1.87 (3.12)</td><td rowspan="7">380</td></tr>
<tr><td>MS1H2-15C30CD</td><td>1.5</td><td>4.90</td><td>14.7</td><td>4.50</td><td>14.00</td><td rowspan="6">5000</td><td>1.07</td><td>2.46 (3.71)</td></tr>
<tr><td>MS1H2-20C30CD</td><td>2.0</td><td>6.36</td><td>19.1</td><td>5.89</td><td>20.00</td><td>1.14</td><td>3.06 (4.31)</td></tr>
<tr><td>MS1H2-25C30CD</td><td>2.5</td><td>7.96</td><td>23.9</td><td>7.56</td><td>25.00</td><td>1.11</td><td>3.65 (4.90)</td></tr>
<tr><td>MS1H2-30C30CD</td><td>3.0</td><td>9.8</td><td>29.4</td><td>10.00</td><td>30.00</td><td>1.16</td><td>7.72 (10.22)</td></tr>
<tr><td>MS1H2-40C30CD</td><td>4.0</td><td>12.6</td><td>37.8</td><td>13.60</td><td>40.80</td><td>1.16</td><td>12.1 (14.6)</td></tr>
<tr><td>MS1H2-50C30CD</td><td>5.0</td><td>15.8</td><td>47.6</td><td>16.00</td><td>48.00</td><td>1.16</td><td>15.4 (17.9)</td></tr>
</table>

Model	Rated Output (kW)[1]	Rated Torque (N·m)	Max. Torque (N·m)	Rated Current (Arms)	Max. Current (Arms)	Rated Speed (RPM)	Max. Speed (RPM)	Torque Specifications (N·m/Arms)	Rotor Moment of Inertia ($10^{-4}kg\cdot m^2$)	Voltage (V)
Ratings of MS1H3 (Vn = 1500 RPM, Vmax = 3000 RPM) Series Motors										
MS1H3-85B15CB	0.85	5.39	13.5	6.60	16.50	1500	3000	0.95	13.3 (14)	220
MS1H3-13C15CB	1.3	8.34	20.85	10.00	25.00			0.96	17.8 (18.5)	
MS1H3-85B15CD	0.85	5.39	13.5	3.30	8.25			1.87	13.3 (14)	380
MS1H3-13C15CD	1.3	8.34	20.85	5.00	12.50			1.87	17.8 (18.5)	
MS1H3-18C15CD	1.8	11.5	28.75	6.60	16.50	1500	3000	1.87	25 (25.7)	380
MS1H3-29C15CD	2.9	18.6	37.2	11.90	23.80			1.82	55 (57.2)	
MS1H3-44C15CD	4.4	28.4	71.1	16.50	40.50			1.90	88.9 (90.8)	
MS1H3-55C15CD	5.5	35.0	87.6	20.85	52.00			1.74	107 (109.5)	
MS1H3-75C15CD	7.5	48.0	119	25.70	65.00			1.99	141 (143.1)	
Ratings of MS1H4 (Vn = 3000 RPM, Vmax = 6000 RPM) Series Motors										
MS1H4-40B30CB	0.4	1.27	4.46	2.80	10.10	3000	6000	0.53	0.657 (0.667)	220
MS1H4-75B30CB	0.75	2.39	8.36	4.80	16.9			0.58	2 (2.012)	

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

[2] Values inside parentheses "()" are for motors with brake.

NOTE

- Values in the preceding table are obtained when motors equipped with the following heatsinks are working with Inovance servo drives under an armature coil temperature of 20° C.

  MS1H1/MS1H4: 250 mm x 250 mm x 6 mm (aluminum)

  MS1H2-10C to 25C: 300 mm x 300 mm x 12 mm (aluminum)

  MS1H2-30C to 50C: 400 mm x 400 mm x 20 mm (aluminum)

  MS1H3-85B to 18C: 400 mm x 400 mm x 20 mm (iron)

  MS1H3-29C to 75C: 360 mm x 360 mm x 25 mm (double-layer aluminum plate)

3 Motor overload characteristics

Load Ratio (%)	Operating 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
350	2

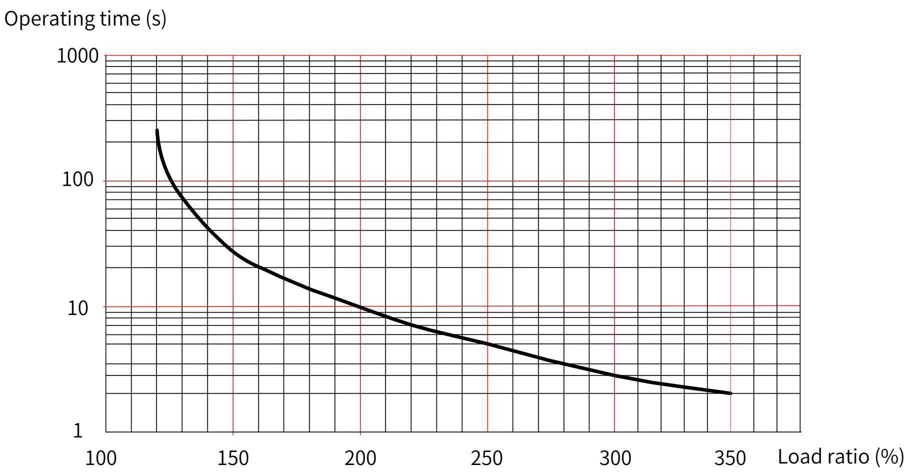
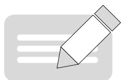


Figure 1-11 Motor overload curve


NOTE

- ◆ The maximum torque of H1 and H4 models is 3.5 times the rated torque.
- ◆ The maximum torque of H2 models is three times the rated torque.
- ◆ The maximum torque of H3 models (2.9 kW models excluded) is 2.5 times the rated torque.
- ◆ The maximum torque of 2.9 kW models is two times the rated torque.

4 Allowable radial and axial loads of the motor

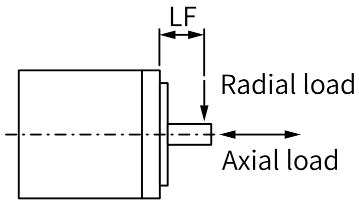


Figure 1-12 Radial and axial loads

Motor Model	Flange Size (mm)	LF (mm)	Allowable Radial Load (N)	Allowable Axial Load (N)
MS1H1-05B30CB	40	20	78	54
MS1H1-10B30CB	40	20	78	54
MS1H1-20B30CB	60	25	245	74
MS1H1-40B30CB	60	25	245	74
MS1H1-55B30CB	80	35	392	147
MS1H1-75B30CB	80	35	392	147
MS1H1-10C30CB	80	35	392	147
MS1H2-10C30CB	100	45	686	196
MS1H2-10C30CD	100	45	686	196
MS1H2-15C30CB	100	45	686	196
MS1H2-15C30CD	100	45	686	196
MS1H2-20C30CD	100	45	686	196
MS1H2-25C30CD	100	45	686	196
MS1H2-30C30CD	130	63	980	392
MS1H2-40C30CD	130	63	1176	392
MS1H2-50C30CD	130	63	1176	392
MS1H3-85B15CB	130	45	686	196
MS1H3-13C15CB	130	45	686	196
MS1H3-85B15CD	130	45	686	196
MS1H3-13C15CD	130	45	686	196
MS1H3-18C15CD	130	45	686	196

Motor Model	Flange Size (mm)	LF (mm)	Allowable Radial Load (N)	Allowable Axial Load (N)
MS1H3-29C15CD	180	79	1470	490
MS1H3-44C15CD	180	79	1470	490
MS1H3-55C15CD	180	113	1764	588
MS1H3-75C15CD	180	113	1764	588
MS1H4-40B30CB	60	25	245	74
MS1H4-75B30CB	80	35	392	147

5 Electrical specifications of the motor with brake

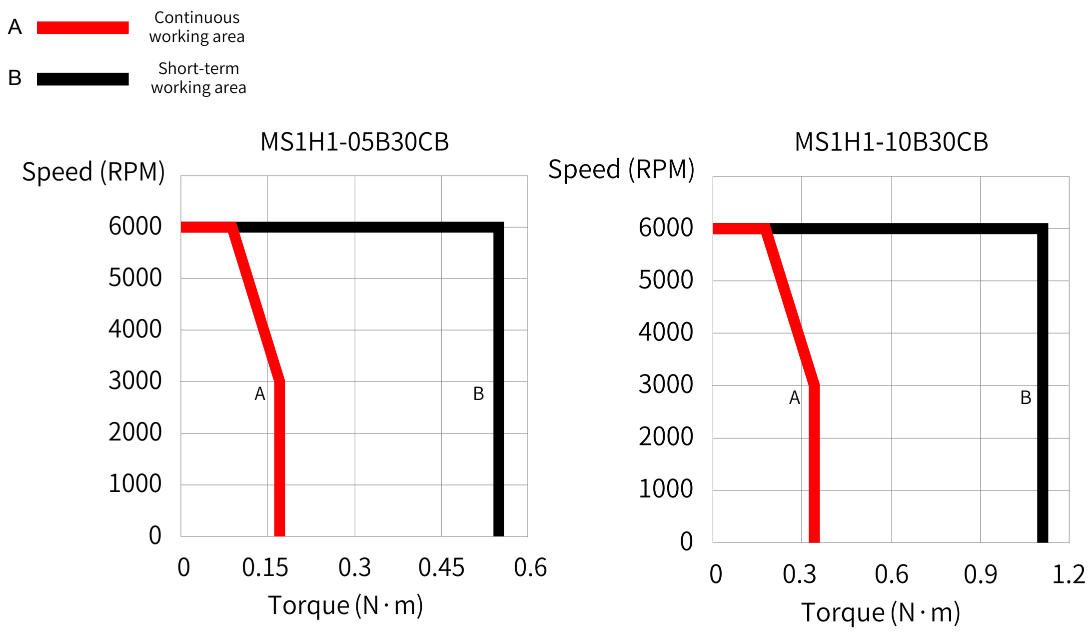
Motor Model	Holding Torque (N·m)	Supply Voltage (V_{DC}) ±10%	Rated Power (W)	Coil Resistance (Ω) (±7%)	Excitation Current (A)	Apply Time (ms)	Release Time (ms)	Backlash (°)
MS1H1-05B/10B	0.32	24	6.1	94.4	0.25	≤ 40	≤ 20	≤ 1.5
MS1H1-20B/40B MS1H4-40B	1.5		7.6	75.79	0.32	≤ 60	≤ 20	≤ 1.5
MS1H1/H4-75B	3.2		10	57.6	0.42	≤ 60	≤ 40	≤ 1.0
MS1H3-85B/13C/18C	12		19.4	29.7	0.81	≤ 120	≤ 60	≤ 0.5
MS1H2-10C/15C/20C/25C	8		23	25	0.96	≤ 85	≤ 30	≤ 0.5
MS1H2-30C/40C/50C	16		27	21.3	1.13	≤ 100	≤ 60	≤ 0.5
MS1H3-29C/44C/55C/75C	50		40	14.4	1.67	≤ 200	≤ 100	≤ 0.5

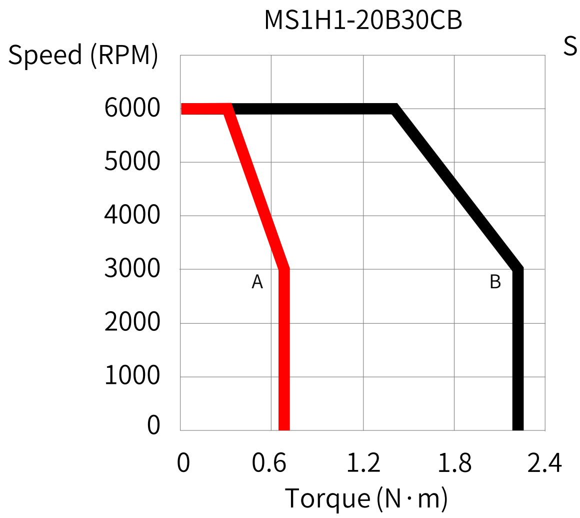
NOTE

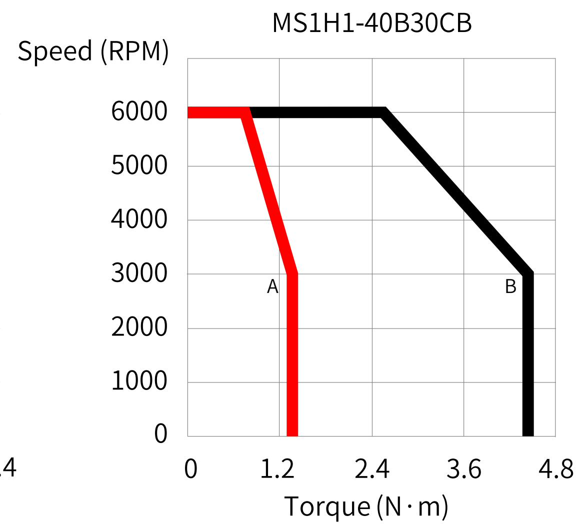
- ◆ The brake cannot share the same power supply with other electrical devices. This is to prevent malfunction of the brake due to voltage or current drop caused by other working devices.
- ◆ It is recommended to use cables of 0.5 mm^2 and above.

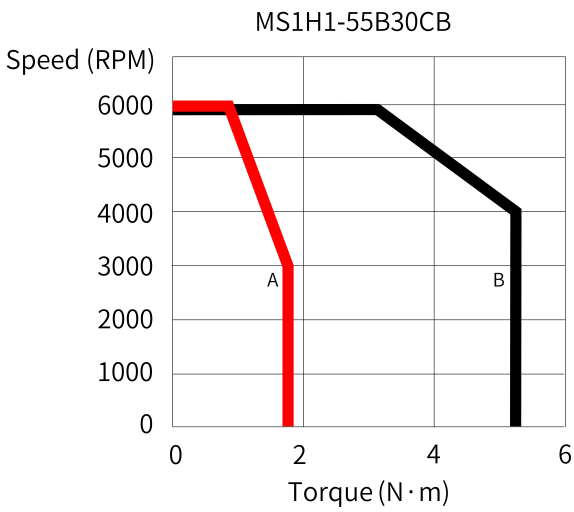
6 Motor torque-speed characteristics

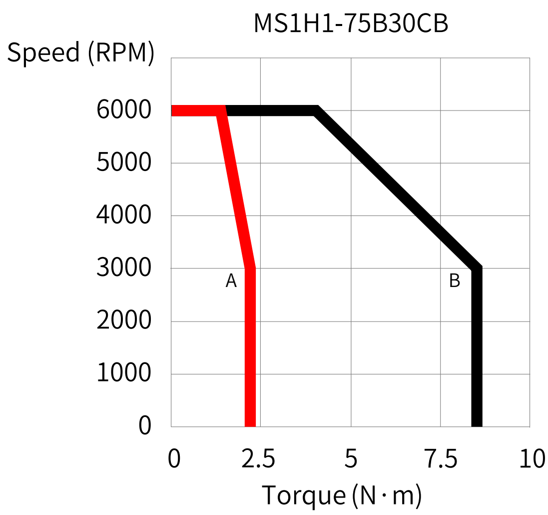
■ MS1H1 (low inertia, small capacity)

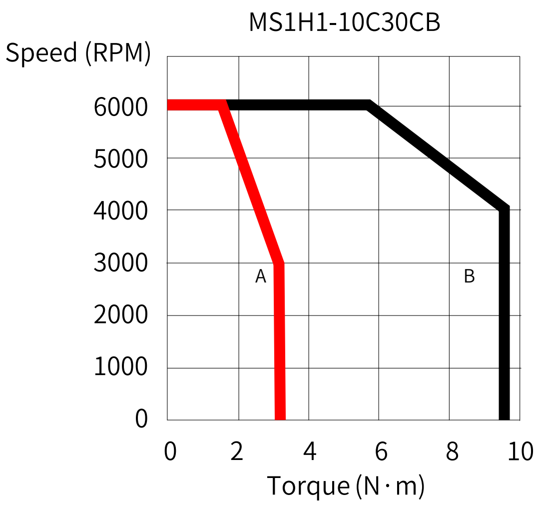



MS1H1-20B30CB
Speed (RPM)
6000
5000
4000
3000
2000
1000
0
A
B
0
0.6
1.2
1.8
2.4
Torque (N·m)


MS1H1-40B30CB
Speed (RPM)
6000
5000
4000
3000
2000
1000
0
A
B
0
1.2
2.4
3.6
4.8
Torque (N·m)


MS1H1-55B30CB
Speed (RPM)
6000
5000
4000
3000
2000
1000
0
A
B
0
2
4
6
Torque (N·m)

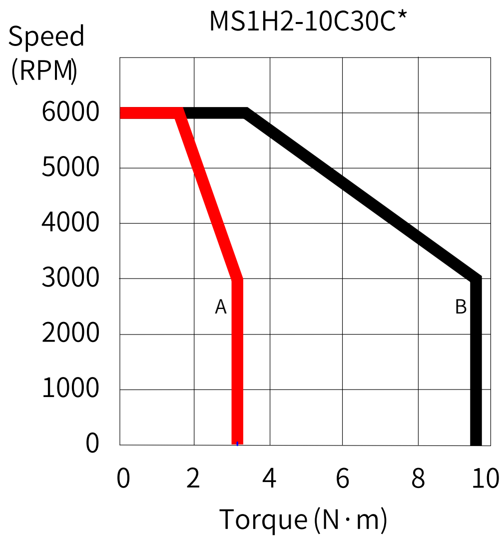

MS1H1-75B30CB
Speed (RPM)
6000
5000
4000
3000
2000
1000
0
A
B
0
2.5
5
7.5
10
Torque (N·m)

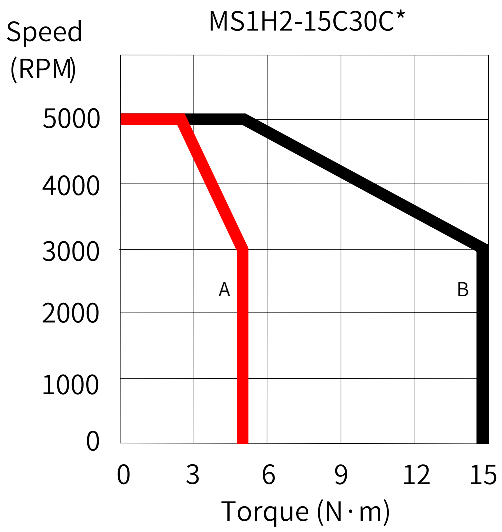

MS1H1-10C30CB
Speed (RPM)
6000
5000
4000
3000
2000
1000
0
A
B
0
2
4
6
8
10
Torque (N·m)

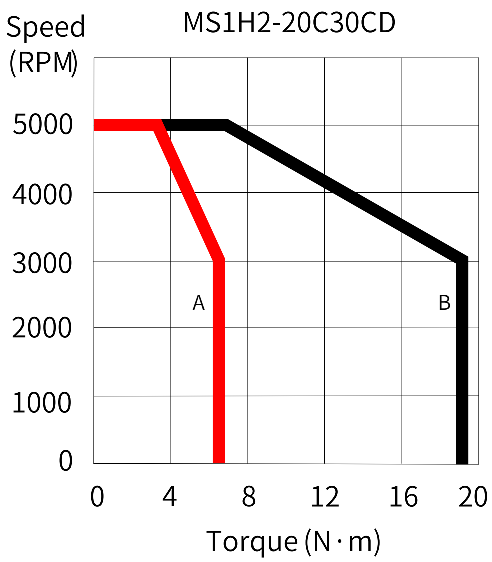
■ MS1H2 (low inertia, medium capacity)

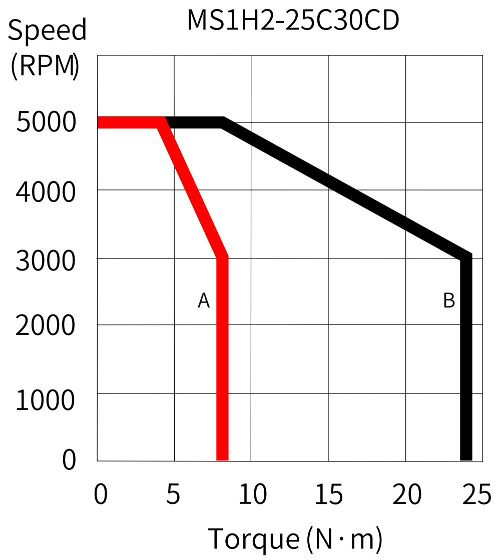
A Continuous working area

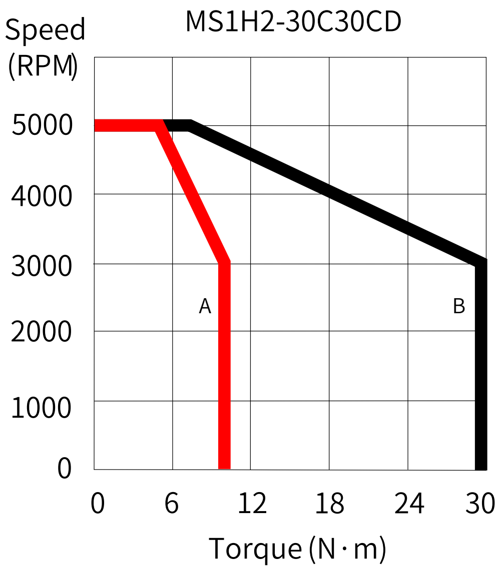
B Short-term working area

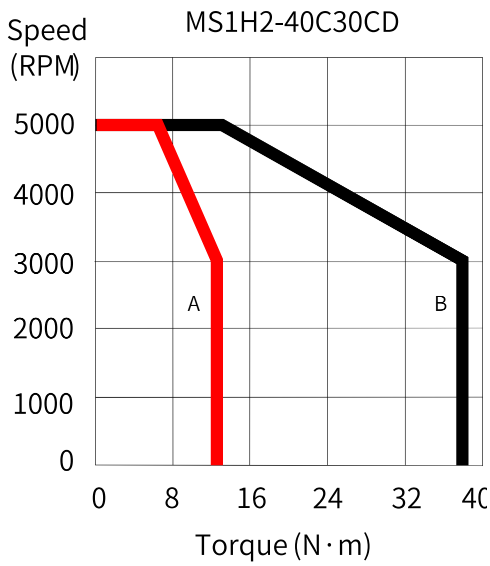


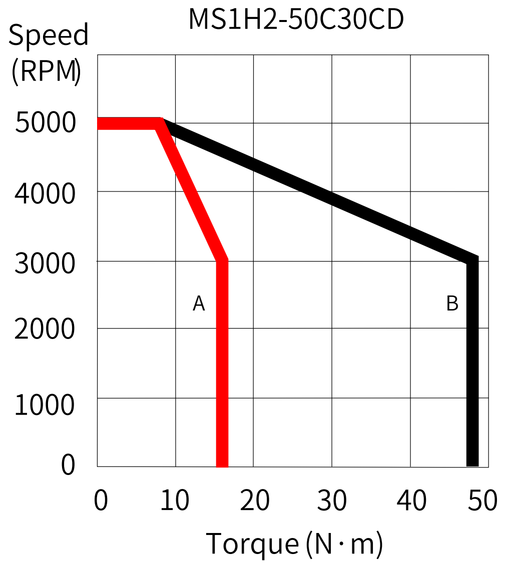








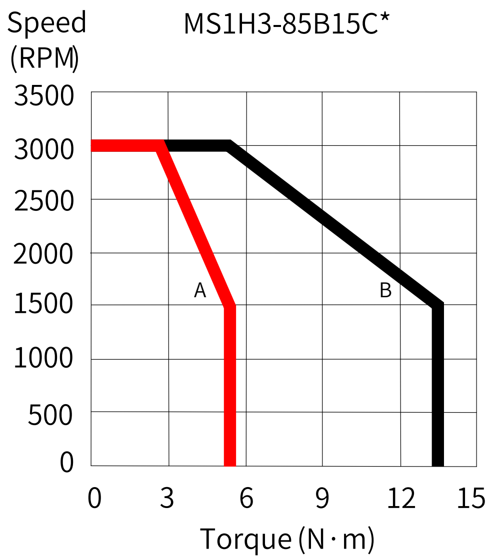


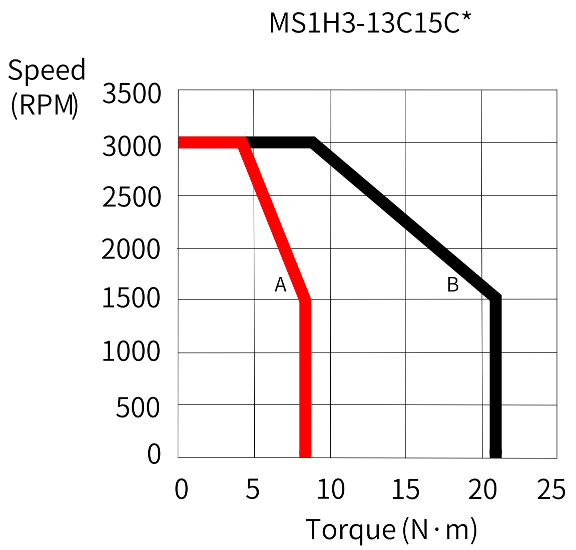


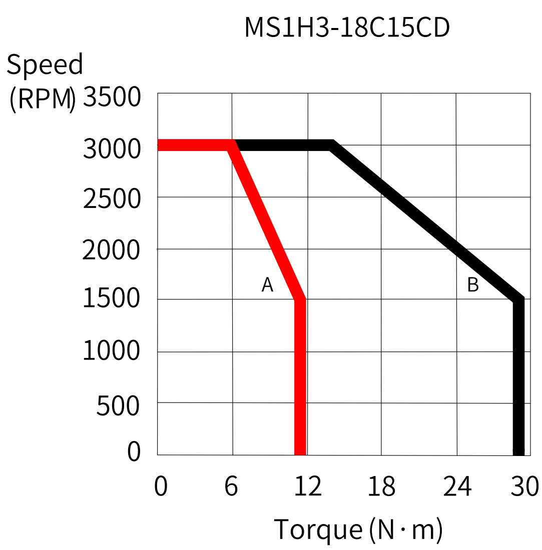
■ MS1H3 (medium inertia, medium capacity)

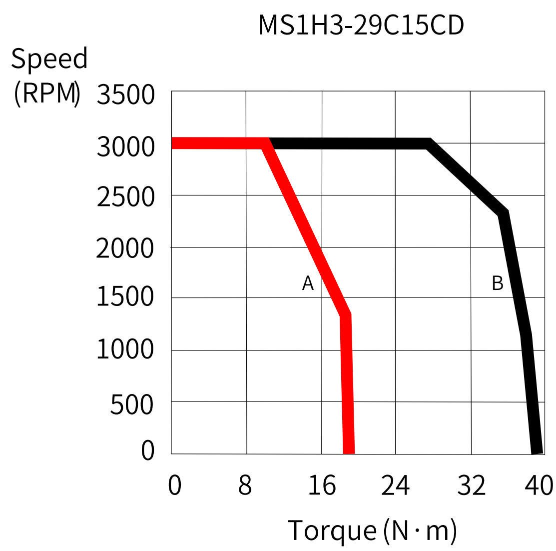
A Continuous working area

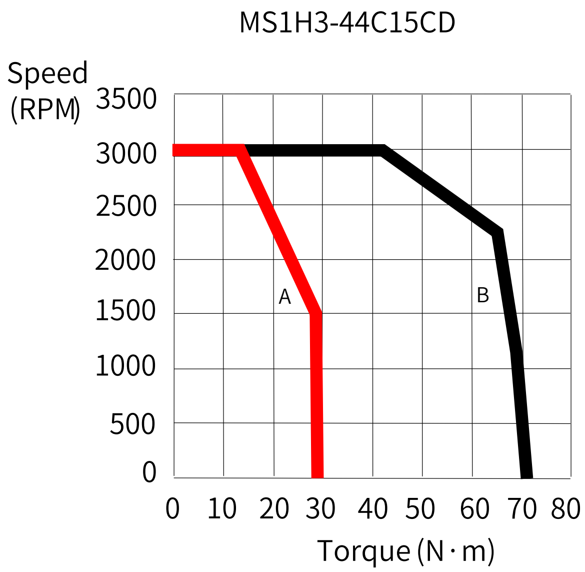
B Short-term working area

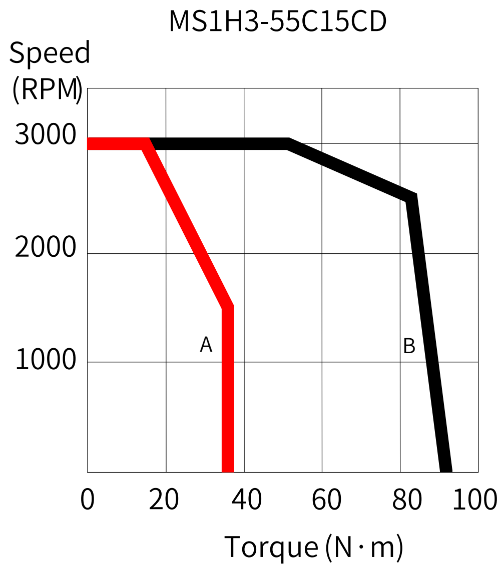


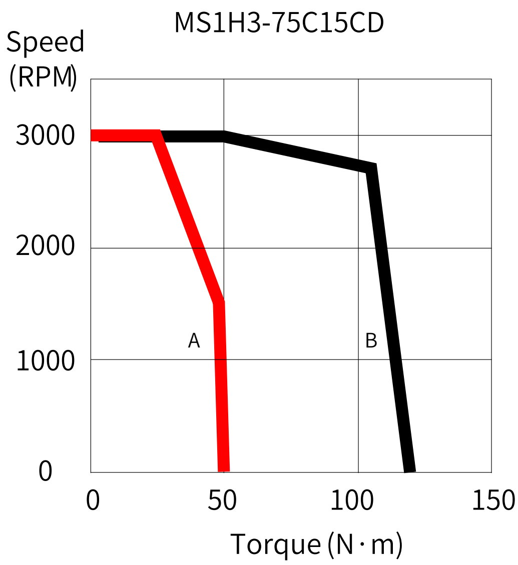




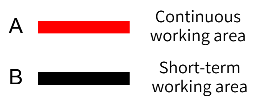


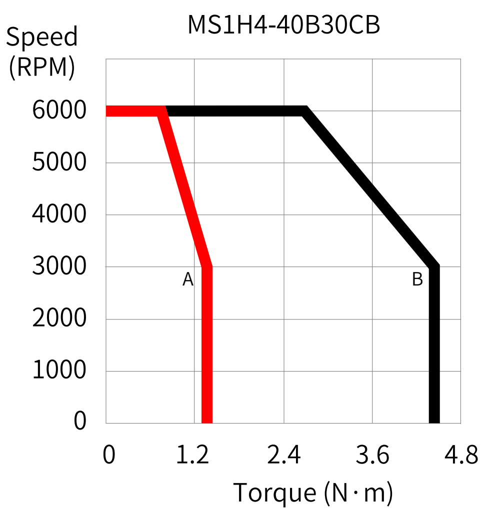


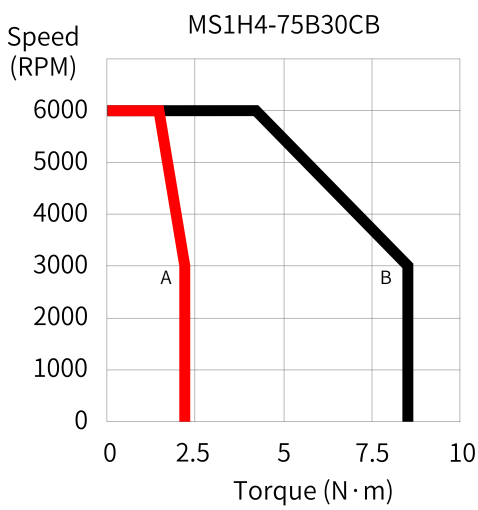




■ MS1H4 (medium inertia, small capacity)

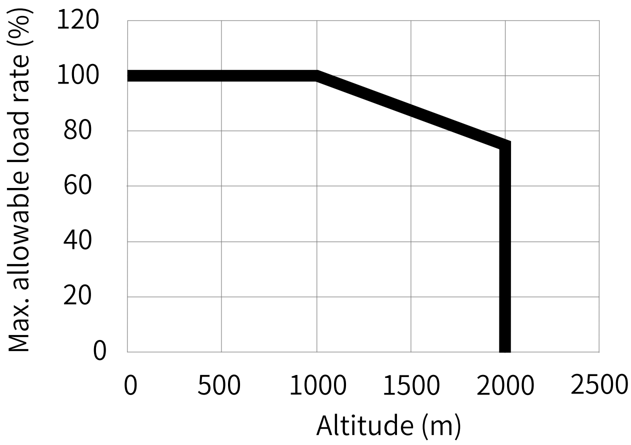




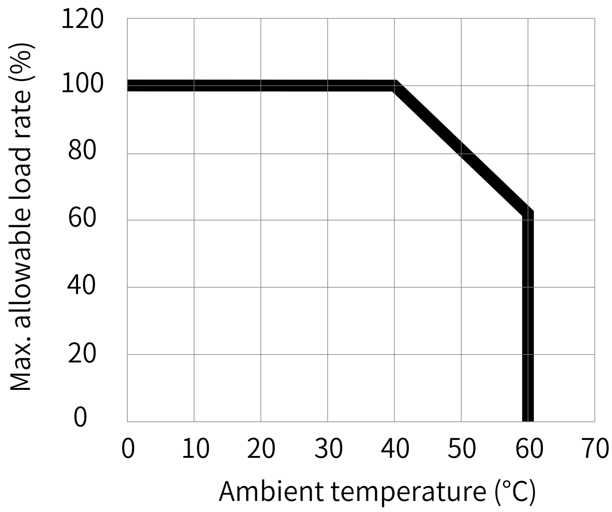


7 Derating curves

■ Altitude-based derating curve



■ Temperature-based derating curve



1.3 Servo System Configurations

■ 220 V:

<table>
<tr><th rowspan="2">Rated Speed (RPM)</th><th rowspan="2">Maximum Speed (RPM)</th><th rowspan="2">Capacity (W)</th><th rowspan="2" colspan="2">Servo Motor Model</th><th rowspan="2">Motor Flange Size</th><th colspan="2">Servo Drive Model SV660N****I</th><th rowspan="2">Servo Drive Size</th><th rowspan="2">Servo Drive Code (H01-02)</th></tr>
<tr><th>Single-phase 220 VAC</th><th>Three-phase 220 VAC</th></tr>
<tr><td rowspan="9">3000</td><td rowspan="8">6000</td><td>50</td><td rowspan="7">MS1H1
(low inertia, small capacity)</td><td>05B30CB</td><td>40</td><td>S1R6</td><td>-</td><td>A</td><td>00002</td></tr>
<tr><td>100</td><td>10B30CB</td><td>40</td><td>S1R6</td><td>-</td><td>A</td><td>00002</td></tr>
<tr><td>200</td><td>20B30CB</td><td>60</td><td>S1R6</td><td>-</td><td>A</td><td>00002</td></tr>
<tr><td>400</td><td>40B30CB</td><td>60</td><td>S2R8</td><td>-</td><td>A</td><td>00003</td></tr>
<tr><td>550</td><td>55B30CB</td><td>80</td><td>S5R5</td><td>-</td><td>B</td><td>00005</td></tr>
<tr><td>750</td><td>75B30CB</td><td>80</td><td>S5R5</td><td>-</td><td>B</td><td>00005</td></tr>
<tr><td>1000</td><td>10C30CB</td><td>80</td><td colspan="2">S7R6</td><td>C</td><td>00006</td></tr>
<tr><td>1000</td><td rowspan="2">MS1H2
(low inertia, medium capacity)</td><td>10C30CB</td><td>100</td><td colspan="2">S7R6</td><td>C</td><td>00006</td></tr>
<tr><td>5000</td><td>1500</td><td>15C30CB</td><td>100</td><td colspan="2">S012</td><td>D</td><td>00007</td></tr>
<tr><td>1500</td><td>3000</td><td>850</td><td>MS1H3
(medium inertia, medium capacity)</td><td>85B15CB</td><td>130</td><td colspan="2">S7R6</td><td>C</td><td>00006</td></tr>
<tr><td>1500</td><td>3000</td><td>1300</td><td>MS1H3
(medium inertia, medium capacity)</td><td>13C15CB</td><td>130</td><td colspan="2">S012</td><td>D</td><td>00007</td></tr>
<tr><td rowspan="2">3000</td><td rowspan="2">6000</td><td>400</td><td rowspan="2">MS1H4
(medium inertia, small capacity)</td><td>40B30CB</td><td>60</td><td>S2R8</td><td>-</td><td>A</td><td>00003</td></tr>
<tr><td>750</td><td>75B30CB</td><td>80</td><td>S5R5</td><td>-</td><td>A</td><td>00005</td></tr>
</table>

NOTE

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

- 380 V:

<table>
<tr><th rowspan="2">Rated Speed (RPM)</th><th rowspan="2">Maximum Speed (RPM)</th><th rowspan="2">Capacity (W)</th><th rowspan="2" colspan="2">Servo Motor Model</th><th rowspan="2">Motor Flange Size</th><th>Servo Drive Model SV660N****I</th><th rowspan="2">Servo Drive Size</th><th rowspan="2">Servo Drive Code (H01-02)</th></tr>
<tr><th>Three-phase 380 VAC</th></tr>
<tr><td rowspan="7">3000</td><td>6000</td><td>1000</td><td rowspan="7">MS1H2 (low inertia, medium capacity)</td><td>10C30CD</td><td>100</td><td>T5R4</td><td>C</td><td>10002</td></tr>
<tr><td rowspan="6">5000</td><td>1500</td><td>15C30CD</td><td>100</td><td>T5R4</td><td>C</td><td>10002</td></tr>
<tr><td>2000</td><td>20C30CD</td><td>100</td><td>T8R4</td><td>D</td><td>10003</td></tr>
<tr><td>2500</td><td>25C30CD</td><td>100</td><td>T8R4</td><td>D</td><td>10003</td></tr>
<tr><td>3000</td><td>30C30CD</td><td>130</td><td>T012</td><td>D</td><td>10004</td></tr>
<tr><td>4000</td><td>40C30CD</td><td>130</td><td>T017</td><td>E</td><td>10005</td></tr>
<tr><td>5000</td><td>50C30CD</td><td>130</td><td>T017</td><td>E</td><td>10005</td></tr>
<tr><td rowspan="7">1500</td><td rowspan="7">3000</td><td>850</td><td rowspan="7">MS1H3 (medium inertia, medium capacity)</td><td>85B15CD</td><td>130</td><td>T3R5</td><td>C</td><td>10001</td></tr>
<tr><td>1300</td><td>13C15CD</td><td>130</td><td>T5R4</td><td>C</td><td>10002</td></tr>
<tr><td>1800</td><td>18C15CD</td><td>130</td><td>T8R4</td><td>C</td><td>10003</td></tr>
<tr><td>2900</td><td>29C15CD</td><td>180</td><td>T012</td><td>D</td><td>10004</td></tr>
<tr><td>4400</td><td>44C15CD</td><td>180</td><td>T017</td><td>E</td><td>10005</td></tr>
<tr><td>5500</td><td>55C15CD</td><td>180</td><td>T021</td><td>E</td><td>10006</td></tr>
<tr><td>7500</td><td>75C15CD</td><td>180</td><td>T026</td><td>E</td><td>10007</td></tr>
</table>

1.4 Cable Models

Table 1-1 Cables for MS1H1/MS1H4 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
Multi-turn absolute encoder cable	S6-L-P124-3.0	S6-L-P124-5.0	S6-L-P124-10.0
Single-turn absolute encoder cable	S6-L-P114-3.0	S6-L-P114-5.0	S6-L-P114-10.0

Table 1-2 Cables for MS1H1/MS1H4 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
Multi-turn absolute encoder cable	S6-L-P125-3.0	S6-L-P125-5.0	S6-L-P125-10.0
Single-turn absolute encoder cable	S6-L-P115-3.0	S6-L-P115-5.0	S6-L-P115-10.0

Table 1-3 Cables for MS1H1/MS1H4 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
Multi-turn absolute encoder cable	S6-L-P120-3.0	S6-L-P120-5.0	S6-L-P120-10.0
Single-turn absolute encoder cable	S6-L-P110-3.0	S6-L-P110-5.0	S6-L-P110-10.0

Table 1-4 Cables for MS1H2 (below 3 kW) and MS1H3 (below 2.9 kW) 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
Multi-turn absolute encoder cable	S6-L-P121-3.0	S6-L-P121-5.0	S6-L-P121-10.0
Single-turn absolute encoder cable	S6-L-P111-3.0	S6-L-P111-5.0	S6-L-P111-10.0

Table 1-5 Cables for MS1H2 (4 kW/5 kW) 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
Multi-turn absolute encoder cable	S6-L-P121-3.0	S6-L-P121-5.0	S6-L-P121-10.0
Single-turn absolute encoder cable	S6-L-P111-3.0	S6-L-P111-5.0	S6-L-P111-10.0

Table 1-6 Cables for MS1H3 (below 2.9 kW) motors

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M112-3.0	S6-L-M112-5.0	S6-L-M112-10.0
Power cable (with brake)	S6-L-B112-3.0	S6-L-B112-5.0	S6-L-B112-10.0
Multi-turn absolute encoder cable	S6-L-P121-3.0	S6-L-P121-5.0	S6-L-P121-10.0
Single-turn absolute encoder cable	S6-L-P111-3.0	S6-L-P111-5.0	S6-L-P111-10.0

Table 1-7 Cables for MS1H3 (2.9 kW) motors

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M022-3.0	S6-L-M022-5.0	S6-L-M022-10.0
Power cable (with brake)	S6-L-B022-3.0	S6-L-B022-5.0	S6-L-B022-10.0
Multi-turn absolute encoder cable	S6-L-P121-3.0	S6-L-P121-5.0	S6-L-P121-10.0
Single-turn absolute encoder cable	S6-L-P111-3.0	S6-L-P111-5.0	S6-L-P111-10.0

Table 1-8 Cables for MS1H3 (above 2.9 kW) motors

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M022-3.0	S6-L-M022-5.0	S6-L-M022-10.0
Power cable (with brake)	S6-L-B022-3.0	S6-L-B022-5.0	S6-L-B022-10.0
Multi-turn absolute encoder cable	S6-L-P121-3.0	S6-L-P121-5.0	S6-L-P121-10.0
Single-turn absolute encoder cable	S6-L-P111-3.0	S6-L-P111-5.0	S6-L-P111-10.0

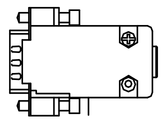
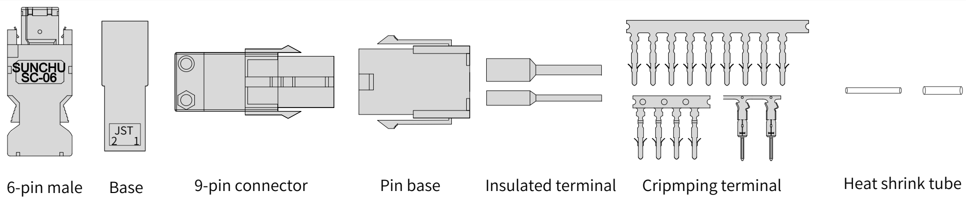
NOTE

If highly flexible cables fit for cable carriers are needed, add a suffix "-T" to the end of the cable model.

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-T04-3.0	Cable for communication between the servo drive and the host controller

1.6 Connector Kits

<table>
<tr><th>Connector Kit</th><th>Outline Drawing</th></tr>
<tr><td>S6-C6</td><td>
(DB15C plug)</td></tr>
<tr><td>S6-C26</td><td>
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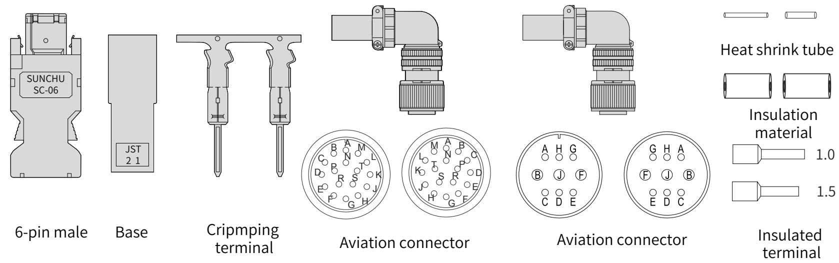
<tr><td>S6-C29</td><td>
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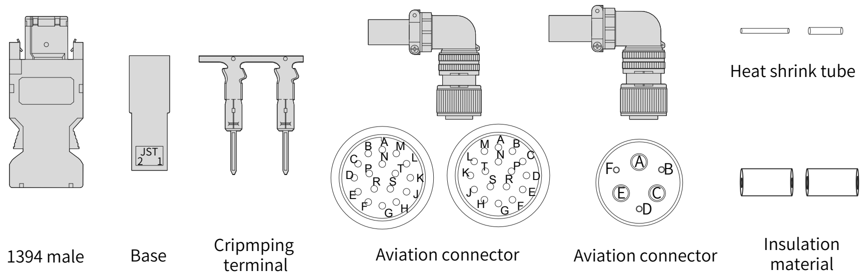
<tr><td>S6-C39</td><td>
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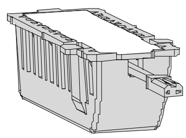
<tr><td>S6-C4</td><td></td></tr>
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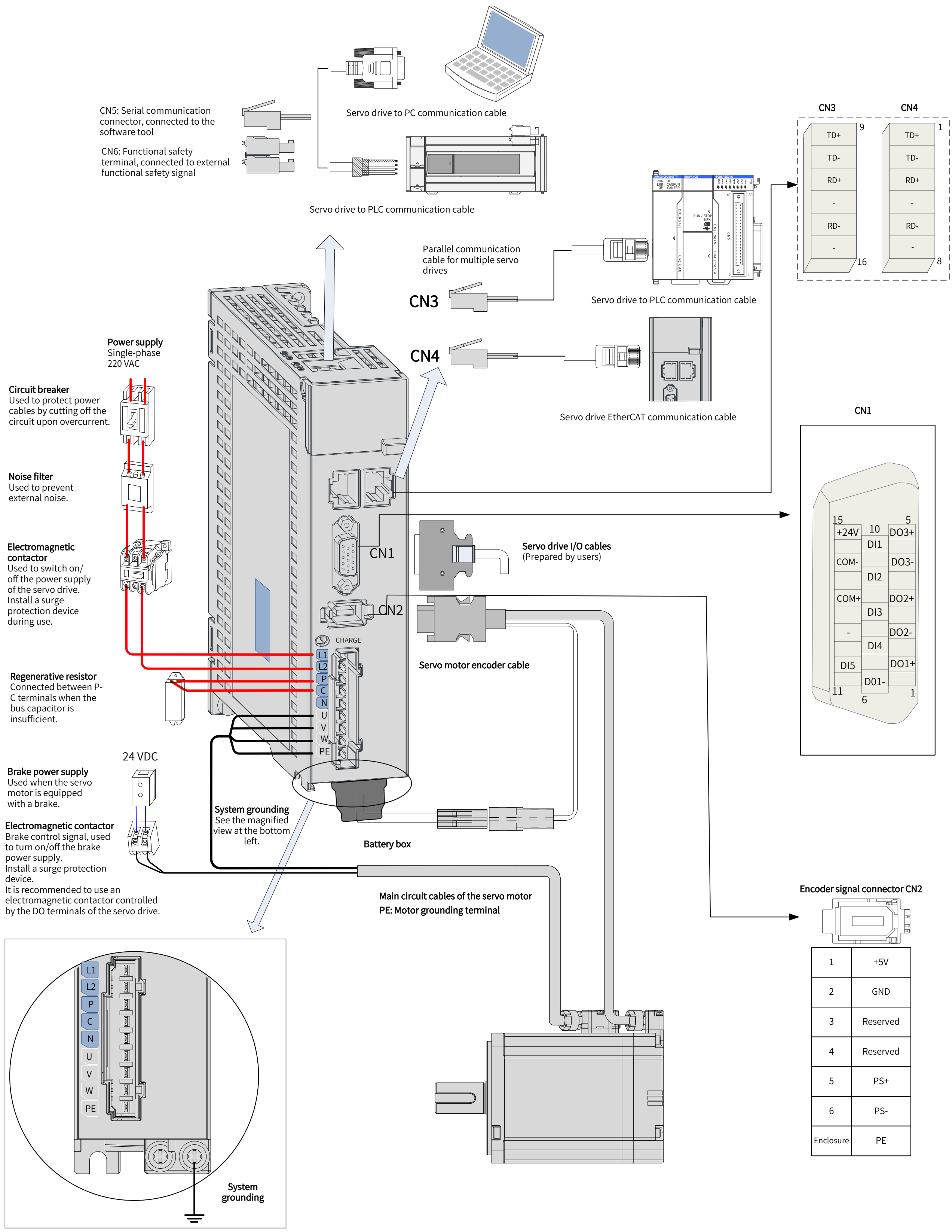
1.7 Servo System Wiring Diagram



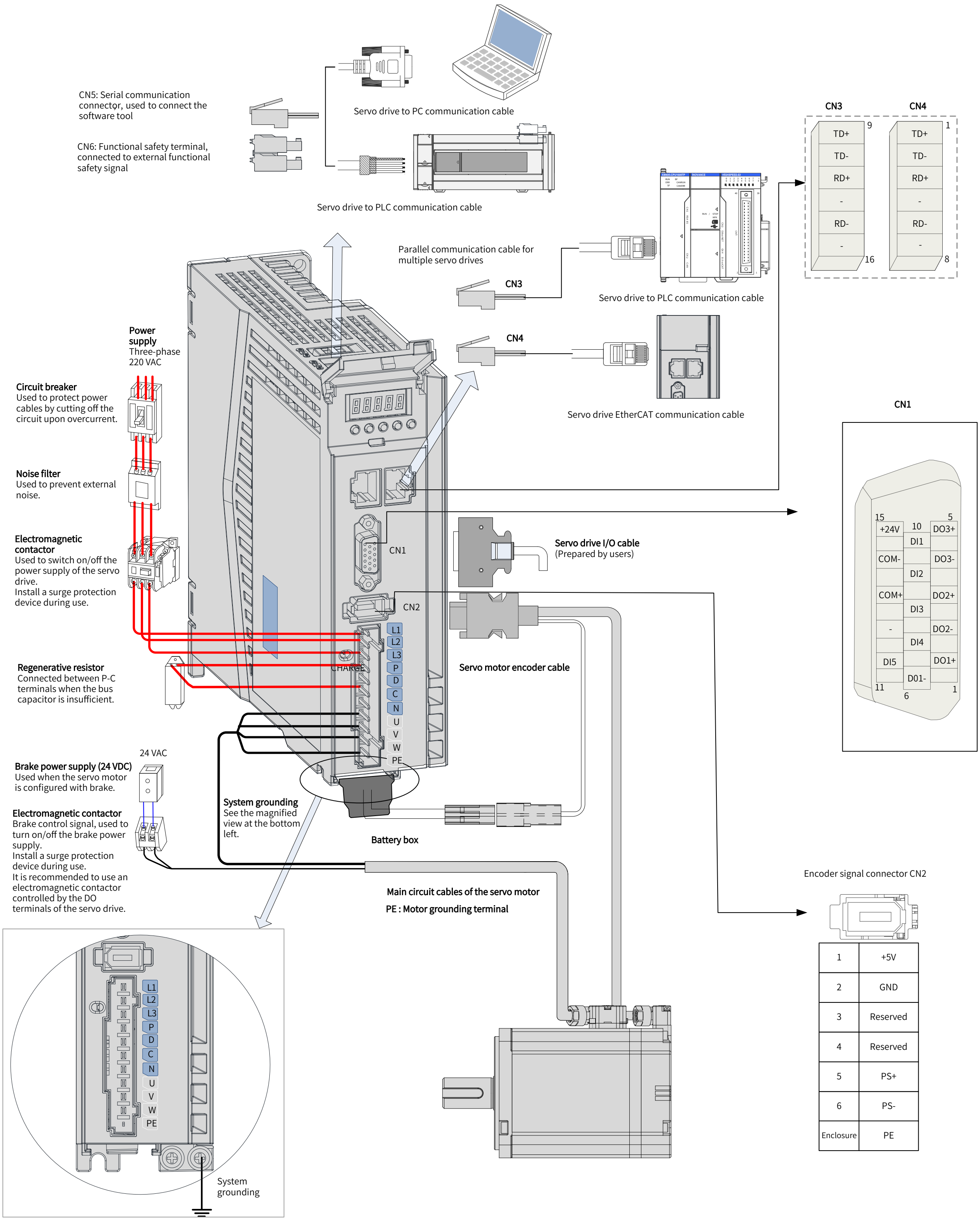
1	+5V
2	GND
3	Reserved
4	Reserved
5	PS+
6	PS-
Enclosure	PE

Figure 1-13 Wiring of single-phase 220 V systems

The servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. To prevent damages in case of short circuit, install a fuse or a circuit breaker on the input power supply. The servo drive is not configured with the built-in earth fault protection circuit. For the sake of safety, install a residual current device (RCD) to provide protection against electrical shock and/or fire.

Do not run or stop the motor by using an 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.



1	+5V
2	GND
3	Reserved
4	Reserved
5	PS+
6	PS-
Enclosure	PE

Figure 1-14 Wiring of three-phase 220 V systems

The servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. To prevent damages in case of short circuit, install a fuse or a circuit breaker on the input power supply. The servo drive is not configured with the built-in earth fault protection circuit. For the sake of safety, install a residual current device (RCD) to provide protection against electrical shock and/or fire.

Do not run or stop the motor by using an 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.

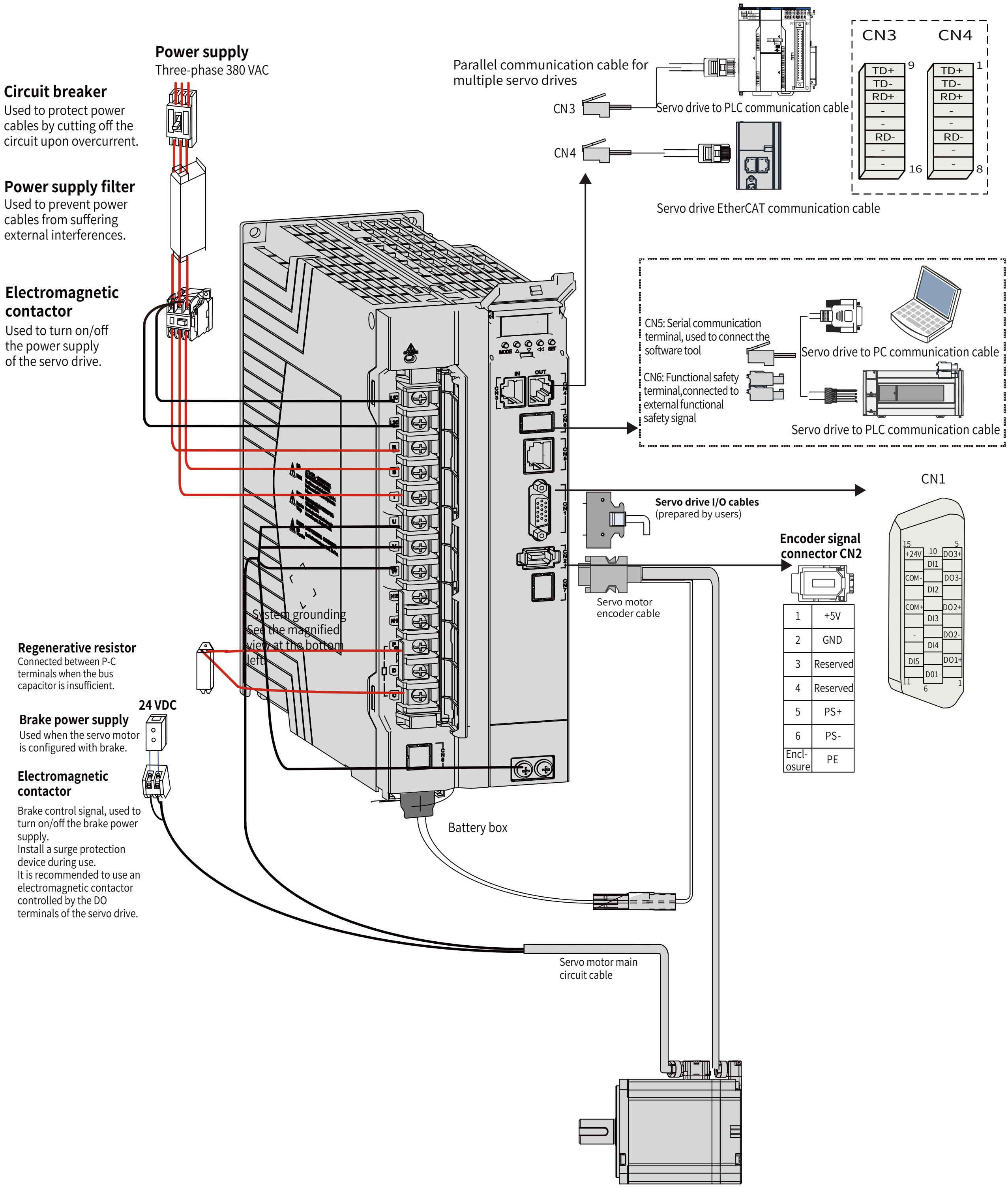


Figure 1-15 Wiring of three-phase 380 V servo systems

The servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. To prevent damages in case of short circuit, install a fuse or a circuit breaker on the input power supply. The servo drive is not configured with the built-in earth fault protection circuit. For the sake of safety, install a residual current device (RCD) to provide protection against electrical shock and/or fire.

Do not run or stop the motor by using an 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	
	◆ Follow the installation directions described in this chapter. Failure to comply may result in device faults or damage. ◆ 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 objects. Failure to comply will result in device faults. ◆ Do not install the device near flammable 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 clearances are reserved among the servo drive, 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 damage. ◆ Do not exert large impact force on the device. Failure to comply may result in device damage. ◆ Do not block the air inlet/outlet port of the servo drive or allow unwanted matters to fall into the device. Failure to comply may result in a fire or device faults.

2.1 Installing 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 temperature	0°C to 55°C (The average load ratio cannot exceed 80% when the ambient temperature is between 45°C to 55°C .)
Ambient 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
Shock	Below 19.6 m/s^2
IP rating	IP20 (except the fan and terminals)
Altitude	Below 1000 m. Derating is required for altitudes above 1000 m. For altitudes above 2000 m, install an isolation transformer besides derating. Derating standard: Derate 1% for every additional 100 m. The maximum altitude is 3000 m.

2.1.3 Dimension Drawings

■ Size A: SV660NS1R6I, SV660NS2R8I

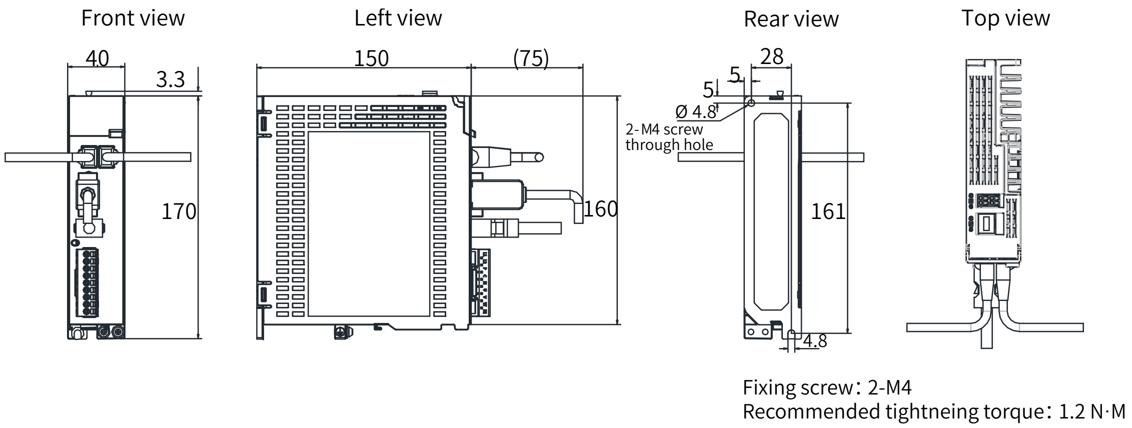


Figure 2-1 Outline dimensions of size A (unit: mm)

The weight of a servo drive in size A is 0.8 kg.

■ Size B: SV660NS5R5I

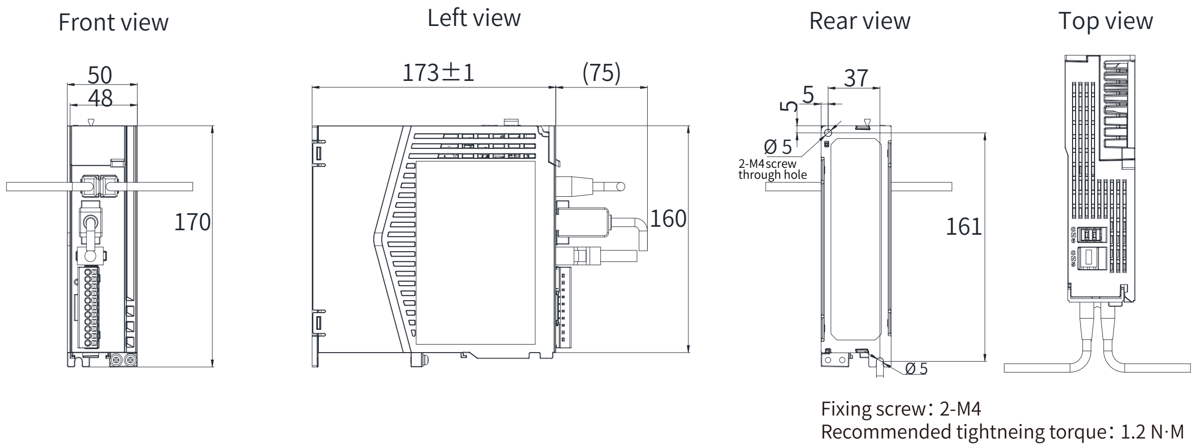


Figure 2-2 Outline dimensions of size B (unit: mm)

The weight of a servo drive in size B is 1.0 kg.

■ Size C: SV660NS7R6I, SV660NT3R5I, SV660NT5R4I

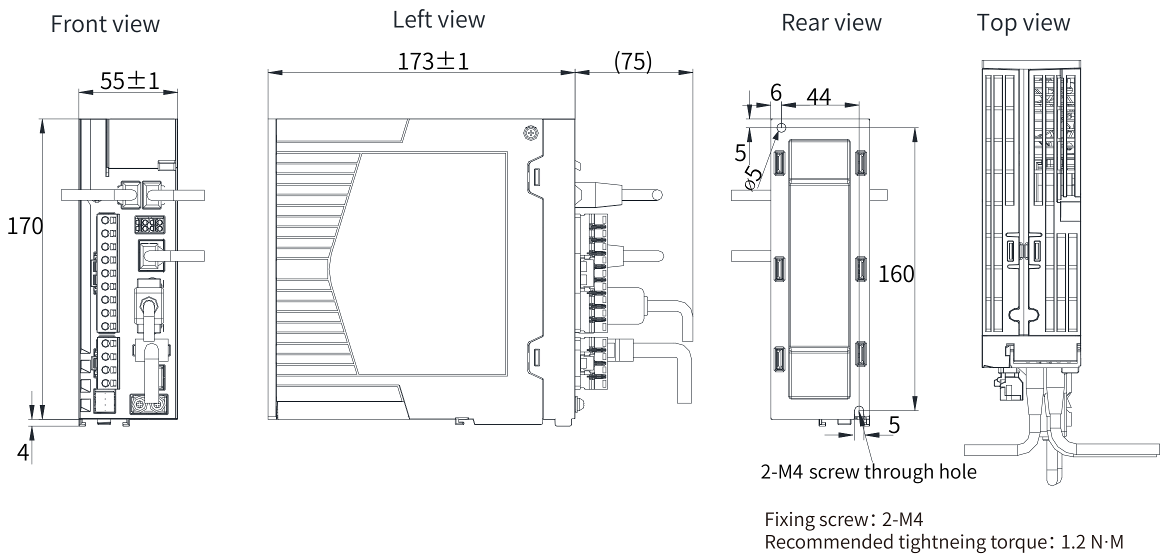


Figure 2-3 Outline dimensions of size C (unit: mm)

The weight of a servo drive in size C is 1.3 kg.

■ Size D: SV660NS012I, SV660NT8R4I, SV660NT012I

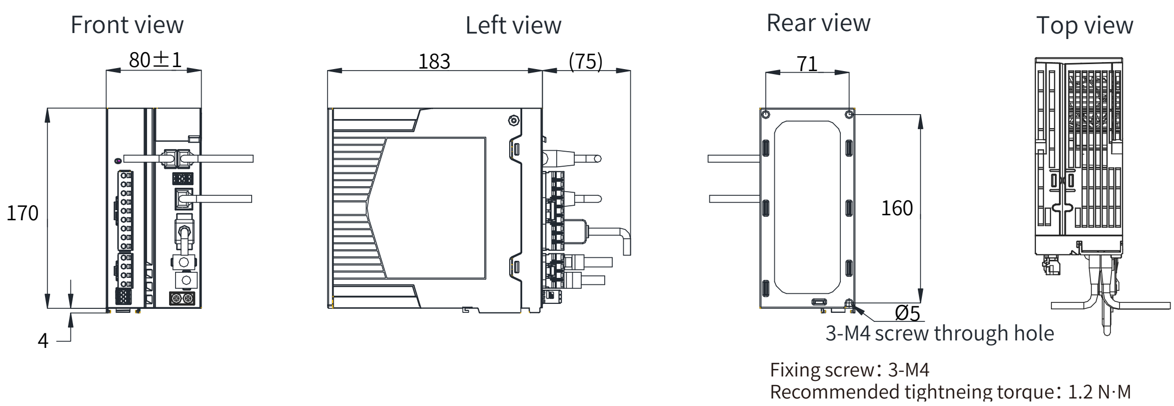


Figure 2-4 Outline dimensions of size D (unit: mm)

The weight of a servo drive in size D is 1.8 kg.

■ Size E: SV660NT017I, SV660NT021I, SV660NT026I

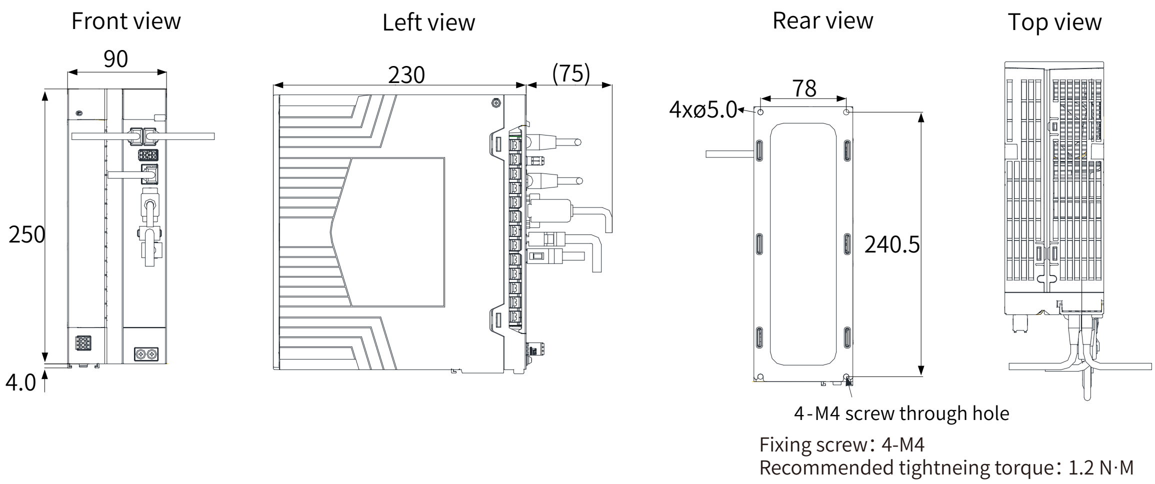


Figure 2-5 Outline dimensions of size E (unit: mm)

The weight of a servo drive in size E is 3.6 kg.

2.1.4 Installation

■ Installation method

Ensure the servo drive is installed vertically to the wall, with its front side (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

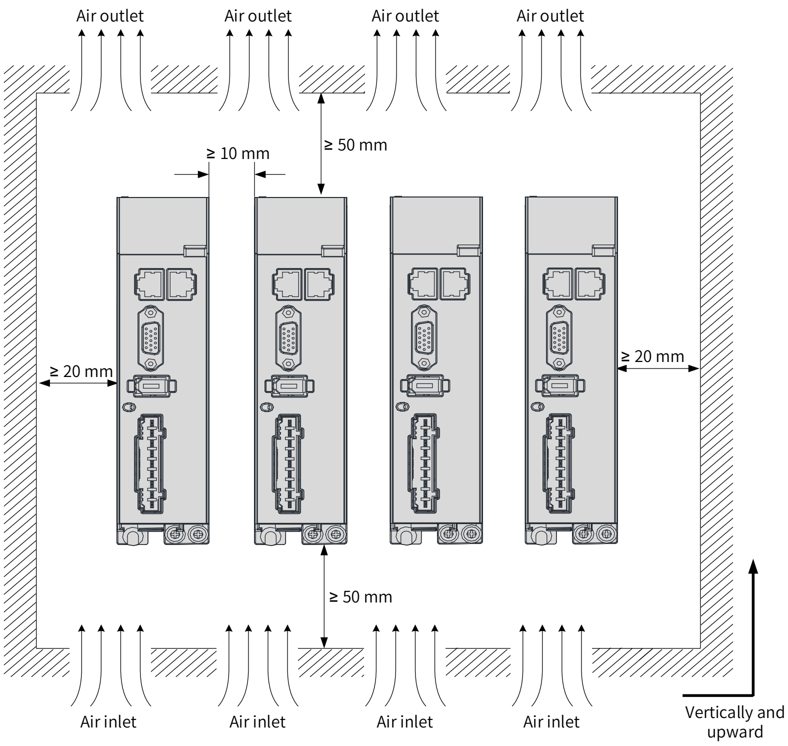
As shown in Figure 2-6, reserve sufficient space around the servo drive to ensure proper cooling by the cooling fan or natural convection. Install the cooling fan to the upper part of the servo drive to avoid excessive regional temperature rise and maintain an even temperature inside the electric cabinet.

■ Installation

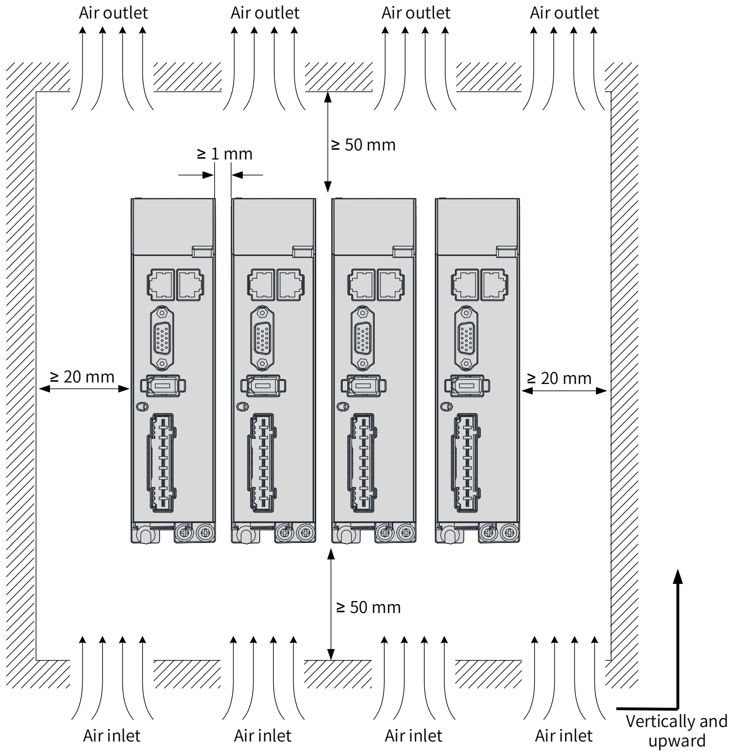
When installing multiple servo drives side by side, for heat dissipation purpose, reserve a clearance of at least 10 mm on the left and right sides of each servo drive and at least 50 mm above and below each servo drive.

For compact installation of servo drives in size A and size B, take the installation tolerance into account and reserve a clearance of at least 1 mm between every two drives. In this case, the rms load should be lower than or equal to 75%.

Servo drives in size C, size D, and size E can be installed side by side without clearance, and derating is not required.



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.

■ Routing direction

As shown in the following figure, route the servo drive cable downwards to prevent liquids from flowing into the servo drive along the cable.

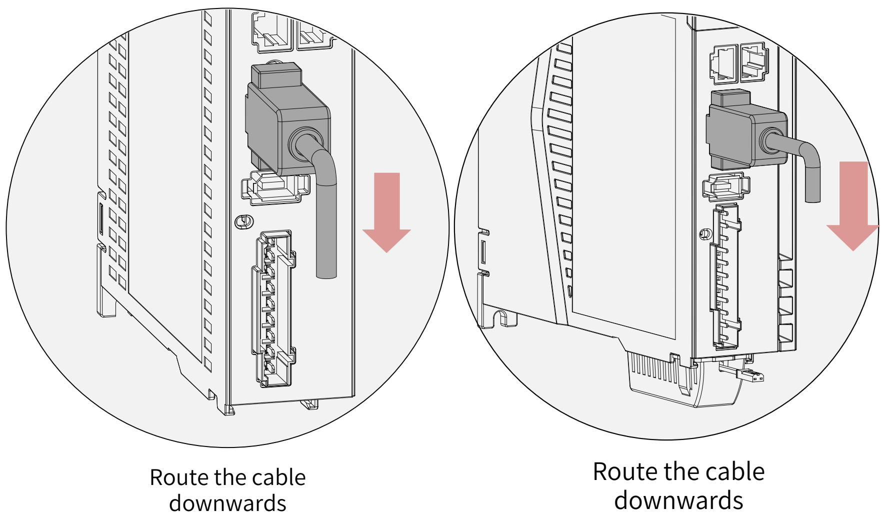


Figure 2-7 Routing direction

■ Dust-proof cover (inserted into the CN5 port by default before delivery)

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

The dust-proof cover is included in the standard configuration. Such dust-proof covers can be purchased separately if required (model: NEX-02-N2B; manufacturer: PINGOOD).

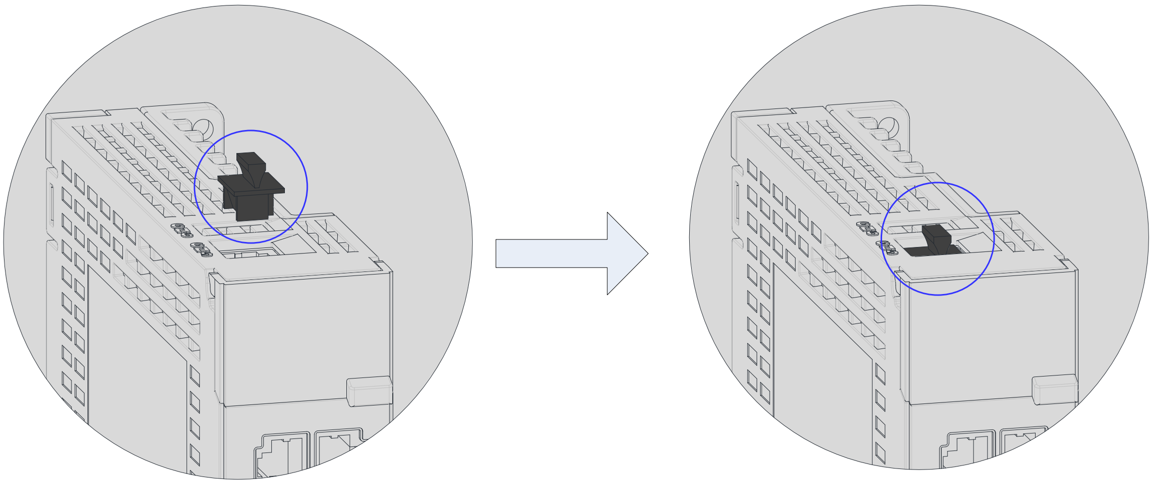


Figure 2-8 Mounting of the dust-proof cover

NOTE

- Dust-proof cover: Prevents unwanted objects (such as solids or liquids) from falling into the servo drive 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 Installing 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 equipped with an oil seal 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 overheat the motor, shortening its service life.

2.2.2 Installation Environment

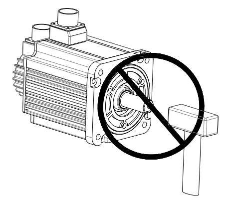
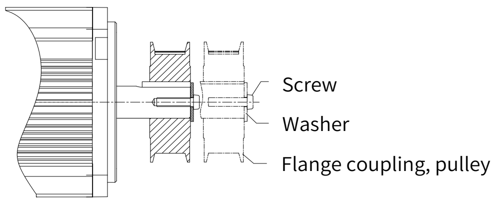
Table 2-2 Installation environment

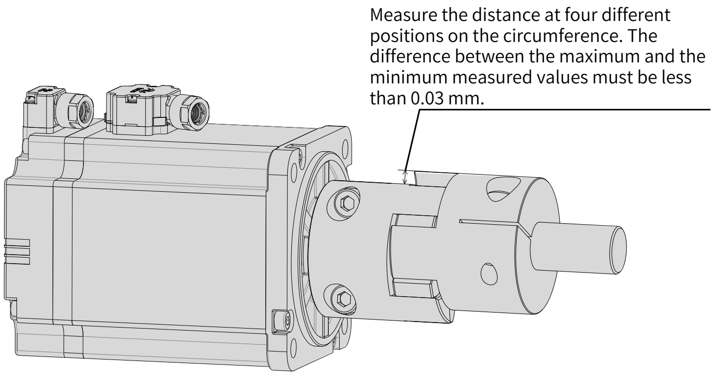
Item	Description
Operating temperature	0°C to 40°C (non-freezing)
Operating humidity	20% to 80% RH (without condensation)
Storage temperature	-20°C to +60°C (peak temperature: 80°C for 72 hours)
Storage humidity	20% to 90% RH (without condensation)
Vibration	Below 49 m/s^2
Shock	Below 490 m/s^2

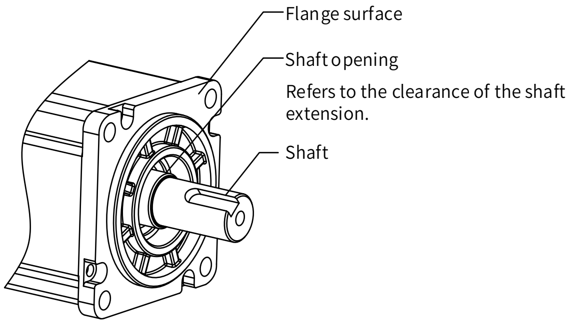
Item	Description
IP rating	IP67 (shaft opening excluded, with power cables and encoder connectors connected properly)
Altitude	Below 1000 m (derating required for altitudes above 1000 m)

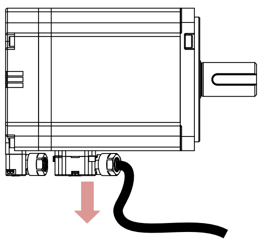
2.2.3 Installation Precautions

Table 2-3 Installation instructions

Item	Description
Rust-proof measures	◆ Wipe up the anti-rust agent applied at the motor shaft extension before installing the servo motor, and then take rust-proof measures.
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.


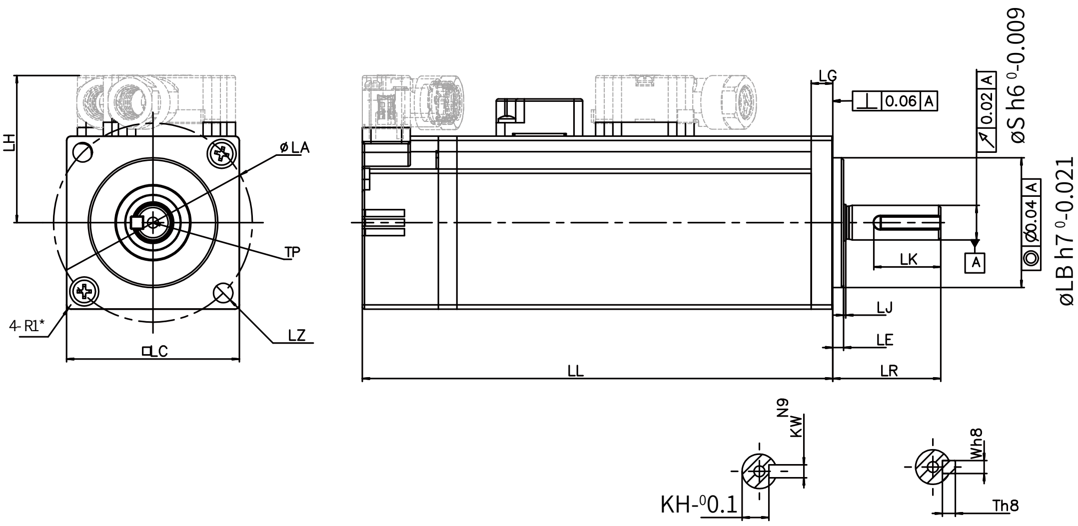
</td></tr>
<tr><td>Installation direction</td><td>◆ The servo motor can be installed horizontally or vertically.</td></tr>
<tr><td>Counter-measures against oil and liquid</td><td>
◆ Do not submerge the motor/cable in water or oil.
◆ Check the IP rating of the servo motor when the application location 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 size: 40



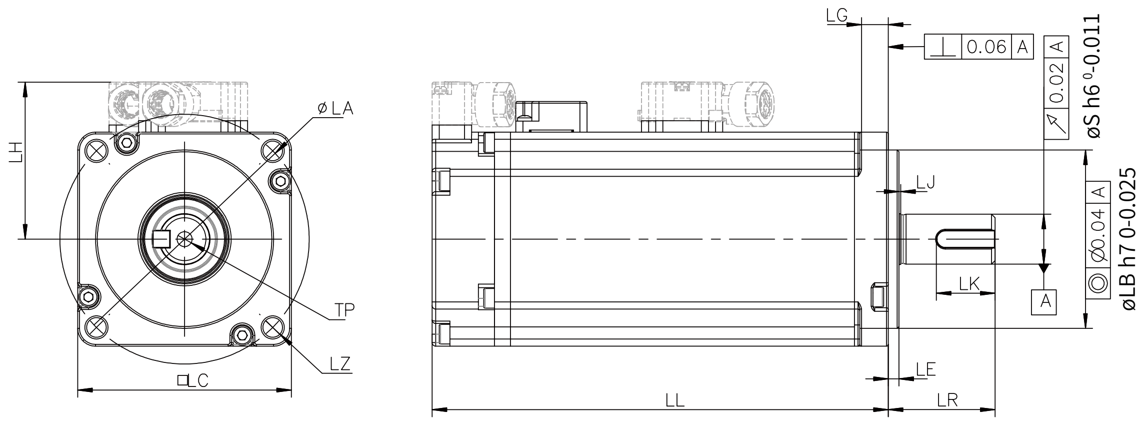
Dimensions of the shaft end

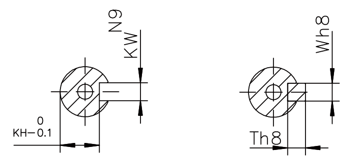
Dimensions of the shaft end with key

Motor Model	LL	LC	LR	LA	LZ	LH	LG	LE	LJ
MS1H1-05B30CB-A3**Z(-S)	65 (96)	40	25±0.5	46	2-φ4.5	34	5	2.5±0.5	0.5±0.35
MS1H1-10B30CB-**30Z	77.5 (109)	40	25±0.5	46	2-φ4.5	34	5	2.5±0.5	0.5±0.35
MS1H1-10B30CB-**32Z									
Motor Model	**S**	**LB**	**TP**	**LK**	**KH**	**KW**	**W**	**T**	**Weight (kg)**
MS1H1-05B30CB-A3**Z(-S)	8	30	M3x6	15.5	6.2	3	3	3	0.39 (0.50)
MS1H1-10B30CB-**30Z	8	30	M3x6	15.5	6.2	3	3	3	0.45 (0.64)
MS1H1-10B30CB-**32Z									

NOTE	
	◆ Dimensions in the preceding table are in millimeters. ◆ Values in side the parentheses "()" are for the servo motor with a holding brake. ◆ The tightening torque terminal screws is 0.19 N·m to 0.21 N·m, violation of which may damage the terminal.

2 Flange size: 60





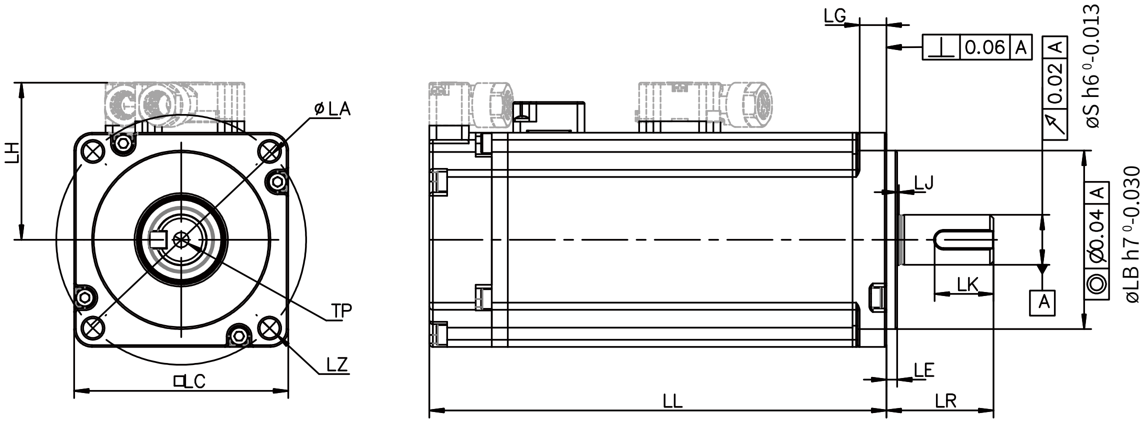
Dimensions of the shaft end   Dimensions of the shaft end with key

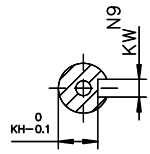
Motor Model	LL	LC	LR	LA	LZ	LH	LG	LE	LJ
MS1H1-20B30CB-**31Z	72.5	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H1-20B30CB-**34Z	100	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H1-40B30CB-**31Z	91	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H1-40B30CB-**34Z	119	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
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

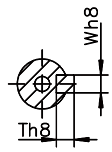
- ◆ Dimensions in the preceding table are in millimeters.
- ◆ The tightening torque for terminal screws is 0.19 N·m to 0.21 N·m, violation of which may damage the terminal.

3 Flange size: 80





Dimensions of the shaft end



Dimensions of the shaft end with key

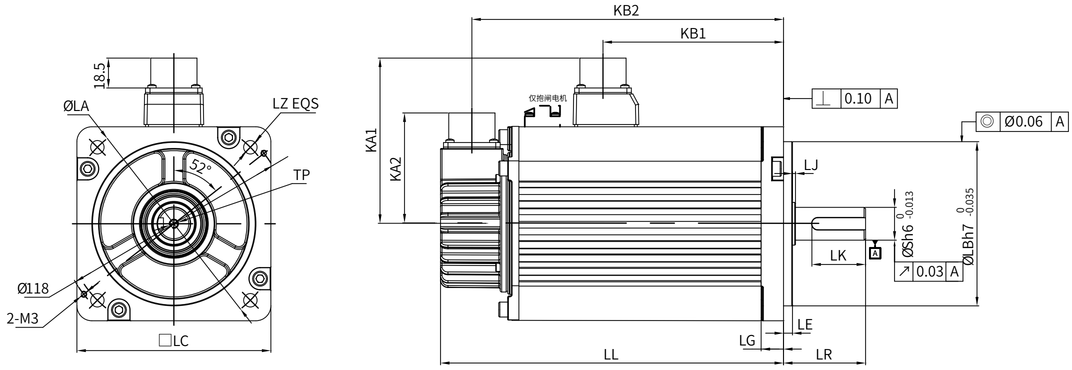
Motor Model	LL	LC	LR	LA	LZ	LH	LG	LE	LJ
MS1H1-55B30CB-A331Z	96.2	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
MS1H1-75B30CB-**31Z	107	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
MS1H1-75B30CB-**34Z	140	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
MS1H1-10C30CB-A331Z(-S)	118.2	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
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

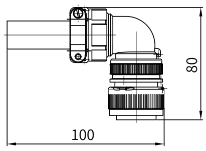
Motor Model	S	LB	TP	LK	KH	KW	W	T	Weight (kg)
MS1H1-55B30CB-A331Z	19	70	M6x20	25	15.5	6	6	6	1.85
MS1H1-75B30CB-**31Z	19	70	M6x20	25	15.5	6	6	6	2.18
MS1H1-75B30CB-**34Z	19	70	M6x20	25	15.5	6	6	6	2.82
MS1H1-10C30CB-A331Z(-S)	19	70	M6x20	25	15.5	6	6	6	2.55
MS1H4-75B30CB-**31Z	19	70	M6x20	25	15.5	6	6	6	2.40
MS1H4-75B30CB-**34Z	19	70	M6x20	25	15.5	6	6	6	3.04

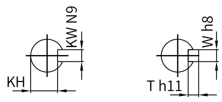
NOTE

- ◆ Dimensions in the preceding table are in millimeters.
- ◆ The tightening torque for terminal screws is 0.19 N·m to 0.21 N·m, violation of which may damage the terminal.

4 Flange size: 100







Dimensions of the shaft end

Dimensions of the shaft end with key

Motor Model	LC	LL	LR	LA	LZ	KA1	KB1	KA2	KB2	LG
MS1H2-10C30CB-A3**Z	100	164 (213.5)	45±1	115	4-ϕ7	88	94.5 (101)	74	143.5 (192.5)	10
MS1H2-15C30CB-A3**Z	100	189 (239)	45±1	115	4-ϕ7	88	119.5 (128)	74	168.5 (219.5)	10
MS1H2-10C30CD- A3**Z	100	164 (213.5)	45±1	115	4-ϕ7	88	94.5 (101)	74	143.5 (192.5)	10
MS1H2-15C30CD-A3**Z	100	189 (239)	45±1	115	4-ϕ7	88	119.5 (128)	74	168.5 (219.5)	10
MS1H2-20C30CD-A3**Z(-S4)	100	214 (265)	45±1	115	4-ϕ7	88	144.5 (153)	74	193.5 (244)	10
MS1H2-25C30CD-A3**Z(-S4)	100	240.5 (290)	45±1	115	4-ϕ7	88	169.5 (178)	74	218.5 (269)	10

Motor Model	LE	LJ	LB	S	TP	LK	KH	KW	W	T	Weight (kg)
MS1H2-10C30CB-A3**Z	5±0.3	2.5±0.75	95	24	M8x16	36	$20^{0}_{-0.2}$	8	8	7	5.11 (6.41)
MS1H2-15C30CB-A3**Z	5±0.3	2.5±0.75	95	24	M8x16	36	$20^{0}_{-0.2}$	8	8	7	6.22 (7.52)
MS1H2-10C30CD-A3**Z	5±0.3	2.5±0.75	95	24	M8x16	36	$20^{0}_{-0.2}$	8	8	7	5.11 (6.41)
MS1H2-15C30CD-A3**Z	5±0.3	2.5±0.75	95	24	M8x16	36	$20^{0}_{-0.2}$	8	8	7	6.22 (7.52)
MS1H2-20C30CD-A3**Z(-S4)	5±0.3	2.5±0.75	95	24	M8x16	36	$20^{0}_{-0.2}$	8	8	7	7.39 (8.7)
MS1H2-25C30CD-A3**Z(-S4)	5±0.3	2.5±0.75	95	24	M8x16	36	$20^{0}_{-0.2}$	8	8	7	8.55 (9.8)

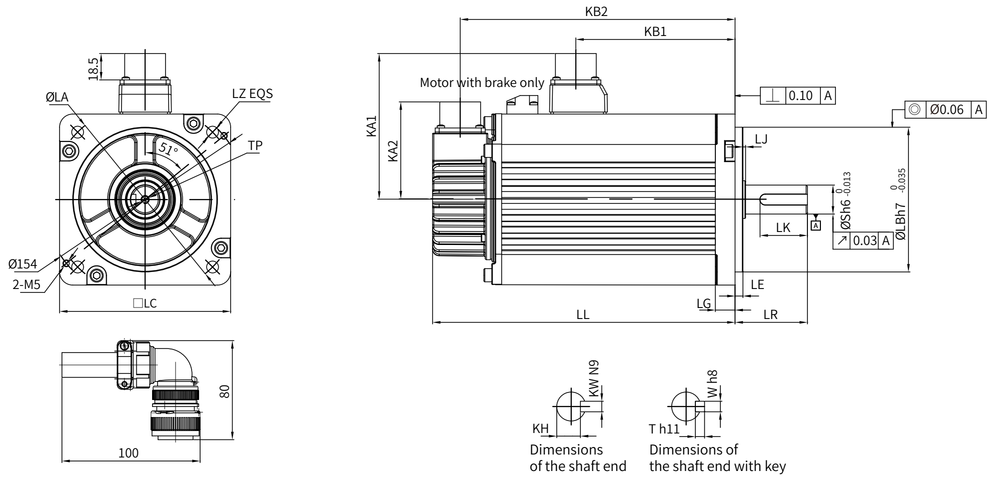
NOTE

◆ Dimensions in the preceding table are in millimeters.

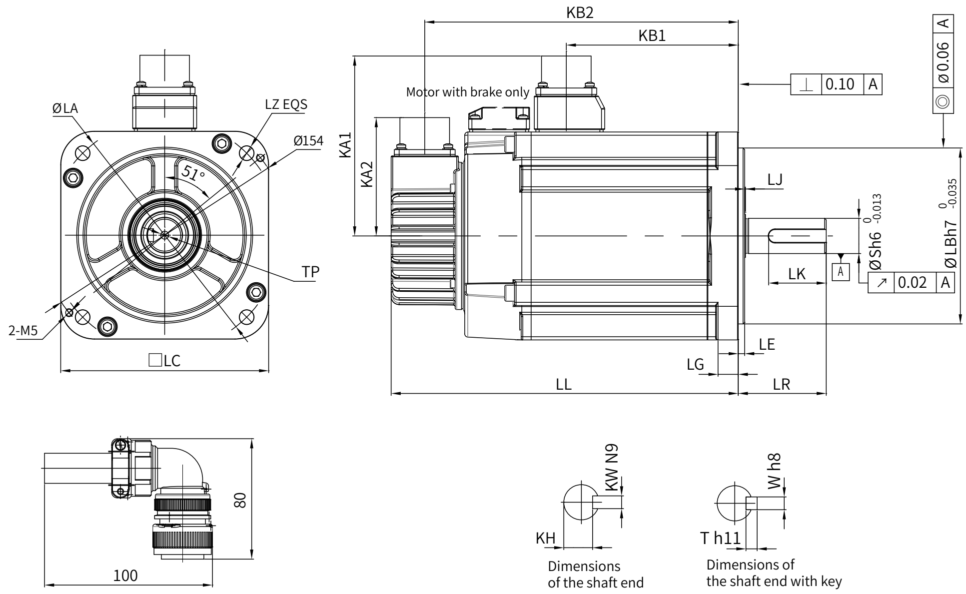
◆ Values inside the parentheses "()" are for the servo motor with a holding brake.

5 Flange size: 130

■ Outline drawing of MS1H2



■ Outline drawing of MS1H3



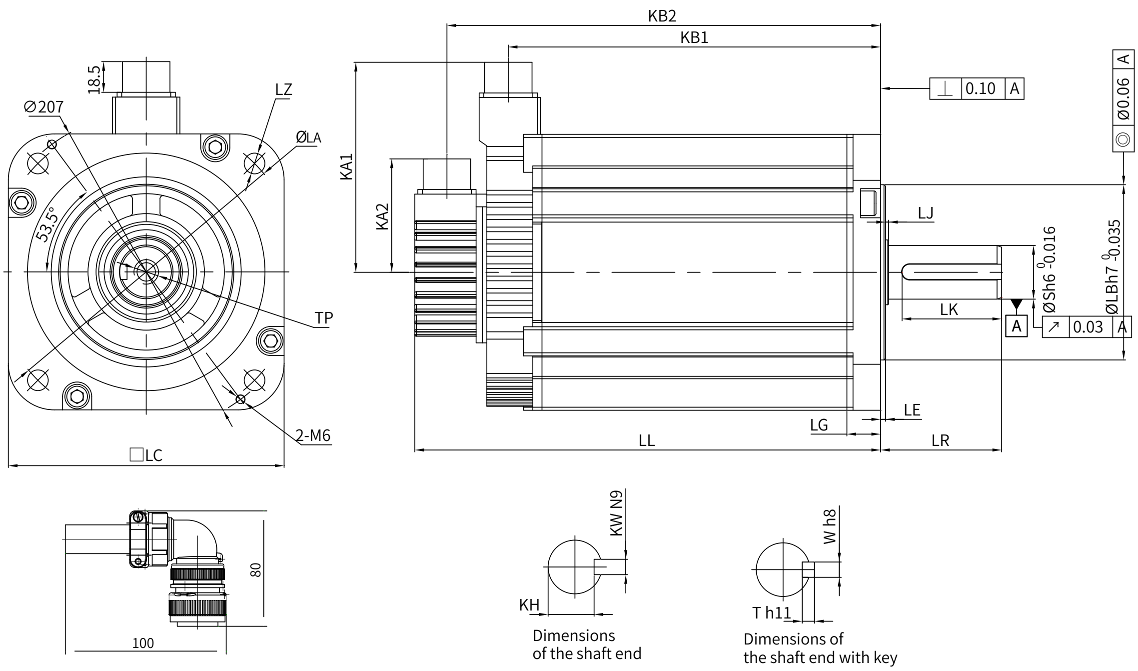
Motor Model	LC	LL	LR	LA	LZ	KA1	KB1	KA2	KB2	LG
MS1H2-30C30CD-A3**Z(-S4)	130	209.5 (265.5)	63±1	145	4-φ9	103	136 (139)	74	188.5 (244.5)	14
MS1H2-40C30CD-A3**Z(-S4)	130	252 (308)	63±1	145	4-φ9	103	178.5 (181.5)	74	231 (287)	14
MS1H2-50C30CD-A3**Z(-S4)	130	294.5 (350.5)	63±1	145	4-φ9	103	221 (224)	74	273.5 (329.5)	14
MS1H3-85B15CB-A3**Z	130	146 (182)	55±1	145	4-Φ9	103	72.5	74	125 (161)	14
MS1H3-13C15CB-A3**Z	130	163 (199)	55±1	145	4-Φ9	103	89.5	74	142 (178)	14
MS1H3-18C15CD-A3**Z	130	181 (217)	55±1	145	4-Φ9	103	107.5	74	160 (196)	14
MS1H3-85B15CD-A3**Z	130	146 (182)	55±1	145	4-φ9	103	72.5	74	125 (161)	14
MS1H3-13C15CD-A3**Z	130	163 (199)	55±1	145	4-φ9	103	89.5	74	142 (178)	14

Motor	LE	LJ	LB	S	TP	LK	KH	KW	W	T	Weight (kg)
MS1H2-30C30CD-A3**Z(-S4)	6±0.3	0.5±0.75	110	28	M8x20	54	$24^{0}_{-0.2}$	8	8	7	10.73 (13.2)
MS1H2-40C30CD-A3**Z(-S4)	6±0.3	0.5±0.75	110	28	M8x20	54	$24^{0}_{-0.2}$	8	8	7	15.43 (17.9)
MS1H2-50C30CD-A3**Z(-S4)	6±0.3	0.5±0.75	110	28	M8x20	54	$24^{0}_{-0.2}$	8	8	7	16.2 (18.7)
MS1H3-85B15CB-A3**Z	4	0.5±0.75	110	22	M6x20	36	$18^{0}_{-0.2}$	8	8	7	7 (8)
MS1H3-13C15CB-A3**Z	4	0.5±0.75	110	22	M6x20	36	$18^{0}_{-0.2}$	8	8	7	8 (9.5)
MS1H3-18C15CD-A3**Z	4	0.5±0.75	110	22	M6x20	36	$18^{0}_{-0.2}$	8	8	7	9.5 (11)
MS1H3-85B15CD-A3**Z	4	0.5±0.75	110	22	M6x20	36	$18^{0}_{-0.2}$	8	8	7	7 (8)
MS1H3-13C15CD-A3**Z	4	0.5±0.75	110	22	M6x20	36	$18^{0}_{-0.2}$	8	8	7	8 (9.5)

NOTE

- ◆ Dimensions in the preceding table are in millimeters.
- ◆ Values in the parentheses "()" are for the motor with a holding brake.

6 Flange size: 180



Motor Model	LC	LL	LR	LA	LZ	KA1	KB1	KA2	KB2	LG
MS1H3-29C15CD-A3**Z	180	197 (273)	79±1	200	4-ϕ13.5	138	136 (134)	74	177 (253)	18
MS1H3-44C15CD-A3**Z	180	230 (307)	79±1	200	4-ϕ13.5	138	169 (167)	74	210 (286)	18
MS1H3-55C15CD-A3**Z	180	274 (350)	113±1	200	4-ϕ13.5	138	213 (211)	74	254 (330)	18
MS1H3-75C15CD-A3**Z	180	330 (407)	113±1	200	4-ϕ13.5	138	269 (267)	74	310 (386)	18

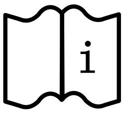
Motor Model	LE	LJ	LB	S	TP	LK	KH	KW	W	T	Weight (kg)
MS1H3-29C15CD-A3**Z	3.2±0.3	0.3±0.75	114.3	35	M12x25	65	$30^{0}_{-0.2}$	10	10	8	15 (25)
MS1H3-44C15CD-A3**Z	3.2±0.3	0.3±0.75	114.3	35	M12x25	65	$30^{0}_{-0.2}$	10	10	8	19.5 (30)
MS1H3-55C15CD-A3**Z	3.2±0.3	0.3±0.75	114.3	42	M16x32	96	$37^{0}_{-0.2}$	12	12	8	28 (38)
MS1H3-75C15CD-A3**Z	3.2±0.3	0.3±0.75	114.3	42	M16x32	96	$37^{0}_{-0.2}$	12	12	8	32 (42)

NOTE

- ◆ Dimensions in the preceding table are in millimeters.
- ◆ Values in the parentheses "()" are for the motor with a holding brake.

3 Wiring

WARNING

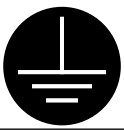


- Read through the safety instructions in *"Safety Instructions"*. Failure to comply may result in serious consequences.

WARNING

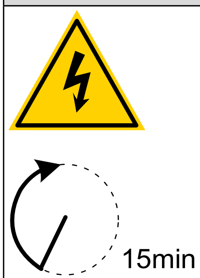
- Feed the servo drive with power from grounded (TN/TT) systems. Failure to comply may result in electric shock.
- Connect an electromagnetic contactor between the input power supply and the main circuit power supply of the servo drive (L1 and L2 for single-phase servo drives; L1, L2, and L3 for three-phase servo drives) to form an architecture 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

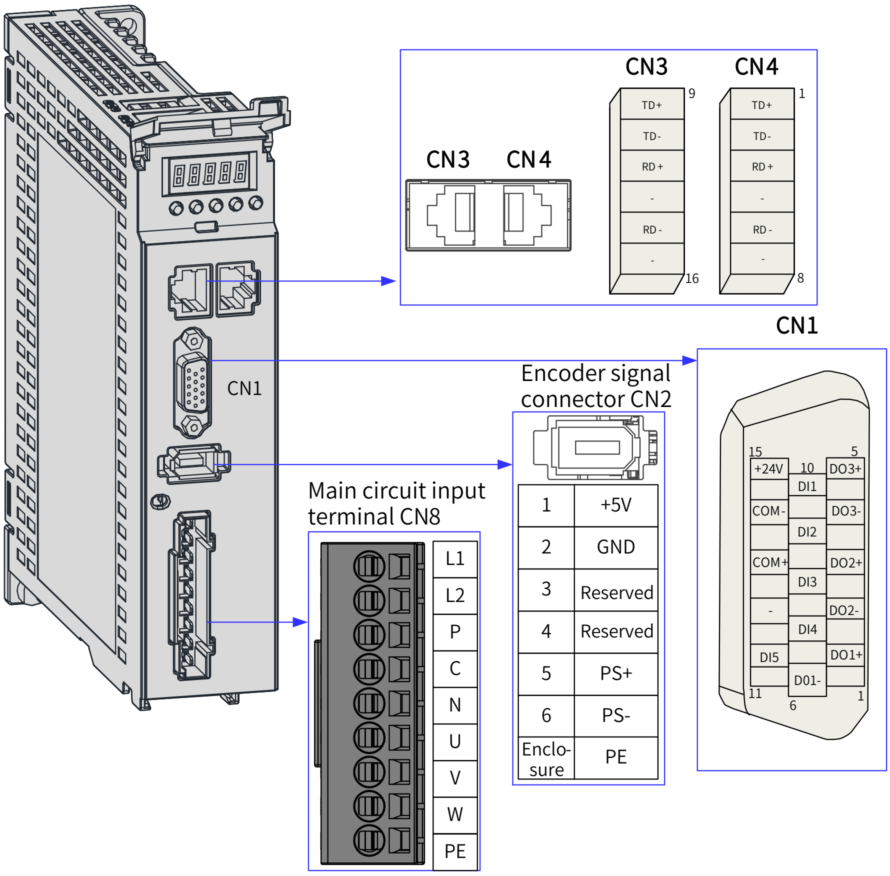


Figure 3-1 Terminal pin layout of servo drives in size A

NOTE

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

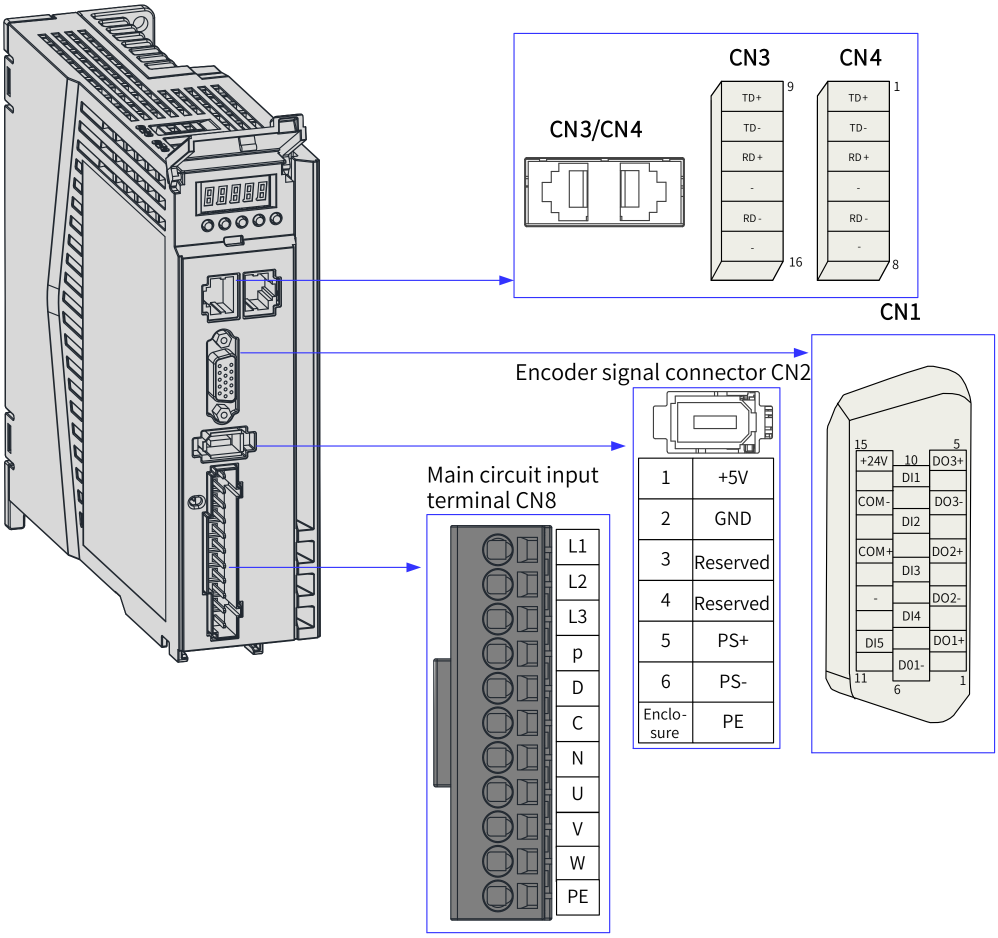


Figure 3-2 Terminal pin layout of servo drives in size B

NOTE

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

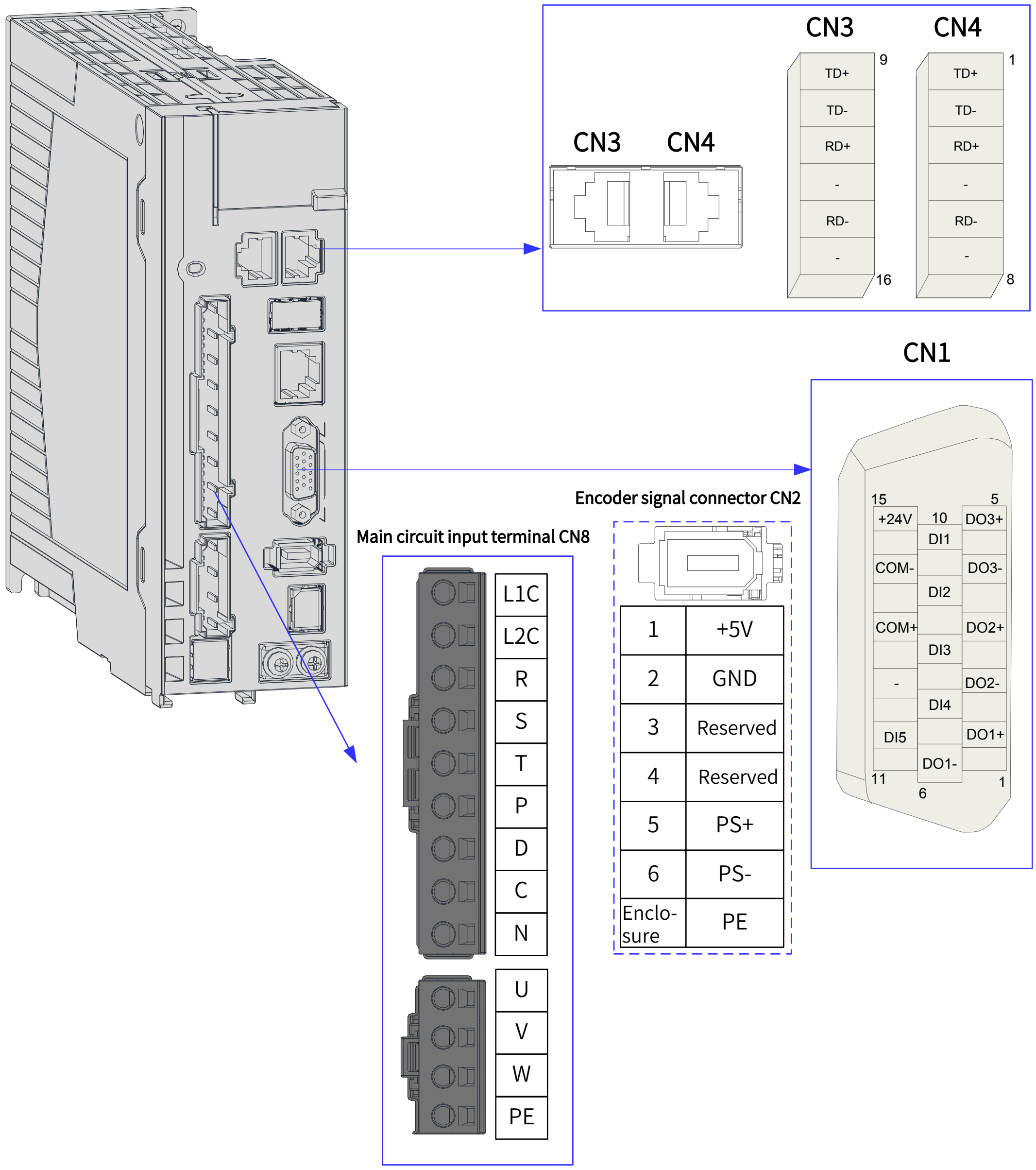


Figure 3-3 Terminal pin layout of servo drives in size C and size D

NOTE

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

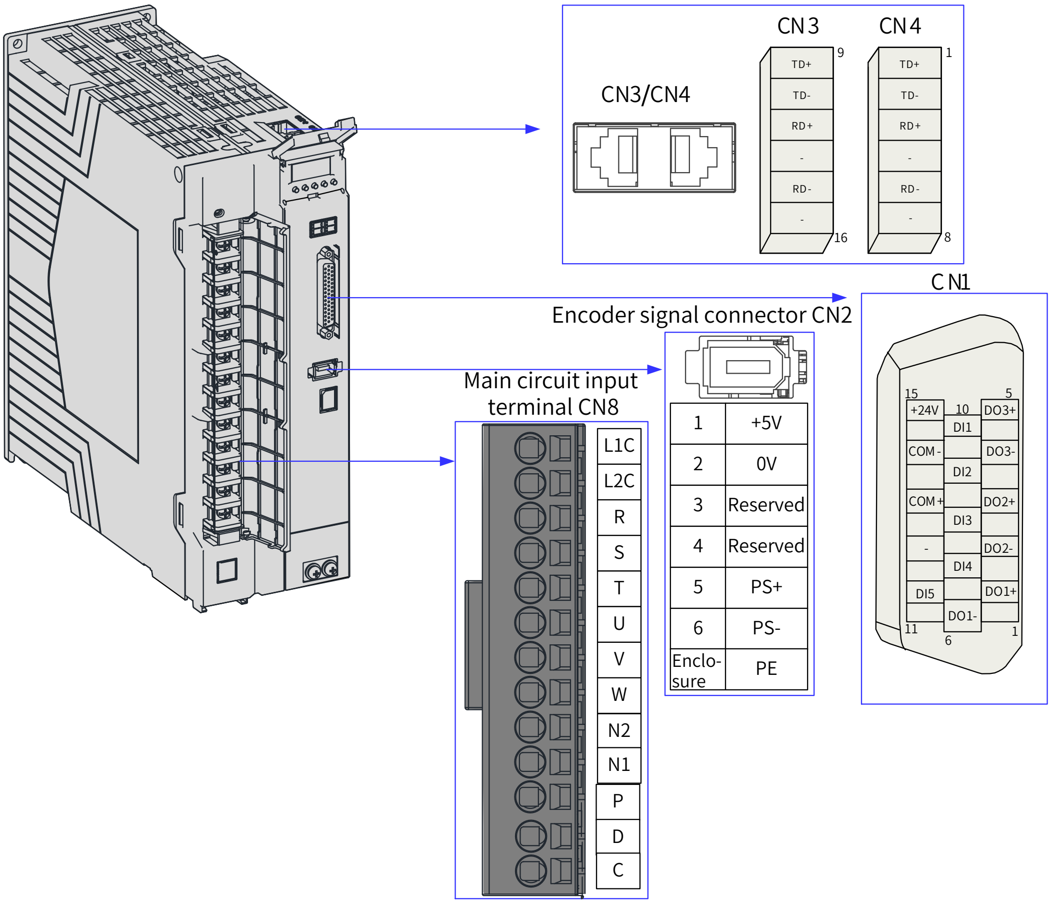


Figure 3-4 Terminal pin layout of servo drives in size E

NOTE

◆ 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

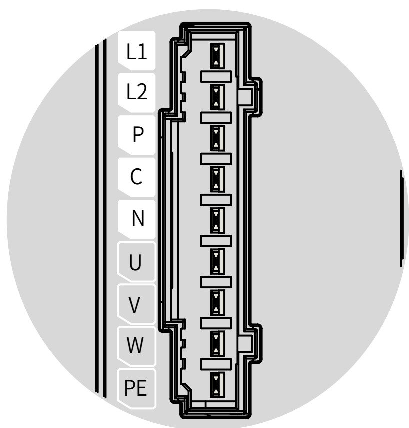


Figure 3-5 Main circuit terminal pin layout of servo drives in size A

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

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

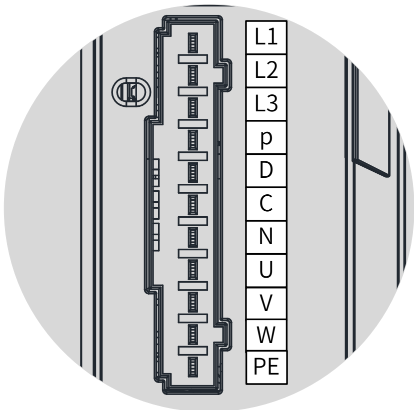


Figure 3-6 Main circuit terminal pin layout of servo drives in size B

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

No.	Name	Description
1	L1, L2, L3 (Power input terminals)	See the nameplate for the rated voltage of the power supply. Note: ◆ S5R5 (750 W) servo drives: Single-phase 220 V power input, with 220 V power supply connected to L1 and L2
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)	When an external regenerative resistor is needed, connect it between terminals P and C. Servo drives in size B are equipped with a built-in regenerative resistor. In this case, 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 power supply ground and the motor grounding terminal.

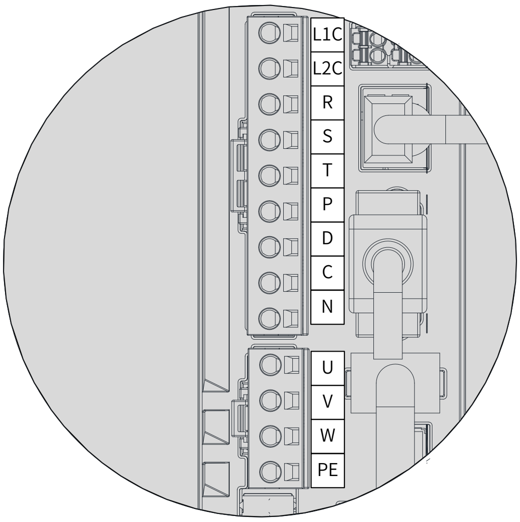


Figure 3-7 Main circuit terminal pin layout of servo drives in size C and size D

Table 3-3 Names and functions of main circuit terminals of servo drives in size C and size D

No.	Name	Description
1	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
2	R, S, T (main circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
3	P, N (DC bus terminals)	Used as the common bus terminal for multiple servo drives.
	P, D, C (terminals for connecting external regerative resistor)	When an external regenerative resistor is needed, connect it between terminals P and C. Servo drives in sizes C and D are equipped with a built-in regenerative resistor. In this case, terminals P and D are shorted by default.
4	U, V, W (terminals for connecting the servo motor)	Connected to the U, V and W phases of the servo motor.
5	PE (grounding terminal)	Connected to the power supply ground and the motor grounding terminal.

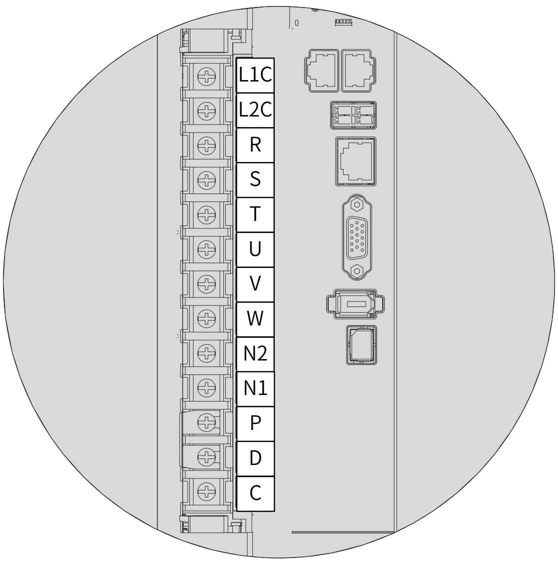


Figure 3-8 Main circuit terminal pin layout of servo drives in size E

Table 3-4 Names and functions of main circuit terminals of servo drives in size E

No.	Component Name	Desciption
1	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
2	R, S, T (main circuit power input terminals)	See the nameplate for the rated voltage of the power supply.
3	U, V, W (terminals for connecting the servo motor)	Connected to the U, V and W phases of the servo motor.
4	N2, N1 (terminals for connecting external reactor)	Terminals N1 and N2 are jumpered by default. Remove the jumper first if you need to install an external DC reactor between N1 and N2.
5	P, D, C (terminals for connecting external regenerative resistor)	When an external regenerative resistor is needed, connect it between terminals P and C. Servo drives in size E are equipped with a built-in regenerative resistor. In this case, terminals P and D are shorted by default.

3.2.2 Wiring Example of the Regenerative Resistor

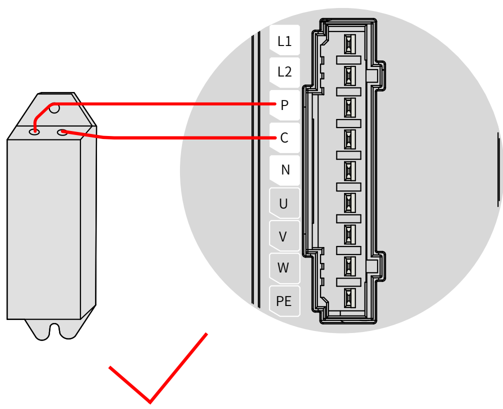


Figure 3-9 Connection of the external regenerative resistor

WARNING

Observe the following requirements when connecting the external regenerative resistor:

◆ Remove the jumper between P and D before connecting 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 a 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 a metal.

3.2.3 Specifications of Main Circuit Cables

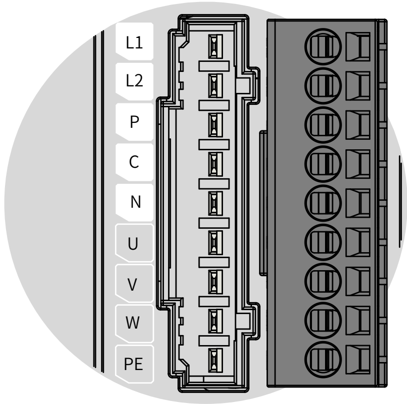


Figure 3-10 Main circuit terminal block of the servo drive

Table 3-5 Input/Output current specifications of SV660N series servo drives

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
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 3-6 Recommended main circuit cables

Servo Drive Model SV660N*****		L1C, L2C		R, S, T		P⊕, C		U, V, W		PE	
		AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2
Single-phase 220 V											
Size A	S1R6I	2x0.75	18	2x0.75	18	2x0.75	18	3x0.5	20	0.5	20
	S2R8I	2x0.75	18	2x0.75	18	2x0.75	18	3x0.5	20	0.5	20
Size B	S5R5I	2x0.75	18	2x0.75	18	2x0.75	18	3x0.5	20	0.5	20
Size C	S7R6I	3x0.75	18	3x0.75	18	3x0.75	18	Matching MS1H1-10C30CB motors: 3x0.5	20	Matching MS1H1-10C30CB motors: 0.5	20
								Matching MS1H2-10C30CB/MS1H3-85B15CB motors: 3x1.5	16	Matching MS1H2-10C30CB/MS1H3-85B15CB motors: 1.5	16
Size D	S012I	3x0.75	16	3x0.75	16	3x0.75	16	3x1.5	16	1.5	16

Servo Drive Model SV660N*****		L1C, L2C		R, S, T		P⊕, C		U, V, W		PE	
		AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2
Three-phase 220 V											
Size C	S7R6I	2x0.75	18	3x0.75	18	2x0.75	18	Matching MS1H1-10C30CB motors: 3x0.5	20	Matching MS1H1-10C30CB motors: 0.5	20
								Matching MS1H2-10C30CB/MS1H3-85B15CB motors: 3 x 1.5	16	Matching MS1H2-10C30CB/MS1H3-85B15CB motors: 1.5	16
Size D	S012I	2x0.75	18	3x1.5	16	2x1.5	16	3x1.5	16	1.5	16
Three-phase 380 V											
Size C	T3R5I	2x0.75	18	3x0.75	18	2x0.75	18	3x1.5	16	1.5	16
	T5R4I	2x0.75	18	3x0.75	18	2x0.75	18	3x1.5	16	1.5	16
Size D	T8R4I	2x0.75	18	3x0.75	18	2x1.5	16	3x1.5	16	1.5	16
	T012I	2x0.75	18	3x1.5	16	2x1.5	16	3x1.5	16	1.5	16
Size E	T017I	2x0.75	18	3x1.5	16	2x4.0	12	Matching MS1H2-40C30CD/MS1H2-50C30CD motors: 3x2.5	14	2.50	14
								Matching MS1H3-44C15CD motors: 3x4.0	12	4.00	12
	T021I	2x0.75	18	3x2.5	14	2x4.0	12	3x4.0	12	4.00	12
	T026I	2x0.75	18	3x4.0	12	2x4.0	12	3x4.0	12	4.00	12

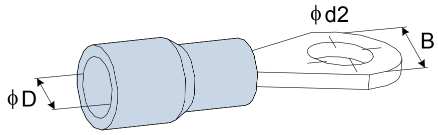
See "3.2.5 Precautions for Main Circuit Wiring" for details.

Table 3-7 Recommended grounding cable lug of the main circuit

Servo Drive Model SV660N****I		PE
Size A	SV660NS1R6I	TVR 2-4
	SV660NS2R8I	TVR 2-4
Size B	SV660NS5R5I	TVR 2-4
Size C	SV660NS7R6I	TVR 2-4
	SV660NT3R5I	TVR 2-4
	SV660NT5R4I	TVR 2-4
Size D	SV660NS012I	TVR 2-4
	SV660NT8R4I	TVR 2-4
	SV660NT012I	TVR 2-4
Size E	SV660NT017I	TVR 2-4
	SV660NT021I	TVR 2-4
	SV660NT026I	TVR 2-4

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

Table 3-8 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 3-9 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 UVW cables, 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 3-10 Specifications for UVW cables

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 Wiring Example of the Power Supply

- Single-phase 220 V models: SV660NS1R6I, SV660NS2R8I, SV660NS5R5I, SV660NS7R6I and SV660NS012

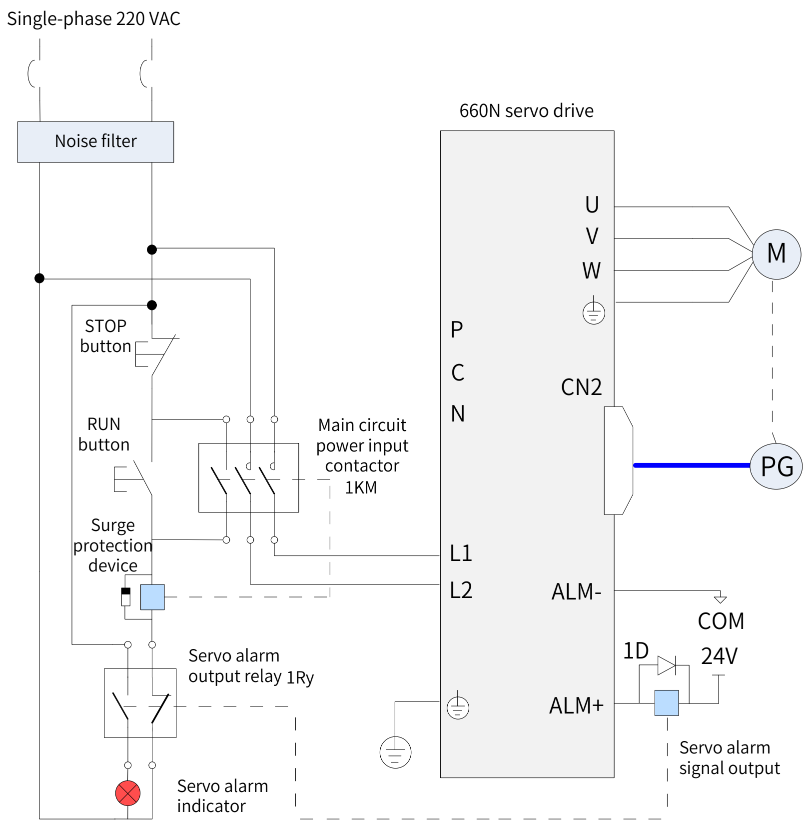


Figure 3-11 Main circuit wiring example of single-phase 220 V models

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 terminals P and C if required.

■ Single-phase/Three-phase 220 V models: SV660NS7R6I and SV660NS012I

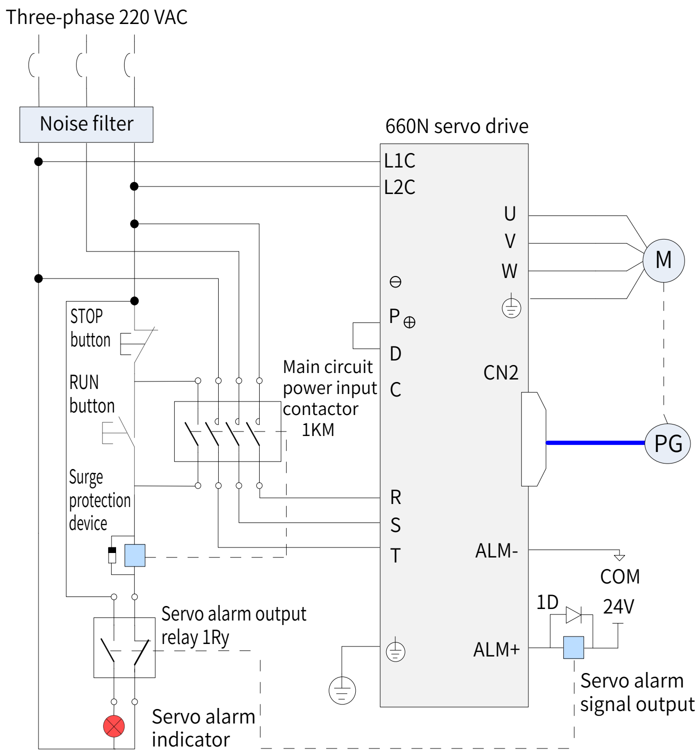


Figure 3-12 Main circuit wiring example of three-phase 220 V models

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.

■ Three-phase 380 V models: SV660NT3R5I, SV660NT5R4I, SV660NT8R4I, SV660NT012I, SV660NT021I, SV660NT026I

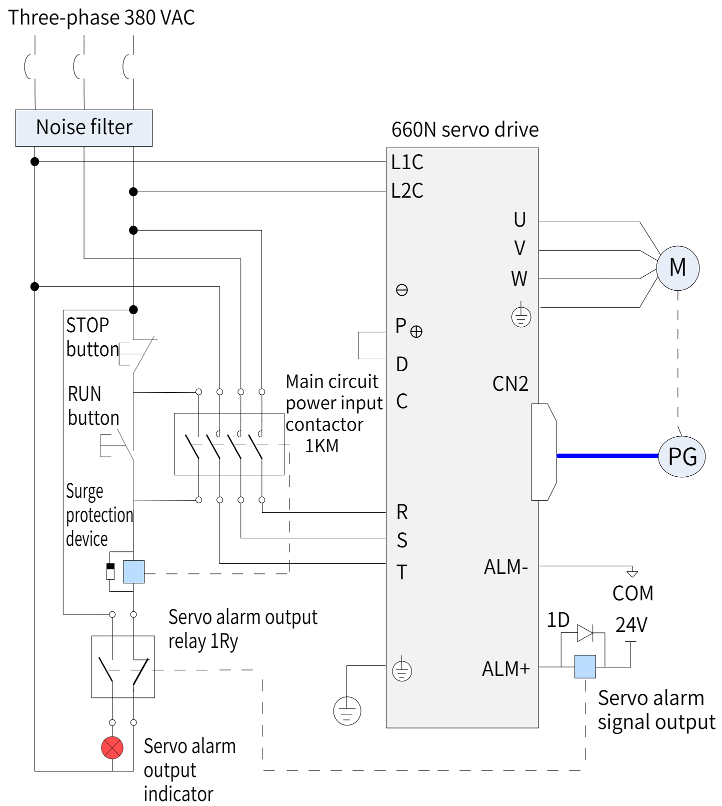


Figure 3-13 Main circuit wiring example of three-phase 380 V models

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 an environment with a low temperature.

■ 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 an ambient temperature of 30° C with 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 case of high ambient temperatures or bundled cables.

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

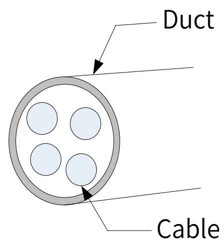


Table 3-11 Reduction coefficient of current-carrying density of the conductor

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 ON/OFF interval is less than 1s, fault E740, E136, or E430 may be reported (see details in "10 Troubleshooting"). If the fault does occur, power on again based on the required ON/OFF interval. As the capacitor in the main circuit is charged with a large current for 0.2s upon power on, the main circuit components inside the servo drive will be adversely affected by frequent ON/OFF. If frequent ON/OFF is required, ensure the time interval is at least one minute.
- 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 loose. 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 3-12 Recommended circuit breakers and electromagnetic contactors

Main Circuit Power Supply	Servo Drive Model	Breaker		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	16	OSMC32N3C16	9	LC1 D09
	SV660NS7R6I	10	OSMC32N3C10	9	LC1 D09
	SV660NS012I	16	OSMC32N3C16	9	LC1 D09
Three-phase 220 V	SV660NS7R6I	10	OSMC32N3C10	9	LC1 D09
	SV660NS012I	16	OSMC32N3C16	9	LC1 D09

Main Circuit Power Supply	Servo Drive Model	Breaker		Contactor	
		Current (A)	Schneider Model	Current (A)	Schneider Model
Single-phase 380 V	SV660NT3R5I	4	OSMC32N3C4	9	LC1 D09
	SV660NT5R4I	6	OSMC32N3C6	9	LC1 D09
	SV660NT8R4I	10	OSMC32N3C10	9	LC1 D09
	SV660NT012I	16	OSMC32N3C16	9	LC1 D09
	SV660NT017I	20	OSMC32N3C20	12	LC1 D12
	SV660NT021I	25	OSMC32N3C25	18	LC1 D18
	SV660NT026I	32	OSMC32N3C32	25	LC1 D25

3.3 Connecting the Servo Drive and Servo Motor Power Cables

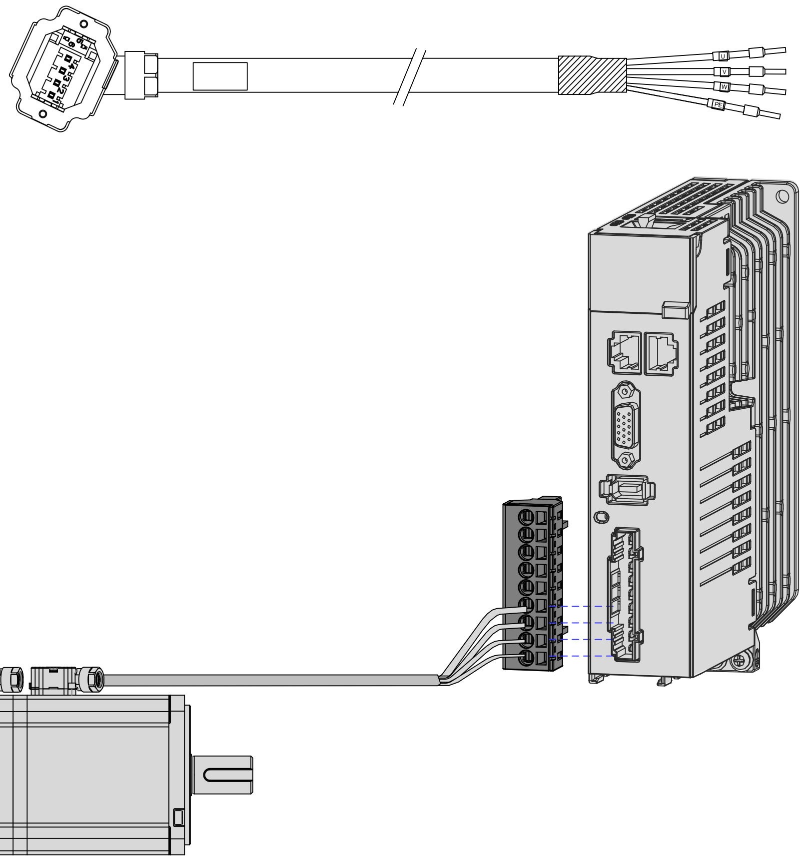
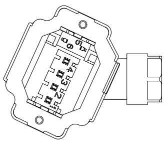
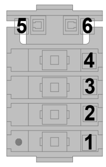


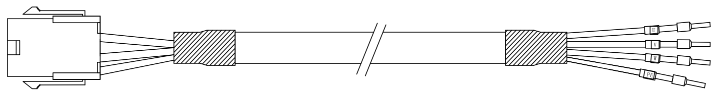
Figure 3-14 Example of the wiring between the servo drive and the servo motor

Table 3-13 Power cable connector of terminal-type motors (motor side).

<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Flange Size [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 flange size refers to the width of the mounting flange.
- ◆ Power cable colors are subject to the colors of the actual product. Cable colors mentioned in this user guide refer to Inovance's cable colors.



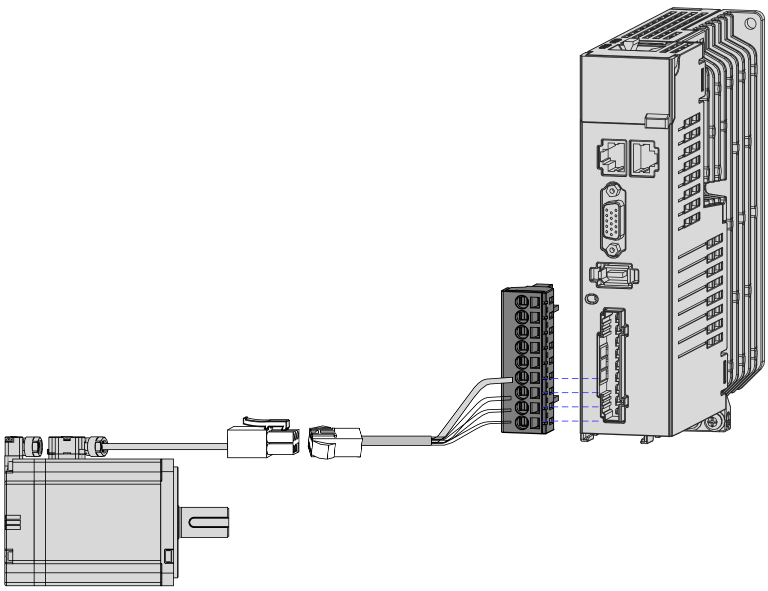
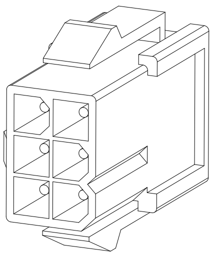
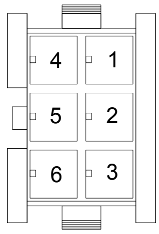


Figure 3-15 Example of the wiring between the servo drive and the servo motor

Table 3-14 Power cable connector of lead-wire type motors (motor side).

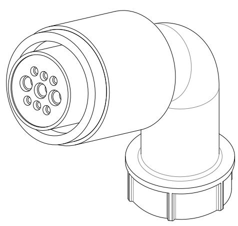
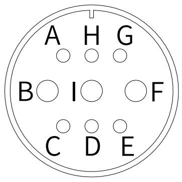
<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Flange Size [Note]</th></tr>
<tr><td></td><td>
Black 6-pin connector


<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>

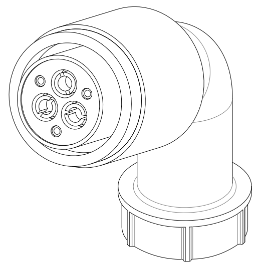
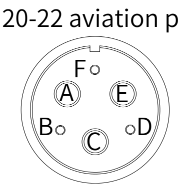
NOTE

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

Table 3-15 Connectors for power cables on the servo motor side

<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Flange Size</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>

<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Flange Size</th></tr>
<tr><td></td><td>MIL-DTL-5015 series 3108E20-22S aviation plug


<table>
<tr><th colspan="2">Definition of Y Series Terminal</th><th colspan="2">Definition of Z series Terminal</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>A</td><td>U</td><td>A</td><td>U</td><td>Blue</td></tr>
<tr><td>C</td><td>V</td><td>C</td><td>V</td><td>Black</td></tr>
<tr><td>E</td><td>W</td><td>E</td><td>W</td><td>Red</td></tr>
<tr><td>F</td><td>PE</td><td>F</td><td>PE</td><td>Yellow/ Green</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>B</td><td rowspan="2">Brake (polarity insensitive)</td><td rowspan="2"></td></tr>
<tr><td>D</td></tr>
</table></td><td>180</td></tr>
</table>

3.4 Connecting the Servo Drive and Servo Motor Encoder Cables

1 Installing the absolute encoder battery box

■ The S6-C4 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:

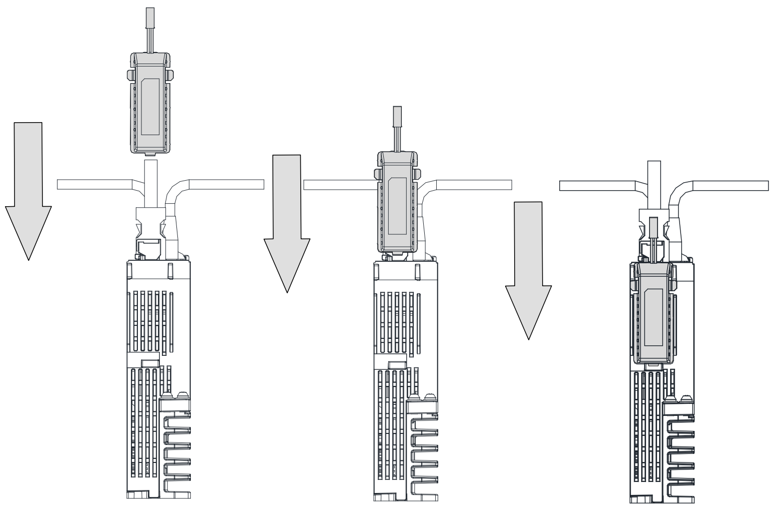
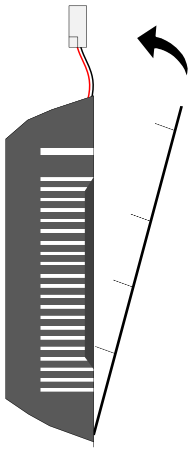


Figure 3-16 Installing the absolute encoder battery box (bottom view)

■ 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 shown 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 regularly (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 3-16 Description of the absolute encoder battery

Battery Model and Specifications	Items	Ratings			Condition
		Minimum Value	Typical Value	Maximum Value	
Output: 3.6 V, 2600 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 at a standstill
		-	80	-	In standby mode, shaft rotating
	Ambient temperature for operation (°C)	0	-	40	Same as that required by the motor
	Ambient temperature for storage (°C)	-20	-	60	

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

[1] During normal operation, the absolute encoder supports single-turn or multi-turn data counting and data transceiving. 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 is powered up by an external battery to count the multi-turn data. In this case, data transceiving 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 3-17 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

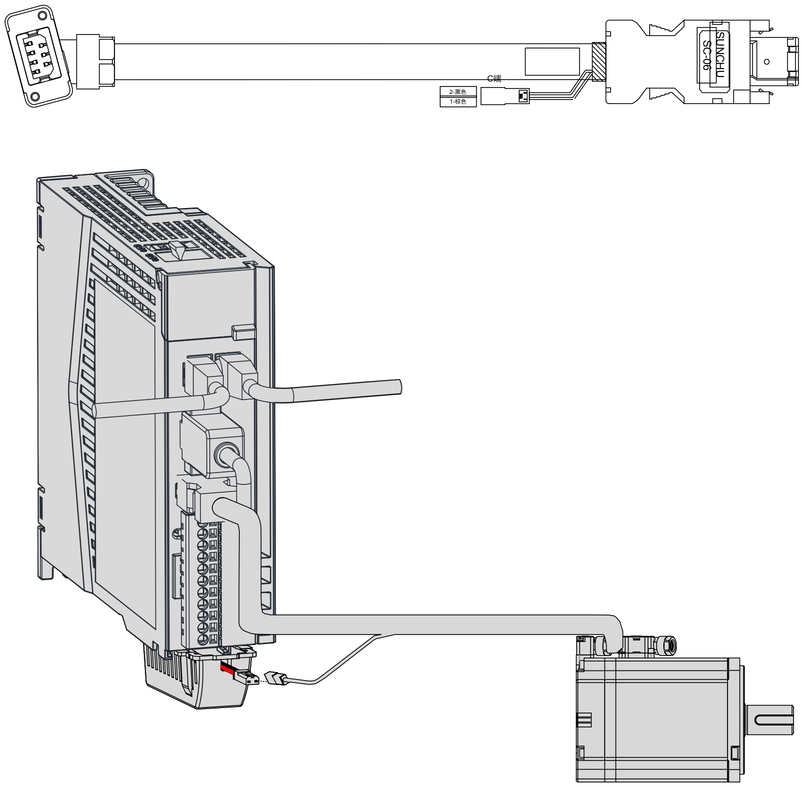
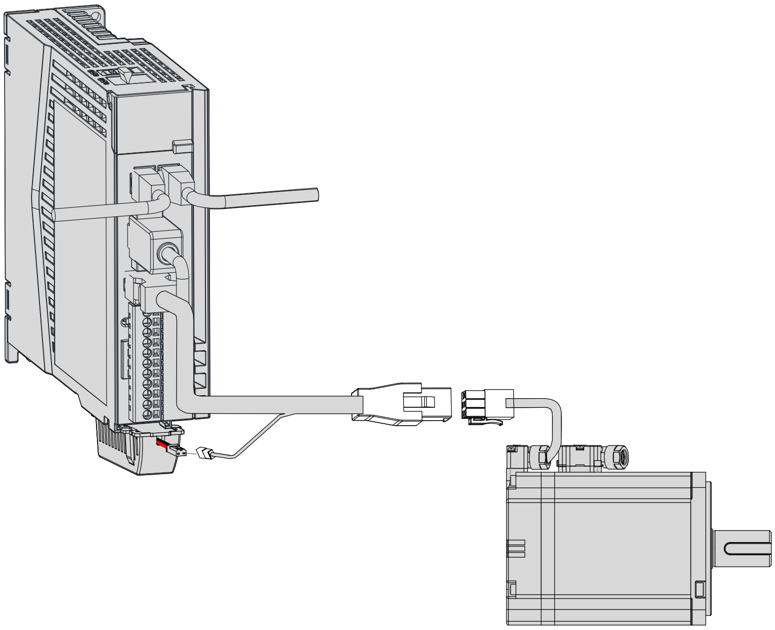


Figure 3-17 Wiring example of absolute encoder signals[1]

[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.

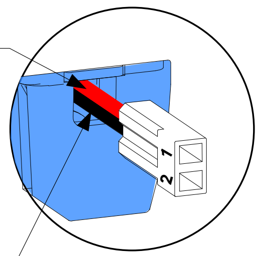
NOTE

The encoder cable color is subject to the color of the actual product. 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 3-18 Lead wires of the absolute encoder battery

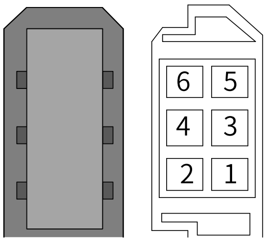
NOTE

- Store the battery under an allowabl temperature and ensure reliable contact and sufficient battery power. Failure to comply may cause encoder data loss.
- Model of the battery box (battery included): S6-C4

Table 3-18 Encoder cable connector of terminal-type motors (motor side).

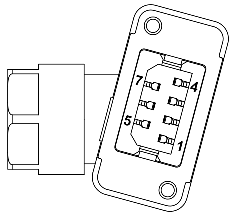
Outline Drawing and Pin Layout of the Connector		Applicable Flange Size [1]
Servo Drive Side	Motor Side	
6-pin male (Left: connecting side Right: soldering side)	7-pin connector	Terminal-type motors: 40 60 80

6-pin male
(Left: connecting side
Right: soldering side)



Pin No.	Signal Name	Color	Type
1	+5V	Red	Twisted pair
2	GND	Orange	
5	PS+	Blue	Twisted pair
6	PS-	Purple	
Enclosure	PE	-	-

7-pin connector

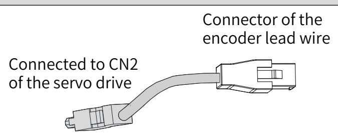


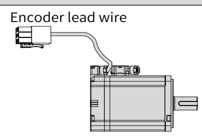
Pin No.	Signal Name	Color	Type
1	PS+	Blue	Twisted pair
2	PS-	Purple	
3	DC+	Brown	Twisted pair
4	DC-	Black	
5	+5V	Red	Twisted pair
6	0V	Orange	
7	PE	-	-

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

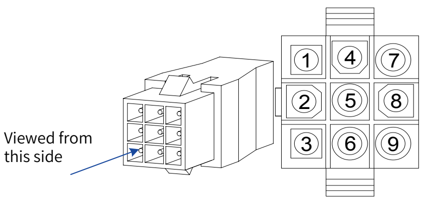
Table 3-19 Encoder cable connector of lead wire-type motors (motor side)

Outline Drawing and Pin Layout of the Connector		Applicable Flange Size [1]
9-pin connector		Lead wire-type motors: 40 60 80





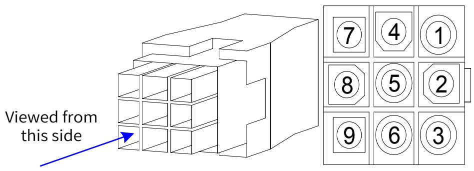
9-pin connector



Pin No.	Signal Name	Type
1	Battery (+)	-
4	Battery (-)	
3	PS+	Twisted pair
6	PS-	
9	+5V	-
8	GND	
7	Shield	

Recommendations:

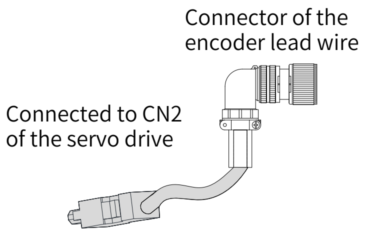
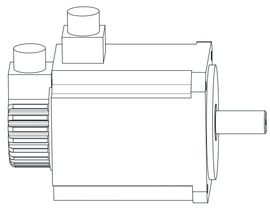
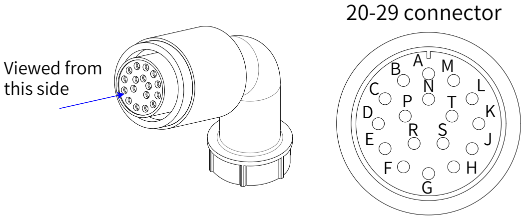
Plastic housing: AMP 172161-1
Terminal: AMP 770835-1

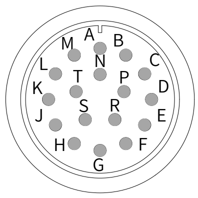


Pin No.	Signal Name	Color	Type
1	Battery (+)	Blue	Twisted pair
4	Battery (-)	Blue and black	
3	PS+	Yellow	
6	PS-	Yellow and black	
9	+5V	Red	-
8	GND	Black	
7	Shield	-	

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

Table 3-20 Absolute encoder cable connector (MIL-DTL-5015 series 3108E20-29S connector)

<table>
<tr><th colspan="2">Outline Drawing and Terminal Layout of the Connector</th><th>Applicable Flange Size [1]</th></tr>
<tr>
<td>
</td>
<td>Encoder connector
</td>
<td>100
130
180</td>
</tr>
<tr>
<td>20-29 connector


<table>
<tr><th>Pin No.</th><th>Signal Name</th><th></th></tr>
<tr><td>A</td><td>PS+</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>B</td><td>PS-</td></tr>
<tr><td>E</td><td>Battery +</td><td rowspan="2"></td></tr>
<tr><td>F</td><td>Battery -</td></tr>
<tr><td>G</td><td>+5V</td><td rowspan="3"></td></tr>
<tr><td>H</td><td>GND</td></tr>
<tr><td>J</td><td>Shield</td></tr>
</table></td>
<td>20-29 connector


<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>Color</th><th></th></tr>
<tr><td>A</td><td>PS+</td><td>Yellow</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>B</td><td>PS-</td><td>Yellow and black</td></tr>
<tr><td>E</td><td>Battery+</td><td>Blue</td><td rowspan="2"></td></tr>
<tr><td>F</td><td>Battery-</td><td>Blue and black</td></tr>
<tr><td>G</td><td>+5V</td><td>Red</td><td rowspan="3"></td></tr>
<tr><td>H</td><td>GND</td><td>Black</td></tr>
<tr><td>J</td><td>Shield</td><td></td></tr>
</table></td>
<td>100
130
180</td>
</tr>
</table>

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

3.5 Connecting Control Signal Terminal CN1

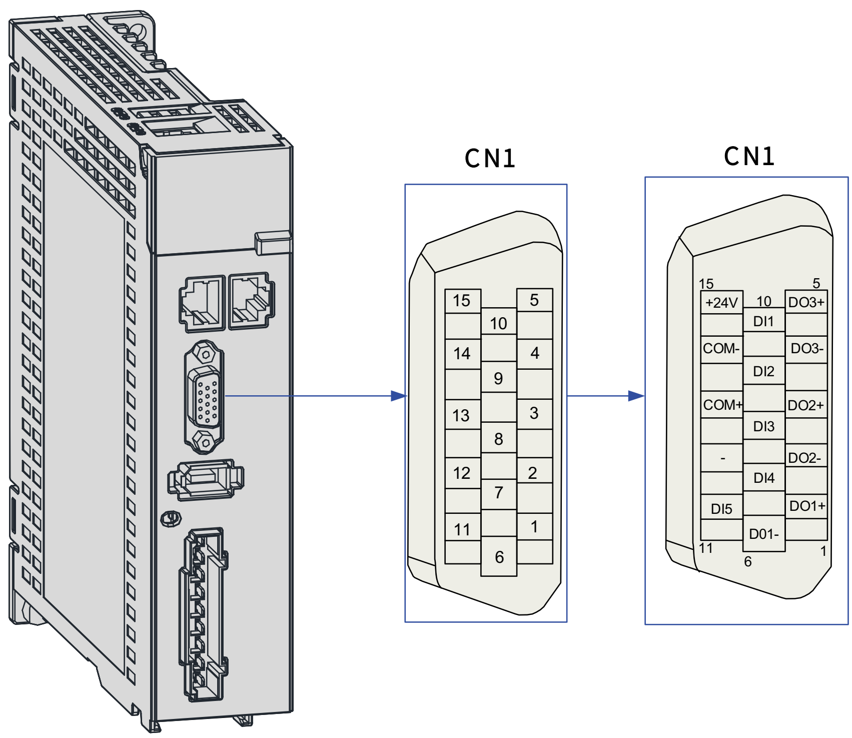


Figure 3-19 Pin layout of CN1

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

NOTE

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

3.5.1 DI/DO Signals

Table 3-21 Description of DI/DO signals

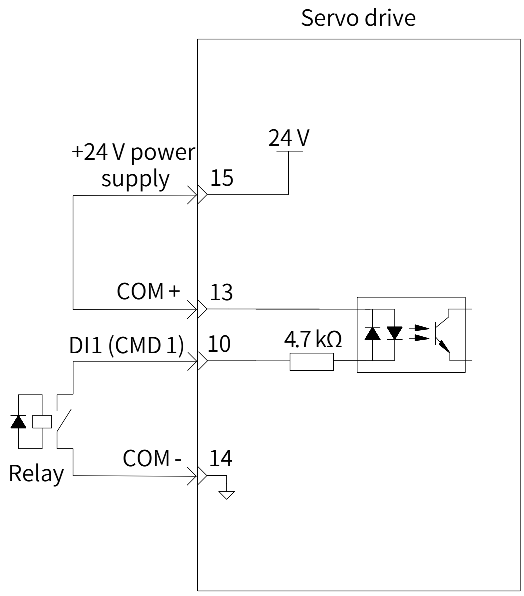
Signal Name		Function	Pin No.	Function
General	DI1	P-OT	10	Positive limit switch
	DI2	N-OT	9	Negative limit switch
	DI3	HomeSwitch	8	Home switch
	DI4	TouchProbe2	7	Touch probe 2
	DI5	TouchProbe1	11	Touch probe 1
	+24V		15	Internal 24 V power supply, voltage range: 20 V to 28 V, maximum output current: 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

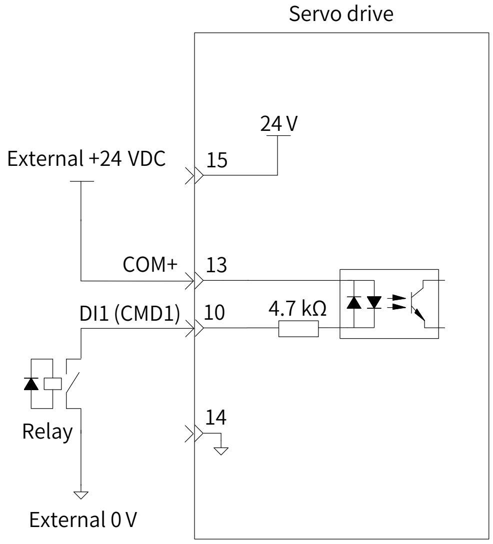
DI1 to DI5 circuits are the same. The following description takes DI1 circuit as an example.

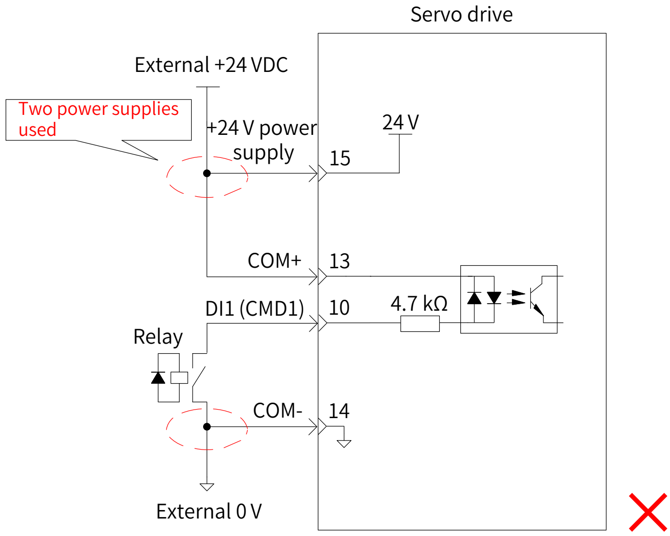
1) The host controller provides relay output.

■ When using the internal 24 V power supply of the servo drive



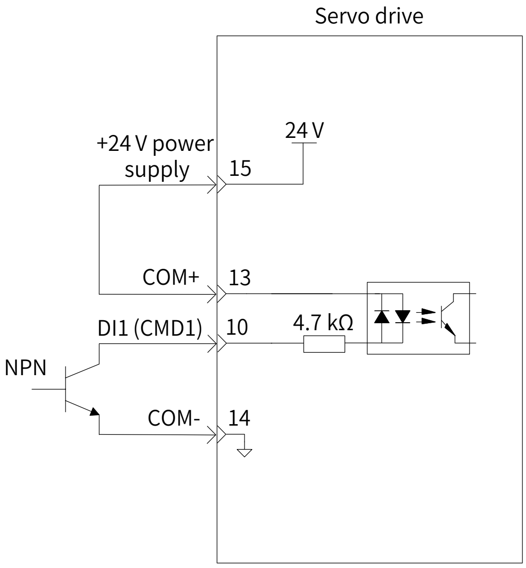
- When using an external power supply

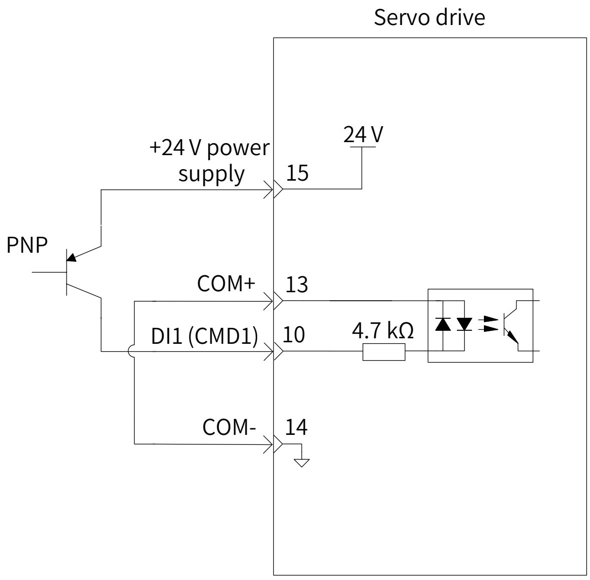




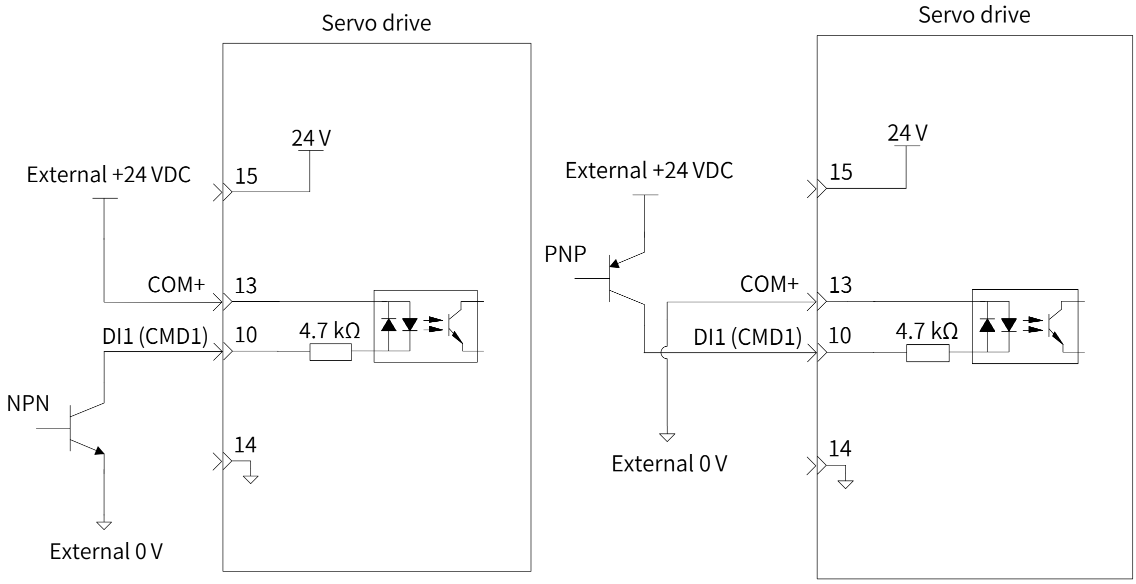
2) The host controller provides open-collector output.

- When using the internal 24 V power supply of the servo drive





■ When using an external power supply



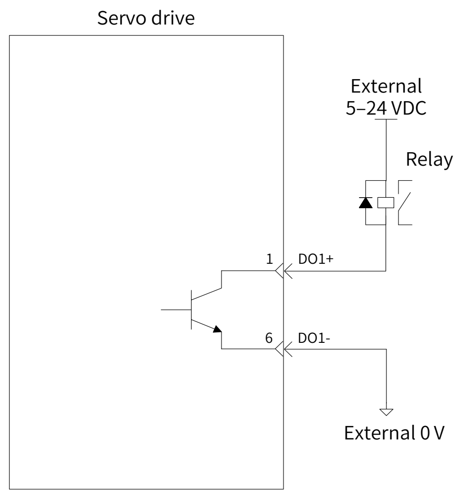
NOTE

PNP and NPN inputs cannot be mixed in the same servo drive.

2 DO circuit

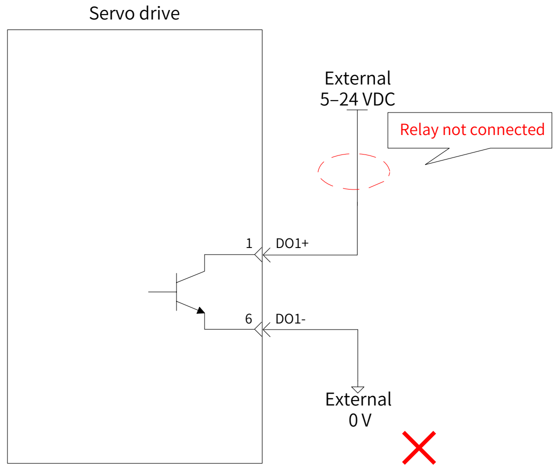
DO1 to DO3 circuits are the same. The following description takes DO1 circuit as an example.

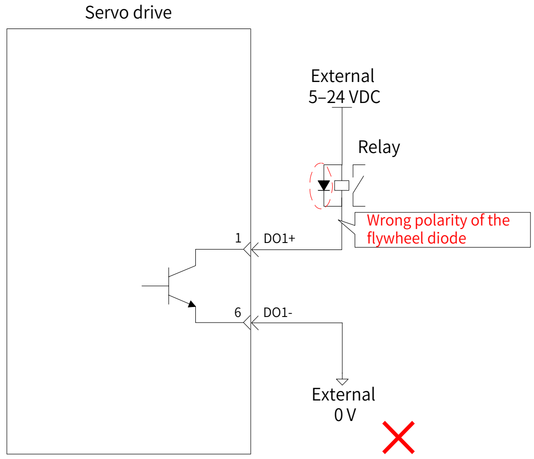
1) The output terminal is connected to a relay-type device.



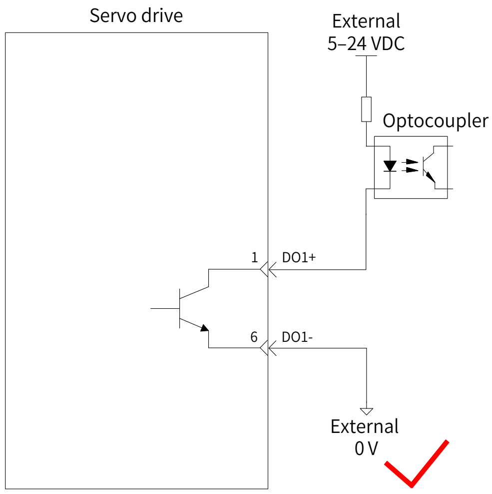
NOTE

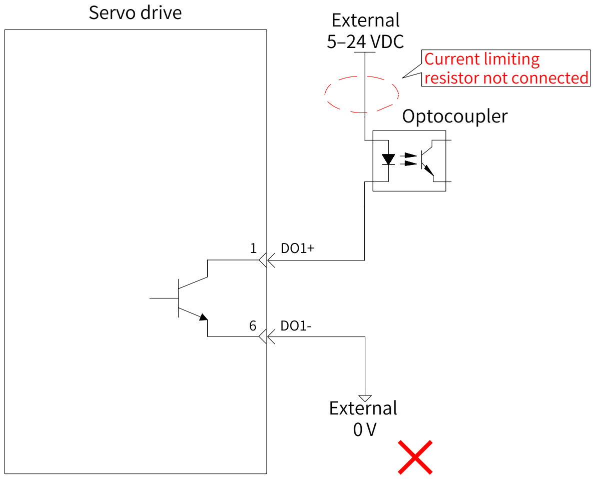
When the output terminal is connected to a relay-type device, a flywheel diode must be installed. Otherwise, the DO terminals may be damaged.





2) The output terminal is connected to an optocoupler-type device.





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 load in locked positions.

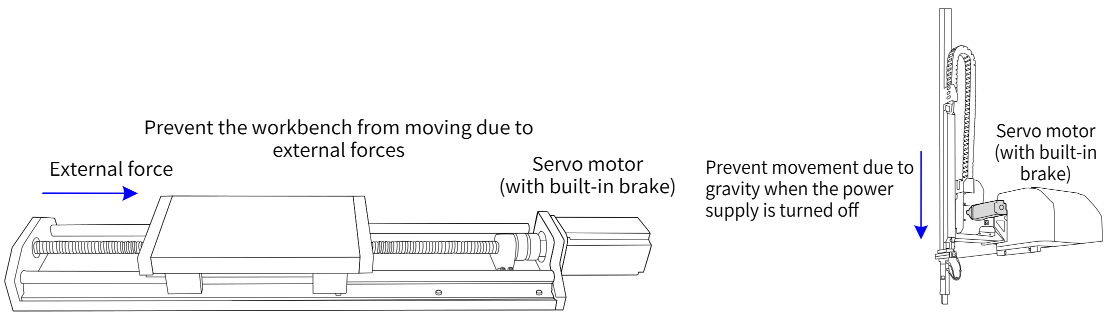


Figure 3-20 Application of the brake

CAUTION

- Use the built-in brake for position-lock in the stop state only.
- The brake coil has no polarity.
- Switch off the S-ON signal after the servo motor stops.
- When the servo motor with a built-in brake runs, the brake may generate a clattering sound. Such sound can be considered normal.
- 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 brake input signal is connected without polarity differentiation. 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.

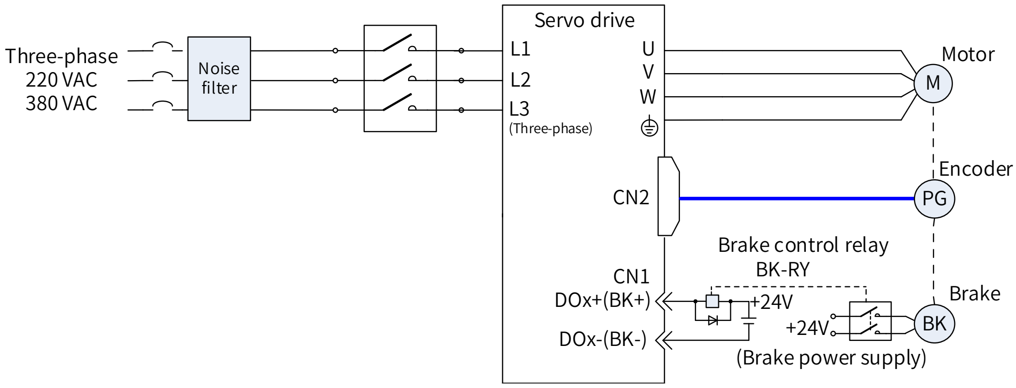


Figure 3-21 Wiring of the brake

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 3-22 Brake specifications

Motor Model	Holding Torque (N·m)	Supply Voltage (VDC) ±10%	Rated Power (W)	Coil Resistance (Ω) (±7%)	Excitation Current (A)	Apply Time (ms)	Release Time (ms)	Backlash (°)
MS1H1-05B/10B	0.32	24	6.1	94.4	0.25	≤ 40	≤ 20	≤ 1.5
MS1H1-20B/40B MS1H4-40B	1.5		7.6	75.79	0.32	≤ 60	≤ 20	≤ 1.5
MS1H1/H4-75B	3.2		10	57.6	0.42	≤ 60	≤ 40	≤ 1.0
MS1H3-85B/13C/18C	12		19.4	29.7	0.81	≤ 120	≤ 60	≤ 0.5
MS1H2-10C/15C/20C/25C	8		23	25	0.96	≤ 85	≤ 30	≤ 0.5
MS1H2-30C/40C/50C	16		27	21.3	1.13	≤ 100	≤ 60	≤ 0.5
MS1H3-29C/44C/55C/75C	50		40	14.4	1.67	≤ 200	≤ 100	≤ 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

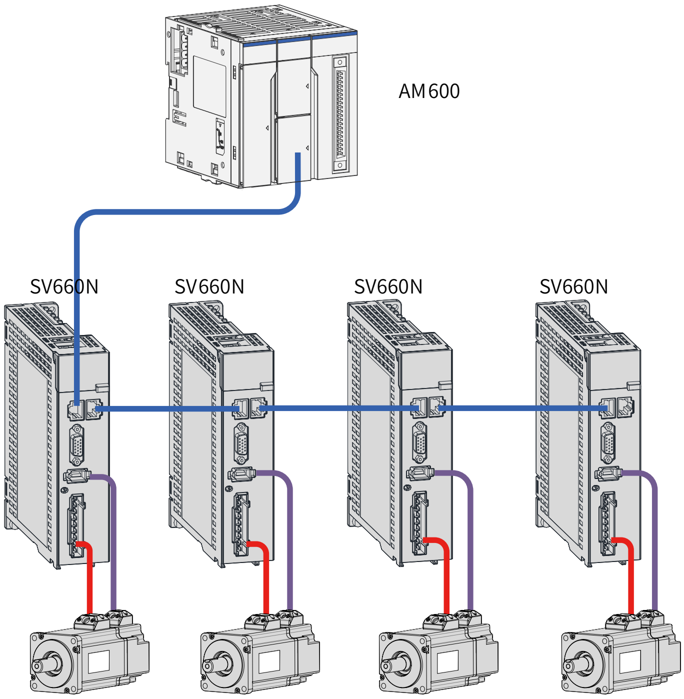


Figure 3-22 Network topology

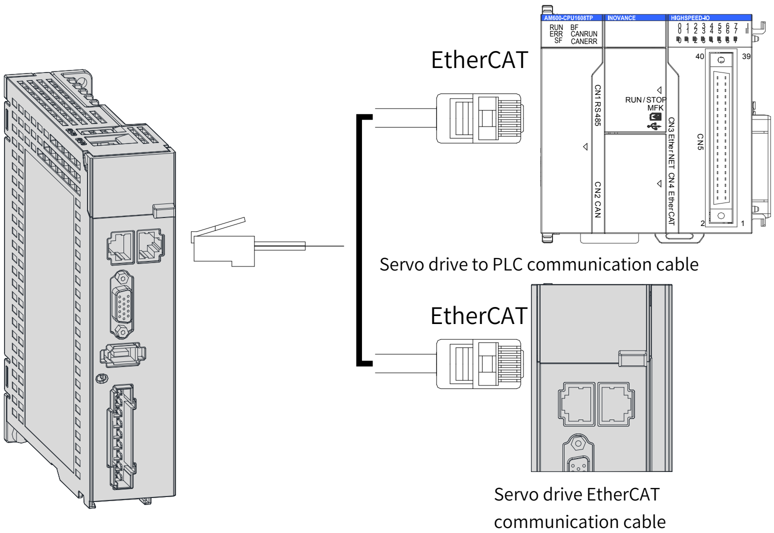
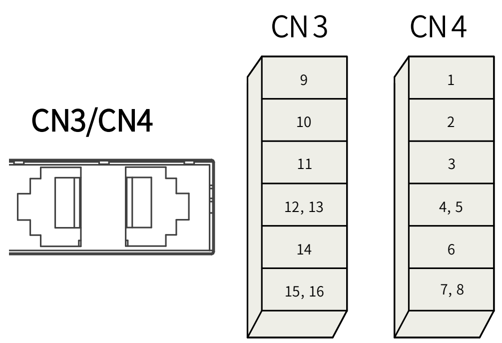


Figure 3-23 Wiring of communication cables

3.6.1 Pin Assignment of Communication Signal Connectors

CN3 and CN4 connectors are the EtherCAT interface connectors. CN3 (IN) is connected to the master and CN4 (OUT) is connected to the next slave.

Table 3-23 Pin assignment of CN3 and CN4

Pin No.	Name	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 Communication Cable Selection

■ Principle for cable selection

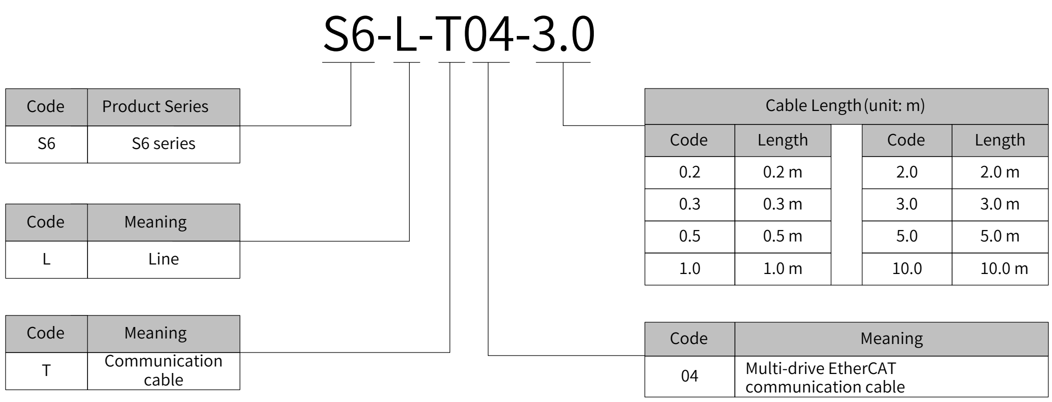
Cable Specifications	Supplier	Price
0.2 m to 10 m	Inovance, Haituo and others	See the following content for information on cable ordering.
Above 10 m		The cable price is added by RMB 5 for every additional 1 m based on the price of S6-L-T04-10.0. The cable price is also related to the magnitude of the order.

NOTE

◆ Cable selection is subject to the cable supplier. See "Instructions for purchasing servo encoder cables/power cables" in Inovance business system.

■ Basic information of Inovance EtherCAT communication cables

Cable models are described in the following figure.



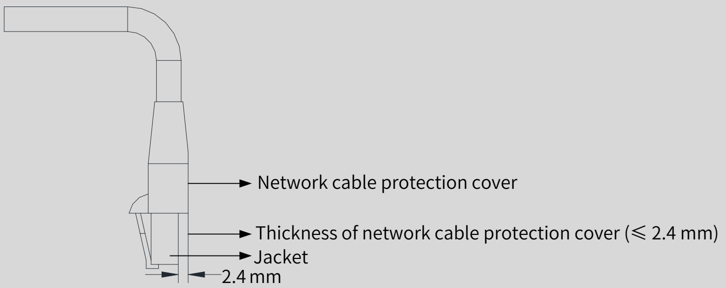
■ Cable ordering information

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

Cables need to be purchased from Haituo. (Guide price: The cable price is added by RMB 5 for every additional 1 m based on the price of S6-L-T04-10.0. The cable price is also related to the magnitude of the order.)

NOTE

◆ The thickness of the head of dual network ports cannot be too large, otherwise, interference may occur. The recommended thickness is 2.4 mm, as shown below.



■ 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 worthiness	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.

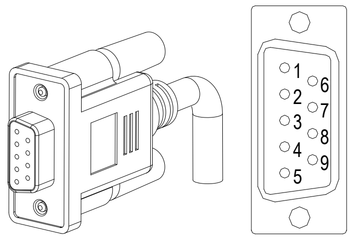
Figure 3-24 Outline drawing of the PC communication cable

Table 3-24 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 the PC side is shown in the following table.

Table 3-25 Pin definition of DB9 ("B" in the preceding figure) on the 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 is not equipped with serial ports and offers an USB interface only, use a serial-to-USB converter.

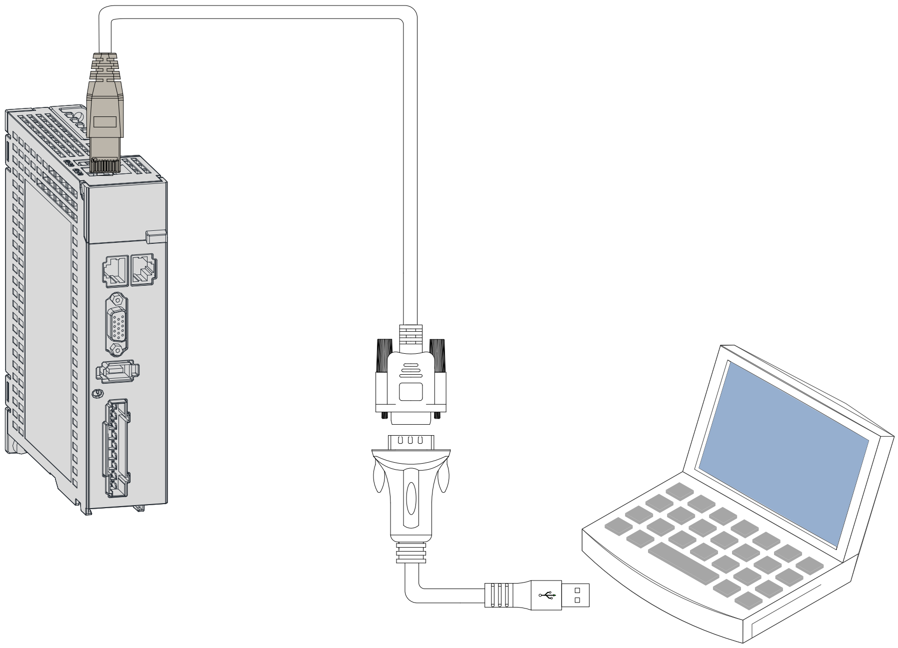


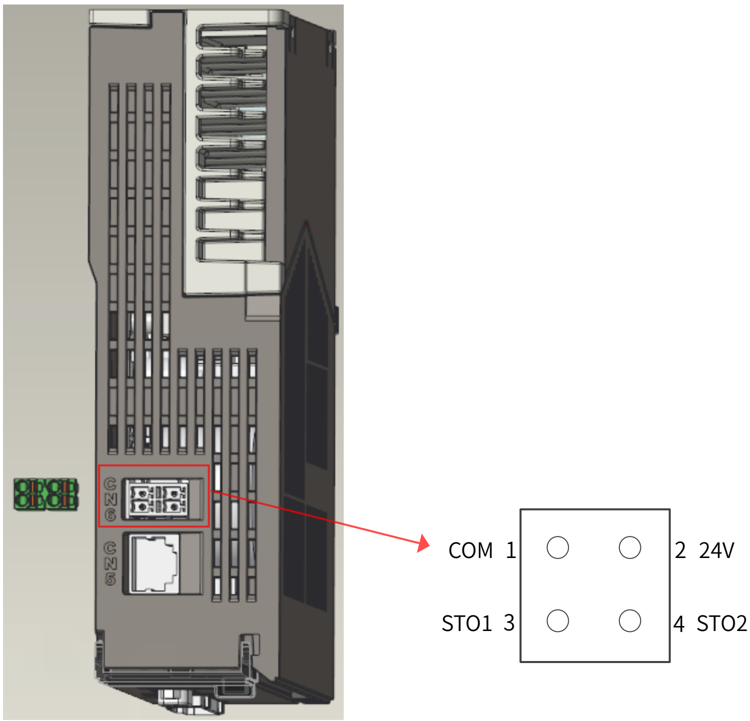
Figure 3-25 Serial-to-USB conversion

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 terminals

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

1 Terminal layout



1) Pin assignment of the input connector

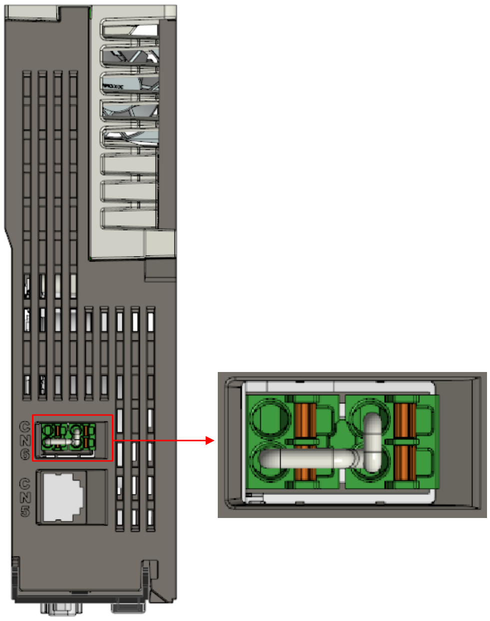
Terminal	Pin No.	Name	Value	Description
CN6	1	COM	0 V	STO reference ground
	2	24V	24 V	24 V power supply
	3	STO1	-	Control input for STO1
	4	STO2	-	Control input for STO2

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

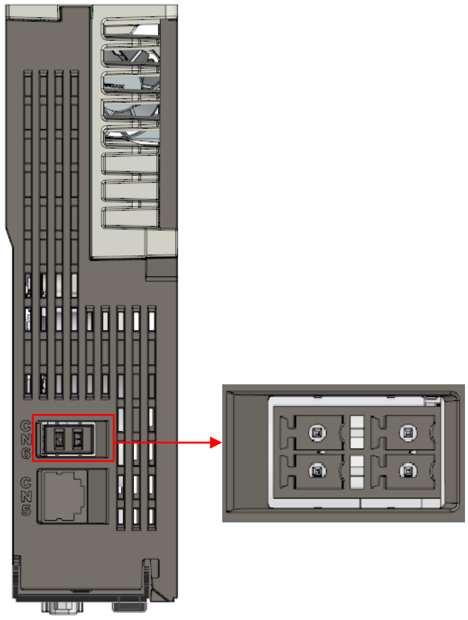
3) To make it more convenient and safe for installation, an additional pin with supply voltage (+24V) is integrated. The bridging of the 24 volts is needed in case the safety circuit is installed but no STO function is needed.

NOTE

Remove the short-circuit jumper when STO function 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

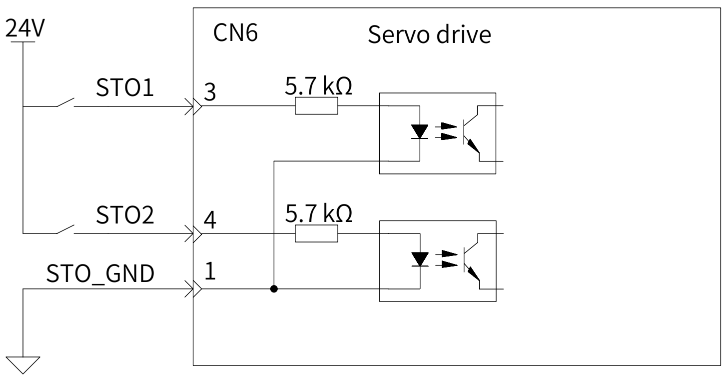
The servo drive can operate normally only if the input status of STO1 and STO2 are both "1" or "H".

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

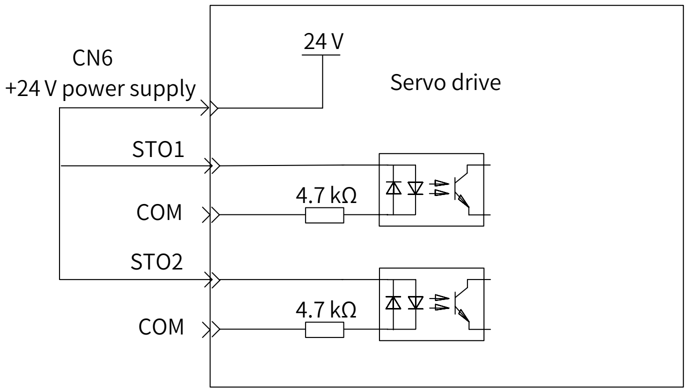
■ Electrical characteristics of the safety request input signal

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



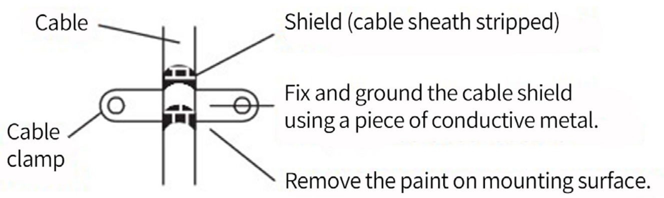
3 EMC requirements

■ 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 using a double shield.

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 lengths of the command input cable and the encoder cable are 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 switching 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

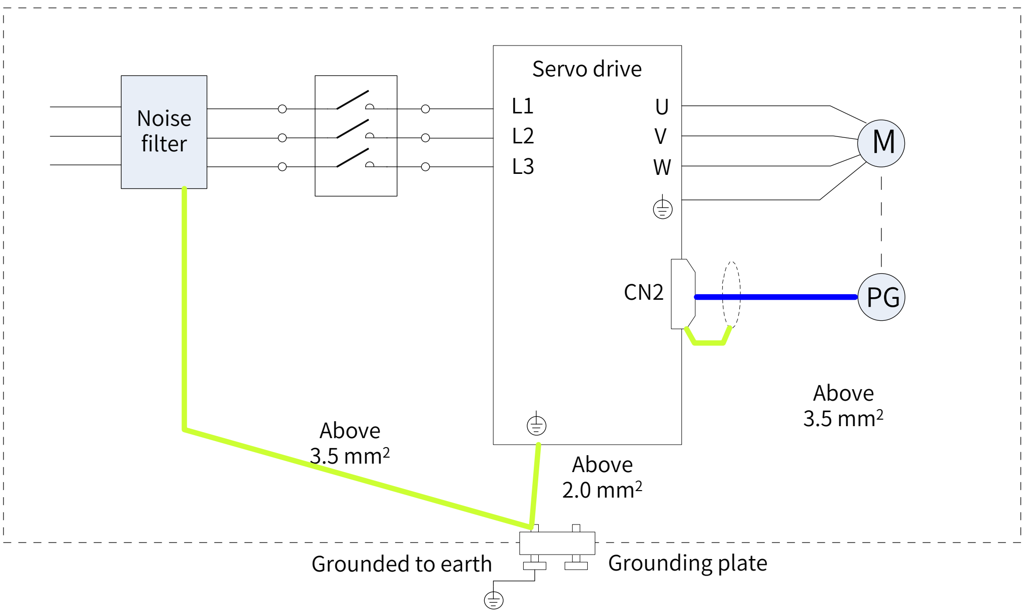


Figure 3-26 Anti-interference wiring example

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, observe the precautions described in "3.7 Definition and Connection of STO terminals".

2 Grounding

To prevent potential electromagnetic interferences, observe the following instructions during grounding.

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, observe 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.

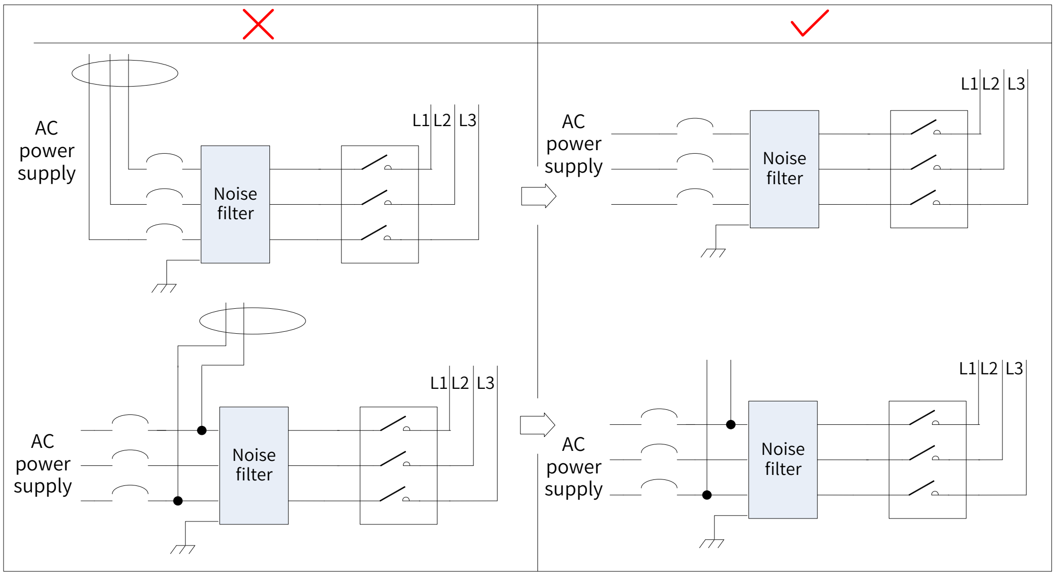


Figure 3-27 Separate routing of input and output cables

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

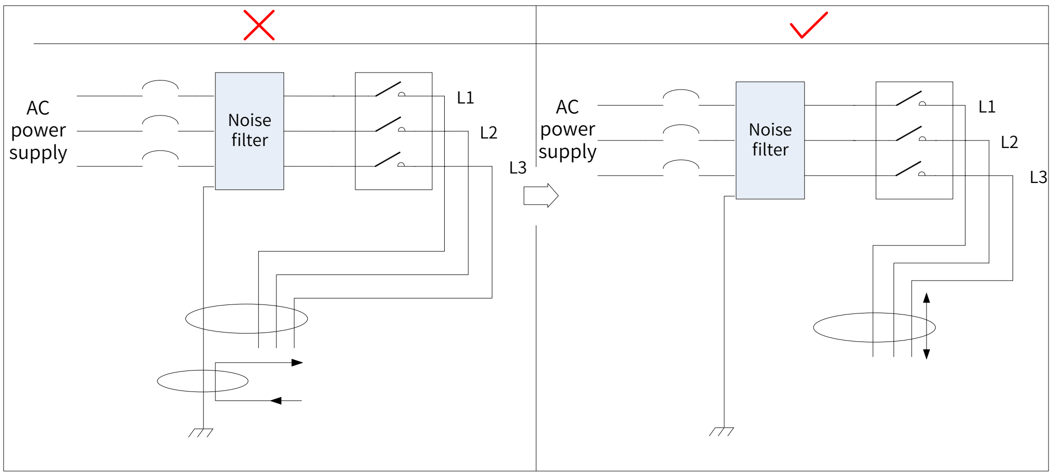


Figure 3-28 Separate routing of the grounding cable and the power output cable

■ 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.

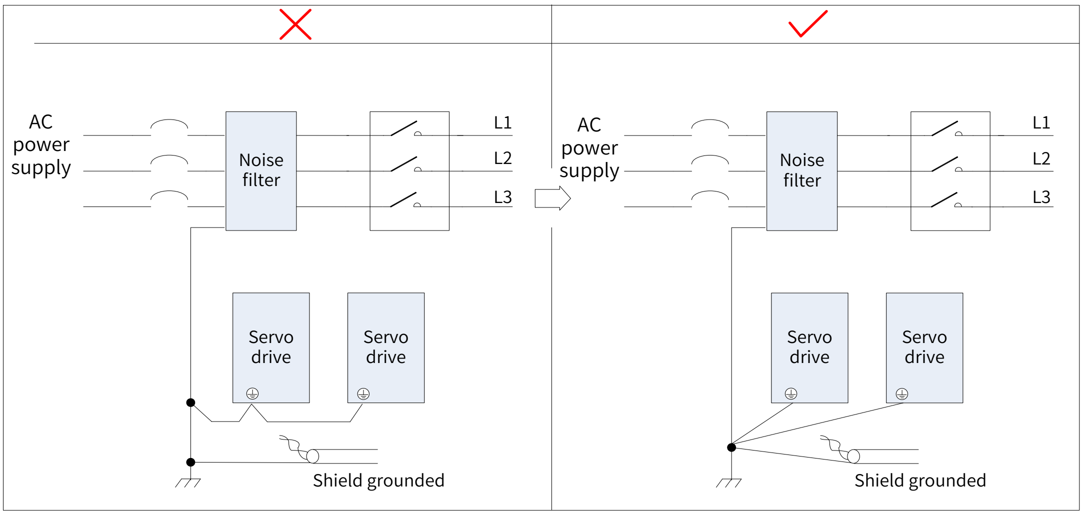


Figure 3-29 Single-point grounding

■ Ground the noise filter installed inside the control cabinet.

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

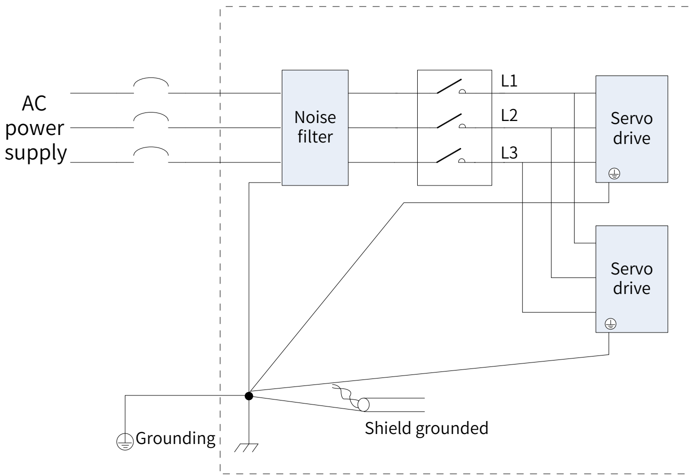


Figure 3-30 Grounding cable of the noise filter

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.

■ Use flexible cables for cable carriers. Ordinary cables may be easily damaged after being bent for a long time. Cables suitable for small-power servo motors do not fit for cable carriers.

Ensure the following requirements are fulfilled for use of cable carriers:

■ The bending radius of the cable must be 10 times longer than its outer diameter.

■ Do not secure or bundle the cables inside the cable carrier. Cables can be bundled and secured only at the two fixed ends of the cable carrier.

■ Do not wind or twist the cables.

- Ensure the space factor inside the cable carrier 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.

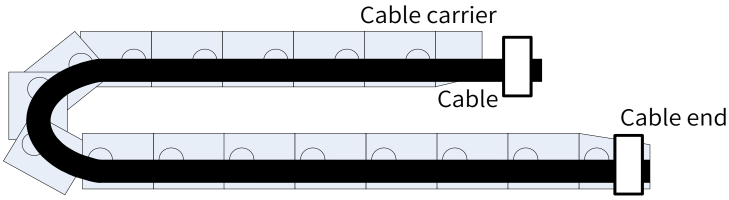


Figure 3-31 Cable carrier

4 Keypad Display and Operations

4.1 Introduction to the Keypad

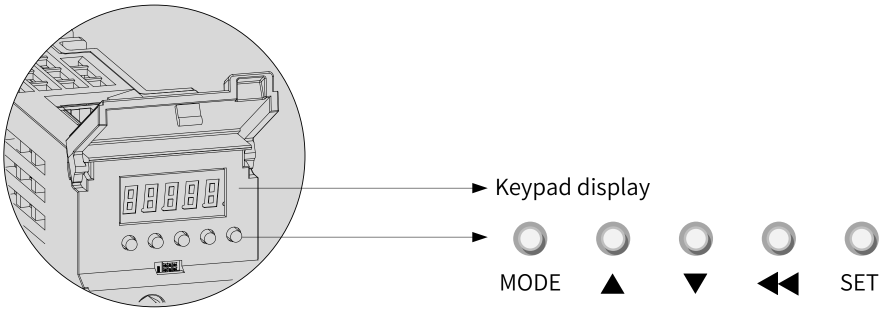


Figure 4-1 Appearance of the LED keypad

The keypad on the SV660N servo drive consists of five LEDs and five 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 buttons are described as follows.

Table 4-1 Functions of buttons

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 for viewing the high digits of a number consisting of more than 5 digits.
SET	SET	Used to enter the next menu and save parameter settings.

4.2 Display

The keyad displays the status, parameters, faults, and monitored values during operation.

- Status display: Displays current servo drive status, such as servo ready or running.
- Parameter display: Displays parameters and their setpoints.
- Fault display: Displays faults and warnings that occur on the servo drive
- Monitored value display: Displays present running parameters of the servo drive

4.2.1 Mapping 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 in the host controller.

4.2.2 Display Modes Switchover

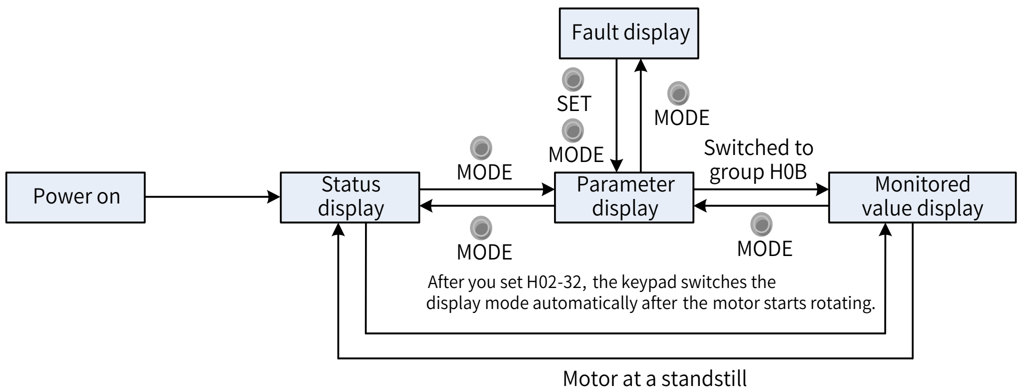
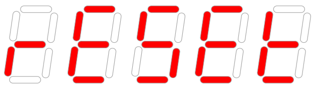
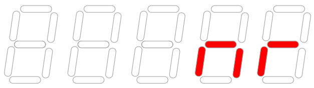
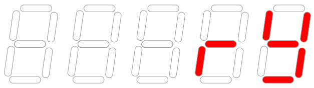
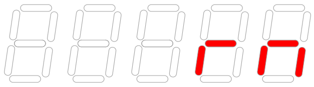
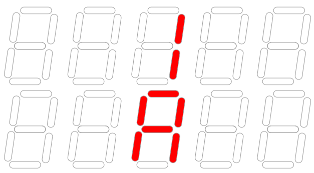
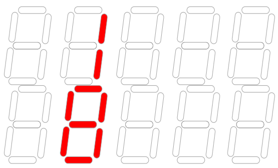
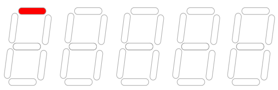
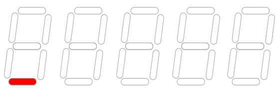


Figure 4-2 Switchover between different display modes

- After power-on, the keypad enters status display mode.
- Press MODE to switch between different modes, as shown in the preceding figure.
- In the status display mode, set H02-32 (Default keypad display) and select parameters to be monitored. When the motor rotates, the keypad automatically switches to the monitored value display mode. After the motor stops, the keypad automatically reverts to the status display mode.
- In the parameter display mode, set parameters in group H0B to select the parameters to be pre-monitored. After setting, the keypad switches to the monitored value display mode.
- Once a fault occurs, the keypad enters the fault display mode immediately, and all the five LEDs blink. Press SET to stop the LEDs from 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 the 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	As the main circuit is not powered on, the servo drive is not ready to run. See "10 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 from the host controller.
	rn (servo running)	S-ON signal activated	The servo drive is running.
	1–A (control mode)	-	Displays present operation 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: Initialization 2: Pre-operational 4: Safe operational 8: Operational
	- 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	

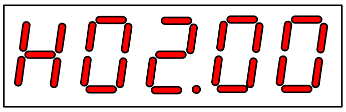
4.2.4 Parameter Display

SV660N servo drive parameters are divided into 14 groups based on parameter functions. A parameter can be located quickly based on the group it belongs to. See "12.2 List of Object Groups" to view the parameter list.

■ Display of the parameter group

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

For example, H02-00 is displayed as follows.

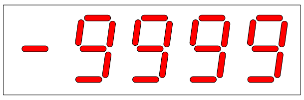
Display	Name	Description
	H02-00	02: Parameter group No. 00: Parameter No. within the group

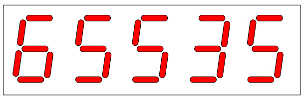
■ Display of negative numbers and data of different lengths

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 signed numbers, 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 the current page). Hold down for more than 2s to switch to the next page.

For example, -1073741824 is displayed as follows.

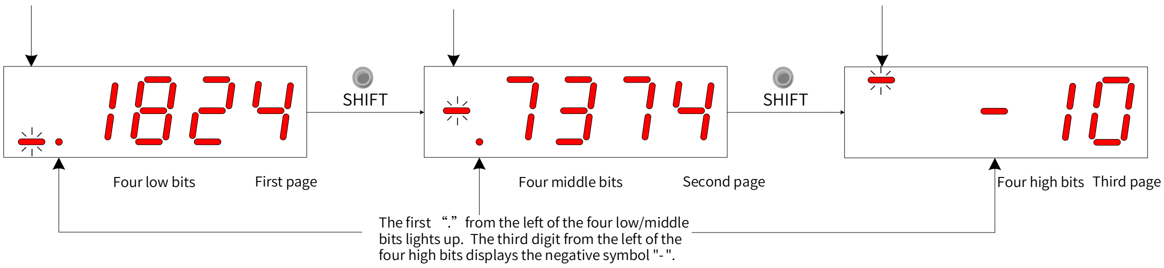


Figure 4-3 Display of "-1073741824"

For example, 1073741824 is displayed as follows.

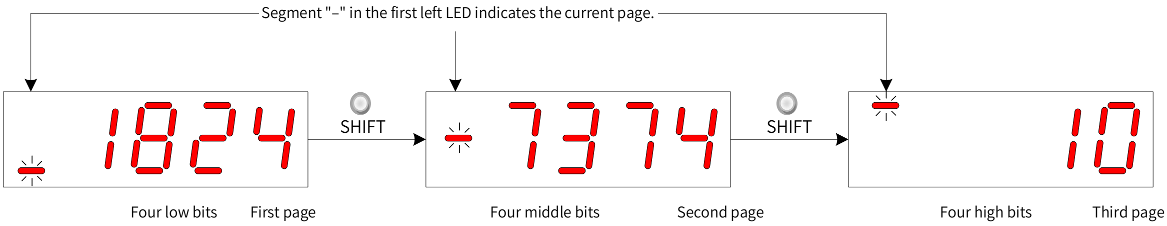
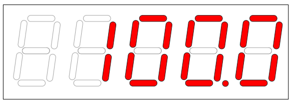


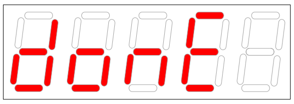
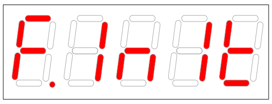
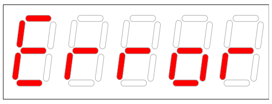
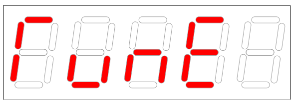
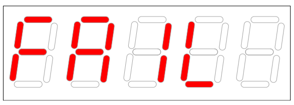
Figure 4-4 Display of "1073741824"

■ 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 done)	Parameter setting done	The parameter value is set and stored in the servo drive. The servo drive is ready to perform 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, restart the control circuit power supply.
	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 failed.

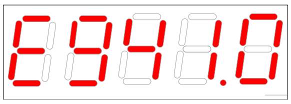
4.2.5 Fault Display

■ The keypad can display present or previous faults and warnings. For analysis and solutions to the faults and warnings, see *"10 Troubleshooting"*.

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

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

For example, E941.0 is displayed as follows.

Display	Name	Description
	E941.0	E: Fault or warning 941.0: Fault or warning code

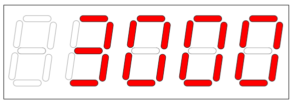
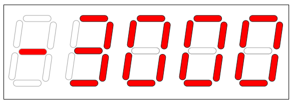
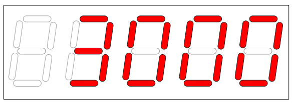
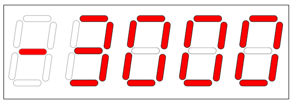
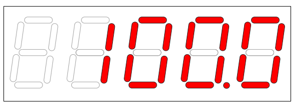
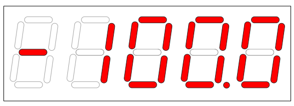
4.2.6 Monitored Value Display

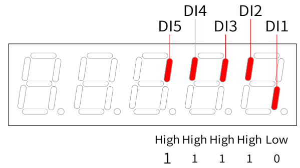
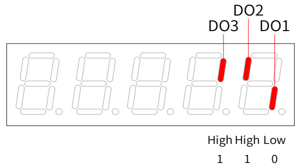
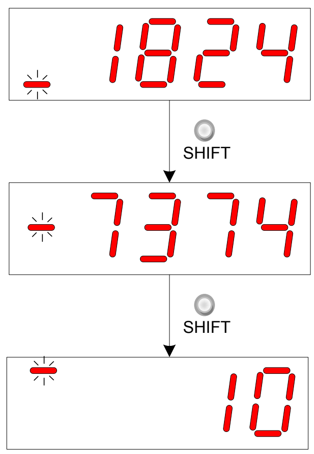
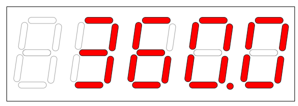
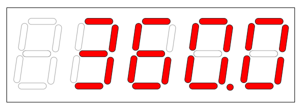
Group H0B: Displays parameters used to monitor the operating state of the servo drive.

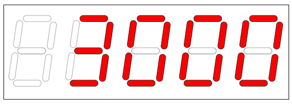
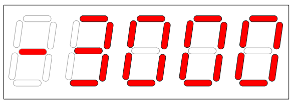
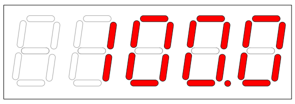
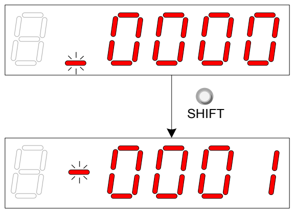
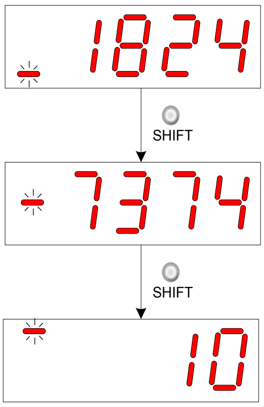
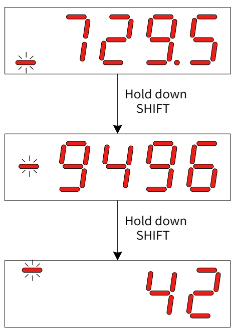
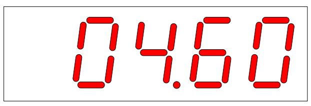
Set H02-32 (Default keypad display). After the servo motor runs, the keypad switches from the status display mode to the parameter display mode and displays the parameter No. defined by H02-32 in group H0B.

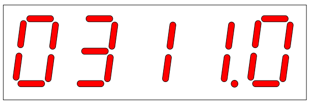
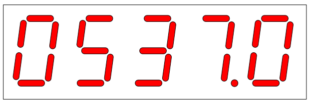
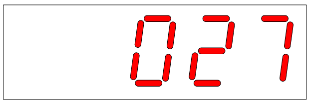
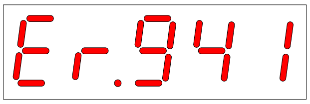
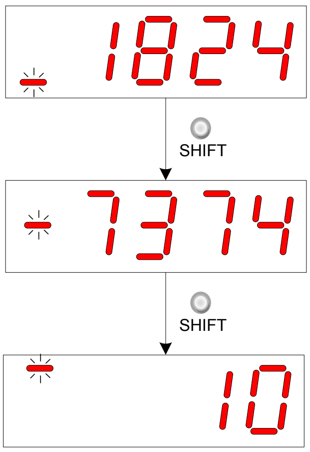
For example, if H02-32 is set to 00, the keypad displays the value of H0B-00 when the motor speed is not 0 RPM.

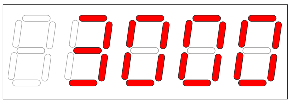
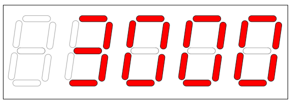
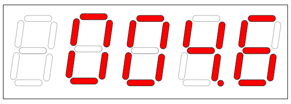
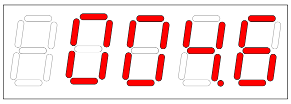
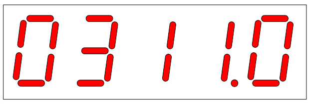
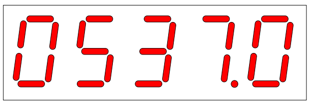
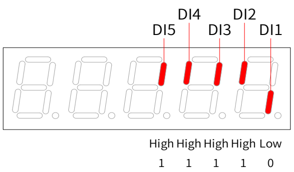
See details of the monitored value display mode in the following table.

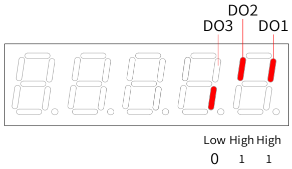
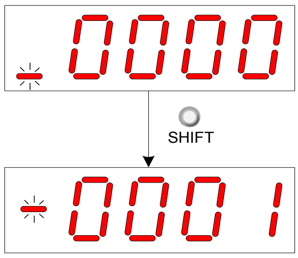
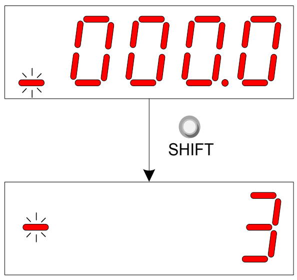
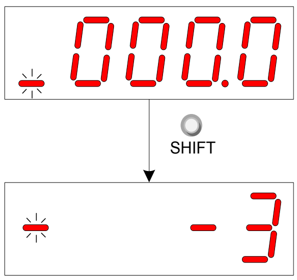
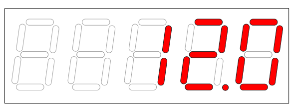
Para. No.	Name	Unit	Meaning	Display Example
H0B-00	Motor speed actual value	RPM	Displays the actual value of the motor speed after round-off, which is accurate to 1 RPM.	Display of 3000 RPM:  Display of -3000 RPM: 
H0B-01	Speed reference	RPM	Displays present speed reference of the servo drive.	Display 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%: 

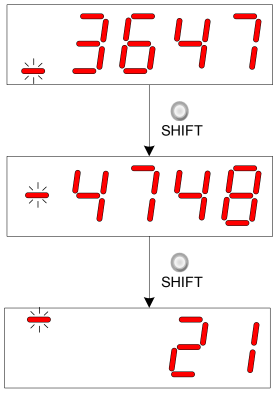
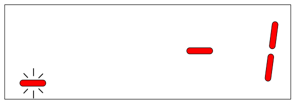
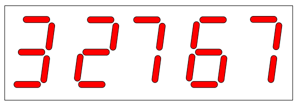
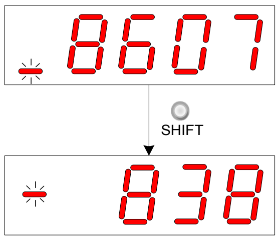
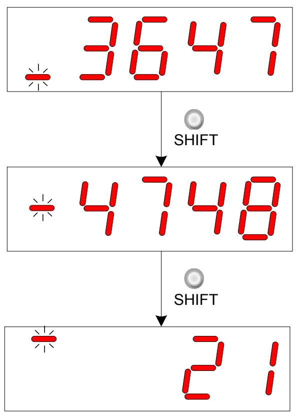
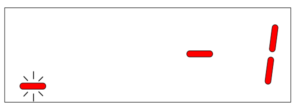
Para. No.	Name	Unit	Meaning	Display Example
H0B-03	Monitored DI status	-	Displays the level status of DI1 to DI5: Upper LED segment ON: High level (indicated by "1") Lower LED segment ON: Low level (indicated by "0") The value of H0B-03 read using the software tool is a decimal number.	In the case where DI1 input is low level and DI2 to DI5 inputs are high level, the corresponding binary value is 11110, the value of H0B-03 read using the software tool is 0x001E, and the corresponding display status is as follows. 
H0B-05	Monitored DO status	-	Displays the level status of DO1 to DO3: Upper LED segment ON: High level (indicated by "1") Lower LED segment ON: Low level (indicated by "0") The value of H0B-05 read using the software tool is a decimal number.	In the case where DO1 is low level and DO2 to DO3 are high level, the corresponding binary value is 110, the value of H0B-05 read using the software tool is 0x0006, and the corresponding display status 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 in reference unit: 
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°: 

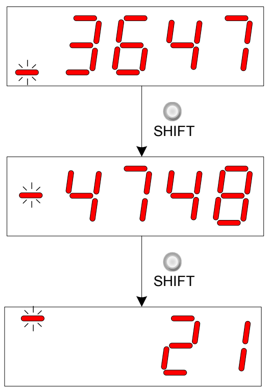
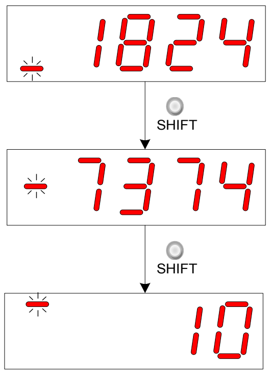
Para. No.	Name	Unit	Meaning	Display Example
H0B-11	Speed information corresponding to the input position reference	RPM	Displays the speed corresponding to the position reference in an individual control cycle.	Display of 3000 RPM:  Display of -3000 RPM: 
H0B-12	Average load rate	0.1%	Displays the percentage of the average load torque to the rated torque of the motor.	Display of 100.0%: 
H0B-15	Encoder position deviation counter (displayed in 32-bit decimal)	Encoder unit	Encoder position deviation = Sum of input position references (encoder unit) - Sum of pulses fed back by the encoder (encoder unit)	Display of 10000 in encoder unit: 
H0B-17	Feedback pulse counter (displayed in 32-bit decimal)	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 in encoder unit: 
H0B-19	Total power-on time (displayed in 32-bit decimal)	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 terminals 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 of the fault defined by H0B-33. When no fault occurs, 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-33 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-33 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-33 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-33 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-33 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 electrical status of the five DIs when the fault defined by H0B-33 occurred. The viewing method is the same as that of H0B-03. When there is no fault, all the DIs are low level, as displayed in in H0B-41, and the corresponding hexadecimal value is "0".	In the case where the value of H0B-41 read using the software tool is 0x0001, the corresponding binary code will be 0000 0000 0000 0001. 

Para. No.	Name	Unit	Meaning	Display Example
H0B-43	Output terminal status upon occurrence of the selected fault	-	Displays the electrical status of the three DOs when the fault defined by H0B-33 occurred. The viewing method is the same as that of H0B-05. When there is no fault, all the DOs are low level, as displayed in H0B-43, and the corresponding decimal value is "0".	Display of H0B-43 = 0x0003: 
H0B-53	Position deviation counter (displayed in 32-bit decimal)	Reference unit	Position deviation = Sum of input position references (reference unit) - Sum of pulses fed back by the encoder (reference unit)	Display of 10000 in reference unit: 
H0B-55	Motor speed actual value	0.1 RPM	Displays the actual value of the motor speed, which is accurate to 0.1 RPM.	Display of 3000.0 RPM:  Display of -3000.0 RPM: 
H0B-57	Control circuit voltage	0.1 V	Displays the DC voltage of the control circuit.	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 in encoder unit: 
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" in encoder unit: 
H0B-70	Number of absolute encoder revolutions	Rev	Displays the present number of revolutions of an absolute encoder.	Display of 32767: 
H0B-71	Single-turn position feedback of the absolute encoder	Encoder unit	Displays the single-turn position feedback of the absolute encoder.	Display of 8388607 in encoder unit: 
H0B-77	Absolute encoder position (low 32 bits)	Encoder unit	Displays the absolute position (low 32 bits) of the motor when the absolute encoder is used.	Display of 2147483647 in encoder unit: 
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" in 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 the rotation mode.	Display of 2147483647 in encoder unit: 
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 the rotation mode.	Display of 1 in 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 the rotation mode.	Display of 1073741824 in reference unit: 

4.3 Parameter Settings

Parameter settings can be performed through the keypad. For details on parameters, see "12.2 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.

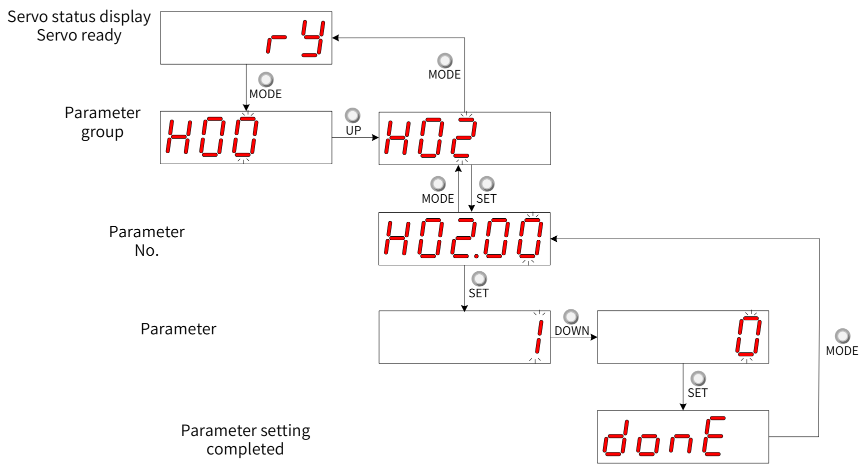


Figure 4-5 Procedure for parameter setting

- 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 setpoint 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 the 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".

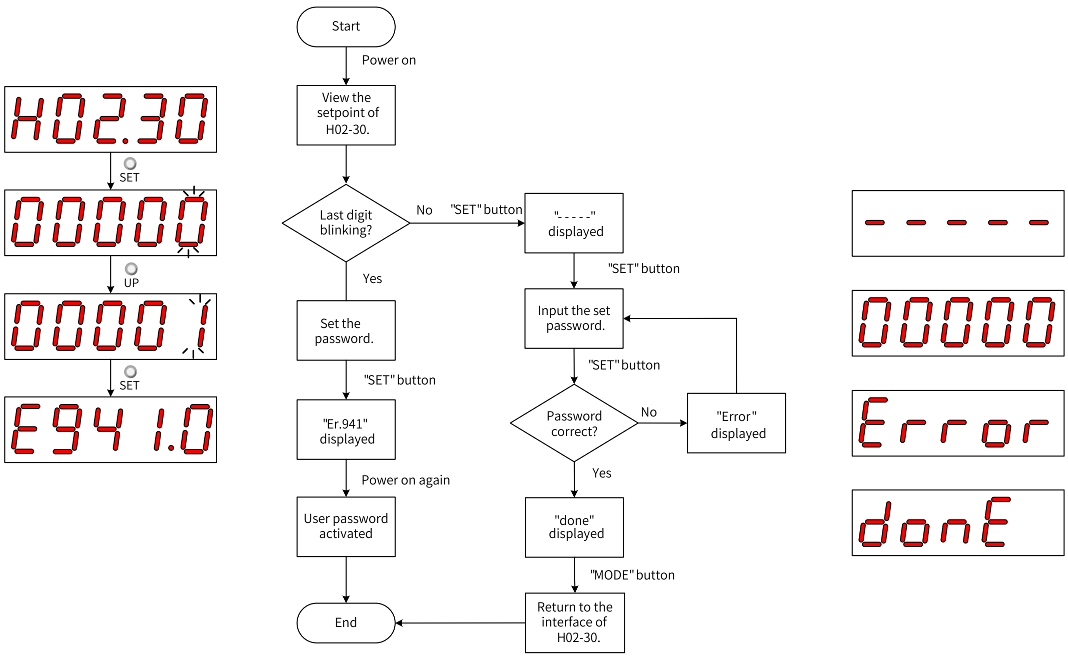


Figure 4-6 Procedure for user password setting

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, access to parameters is password 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 the 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

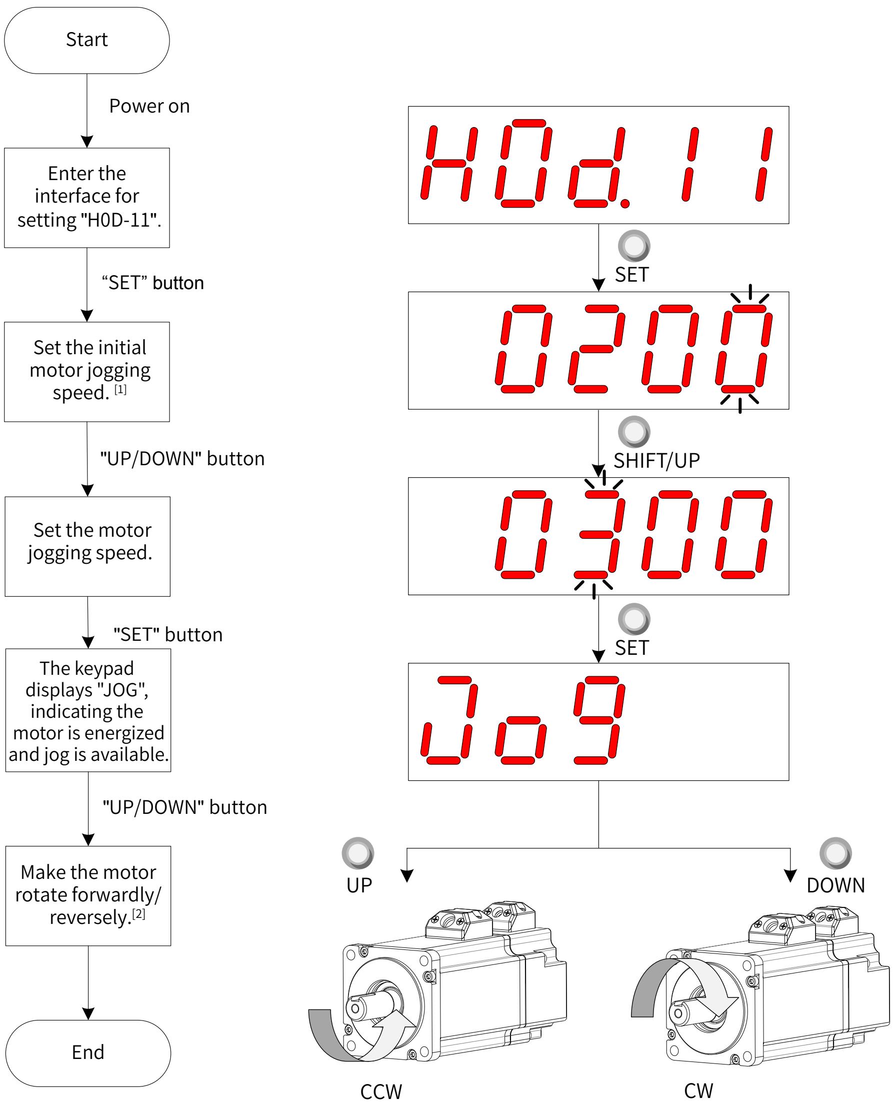


Figure 4-7 Procedure for setting the jog function

[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 jog status and return to the previous menu.

4.5.2 Forced DI/DO Signals

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

The servo drive also offers 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 DI terminal function				
Functions of DI signals				
01	S-ON	Servo ON	Inactive - Servo motor disabled in local mode Active - Servo motor enabled in local mode	The S-ON function is active only in the non-bus control mode. The corresponding DI logic must be level-triggered.
02	ALM-RST	Fault reset	Active: Fault reset under local mode Inactive: Fault not reset under local mode	This function is active only in the non-bus control mode. It is recommended the corresponding DI logic be level-triggered.
14	P-OT	Positive limit switch	Active - Forward drive inhibited Inactive - Forward drive permitted	Overtravel prevention applies when the mechanical movement is beyond the movable range. It is recommended the corresponding DI logic be level-triggered.
15	N-OT	Negative limit switch	Active - Reverse drive inhibited Inactive - Reverse drive permitted	Overtravel prevention applies when the mechanical movement is beyond the movable range. It is recommended the corresponding DI logic be level-triggered.
31	HomeSwitch	Home switch	Inactive - Mechanical load beyond the home switch range Active - Mechanical load within the home switch range	The corresponding DI logic must be level-triggered.
34	EmergencyStop	Emergency stop	Active: Position locked after stopping at zero speed Inactive: Current running status not affected	It is recommended the corresponding DI logic be level triggered.
38	TouchProbe1	Touch probe 1	Inactive - Probe not triggered Active - Probe can be triggered	The probe logic is only related to the probe function (60B8h).
39	TouchProbe2	Touch probe 2	Inactive - Probe not triggered Active - Probe can be triggered	The probe logic is only related to the probe function (60B8h).
Functions of DO signals				

Code	Name	Function	Description	Remarks
01	S-RDY	Servo ready	Active - Servo ready Inactive - Servo not ready	The servo drive is ready to run.
02	TGON	Motor rotating	Inactive - Absolute value of filtered motor speed smaller than the value of H06-16. Active - Absolute value of filtered motor speed reaching the value of H06-16.	-
09	BRK	Brake output	Active: Brake signal outputted Inactive: Brake signal not outputted	-
10	WARN	Warning	Active - Warning occurred on the servo drive Inactive - No warning occurred on the servo drive or the warning has been reset	-
11	ALM	Fault	Active - Fault occurred on the servo drive Inactive - No fault occurred on the servo drive or the fault has been reset	-
25	CMP	Position comparison	Active: Servo drive passing the target position comparison point Inactive: Servo drive not passing the target position comparison point	-
32	EDM	Safety status	Active: STO function triggered Inactive: STO function not triggered	The EDM outputs active signals only when the 24 V input voltages for STO1 and STO2 are disconnected simutaneously.

1 Forced DI function

When this function is enabled, all DI levels are controlled by H0D-18 (Forced DI value), which is not related to the external DI signal status.

■ Operating process

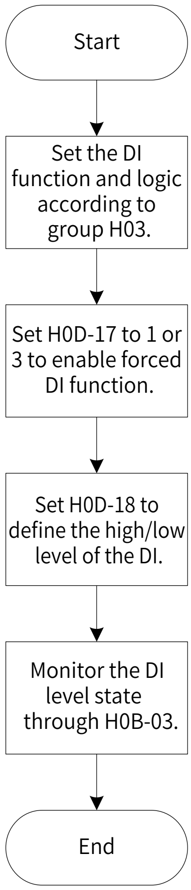


Figure 4-8 Procedure for setting forced DI function

☆ Related parameter

Parameter No.		Name	Value Range	Function	Setting Condition	Effective Time	Default
Keypad Side	Software Tool Side						
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: EtherCAT 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 display value is a hexadecimal, after being converted to a binary, the number "1" indicates high level and the number "0" indicates low level.

The DI logic is defined by parameters in group H03. The DI level status is monitored by H0B-03 and displayed on the keypad. The value of H0B-03 (Monitored DI signal) read through the software tool is a hexadecimal.

■ Example

To activate the function assigned to DI1 and deactivate functions assigned to DI2...DI5, set as follows (logic of all the five DIs being "active low"):

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

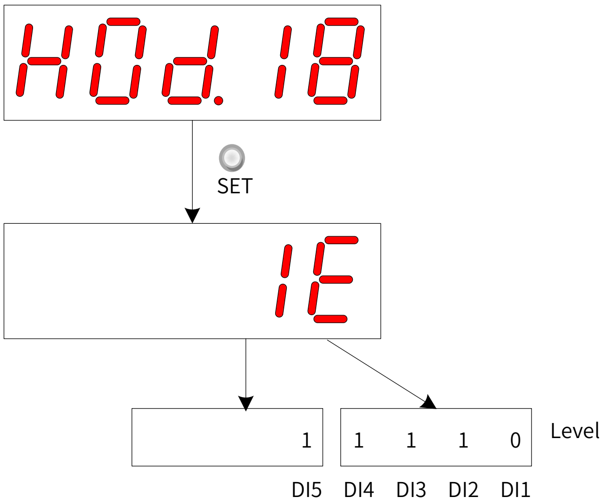


Figure 4-9 Description of the setpoint of H0D-18

Monitoring the DI level status through H0B-03:

If the DI function is normal, the display 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 DI5 are displayed as high level on the keypad, and the value of H0B-03 read through the software tool is 1E (hexadecimal). The keypad displays as follows.

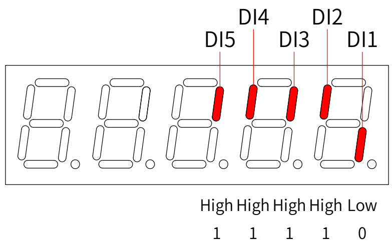


Figure 4-10 DI level status corresponding to H0B-03

■ 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 function

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 in vertical motion, if the brake output signal (FunOUT.9: BK, brake output) is used, the brake is released and the load may fall. Therefore, take protective measures on the machine to prevent falling.

■ Operating process

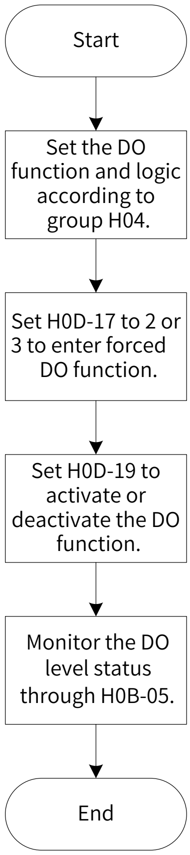


Figure 4-11 Procedure for setting forced DO function

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

The DO logic is defined by parameters in group H04. The DO level status is monitored by H0B-05 and displayed on the keypad. The value of H0B-05 (Monitored DO signal) read through the software tool is a hexadecimal.

Example: To activate the DO function assigned to DO1 and deactivate DO functions assigned to DO2...DO3, set as follows:

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

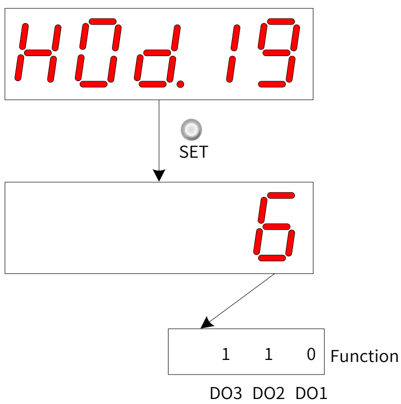


Figure 4-12 Description of the setpoint of H0D-19

Monitoring the DO level status through H0B-05

If the logics of DO1 to DO3 are "active low", then DO1 is high level and DO2 to DO3 are low level, and the corresponding binary number is "001". In this case, the value of H0B-05 (Monitored DO signal) read through the software tool is 1 (decimal). The keypad displays as follows.

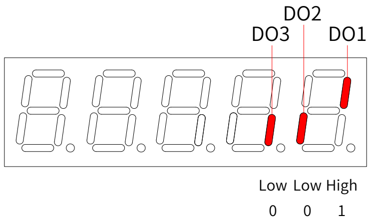


Figure 4-13 Display of H0B-05 when all DOs are "active low"

If the logics of DO1 to DO3 are "active high", then DO1 is low level and DO2 to DO3 are high level, the corresponding binary number is "110", and the value of H0B-05 (Monitored DO signal) read through the software tool is 6 (decimal). The keypad displays as follows.

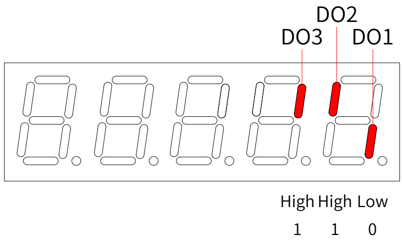


Figure 4-14 Display of H0B-05 when all DOs are "active high"

■ 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 EtherCAT-controlled forced DO function

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

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

■ Operating process

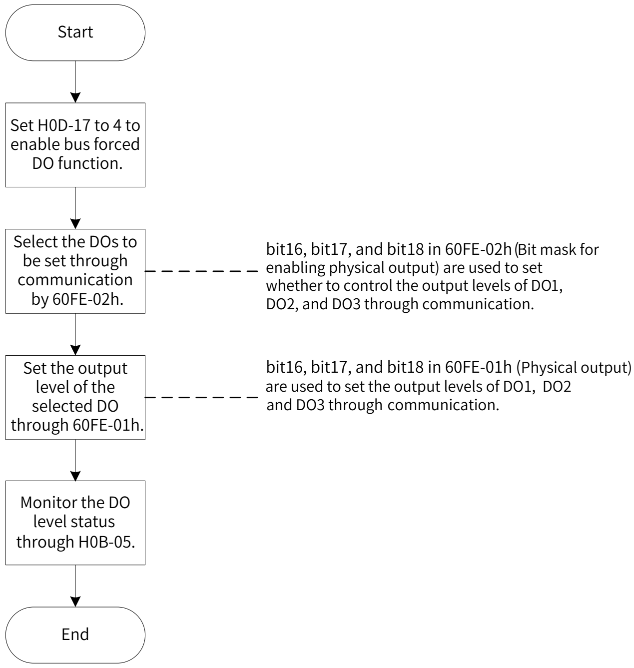


Figure 4-15 Procedure for setting forced DO through EtherCAT

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

Bit	Related DO	Physical Output Enable: 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 among bit16 to bit18 of 60FE-02h is set to 1, the corresponding forced DO is OFF.

The DO level status is monitored by H0B-05 and displayed on the keypad. The value of H0B-05 (Monitored DO signal) read through the software tool is a hexadecimal.

Example: To make the output level of DO1 to DO3 be forcibly set by the EtherCAT 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 displays as follows.

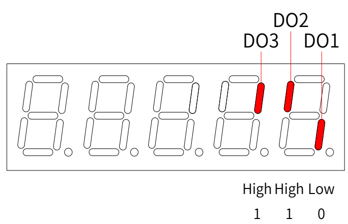


Figure 4-16 Display of H0B-05 when DO signals are controlled by EtherCAT

■ Exit

The EtherCAT-controlled 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.

5 Commissioning and Operation

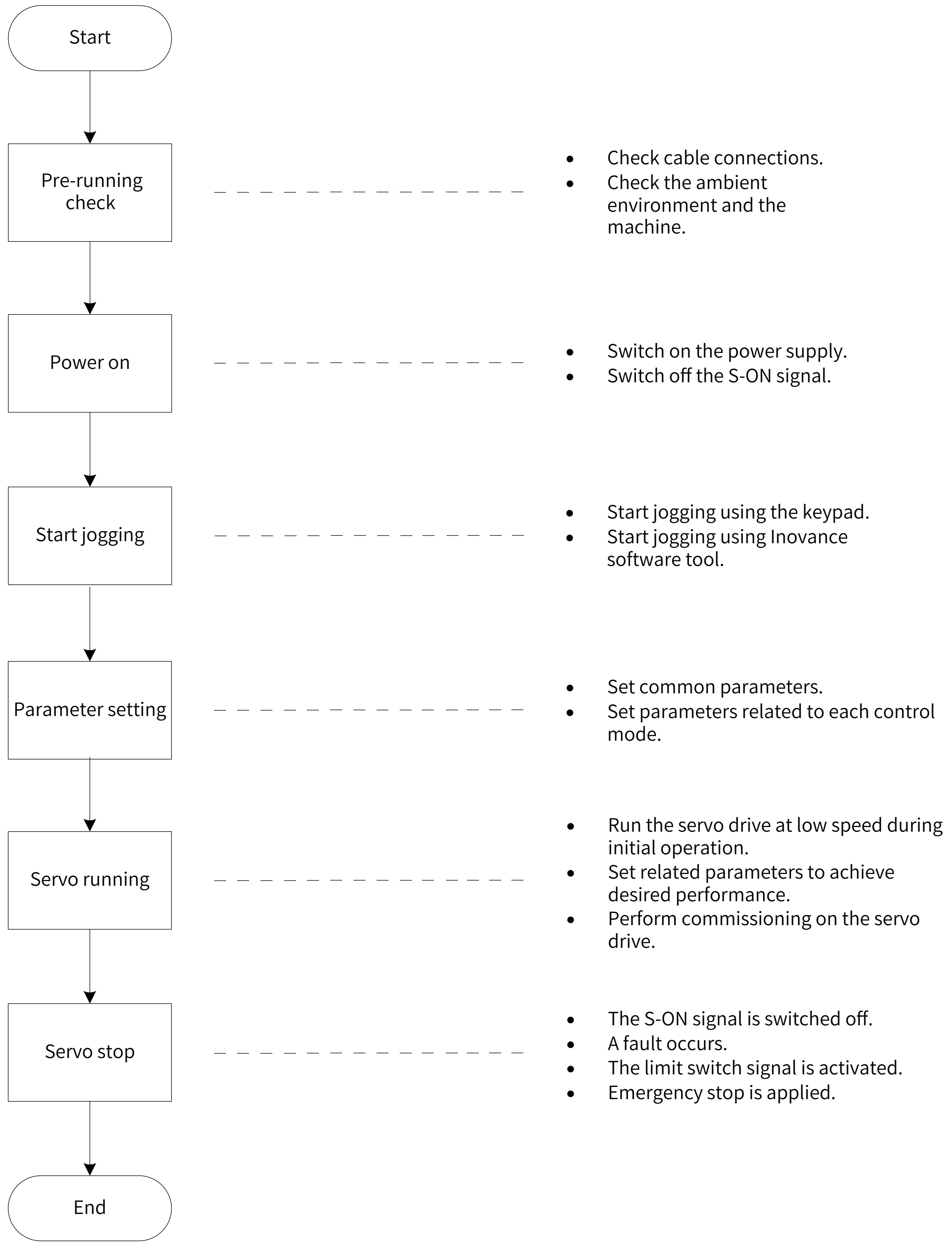


Figure 5-1 Flowchart for setting the servo drive

5.1 Pre-running Check

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

Table 5-1 Pre-running checklist

Record	No.	Description
Wiring		
☐	1	Power input terminals 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 or the main circuit output terminals (U, V, W) of the servo drive.
☐	4	The control signal cables are connected properly. External signal cables such as brake and overtravel prevention signals are connected properly.
☐	5	The servo drive and the servo motor are grounded properly.
☐	6	The stress on cables is within the permissible range.
☐	7	The connecting terminals are well insulated.
Environment and Mechanical Conditions		
☐	1	No unwanted objects (such as the cable end or metal filings) which may cause short circuit are present inside or near the servo drive.
☐	2	The servo drive and the external regenerative resistor are placed on incombustible 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 terminals for single-phase 220 V power supplies are L1 and L2.

The input terminals for three-phase power supplies are L1/L2/L3 or L1C/L2C (control circuit power input terminals) and R/S/T (main circuit power input terminals)

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 *"10 Troubleshooting"* for solutions.

If the keypad displays the fault code, see *"10 Troubleshooting"* for solutions.

■ Deactivating the S-ON signal

Switch the servo state machine and deactivate the S-ON signal sent from the host controller.

Deactivate the DI enable signal or the internal auxiliary function enable signal.

5.3 Jogging

Perform jogging to check whether the servo motor rotates properly without unusual vibration or noise. The jog function can be started using the keypad (jogging in the speed mode/jogging in the position mode) or Inovance software tool (jogging in the speed mode).

NOTE

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

■ Using the keypad (jogging in the speed mode)

Enter jogging in the 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 jogging as needed. Press MODE to exit from the jogging mode.

■ Using Inovance software tool (jogging in the speed mode)

Open the "Speed JOG" interface 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.

■ Using the keypad (jogging in the position mode)

Enter jogging in the 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 jogging as needed. Press MODE to exit from the jogging 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 Direction of Rotation

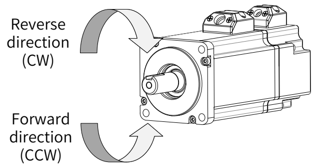
Set H02-02 (2002-03h) (Direction of rotation) to change the motor direction of rotation without changing the polarity of the input reference.

☆ Related parameters:

H02-02	Name	Direction of rotation			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 shaft side.

Value	Rotation direction	Remarks
0	CCW as the forward direction	Defines the CCW direction as the forward direction when a forward run command is received, indicating the motor rotates in the CCW direction when viewed from the motor shaft side.
1	CW as the forward direction	Defines the CW direction as the forward direction when a forward run command is received, indicating the motor rotates in the CW direction when viewed from motor shaft side.



Changes in the setpoint of H02-02 (2002-03h) do not affect the pulse output form or the positive/ negative attribute of monitoring parameters.

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

5.4.2 Brake Settings

The brake is used to prevent the servo motor shaft from rotating when the servo drive is in the non-operating state. This is to keep the motor and the mechanical load in locked positions.

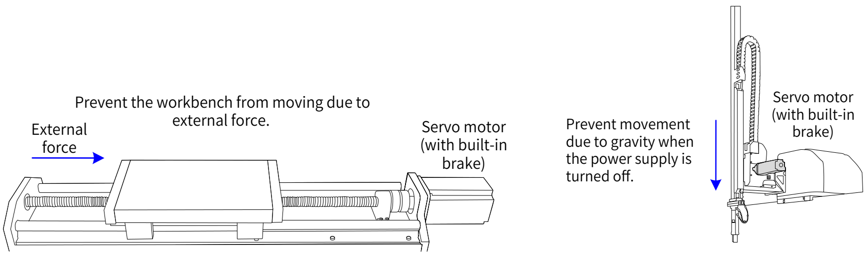


Figure 5-2 Application of the motor brake

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 a clattering sound. Such sound can be considered normal. ◆ 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 Wiring of the brake

The motor brake input signal is connected without polarity differentiation. 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.

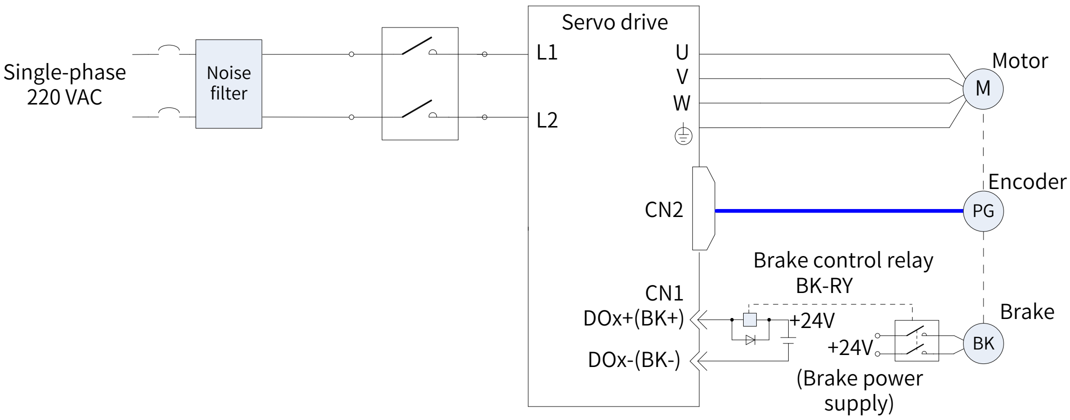


Figure 5-3 Wiring of the motor brake

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 servo motors.

Table 5-2 Brake specifications

Motor Model	Holding Torque (N·m)	Supply Voltage (V_{DC}) ±10%	Rated Power (W)	Coil Resistance (Ω) (±7%)	Excitation Current (A)	Apply Time (ms)	Release Time (ms)	Backlash (°)
MS1H1-05B/10B	0.32	24	6.1	94.4	0.25	≤ 40	≤ 20	≤ 1.5
MS1H1-20B/40B MS1H4-40B	1.5		7.6	75.79	0.32	≤ 60	≤ 20	≤ 1.5
MS1H1/H4-75B	3.2		10	57.6	0.42	≤ 60	≤ 40	≤ 1.0
MS1H3-85B/13C/18C	12		19.4	29.7	0.81	≤ 120	≤ 60	≤ 0.5
MS1H2-10C/15C/20C/25C	8	24	23	25	0.96	≤ 85	≤ 30	≤ 0.5
MS1H2-30C/40C/50C	16		27	21.3	1.13	≤ 100	≤ 60	≤ 0.5
MS1H3-29C/44C/55C/75C	50		40	14.4	1.67	≤ 200	≤ 100	≤ 0.5

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 DO function 9 (FunOUT.9: BK, brake output) to a certain DO (DO3 by default), and set the active logic of this DO.

Related DO function

Function No.	Name	Function	Description
FunOUT.9	BK	Brake output	Inactive: The brake power supply is switched off and the brake applies. In this case, the motor is locked. Active: The brake power supply is switched on and the brake is released. In this case, 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 under normal state and brake time sequence under fault state.

3 Brake time sequence under normal state

The brake time sequence under normal state is divided into the following two conditions:

Motor at a 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 a 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 for the motor at a standstill.

CAUTION

- When the brake output 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 operation 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 a 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 load from moving due to the gravity or external force.

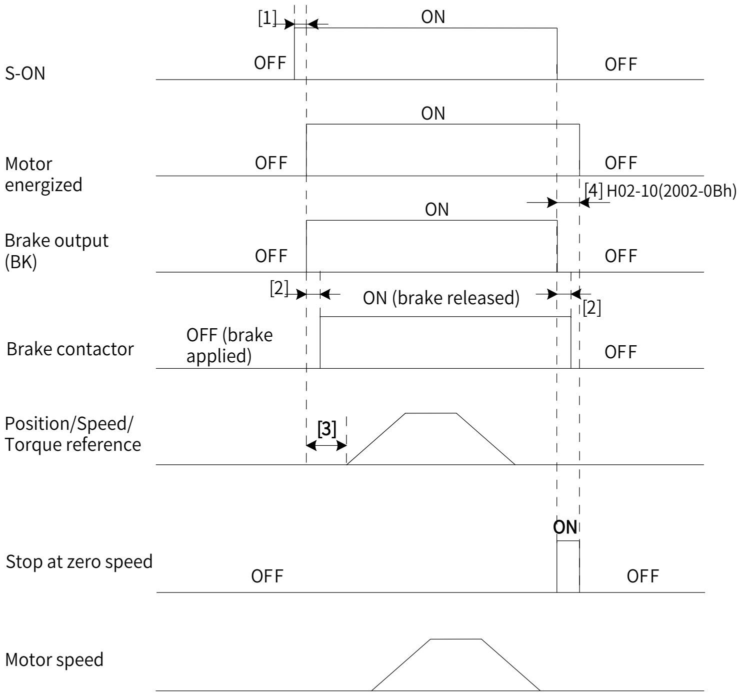


Figure 5-4 Brake time sequence for motor at a standstill

[1] For the brake delay time, see *"4 Keypad Display and Operations"* for details.

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

[3] For the motor at a standstill (motor speed less than 20 RPM), when the S-ON signal is off, the brake output will be off immediately. 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 is 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 is off to the moment when the motor enters de-energized status.										

■ Motor rotating

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

CAUTION

- When S-OFF changes to S-ON, do not input a position/speed/torque reference within the time defined by 2009-0Ah/2000-34h. Otherwise, reference loss or operation error may occur.
- If the S-ON signal is off during motor rotating, the servo motor enters ramp-to-stop state as defined by 6085h, but the brake output signal will be 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 stays energized within the time defined by 2002-0B to prevent the mechanical load from moving due to the gravity or external force.

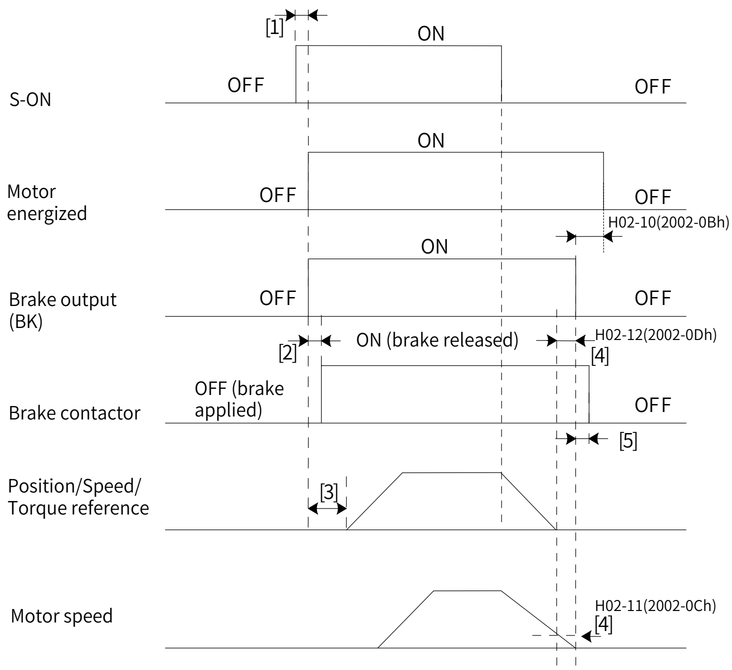


Figure 5-5 Brake time sequence for motor in the rotating state

[1] For the brake delay time, see "4 Keypad Display and Operations" for details.

[2] The time interval from the moment when brake output is on to the moment when the command is input must be longer 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

H02-11	Name	Motor speed threshold at brake output OFF in the rotating state			Setting Condition & Effective time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
2002-0Ch	Access	RW	Mapping	-	Related Mode	All	Data Range	20–3000 (RPM)	Default	30
Defines the motor speed threshold when the brake output signal is off during motor rotating.										

H02-12	Name	Delay from S-ON OFF to brake output OFF in the rotating state			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
2002-0Dh	Access	RW	Mapping	-	Related Mode	All	Data Range	1–1000 (ms)	Default	500
Defines the delay from the moment the S-ON signal is off to the moment when brake output signal is off.										

■ 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 under normal state (motor rotating).

■ Brake time sequence under fault state

The servo drive faults are classified into level 1 faults (No. 1) and level 2 (No. 2) faults. For details, see "10 Troubleshooting". The brake time sequences under fault state are divided into the following two situations:

1) No. 1 faults:

When a No. 1 fault occurs and the brake is used, the stop mode is forcibly set to "Dynamic braking stop, keeping dynamic braking state", but the brake output condition is the same as the brake time sequence under normal state (motor rotating).

2) No. 2 faults:

When a No. 2 fault occurs and the brake is used, the stop mode is forcibly set to "Ramp to stop, keeping dynamic braking state", but the brake output condition is the same as the brake time sequence under normal state (motor rotating).

NOTE

◆ Recommended setpoints:
When the brake is used, the setpoint 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 direction of rotation, the energy is returned 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 one. The following table lists the specifications of the regenerative resistor.

Table 5-3 Specifications of the regenerative resistor

Servo Drive Model	Specifications of Built-in Regenerative Resistor			Minimum Permissible Resistance of External Regenerative Resistor (Ω) (H02-21)
	Resistance (Ω)	Power Pr (W)	Processable Power Pa (W)	
SV660NS1R6I	-	-	-	50
SV660NS2R8I	-	-	-	45
SV660NS5R5I	50	50	25	40
SV660NS7R6I	25	60	30	20
SV660NS012I				15
SV660NT3R5I	100	60	30	80
SV660NT5R4I	100	60	30	60
SV660NT8R4I	50	75	40	45
SV660NT012I				40
SV660NT017I	35	100	50	35
SV660NT021I				25
SV660NT026I				

S1R6 and S2R8 models do not have the built-in regenerative resistor. For these models, you need to prepare an external regenerative resistor if required.

■ Without external load torque

The kinetic energy upon braking of a reciprocating motor motion 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 shows the motor speed curve in a no-load operation from 3000 RPM to a standstill.

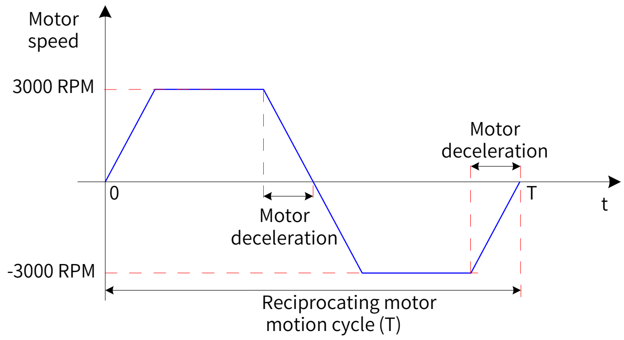


Figure 5-6 Motor speed curve without external load torque

■ Energy data caculation

SV660NS1R6I and SV660NS2R8I models do not carry a built-in regenerative resistor. The energy that can be charged by the capacitor is shown as follows. If the rotating energy of the servo motor and the load exceed the regenerative energy that can be processed, connect an external regenerative resistor.

<table>
<tr><th>Servo Drive Model</th><th>Processable Regenerative Energy</th><th>Remark</th></tr>
<tr><td>SV660NS1R6I</td><td>13.15</td><td rowspan="2">The input voltage of the main circuit power supply is 220 VAC.</td></tr>
<tr><td>SV660NS2R8I</td><td>26.29</td></tr>
</table>

The following table lists the energy generated when a 220 V servo motor changes from no-load operation at the rated speed to a standstill.

<table>
<tr><th>Capacity (W)</th><th colspan="2">Servo Motor Model MS1H*-*******-*****</th><th>Rotor Inertia J(10^{-4}kgm^2)</th><th>Braking Energy Generated When Changing From No-load Operation at Rated Speed to a Standstill E_O(J)</th><th>Maximum Braking Energy Absorbed by the Capacitor E_C(J)</th></tr>
<tr><td rowspan="2">750</td><td rowspan="2">MS1H1 (low inertia, small capacity)</td><td>MS1H1-75B30CB-*331Z</td><td>1.38</td><td>6.8</td><td rowspan="2">22.4</td></tr>
<tr><td>MS1H1-75B30CB-*334Z</td><td>1.43</td><td>7.1</td></tr>
<tr><td rowspan="2">1000</td><td rowspan="4">MS1H2 (low inertia, medium capacity)</td><td>MS1H2-10C30CB-*331Z</td><td rowspan="2">1.87</td><td rowspan="2">9.2</td><td rowspan="2">26.7</td></tr>
<tr><td>MS1H2-10C30CB-*334Z</td></tr>
<tr><td rowspan="2">1500</td><td>MS1H2-15C30CB-*331Z</td><td rowspan="2">2.46</td><td rowspan="2">12.2</td><td>26.7</td></tr>
<tr><td>MS1H2-15C30CB-*334Z</td><td>47.7</td></tr>
<tr><td rowspan="2">850</td><td rowspan="4">MS1H3 (medium inertia, medium capacity)</td><td>MS1H3-85B15CB-*331Z</td><td>13.3</td><td>65.8</td><td rowspan="2">22.4</td></tr>
<tr><td>MS1H3-85B15CB-*334Z</td><td>14</td><td>69.2</td></tr>
<tr><td rowspan="2">1300</td><td>MS1H3-13C15CB-*331Z</td><td>17.8</td><td>88.0</td><td rowspan="2">22.4</td></tr>
<tr><td>MS1H3-13C15CB-*334Z</td><td>18.5</td><td>91.5</td></tr>
<tr><td rowspan="2">750</td><td rowspan="2">MS1H4 (medium inertia, small capacity)</td><td>MS1H4-75B30CB-*331Z</td><td>2</td><td>9.9</td><td rowspan="2">22.4</td></tr>
<tr><td>MS1H4-75B30CB-*334Z</td><td>2.012</td><td>9.9</td></tr>
</table>

The following table lists the energy generated when a 380 V motor changes from no-load operation at the rated speed to a standstill.

Capacity (W)	Servo Motor Model MS1H*-*******-*****		Rotor Inertia $J(10^{-4}kgm^2)$	Braking Energy Generated When Changing From No-load Operation at Rated Speed to a Standstill $E_O(J)$	Maximum Braking Energy Absorbed by the Capacitor $E_C(J)$
1000	MS1H2 (low inertia, medium capacity)	MS1H2-10C30CD-*331Z	1.87	9.2	34.3
		MS1H2-10C30CD-*334Z			
1500		MS1H2-15C30CD-*331Z	2.46	12.2	34.3
		MS1H2-15C30CD-*334Z			
2000		MS1H2-20C30CD-*331Z	3.06	15.1	50.4
2500		MS1H2-25C30CD-*331Z	3.65	18.0	50.4
3000		MS1H2-30C30CD-*331Z	7.72	38.2	50.4
4000		MS1H2-40C30CD-*331Z	12.1	59.8	82.7
5000		MS1H2-50C30CD-*331Z	15.4	76.2	82.7
850	MS1H3 (medium inertia, medium capacity)	MS1H3-85B15CD-*331Z	13.3	65.8	28.2
		MS1H3-85B15CD-*334Z	14	69.2	34.3
1300		MS1H3-13C15CD-*331Z	17.8	88.0	34.3
		MS1H3-13C15CD-*334Z	18.5	91.5	34.3
1800		MS1H3-18C15CD-*331Z	25	123.6	50.4
		MS1H3-18C15CD-*334Z	25.7	127.1	50.4
2900		MS1H3-29C15CD-*331Z	55	271.98	50.4
		MS1H3-29C15CD-*334Z	55	271.98	50.4
4400		MS1H3-44C15CD-*331Z	88.9	439.6	82.7
		MS1H3-44C15CD-*334Z	88.9	439.6	82.7
5500		MS1H3-55C15CD-*331Z	107	529.1	100.8
		MS1H3-55C15CD-*334Z	107	529.1	100.8
7500		MS1H3-75C15CD-*331Z	141	697.3	100.8
		MS1H3-75C15CD-*334Z	141	697.3	100.8

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

■ Regenerative resistor selection

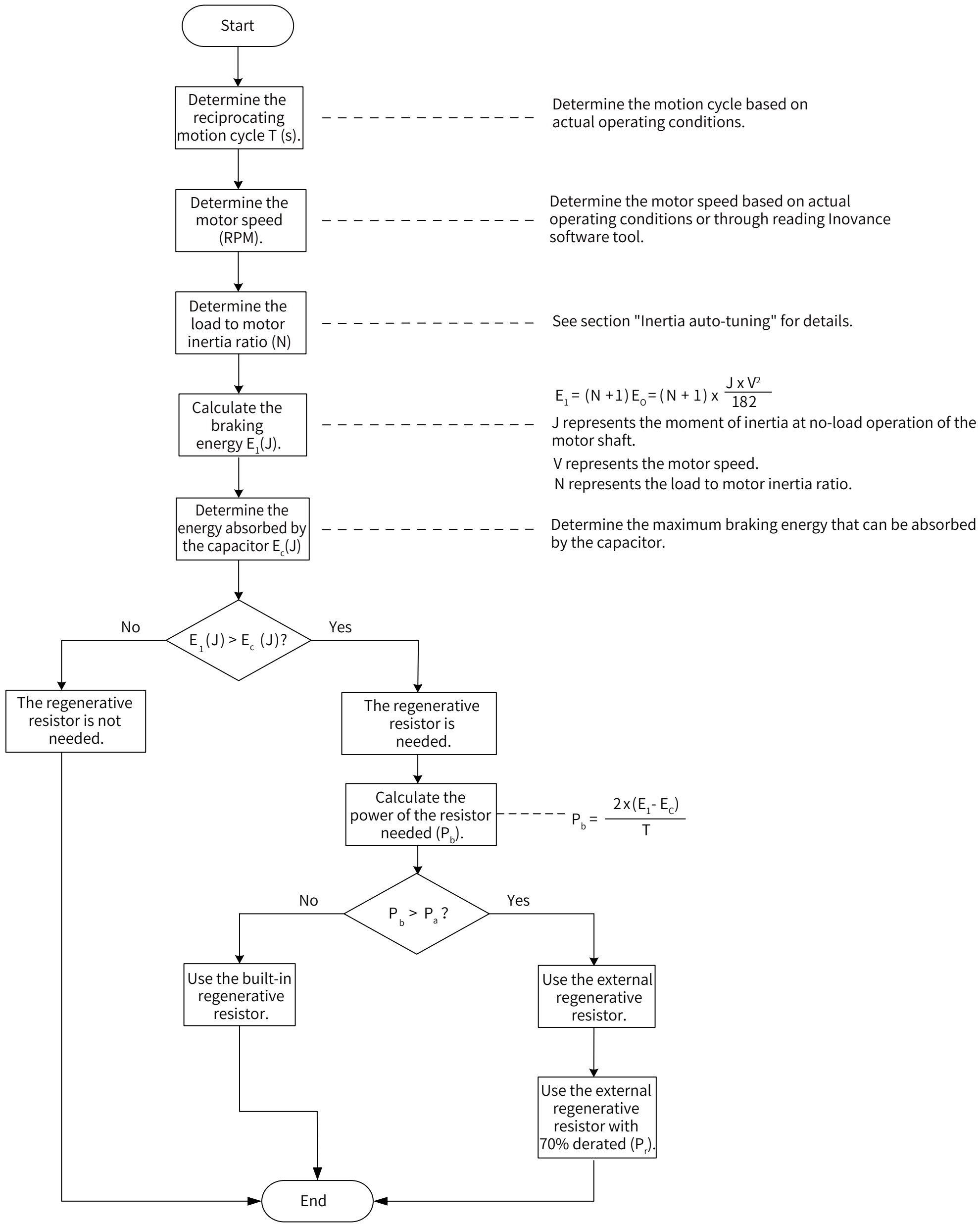


Figure 5-7 Flowchart for selecting the regenerative resistor

NOTE

- Assume that the load inertia is motor inertia multiplied by N, 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 motion cycle 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 an aluminum housing is recommended.

☆ Related parameter

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 motion cycle (T) is 2s, the maximum speed is 3000 RPM, and the load inertia is four times the motor inertia, the regenerative resistor power needed will be as follows:

$$P_b = \frac{2x[(N+1) \times E_O - E_C]}{T} = \frac{2x[(4+1)x6.4-26]}{2} = 6\ W$$

The calculation result 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 regenerative resistor power needed will be as follows:

$$P_b = \frac{2x[(N+1) \times E_O - E_C]}{T} = \frac{2x[(10+1)x6.4-26]}{2} = 44.4\ W$$

The calculation result 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 P_b/(1 - 70%) = 148 W.

1) Connection and setting of the regenerative resistor

■ When using an external regenerative resistor

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

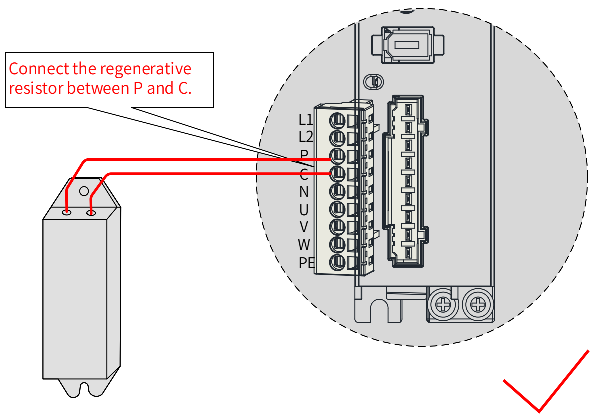


Figure 5-8 Connection of an extenal regenerative resistor

See "Table 3-6 Recommended main circuit cables" 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 and model dependent	-	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 used. Note: The power of the external regenerative resistor used cannot be smaller than the calculated 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 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 value.
- In temperatures within the operating temperature range of the servo drive, when the regenerative resistor is used at the processable power (average value) under the rated capacity, 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 parameter:

Parameter No.		Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
2002h	19h	Resistor heat dissipation coefficient	10–100	%	Defines the heat dissipation coefficient when an external regenerative resistor is used. The value cannot be higher than 30% when natural ventilation is used. The value cannot be higher 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 $E_1 > E_C$, use the built-in regenerative resistor. In this case, set H02-25 to 0.
- ◆ When $E_1 < E_C$, 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) With external load torque and motor staying in the generating state

When the motor torque direction is the same with the axis rotating direction, the motor outputs mechanical energy. 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 topology.

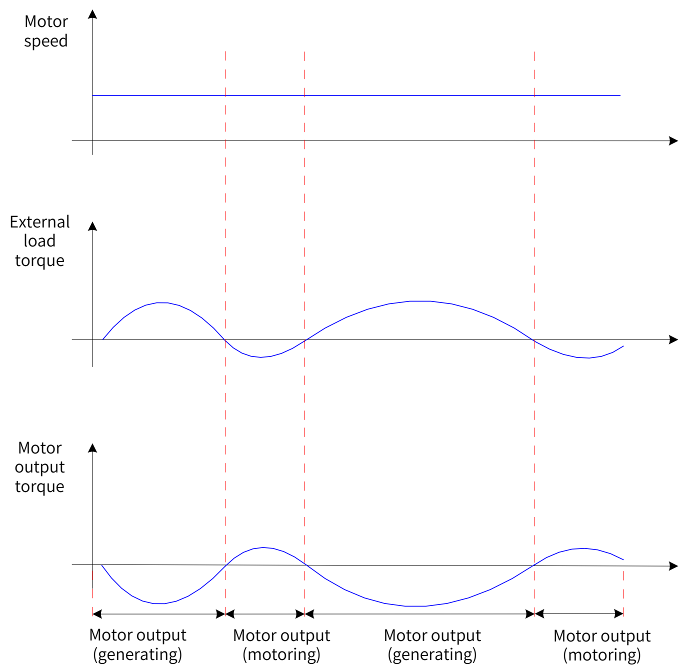


Figure 5-9 Example of the curve with external load torque

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 at this moment, the servo motor will stay in the locked state, without rotating.

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

Table 5-4 Instructions for operating the servo drive

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

3) Power-on timing diagram

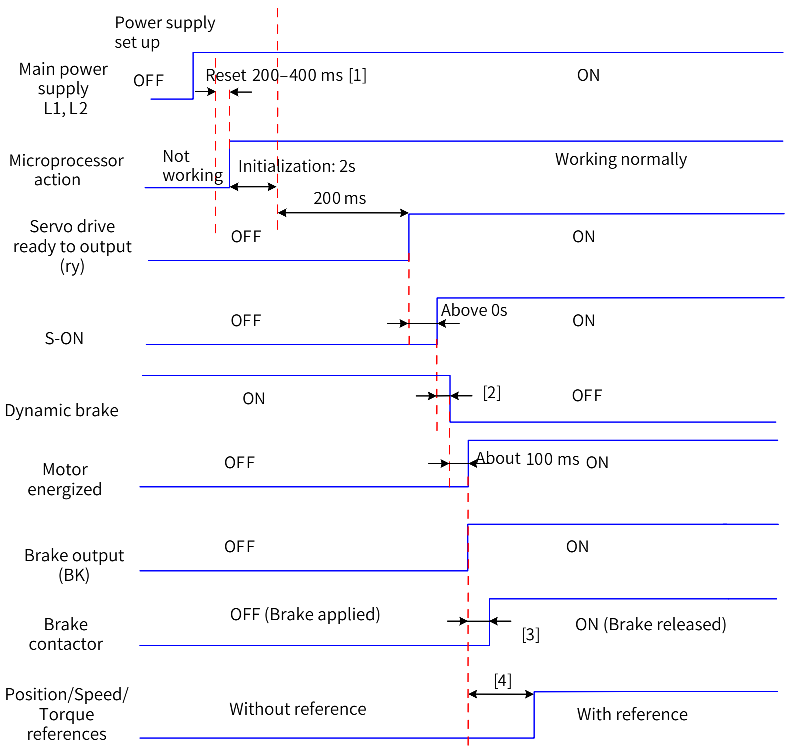


Figure 5-10 Power-on timing diagram

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

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

[3] For brake contactor delay, see "4 Keypad Display and Operations" for details.

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

4) Timing diagram for stop upon warning or fault

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

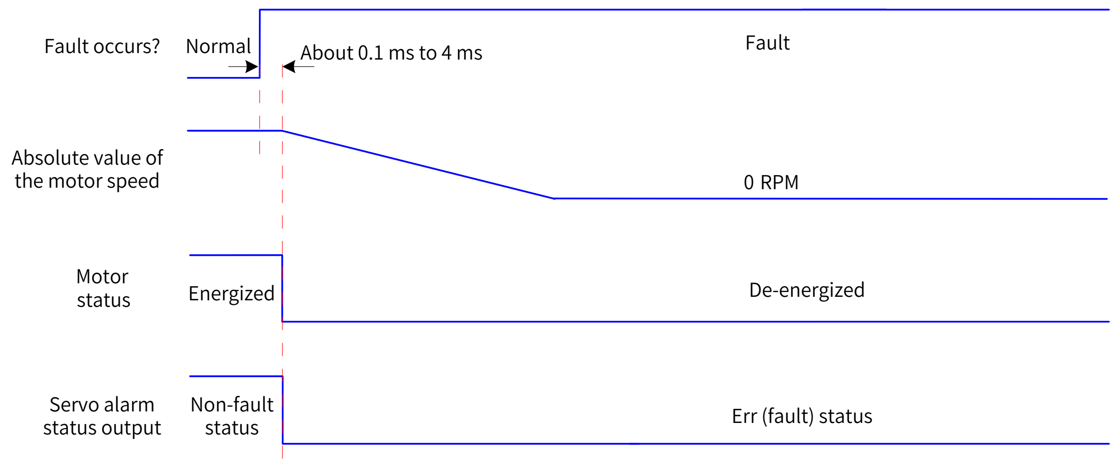


Figure 5-11 Timing diagram of "coast to stop, keeping de-energized status" at No. 1 fault

■ Fault 1 (without brake): Dynamic braking stop, keeping de-energized status

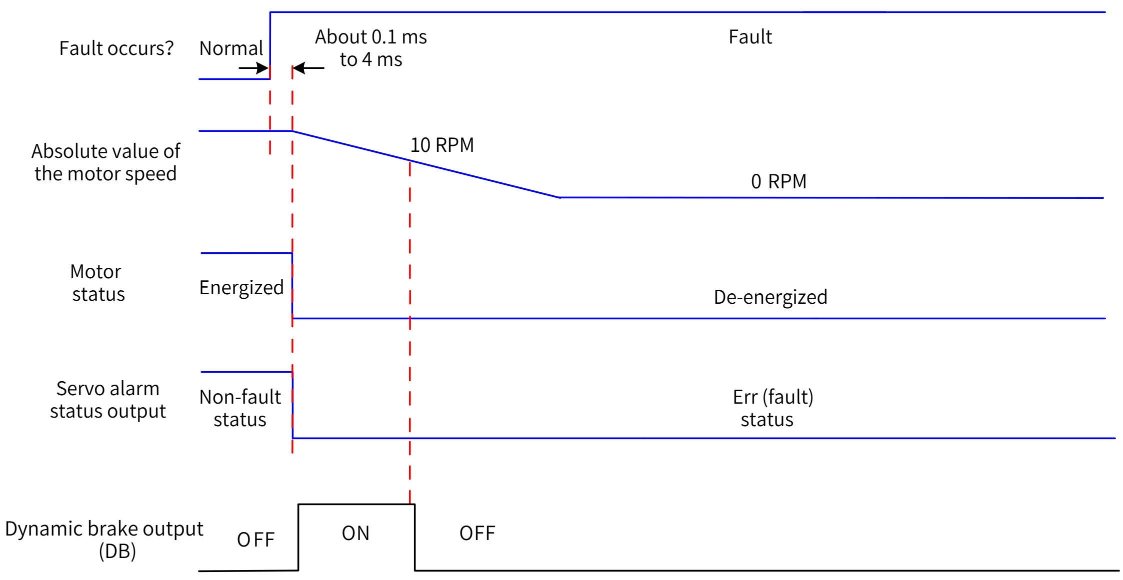


Figure 5-12 Timing diagram of "Dynamic braking stop, keeping de-energized status" at No. 1 fault (without brake)

■ Fault 1 (with brake): Dynamic braking stop, keeping dynamic braking status

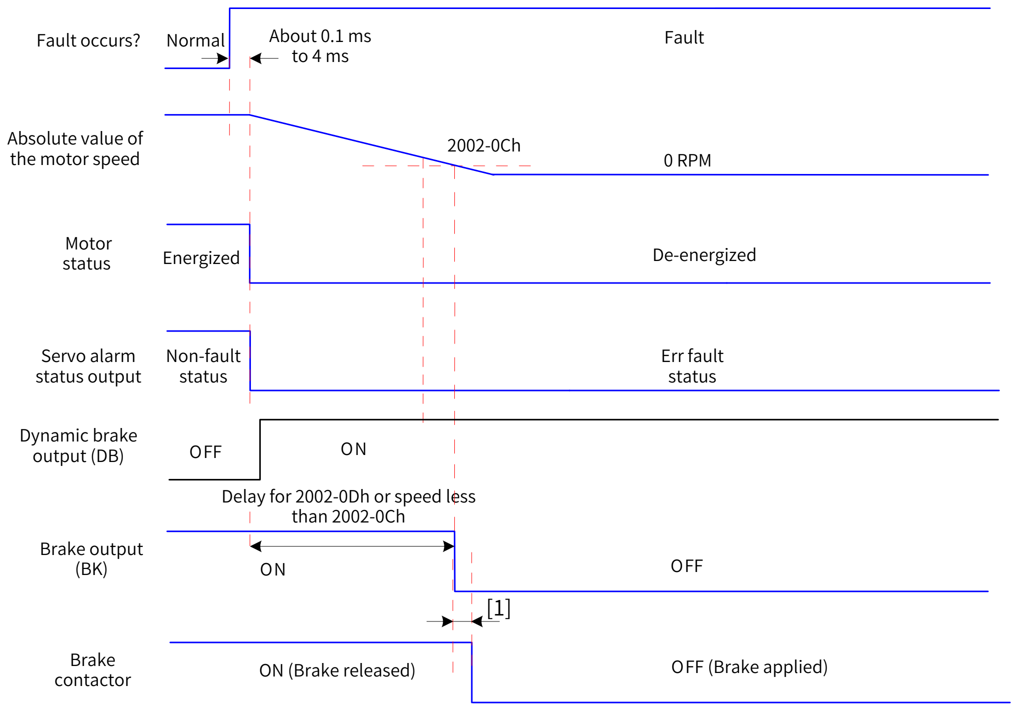


Figure 5-13 Timing diagram of "Dynamic braking stop, keeping dynamic braking status" at No. 1 fault (with brake)

[1] For brake contactor delay, see *"4 Keypad Display and Operations"* for details.

■ Fault 1 (without brake): Dynamic braking stop, keeping dynamic braking status

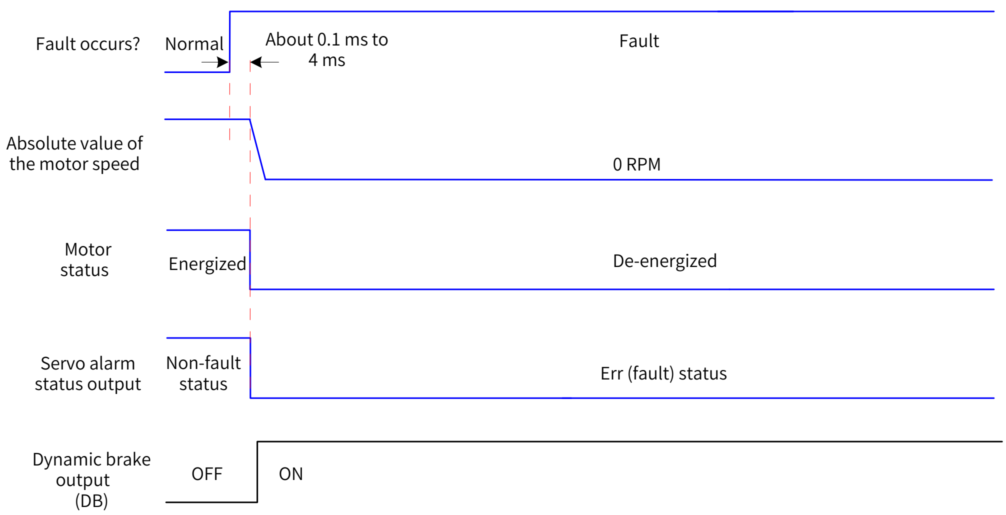


Figure 5-14 Timing diagram of "Dynamic braking stop, keeping dynamic braking state" at No. 1 fault (without brake)

■ Fault 2 (without brake)

Coast to stop, keeping de-energized status, same as "Coast to stop upon No. 1 fault"

Dynamic braking stop, keeping dynamic braking status[1]

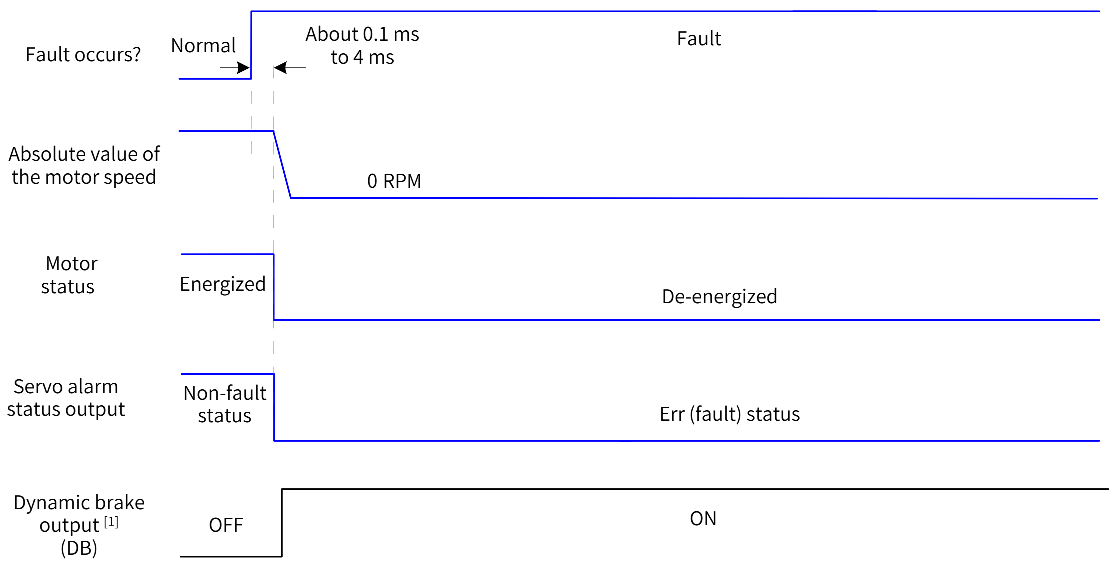


Figure 5-15 Timing diagram of "Coast to stop, keeping de-energized state" at No. 2 fault (without brake)

[1] After the dymanic brake is enabled

■ Fault 2 (without brake): Ramp to stop or stop at emergency torque, keeping de-energized/dynamic braking status[1]

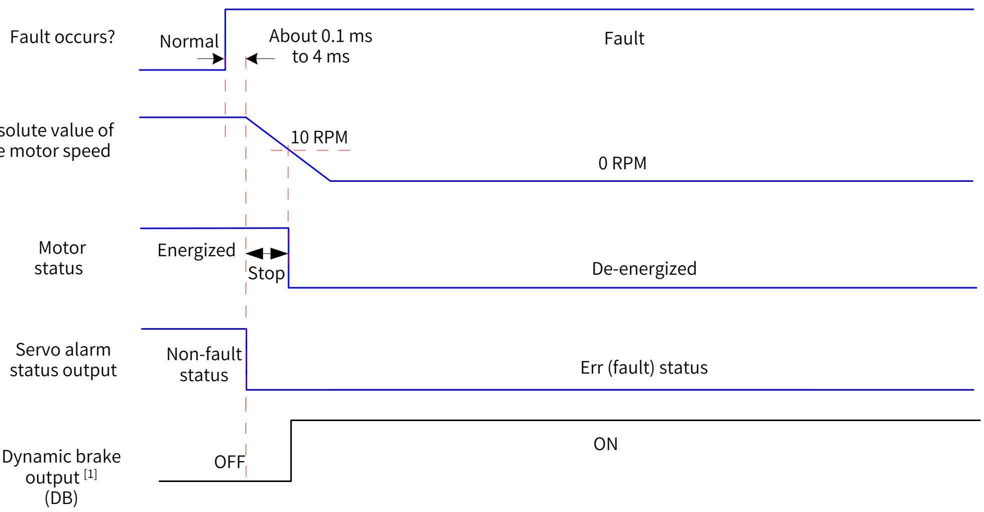


Figure 5-16 Timing diagram of "Ramp to stop or stop at emergency stop torque, keeping de-energized state" at No. 2 fault (without brake)

[1] After the dymanic brake is enabled

■ Fault 2 (with brake): Ramp to stop, keeeping dynamic braking status

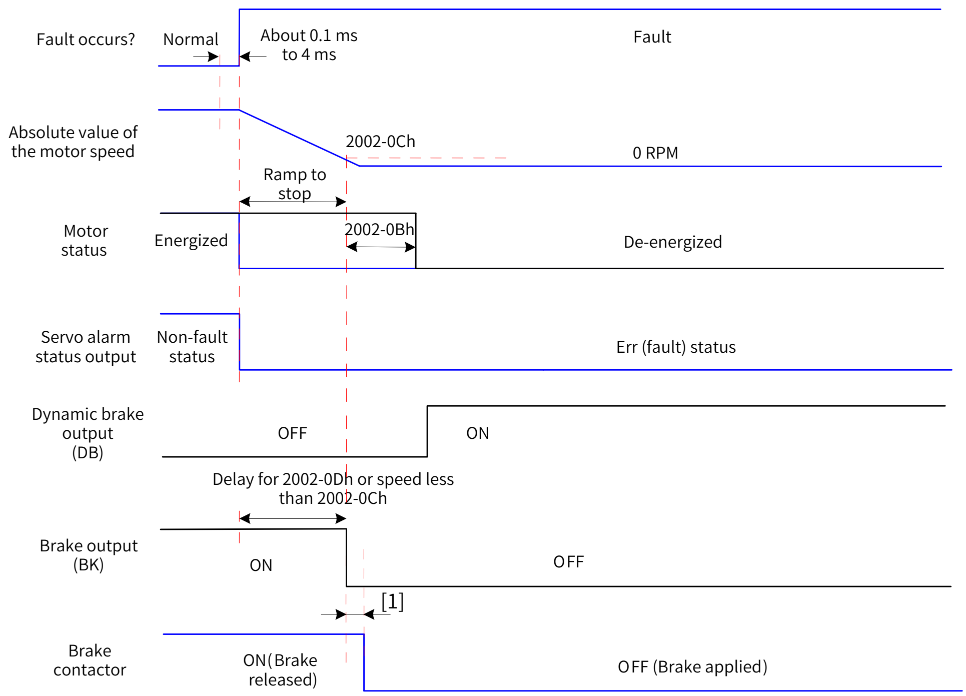


Figure 5-17 Timing diagram of "Ramp to stop, keeping dynamic braking state" at No. 2 fault (with brake)

[1] For brake contactor delay, see "4 Keypad Display and Operations" 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

Stoppinf at zero speed as defined by 6085h if the brake function is enabled, keeping position lock status

Stopping at zero speed if the brake function is not enabled, keeping position lock status

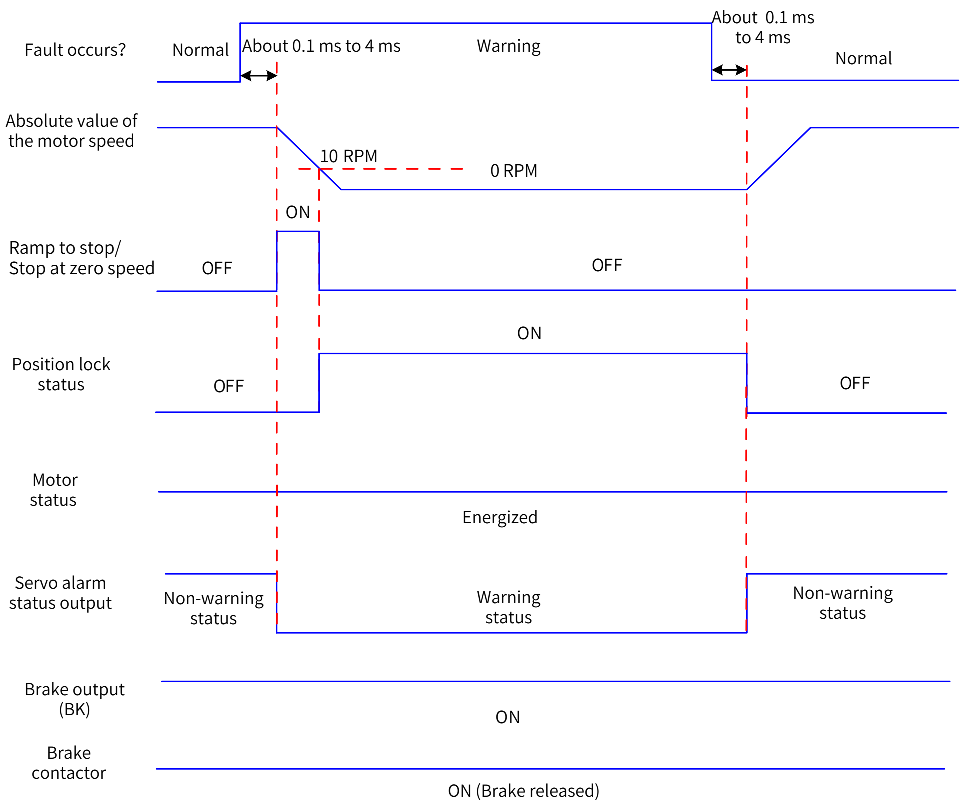


Figure 5-18 Timing diagram for warnings that cause stop

Except Er.950 and Er.952, the other warnings do not affect the operating status of the servo drive. The timing diagram upon occurrence of these warnings is as follows:

■ Warnings that do not cause stop

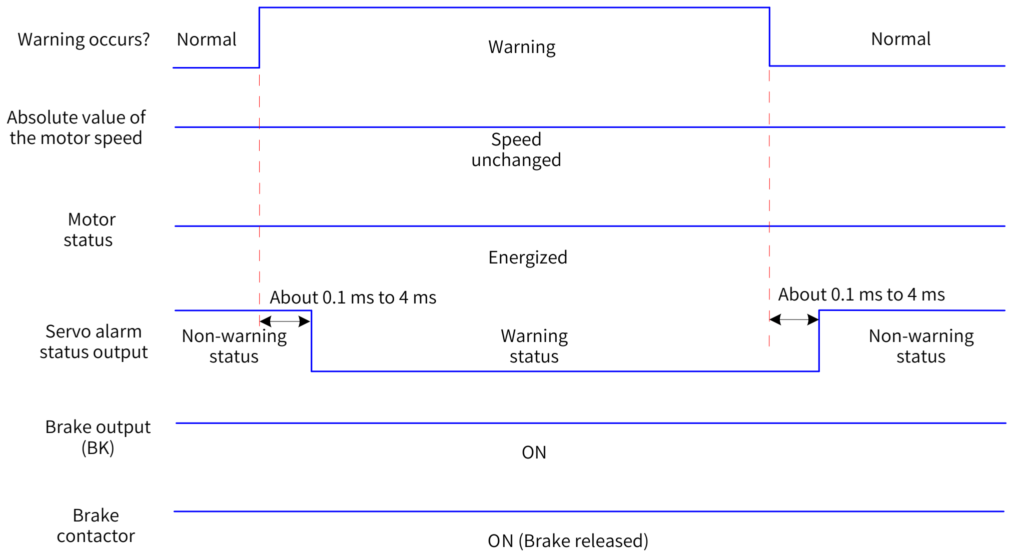


Figure 5-19 Timing diagram at warnings that do not cause stop

■ Fault reset

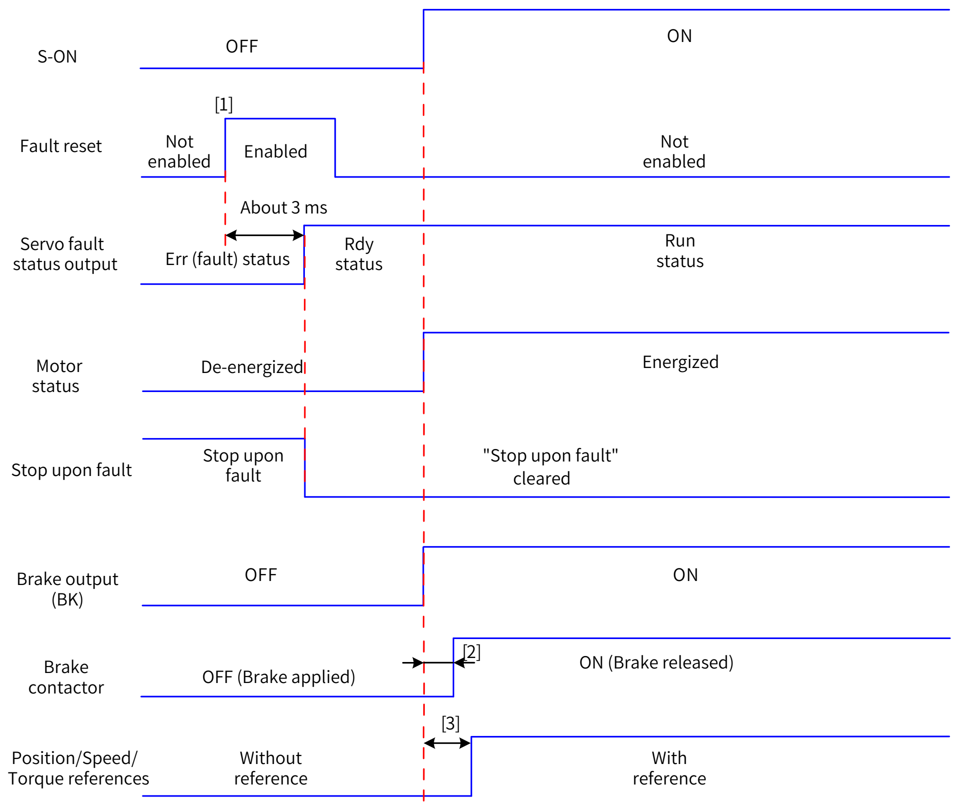


Figure 5-20 Timing diagram of fault reset

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

[2] For brake contactor delay, see "4 Keypad Display and Operations" for details.

[3] The command delay is invalid when the brake function 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 dynamic braking stop. The stop status can be de-energized status, position lock status, and dynamic braking status. 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 RPM gradually. The deceleration time is affected by 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, but the mechanical impact is large.
Ramp to stop	The servo motor decelerates to 0 RPM smoothly upon receiving position/speed/torque references.	This mode features a 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, but the mechanical impact is large.
Dynamic braking stop	The servo motor is in the dynamic braking status.	This mode features quick deceleration, but the mechanical impact is large.

Table 5-6 Comparison of stop status

Stop Status	Description
De-energized	The motor is de-energized after it stops rotating, and the motor shaft can be rotated freely.
Position lock	The motor shaft is locked and cannot be rotated freely after the motor stops rotating.
Dynamic braking	The motor is de-energized after it stops rotating, and the motor shaft cannot be rotated freely.

The servo drive stops 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:

H02-05	Name	Stop mode at S-ON OFF			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Int16
2002-06h	Access	RW	Mapping	No	Related Mode	All	Data Range	-3 to +1	Data Type	0

Defines the deceleration mode of the servo motor for stopping rorating and the servo motor state after stops due to S-ON OFF.

Setpoint	Stop mode
-3	Stop at zero speed, keeping dynamic braking status
-2	Ramp to stop as defined by 6084/609A, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084/609A, keeping de-energized status

Set a proper stop mode according to the mechanical condition and operating requirements.

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

605Ch	Name	Disable operation option code			Setting Condition & Effective Time	At stop & 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 for stopping rotating and the servo motor state after stops due to S-ON OFF.

Value	Stop Mode
-4	Ramp to stop as defined by 6085h, keeping dynamic braking status
-3	Stop at zero speed, keeping dynamic braking status
-2	Ramp to stop as defined by 6084/609A, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084/609A, keeping de-energized status

Set a proper stop mode based on the mechanical condition and operating requirements.

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

NOTE

◆ The stop mode can be set in H02-05 or 605C. If the value of H02-05 or 605C changes, the value of 605C or H02-05 also changes.

■ Stop at fault

The stop mode varies with the fault type. See "10 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 for stopping rotating and the servo motor state after stops due to a No. 1 fault.

Value	Stop mode
0	Coast to stop, keeping de-energized status
1	Dynamic braking stop, keeping de-energized status
2	Dynamic braking stop, keeping dynamic braking status

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

H02-06	Name	Stop mode at No. 2 fault			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Int16
2002-07h	Access	RW	Mapping	-	Related Mode	ALL	Data Range	-5 to +3	Default	2

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor state after stops due to a No. 2 fault.

Value	Stop Mode
-5	Stop at zero speed, keeping dynamic braking status
-4	Stop at emergency torque, keeping dynamic braking status
-3	Ramp to stop as defined by 6085, keeping dynamic braking status
-2	Ramp to stop as defined by 6084/609A, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084/609A, keeping de-energized status
2	Ramp to stop as defined by 6085, keeping de-energized status
3	Stop at emergency torque, keeping e-energized status

After the brake output function is enabled, the stop mode at No. 2 fault is forcibly set to "Ramp to stop as defined by 6085h, keeping dynamic braking status".

<table>
<tr><td rowspan="2">605Eh</td><td>Name</td><td colspan="3">Fault reaction option code</td><td>Setting Condition & Effective Time</td><td>At stop & At stop</td><td>Data Structure</td><td>-</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>-5 to +3</td><td>Default</td><td>2</td></tr>
</table>

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor state after stops at a No. 2 fault.

Value	Stop Mode
-5	Stop at zero speed, keeping dynamic braking status
-4	Stop at emergency torque, keeping dynamic braking status
-3	Ramp to stop as defined by 6085, keeping dynamic braking status
-2	Ramp to stop as defined by 6084/609A, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084/609A, keeping de-energized status
2	Ramp to stop as defined by 6085, keeping de-energized status
3	Stop at emergency torque, keeping e-energized status

After the brake output function is enabled, the stop mode at No. 2 fault is forcicly set to "Ramp to stop as defined by 6085h, keeping dynamic braking status".

NOTE

◆ The "Stop mode at No. 2 fault " can be set in H02-06 or 605E. If the value of H02-06 or 605E changes, the value of 605E or H02-06 also changes.

■ 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 motion part moves beyond the range of safe movement, the limit switch changes the signal level on the digital input, and the servo drive forces the motor to stop.

☆ Related parameters:

<table>
<tr><td>H02-07</td><td>Name</td><td colspan="3">Stop mode at overtravel</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>2002-08h</td><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0–7</td><td>Default</td><td>1</td></tr>
</table>

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor state after stops due to overtravel.

Value	Stop mode
0	Coast to stop, keeping de-energized status
1	Stops at zero speed, keeping position lock status
2	Stop at zero speed, keeping de-energized status
3	Ramp to stop as defined by 6085h, keeping de-energized status
4	Ramp to stop as defined by 6085h, keeping position lock status
5	Dynamic braking stop, keeping de-energized status
6	Dynamic braking stop, keeping dynamic braking status
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 the position lock status after overtravel occurs.

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

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

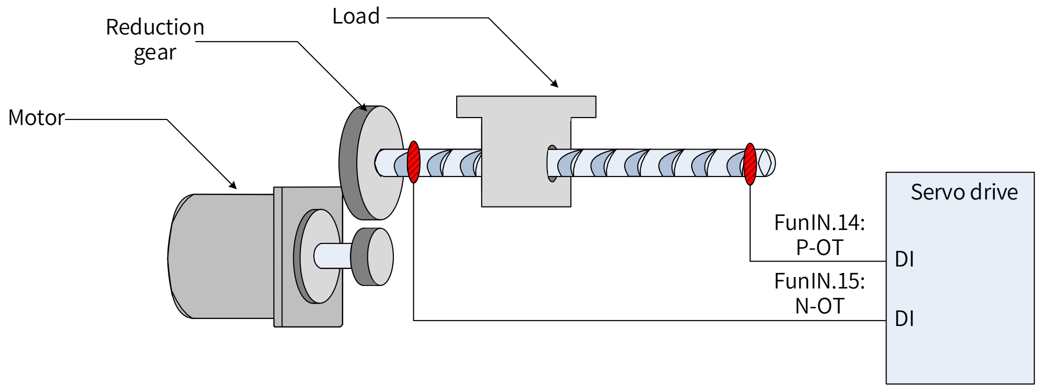


Figure 5-21 Installation of limit switches

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

☆ Related DI functions

Function No.	Name	Function	Description
FunIN.14	P-OT	Positive limit switch	Overtravel prevention applies when the mechanical movement is beyond the movable range. Inactive: Forward drive permitted Active: Forward drive inhibited
FunIN.15	N-OT	Negative limit switch	Overtravel prevention applies when the mechanical movement is beyond the movable range. Inactive: Reverse drive permitted Active: Reverse drive inhibited

■ Emergency stop

The emergency stop can be implemented through the following two methods:

1) FunIN.34: EmergencyStop
2) 200D-06h (Emergency stop)

☆ Related DI function

Function No.	Name	Function	Description
FunIN.34	EmergencyStop	Braking	Inactive: The servo drive keeps the present operating status. Active: The servo drive stops according to the stop mode defined by 605Ah.

☆ Related parameter

H0D-05	Name	Emergency stop			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
200D-06h	Access	RW	Mapping	-	Related Mode	-	Data Range	0–1	Default	0

Defines whether to enable emergency stop:

Value	Description
0	No operation
1	Emergency stop enabled

When H0D-05 is enabled, the servo drive stops in the stop mode defined by 605Ch regardless of the operating state.

■ 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.

605Ah	Name	Quick stop option code			Setting Condition & Effective Time	Any condition & At stop	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	0–7	Default	2

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor state after quick stop.

Value	Stop mode
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084h/609Ah (HM), keeping de-energized status
2	Ramp to stop as defined by 6085h, keeping de-energized status
3	Stop at emergency torque, keeping de-energized status
4	N/A
5	Ramp to stop as defined by 6084h/609Ah (HM), keeping position lock status
6	Ramp to stop as defined by 6085h, keeping position lock status
7	Stop at emergency-stop torque, keeping position lock status

When the brake function is enabled and the setpoint of 605Ah is less than 4, the stop mode is forced to "Ramp to stop as defined by 6085h, keeping de-energized state".

■ 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	Stop option code			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 for stopping rotating and the servo motor state after halt.

PP/PV/HM mode:

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

PT mode:

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

<table>
<tr><th colspan="2">CAUTION</th></tr>
<tr><td></td><td>Do not set the acceleration/deceleration time to an excessively small value. An excessively small value will lead to an overlong stop distance, causing the risk of collision.</td></tr>
</table>

■ Maximum time of ramp-to-stop

When the stop mode is set to "Ramp to stop as defined by 6084h/609Ah (HM)" or "Ramp to stop as defined by 6085h", set the maximum time for ramp-to-stop through H0A-72 to prevent an overlong stop distance caused by an excessively small deceleration setpoint. When 6084h/609Ah (HM) or 6085h is set to an excessively small value, the stop deceleration is restricted by the setpoint of H0A-72.

<table>
<tr><td>H0A-72</td><td>Name</td><td colspan="3">Maximum time for ramp-to-stop</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>200A-49h</td><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>ALL</td><td>Data Range</td><td>0–65535 (ms)</td><td>Default</td><td>10000</td></tr>
<tr><td colspan="11">Defines the maximum time taken by the motor in decelerating from 6000 RPM to 0 RPM when the stop mode is set to "Ramp to stop as defined by 6084h/609Ah (HM)" or "Ramp to stop as defined by 6085h".</td></tr>
</table>

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 mechanisms. Therefore, the gear ratio is related to the mechanical reduction ratio, mechanical dimensions and motor encoder resolution. The calculation formula is as follows.

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

<table>
<tr><td rowspan="2">Index 6091h</td><td>Name</td><td colspan="3">Gear ratio</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>ARR</td><td>Data Type</td><td>Uint32</td></tr>
<tr><td>Access</td><td>-</td><td>Mapping</td><td>Yes</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>OD data range</td><td>Default</td><td>OD default value</td></tr>
<tr><td colspan="11">Defines the proportional relation between the load shaft displacement designated by the user and the motor shaft displacement.
The relation between motor position feedback (in encoder unit) and load shaft position feedback (in 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 (in 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 (in reference unit/s^2) is as follows.
$$\text{Motor acceleration} = \frac{\text{Load shaft acceleration x Gear ratio 6091h}}{\text{Encoder resolution}} \times \frac{1000}{60}$$</td></tr>
</table>

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

Sub-index 1h	Name	Motor revolutions			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 revolutions			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 23-bit serial-type motor encoder resolution P = 8388608 (PPR)

The position factor is calculated as follows:

$$
\begin{aligned}
\text{Position factor} &= \frac{\text{Encoder resolution P x n}}{\text{pB}} \\
&= \frac{8388608 \times 5}{10} \\
&= \frac{41943040}{10} \\
&= 4194304
\end{aligned}
$$

Therefore, 6091-1h = 4194304, and 6091-2h = 1, which means when the load shaft displacement is 1 mm, the motor displacement is 4194304.

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.

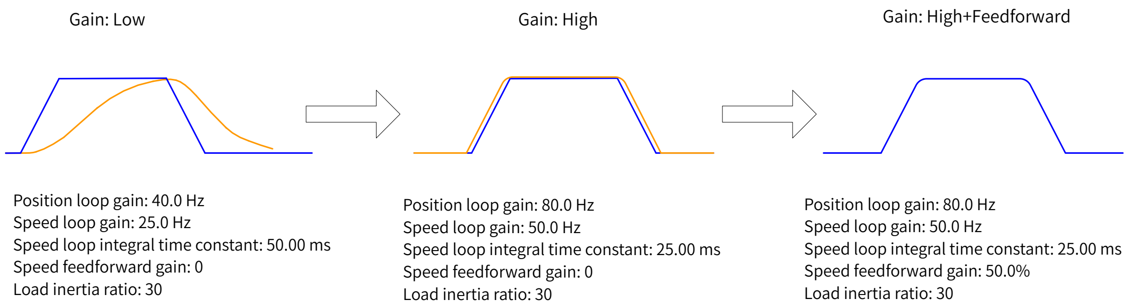


Figure 6-1 Example of gain settings

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

Before gain tuning, perform a trial run through jogging to ensure the motor operates properly.

The following figure shows the general procedure for gain tuning.

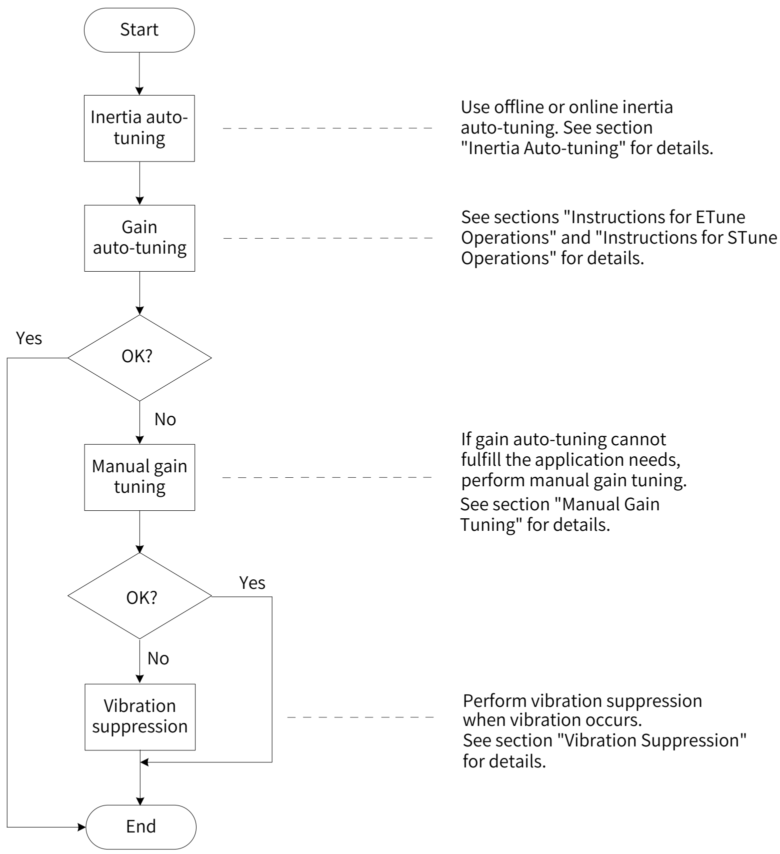


Figure 6-2 General procedure for gain tuning

Table 6-1 Gain tuning procedure

Gain Tuning Procedure			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 a set of gain values that match the inertia ratio (the inertia ratio must be set correctly).	6.3/6.4
3	Manual gain tuning	Basic gain	If 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 follow-up 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.

$$\text{Load inertia ratio} = \frac{\text{Total moment of inertia of the mechanical load}}{\text{Moment of inertia of the motor}}$$

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 inertia auto-tuning (200D-03h), and make the motor rotate by pressing SET on the keypad to perform inertia auto-tuning. This kind of 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 involves the host controller.

NOTE

◆ The following requirements must be met to ensure a 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 acceleration rate as required because 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 the parameter display mode, switch to H0D-02 and press SET to enable offline inertia auto-tuning.

☆ Related parameter

<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 the 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 travel distance must meet the following requirements:

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

Before offline inertia auto-tuning, ensure limit switches are installed to the machine and a travel distance 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 travel distance starting from the stop position is larger than the value of H09-09. If the motor travel distance 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 operating direction at start is determined by ▲ / ▼. For applications requiring unidirectional motion, 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 general procedure for offline inertia auto-tuning.

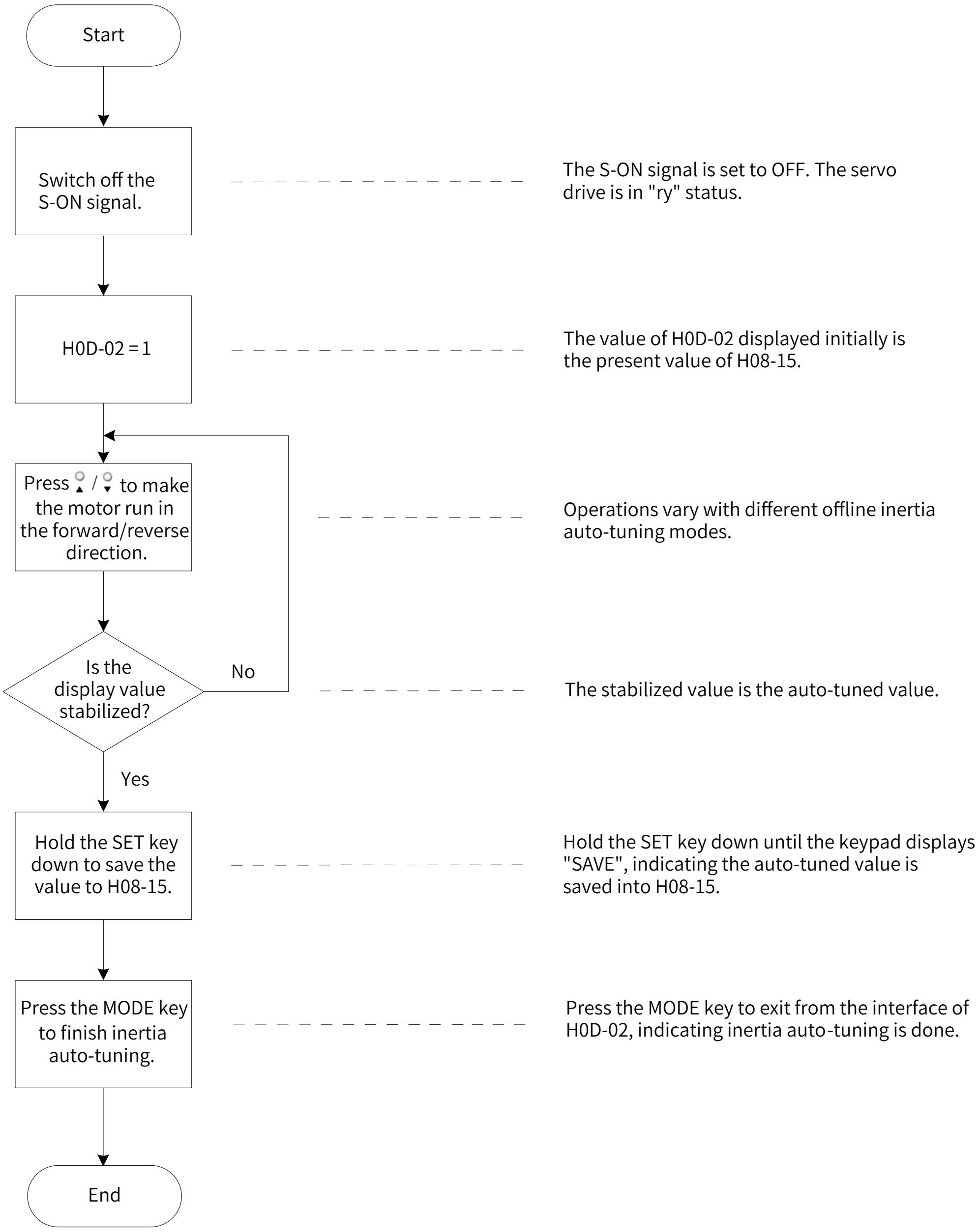


Figure 6-3 Procedure for offline inertia auto-tuning

☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-15	Load moment of inertia ratio	0 to 120	1	Defines the load moment of inertia ratio.	During running	Immediately	3
H09-05	Offline inertia auto-tuning mode	0: Bidirectional auto-tuning 1: Unidirectional auto-tuning	-	Defines the offline inertia auto-tuning mode.	At stop	Immediately	1
H09-06	Maximum speed of inertia auto-tuning	100 to 1000	RPM	Defines the maximum speed reference for offline inertia auto-tuning.	At stop	Immediately	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 accelerate from 0 RPM to 1000 RPM.	At stop	Immediately	125

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-08	Interval after an individual inertia auto-tuning	50 to 10000	ms	Defines the interval between two consecutive speed references.	At stop	Immediately	800
H09-09	Number of motor revolutions per inertia auto-tuning	0 to 100	r	Defines the maximum number of revolutions.	-	-	1

6.2.2 Online Auto-tuning

CAUTION

Before performing inertia auto-tuning, ensure the following conditions are fulfilled to ensure a correct calculation of the load inertia ratio:

- The load inertia changes quickly.
- The load torque changes quickly.
- The motor is running at a speed lower than 120 r/min.
- Acceleration/Deceleration is slow (lower than 1000 r/min per second).
- The acceleration/deceleration torque is smaller than the unbalanced load/viscous friction torque.

The servo drive supports online inertia auto-tuning. The following figure shows the procedure for online inertia auto-tuning.

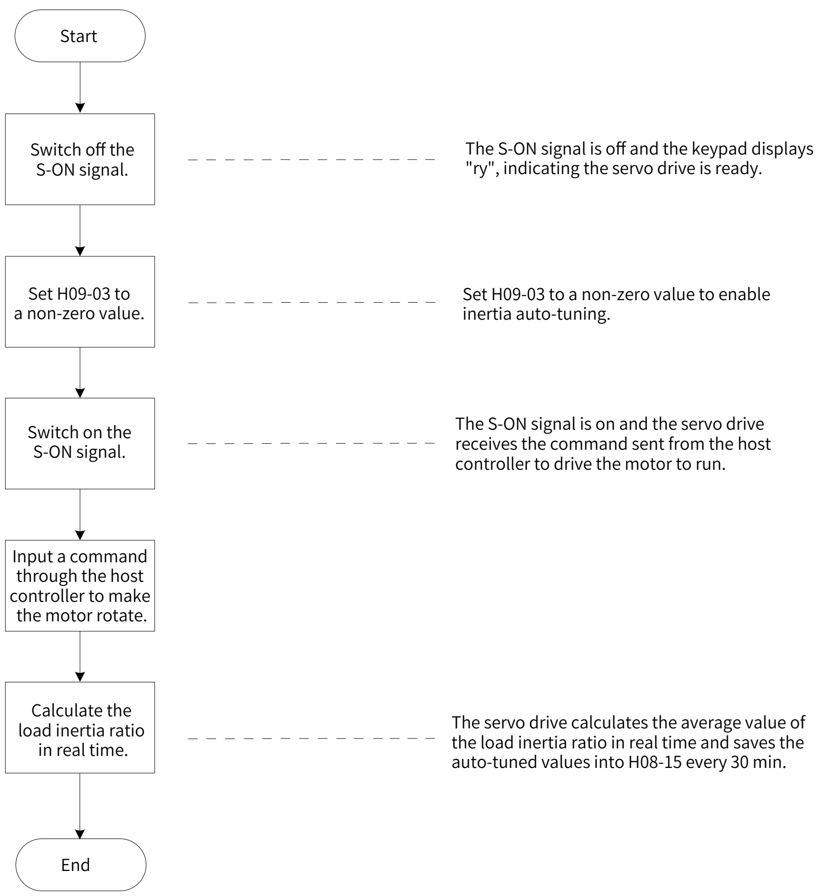


Figure 6-4 Procedure for online inertia auto-tuning

NOTE

- H09-03 sets the updating speed 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 material handling manipulators.

- Do not use online inertia auto-tuning in applications involving hitting against limit switches and press fitting.

☆ Related parameter

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

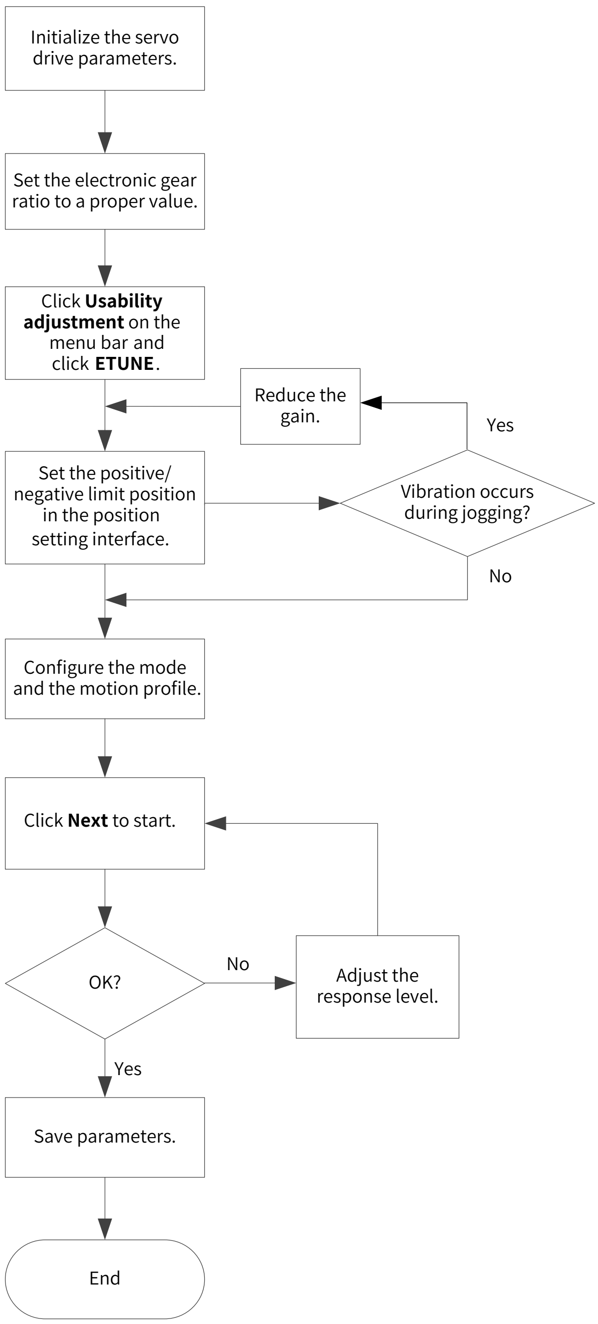
6.3.1 Overview

ETune is a wizard-type function designed to guide users to perform auto-tuning by setting the motion profile and the desired response level. After the motion profile and the response level are set, the servo drive will perform the auto-tuning to obtain 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 slight load inertia changes.

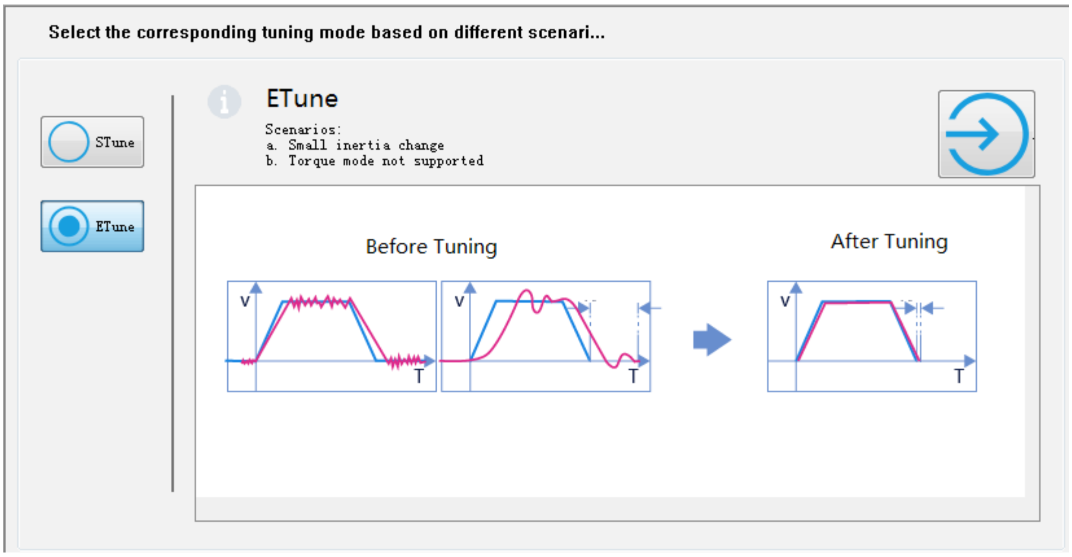
6.3.2 Description of Operations

1 Operation flowchart



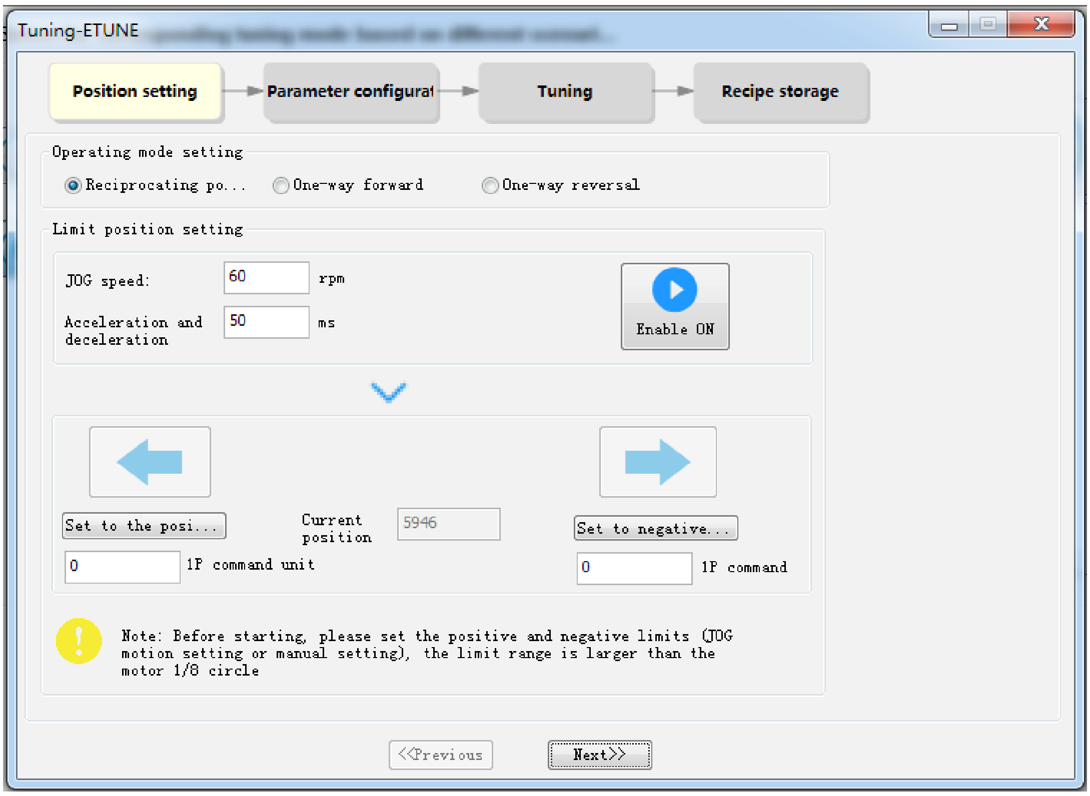
2 Detailed descriptions

1) Click **Usability adjustment** on the software tool, and then click **ETune**.



2) Select any of the following three operation modes based on the operating direction allowed by the machine.

- In the **Reciprocating po...** mode, the motor keeps reciprocating within the positive and negative position limits.
- In the **One-way forward** mode, the motor takes the difference value between the positive and negative position limits as the maximum distance per action and keeps running in the forward direction.
- In the **One-way reversal** mode, the motor operates in the same way as that in the one-way forward mode, but in the opposite direction.



3) Enter the positive and negative position limits appropriate for the motor. The difference value 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.

You can set the position and negative position limits by the following two methods.

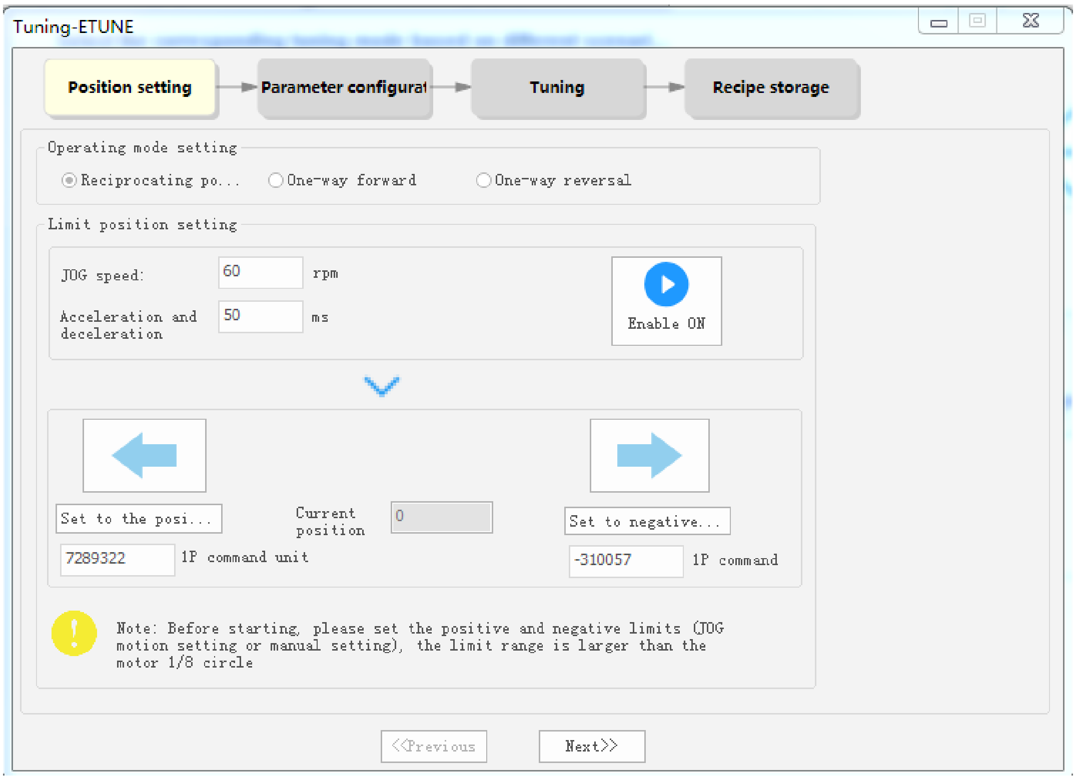
Method 1:

Click **Enable ON**, and then click  to make the motor move to the positive position limit. Next, click **Set to the posi...**. Follow the same procedure for setting the negative position limit, and click **Enable OFF** (the **Enable ON** button turns to **Enable OFF** after a click).

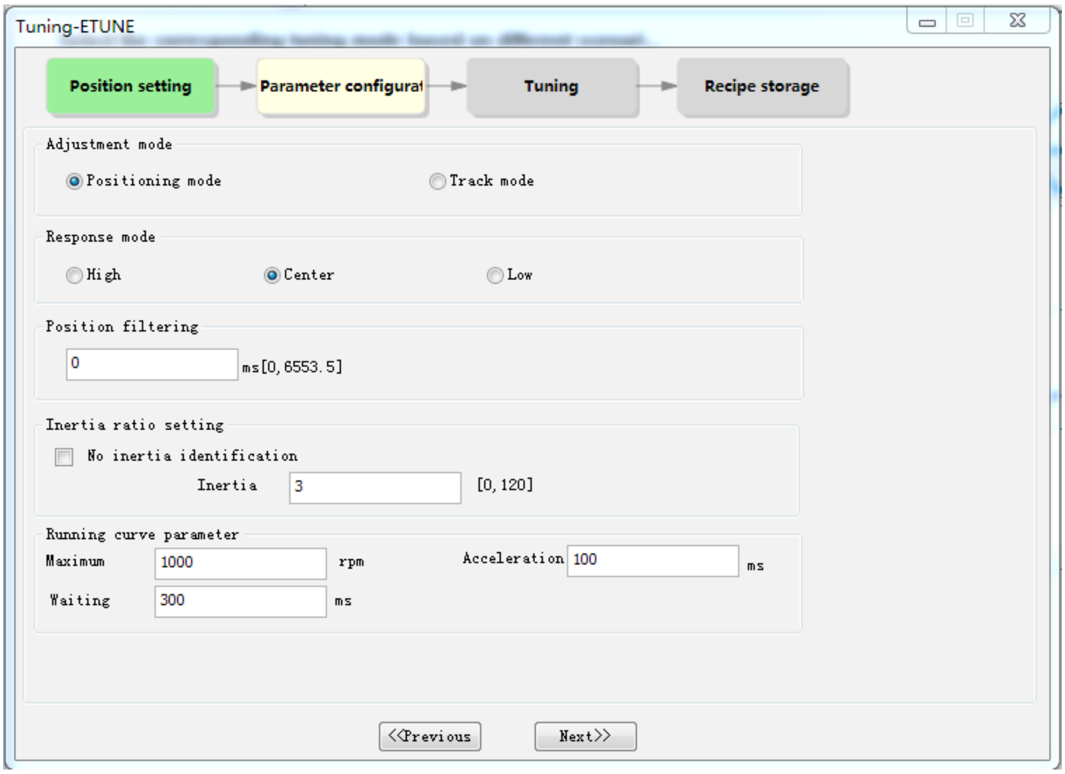
Method 2:

Enter the positive and negative position limits directly.

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

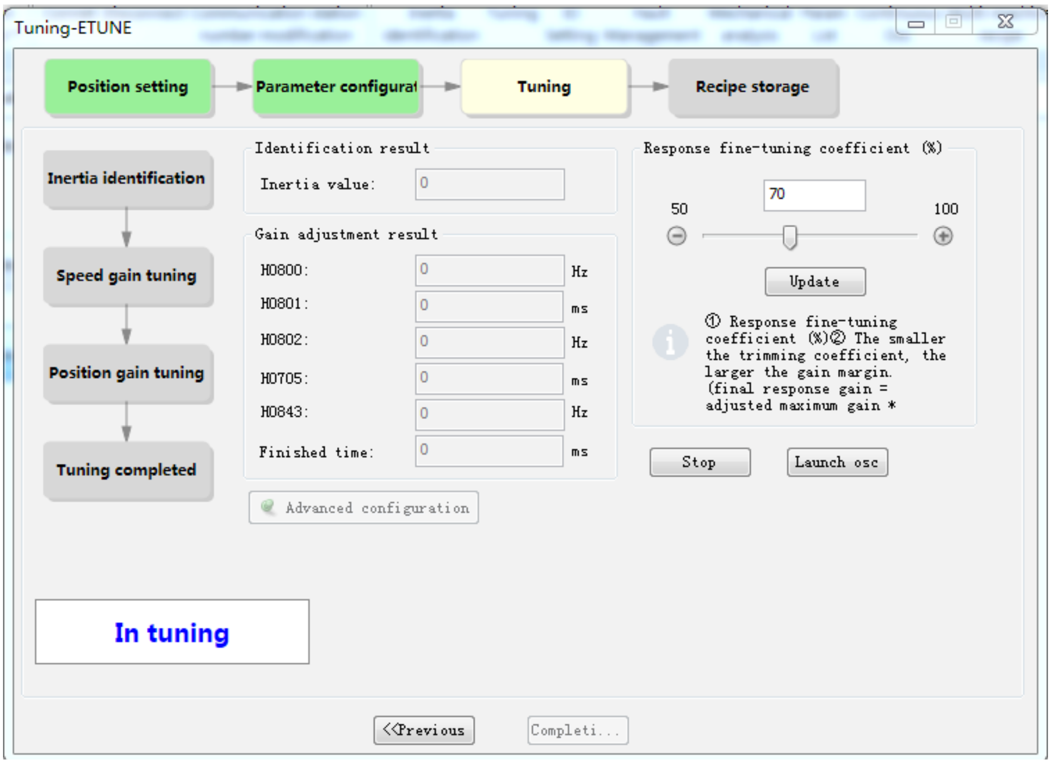


4) Click **Next** to switch to the mode parameter setting interface. The adjustment mode is divided into **Positioning mode** and **Track mode**. Inertia auto-tuning is optional. If you choose not to perform inertia auto-tuning, set the correct inertia ratio first (the value of the inertia ratio can be modified directly). You can adjust the response level and position filter time constant based on the responsiveness needed and the position reference noise generated during operation. Then configure the motion profile by setting the maximum speed, acceleration/deceleration time and time interval for auto-tuning.

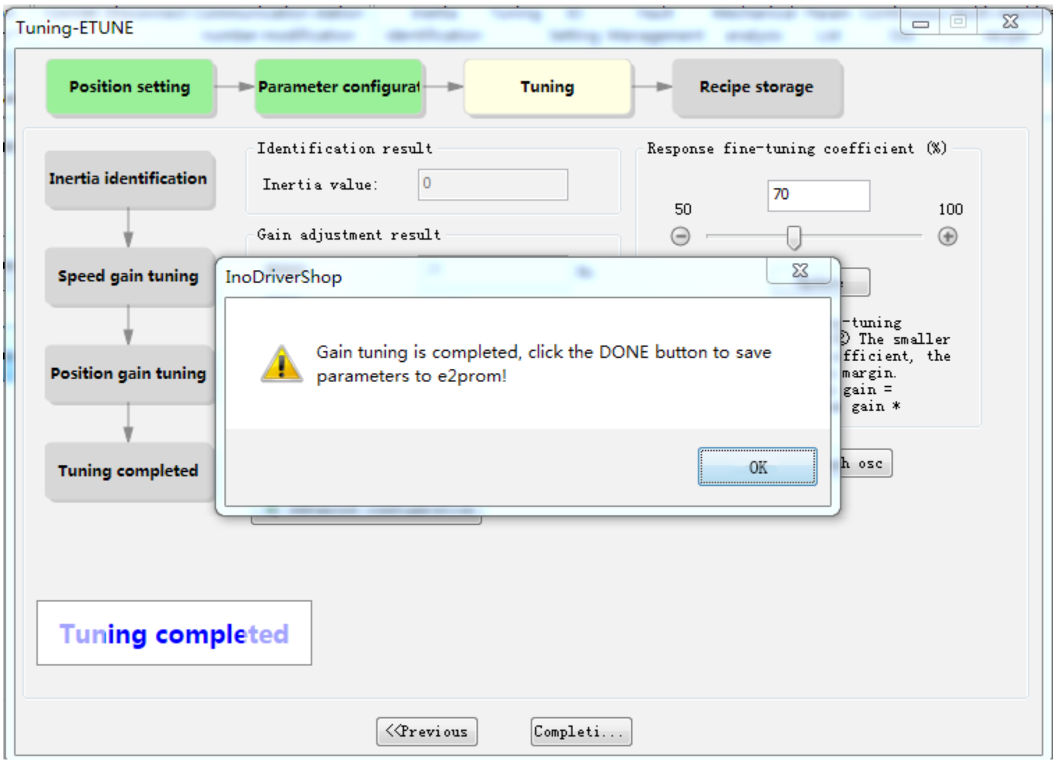


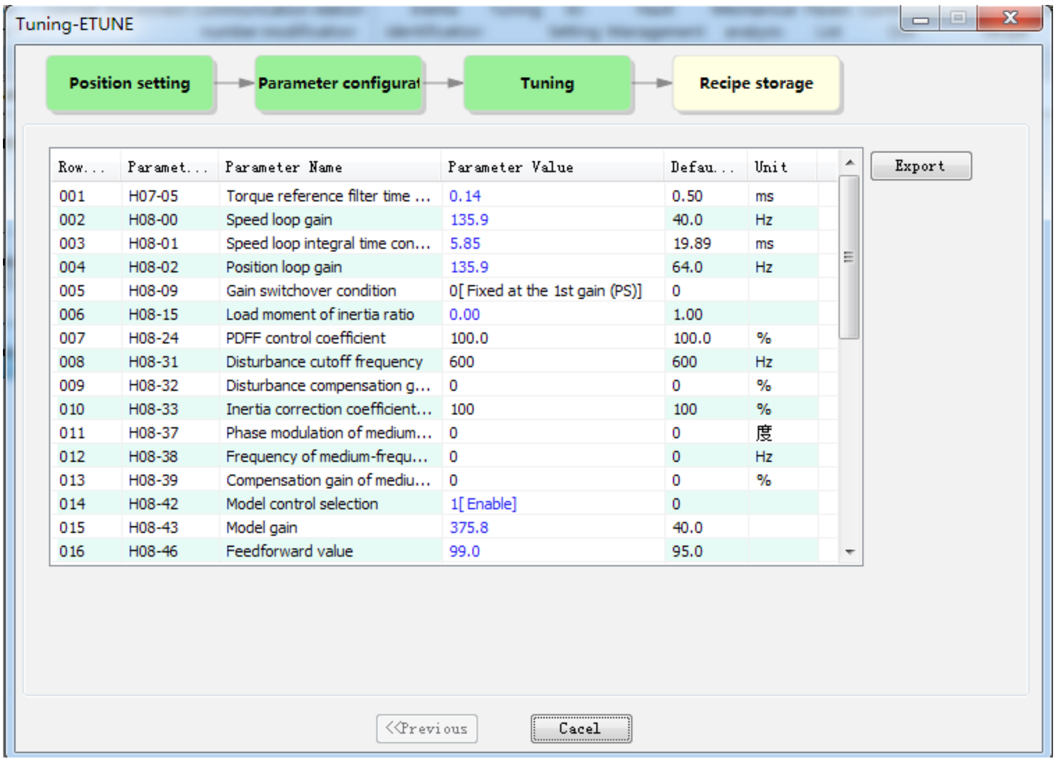
5) Click **Next** to start auto-tuning.

- If you choose to perform inertia auto-tuning, the servo drive starts inertia auto-tuning based on the set motion profile. After inertia auto-tuning is done, the servo drive starts gain tuning automatically.
- If you choose not to perform inertia auto-tuning on the start page, the servo drive starts gain tuning directly after start-up.



6) During gain tuning, if you modify the **Response fine-tuning coefficient** and click **Update**, gain tuning will be continued based on the fine-tuning coefficient entered. After gain tuning is done, you can click **DONE** to save the parameters to EEPROM and export parameters as a recipe file.





6.3.3 Precautions

- The maximum speed and acceleration/deceleration time of the motion profile can be set as needed. 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 tuning 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 reduce the response level.
	3) The reference is disturbed by noise.	3) Modify the electronic gear ratio to improve the reference resolution, or increase the reference filter time constant in the parameter configuration interface.
	4) The current fluctuates.	4) Check whether the current of the machine fluctuates regularly.
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 operating speed and decrease the acceleration/deceleration time. In case of the ball screw, shorten the stroke length.
	3) The load mechanical couplings are loose or the mechanism is eccentric.	3) Rectify the mechanical fault.
	4) Interruption occurs due to a 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 setpoints of H05-04...H05-06, and perform ETune again.

6.4 Instructions for STune Operations

6.4.1 Overview

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

The STune function is enabled by default with H09-00 (Gain auto-tuning mode) being set to 4 (Normal mode+Inertia auto-tuning). The servo drive is turned off automatically 10 min after command input.

The STune function is intended to be used in applications featuring slight load inertia changes. For applications featuring dramatic inertia changes or where inertia auto-tuning is unavailable (due to operating speed too low or acceleration rate too small), disable the STune function after initial power-on.

CAUTION

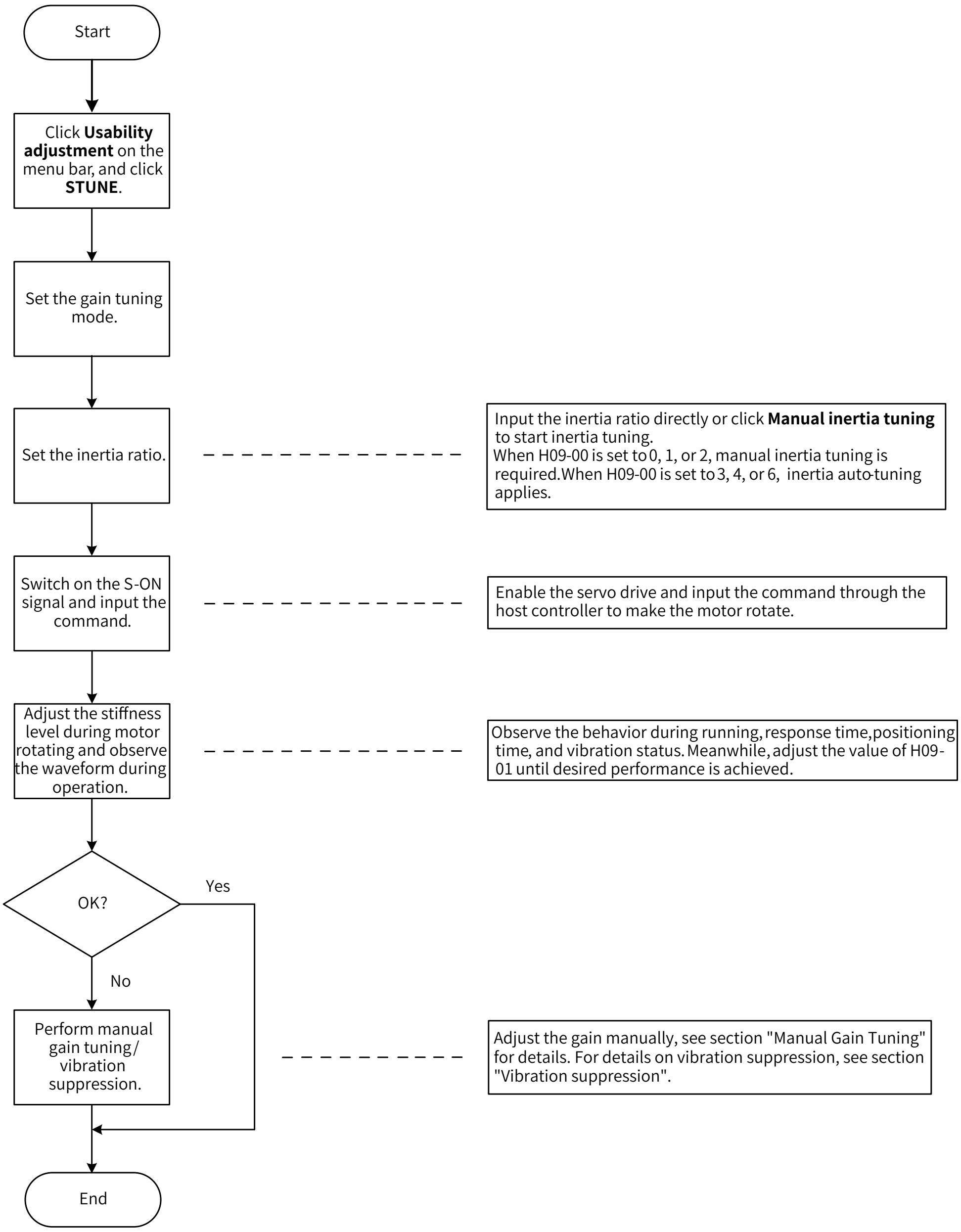
If H09-00 (Gain auto-tuning mode) is set to 4 (Regular mode + Inertia auto-tuning) or 6 (Quick positioning mode+Inertia auto-tuning), a load inertia auto-tuning through online inertia auto-tuning is required. Therefore, ensure the following conditions are met:

- The load inertia changes quickly.
- The load torque changes quickly.
- The motor is running at a speed lower than 120 r/min.
- Acceleration/Deceleration is slow (lower than 1000 r/min per second).
- The acceleration/deceleration torque is smaller than the unbalanced load/viscous friction torque.

If the preceding conditions cannot be fulfilled, set the correct inertia ratio manually..

6.4.2 Description of Operations

1) Operation flowchart



2) Detailed description

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

a) Select the gain 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.
1	Standard stiffness level 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	Normal 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 trajectory tracking.
6	Fast 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 operation of the load. The present stiffness level will be written to the servo drive automatically. Keep monitoring the waveform during operation after modifying the stiffness level (modify by one level each time) until the desired performance is achieved.

c) For mode 4 and mode 6, H09-00 will be restored to 0 to exit from STune mode after running at a speed above 100 r/min for 5 min.

If commissioning is done, you can set H09-00 to 0 to exit from STune in advance.

To modify the operating time of STune, set H09-37 (Vibration monitoring time) based on actual applications.

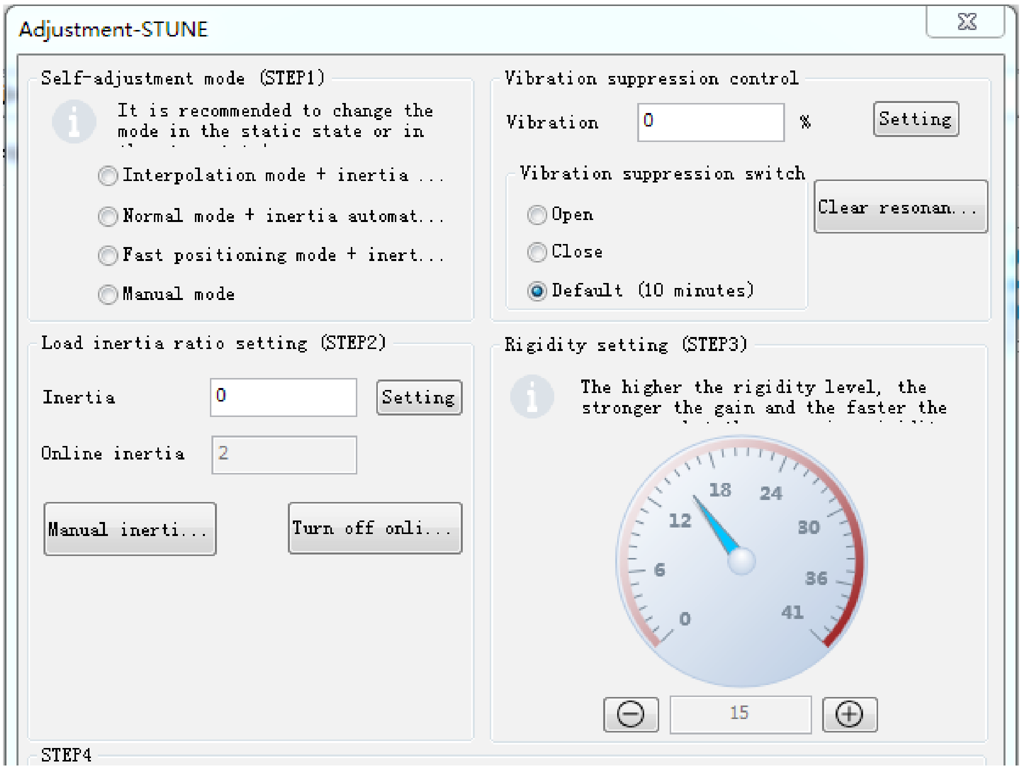
d) For mode 4 and mode 6, resonance suppression will be applied automatically when resonance occurs on the servo drive. If resonance cannot be suppressed, set H09-58 (STune resonance suppression reset) to 1 (Enable) to clear resonance suppression parameters, reduce the stiffness level, and perform STune again.

e) For multi-axis trajectories, perform single-axis commissioning first to determine the maximum response of each axis and modify the response value of each axis manually to ensure position responses of different axes are consistent.

- Mode 4: Determine the minimum value of H08-02 (Position loop gain), set H09-00 of each axis to 0, and set H08-02 of each axis to the same value.
- Mode 6: Determine the minimum value of H08-43 (Model gain), set H09-00 of each axis to 0, and set H08-43 of each axis to the same value.

CAUTION

To ensure a stable operation of Mode 4 under default settings, gain parameters will be adjusted along with the inertia ratio when the inertia ratio is higher than 13. In multi-axis trajectories, different responses may be generated under the same stiffness level.



6.4.3 Precautions

The value 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 a conveyor
Level 15 to level 20	Applications with high stiffness such as a ball screw and direct-coupled 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 suppresses vibration by performing inertia auto-tuning automatically within 10 min (or other time interval defined by H09-37) after power-on or stiffness level setting, and then it exits from inertia 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 couplings, do not set H09-00 to 3, 4, or 6.
- 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).

■ Standard stiffness level 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 automatically in the standard stiffness level mode

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 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 fixed 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	-

Parameters related to speed feedforward are fixed to certain setpoints.

Table 6-5 Parameters with fixed setpoints 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 setpoints.

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 set (H08-00 to H08-02, H07-05) and the 2nd gain set (H08-03 to H08-05, H07-06) is active. In other modes, the original settings are used.
H08-09	Gain switchover condition	10	In the positioning mode, gain switchover is active only if H08-09 is set to 10. In other modes, the original settings are 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 settings are used.
H08-11	Gain switchover level	50	In the positioning mode, the gain switchover level is 50. In other modes, the original settings are used.

Para. No.	Name	Value	Description
H08-12	Gain switchover dead time	30	In the positioning mode, the gain switchover dead time is 30. In other modes, the original settings are used.

CAUTION

◆ In the gain auto-tuning mode, parameters updated automatically along with H09-01 and those with fixed setpoints 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.

6.4.4 Resonance Suppression Parameters

When the H09-00 is set to 3, 4, or 6, automatic resonance suppression will be applied automatically.

When the load changes or the mechanical structure is re-installed, the system resonance frequency changes accordingly. Set H09-58 to "Enable" and turn on the STune mode after clearing resonance suppression parameters.

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-37	Phase modulation of medium frequency suppression 2	-90 to +90	°	Defines the phase of medium frequency suppression 2.	During running	Immediately	0
H08-38	Frequency of medium frequency suppression 2	0 to 1000	Hz	Defines the frequency of medium frequency suppression 2.	During running	Immediately	0
H08-39	Compensation gain of medium frequency supression 2	0 to 300	%	Defines the compensation gain of medium frequency suppression 2.	During running	Immediately	0
H09-18	Frequency of the 3rd notch	50 to 8000	Hz	Defines the frequency of the 3rd notch.	During running	Immediately	8000
H09-19	Width level of the 3rd notch	0 to 20	-	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 attentuation level of the 3rd notch.	During running	Immediately	0
H09-21	Frequency of the 4th notch	50 to 8000	Hz	Defines the frequency of the 4th notch.	During running	Immediately	8000
H09-22	Width level of the 4th notch	0 to 20	-	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 attentuation level of the 4th notch.	During running	Immediately	0
H09-58	STune resonance suppression reset	0 to 1	-	0: Disable 1: Enable After H09-58 is enabled, H08-37...H08-39 and H09-18...H09-23 will be cleared automatically.	During running	Immediately	0

6.4.5 Solutions to Common Faults

■ ER661: Gain too low

When the torque ripple detected by the servo drive exceeds the setpoint of H09-11 and becomes uncontrollable, the stiffness level will be reduced automatically until reaching level 10 where ER661 is reported.

1) For uncontrollable vibration, enable vibration suppression manually.

2) For current fluctuation, check whether the current of the machine fluctuates regulary.

Para. No.	Name	Description	Value Range	Default	Unit	Length	Setting Condition	Effective Time
H08-37	Phase modulation of medium frequency suppression 2	-	-90 to +90	0	°	16 bits	During running	Immediately
H08-38	Frequency of medium frequency suppression 2	-	0 to 1000	0	Hz	16 bits	During running	Immediately
H08-39	Compensation gain of medium frequency supression 2	-	0 to 300	0	1	16 bits	During running	Immediately
H09-58	STune resonance suppression reset	0: Disable 1: Enable	0 to 1	0	1	16 bits	During running	Immediately

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 basic control diagram is shown in the following figure.

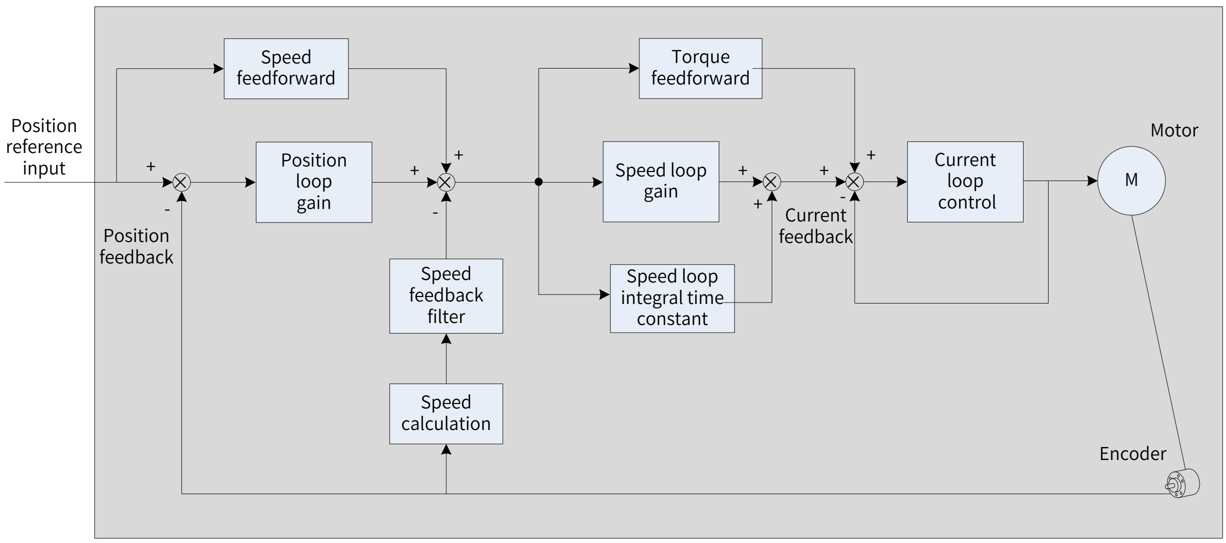


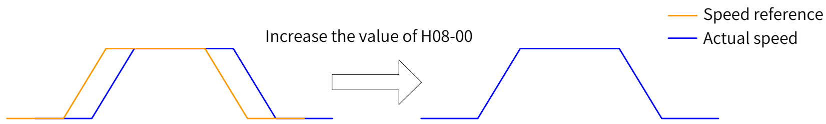
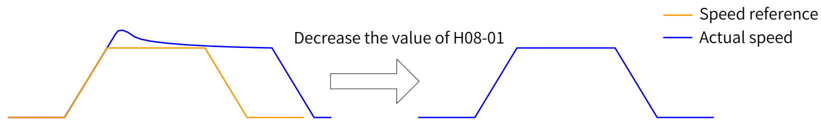
Figure 6-5 Basic control diagram

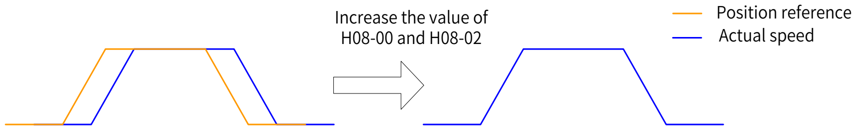
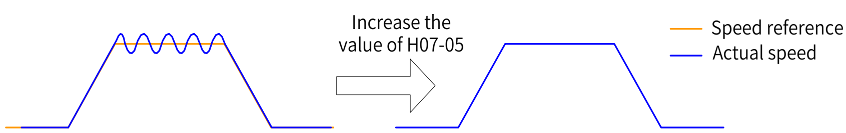
The response level of the inner loop must be higher than that of the outer loop. Otherwise, the system may become unstable.

The default gain of the current loop is already set with the highest level of response, avoiding the need for adjustment. It is only needed 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: Defines the maximum frequency of the speed loop in following the variable 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 follow-up 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: 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 requirement: 12.50 ms ≤ H08-01 ≤ 25.00 ms Decreasing the setpoint of H08-01 strengthens the integral action and shortens the positioning time, but a too small setpoint 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.

Step	Para. No.	Name	Description
3	H08-02	Position loop gain	◆ Parameter function: Defines the maximum frequency of the position loop in following the variable position references. Maximum following frequency of position loop = H08-02  ◆ Adjustment method: To ensure system stability, the maximum follow-up frequency of the speed loop must be 3 to 5 times higher than that of the position loop. Therefore, the following formula must be fulfilled. $3 \le \frac{2 \times \pi \times H8\text{-}00}{H08\text{-}02} \le 5$ For example, when H08-00 is set to 40.0 Hz, the position loop must meet the following requirement: 50.2 Hz ≤ H08-02 ≤ 83.7 Hz Adjust the setpoint based on the positioning time. Increasing the value of H08-02 shortens the acceleration time and improves the response to disturbances of the motor at a standstill. Do not set H08-02 to a too large value. Otherwise, system instability or oscillation may occur.
4	H07-05	Filter time constant of torque reference	◆ Parameter function: Eliminates the high-frequency noise and suppresses mechanical resonance.  ◆ Adjustment method: Ensure the cutoff frequency of the torque reference low-pass filter is 4 times higher than the maximum follow-up frequency of the speed loop. Therefore, the following formula must be fulfilled. $\frac{1000}{2 \times \pi \times H07\text{-}05} \ge (H08\text{-}00) \times 4$ For example, when H08-00 is set to 40.0 Hz, the 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.

☆ 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	39.0

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
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	20.51
H08-02	Position loop gain	0.1 to 2000.0	Hz	Defines the proportional gain of the position loop.	During running	Immediately	55.7
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	0.2

6.5.2 Gain Switchover

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

- Switching to the lower gain when the motor is at a standstill (servo ON) to suppress vibration
- Switching to the higher gain when the motor is at a standstill to shorten the positioning time
- Switching to the higher gain when the motor is running to achieve better command 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 integral control can be switched through DI function 3 (FunIN.3: GAIN_SEL, gain switchover) in the speed loop.

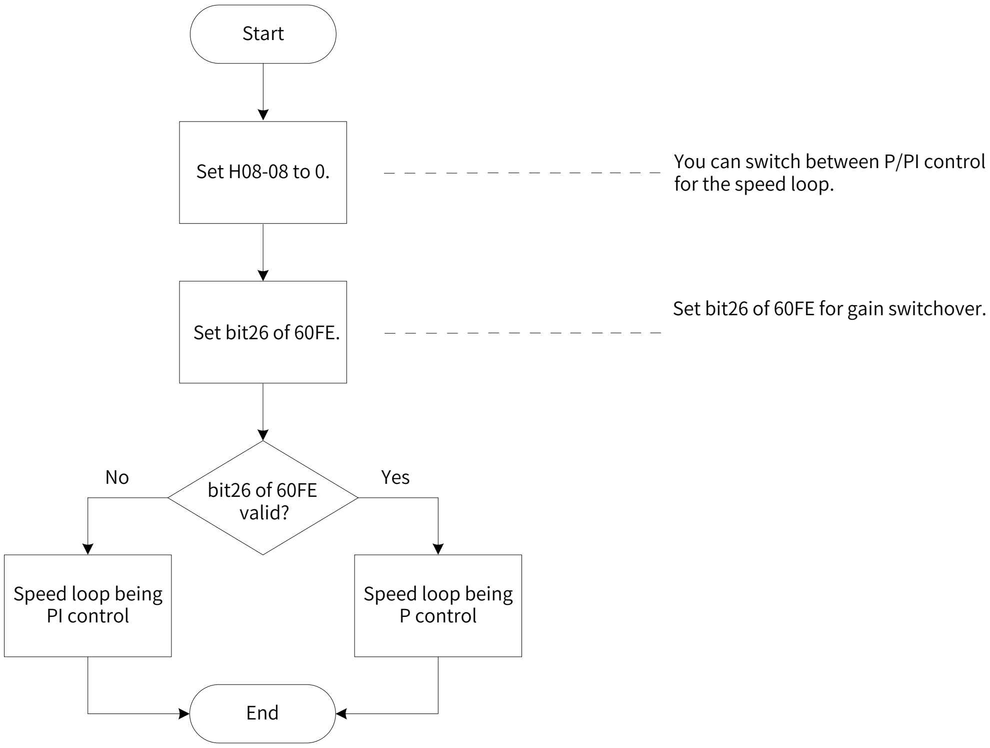


Figure 6-6 Gain switchover flowchart (H08-08 = 0)

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).

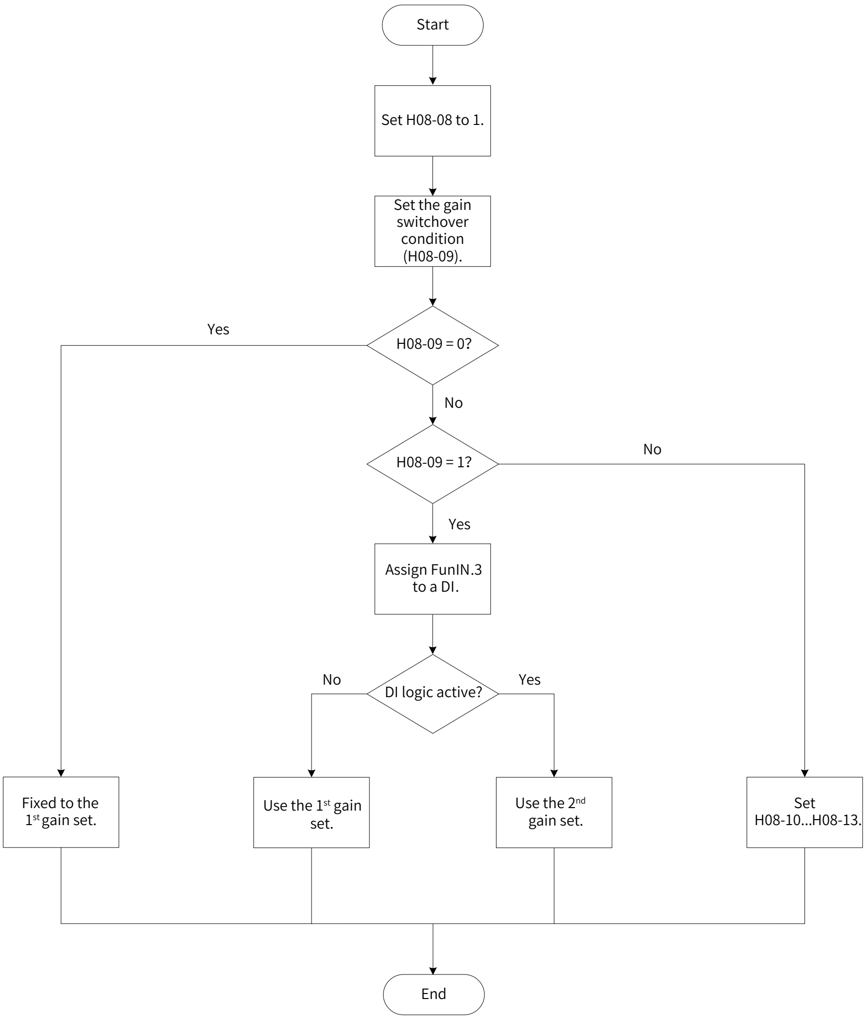
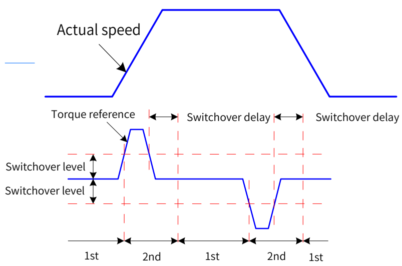
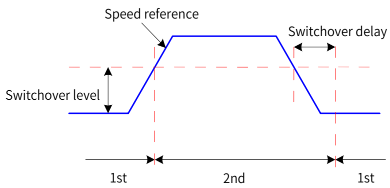
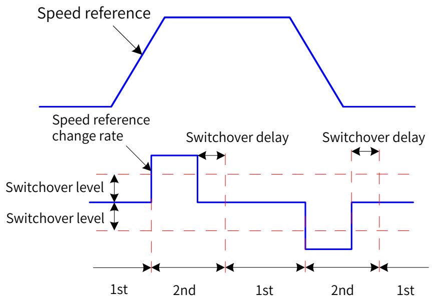
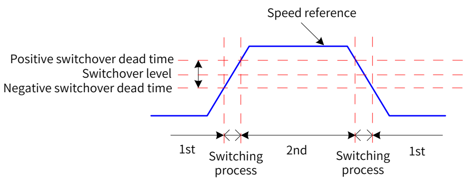
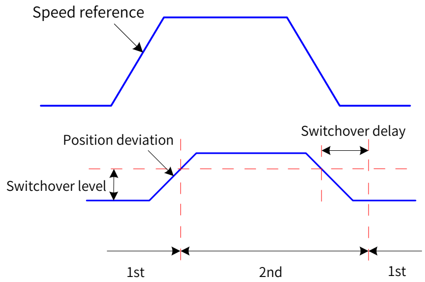
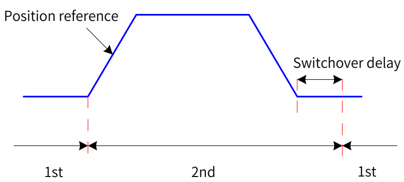
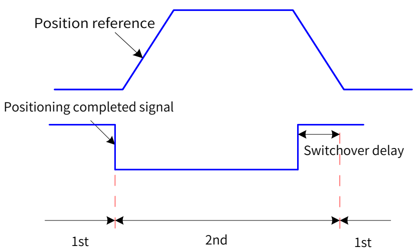


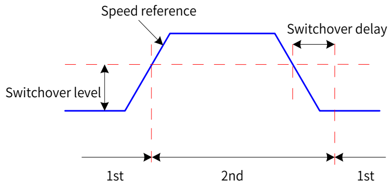
Figure 6-7 Gain switchover flowchart (H08-08 = 1)

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

Table 6-7 Conditions for gain switchover

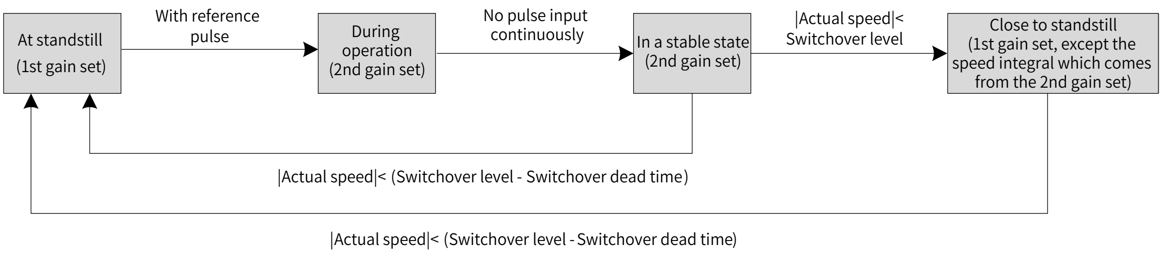
Gain Switchover Condition			Related Parameters		
H08-09	Condition	Diagram	Delay (H08-10)	Gain switchover level (H08-11)	Gain switchover dead time (H08-12)
0	Fixed to the 1st gain set	-	Invalid	Invalid	Invalid
1	Switched by external DI	-	Invalid	Invalid	Invalid
2	Torque reference		Valid	Valid (%)	Valid (%)

Gain Switchover Condition			Related Parameters		
H08-09	Condition	Diagram	Delay (H08-10)	Gain switchover level (H08-11)	Gain switchover dead time (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 dead time (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 set to the 1st gain set.



☆ Related parameters:

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-08	2nd gain set mode	0: Fixed to the 1st gain set, P/PI switched through external DI 1: Switched between the 1st gain set and 2nd gain set as defined by H08-09	-	Defines the mode of the 2nd gain set.	During running	Immediately	1
H08-09	Gain switchover condition	0: Fixed to the 1st gain set 1: Switched 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	Immediately	0
H08-10	Gain switchover delay	0 to 10	-	Defines the gain switchover delay.	During running	Immediately	5.0

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-11	Gain switchover level	0 to 20000	Based on the switchover condition	Defines the gain switchover level.	During running	Immediately	50
H08-12	Gain switchover dead time	0 to 20000	Based on the switchover condition	Defines the gain switchover dead time.	During running	Immediately	30
H08-13	Position gain switchover time	0.0 to 100.0	ms	Defines the gain switchover time of the position loop.	During running	Immediately	3.0

6.5.3 Position Reference Filter

Name	Function	Applicable Occasion	Impact of Excessive Filter
Position reference filter	Filters the position references (in 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.

6.5.4 Feedforward Gain

1 Speed Feedforward

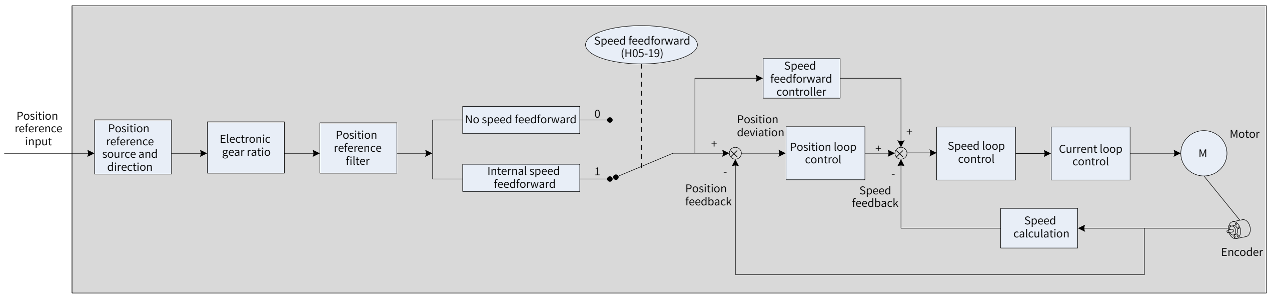


Figure 6-8 Operating process for speed feedforward control

Speed feedforward can be applied to the position control mode to improve speed reference responsiveness and reduce the position deviation during operation at a constant speed.

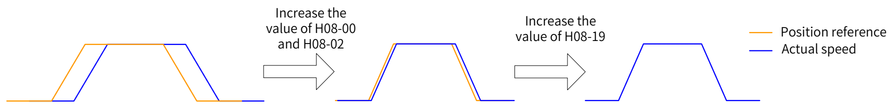
Operating procedure for speed feedforward:

1) Setting the speed feedforward signal source

Set H05-19 to a non-zero value to enable the speed feedforward function. The corresponding signal source will be selected as well.

Para. No.	Name	Value Range	Description
H05-19	Speed feedforward selection	0: No speed feedforward	-
		1: Internal speed feedforward	Defines the speed information corresponding to the position reference (in encoder unit) as the speed feedforward signal source.

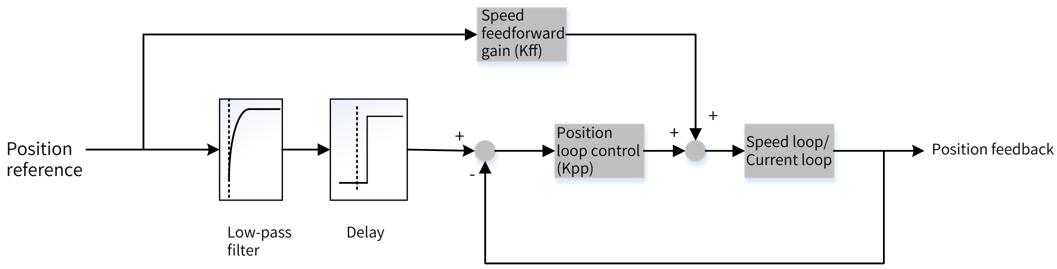
2) Setting the speed feedforward parameters (including H08-18 and H08-19)

Para. No.	Name	Description
H08-18	Speed feedforward filter time constant	 ◆ Parameter function: Increasing the value of H08-19 improves the responsiveness but may cause speed overshoot during acceleration/deceleration.
H08-19	Speed feedforward gain	Decreasing the value of H08-18 suppresses speed overshoot during acceleration/deceleration. Increasing the value of H08-18 not only suppresses noises generated upon long position reference update periods, long drive control periods and uneven position reference pulse frequencies, but also suppresses jitter of the positioning completed signal. ◆ Adjustment method: Set H08-18 to a fixed value first, and then increase the value of H08-19 gradually from 0 to a certain value at which speed feedforward reaches the desired effect. Adjust H08-18 and H08-19 repeatedly until a balanced performance is reached.

2 Zero phase control

Zero phase control is used to compensate for the position deviation generated upon delay of position reference startup, reducing the position deviation upon start/stop of the position control mode.

The loop calculation model is shown in the following figure.



■ Setting parameters related to zero phase

Para. No.	Name	Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
H05-19	Speed feedforward selection	Setting H05-19 to 3 to enable zero phase compensation feedforward. Normal speed feedforward applies when H08-17 is not involved. Zero phase control applies when H08-17 is involved.	0–3	1	1	16 bits	At stop	Immediately
H08-17	Zero phase delay	The setpoint of H08-17 indicates the speed feedforward calculation time in advance.	0–4	0	1 ms	16 bits	During running	Immediately
H05-04	Zero phase low-pass filter time	Defines the low-pass filter time of position references.	0–6553.5	0	0.1 ms	16 bits	At stop	Immediately

3 Torque feedforward

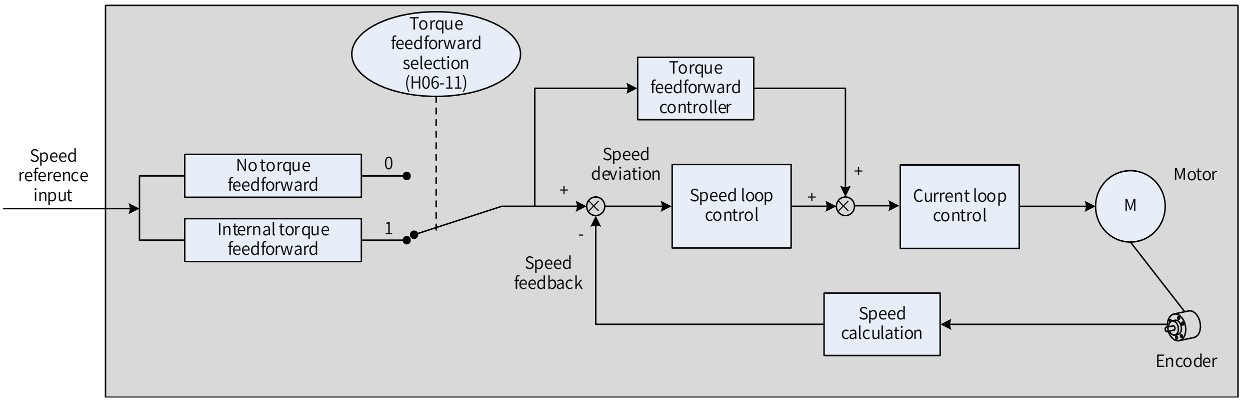


Figure 6-9 Operating process for torque feedforward control

Torque feedforward can be applied to the position control mode to improve torque reference responsiveness and reduce the position deviation during acceleration/deceleration at a constant speed. Torque feedforward can also be applied to the speed control mode to improve torque reference responsiveness and reduce the speed deviation during operation at a constant speed.

Operating procedure for torque feedforward:

1) Setting the torque feedforward signal source

Set H06-11 to 1 to enable the torque feedforward function. The corresponding signal source will be selected as well.

Para. No.	Name	Value Range	Description
H06-11	Torque feedforward 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 generated by 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 desired effect. Adjust H08-20 and H08-21 repeatedly until a balanced performance is reached.
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 method.

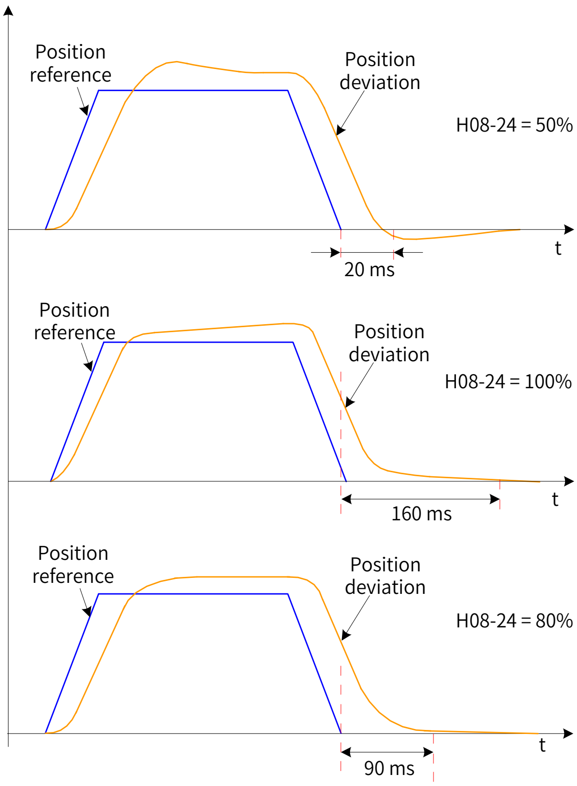


Figure 6-10 Example of PDFF control

Through adjusting the speed loop control method, PDFF control enhances the anti-disturbance capacity of the speed loop and improves the performance in following speed references.

Para. No.	Name	Description
H08-24	PDFF control coefficient	◆ Parameter function: Defines the control method of the speed loop in the non-torque control mode. ◆ Adjustment method: Do not set H08-24 to a too small value. Otherwise, the speed loop responsiveness will be affected. When the speed feedback overshoots, 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 method does not change and the default proportional integral control is used.

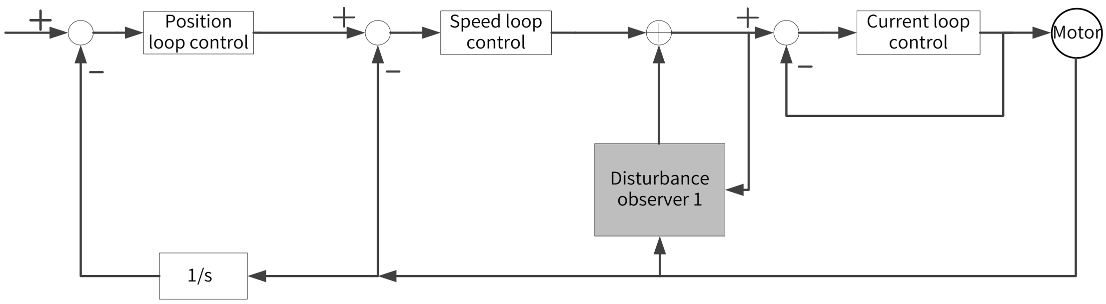
6.5.6 Torque Disturbance Observation

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 disturbances. Disturbances within the frequency range can be observed and suppressed through the cutoff frequency and compensation settings.

The following figure depicts the control block diagram, showing the location of the disturbance observer 1 in the control structure.



NOTE

◆ 1/s: Integral element

Para. No.	Name	Description
H08-31	Disturbance observer cutoff frequency	The higher the cutoff frequency is, the more easily will vibration occur.
H08-32	Disturbance observer compensation coefficient	Defines the compensation percentage for observation.
H08-33	Disturbance observer inertia correction coefficient	H08-33 needs to be set only if the inertia setpoint does not fit the actual conditions. The effective inertia is the product of H08-33 multiplied by the inertia setpoint. It is recommended to use the default value of H08-33.

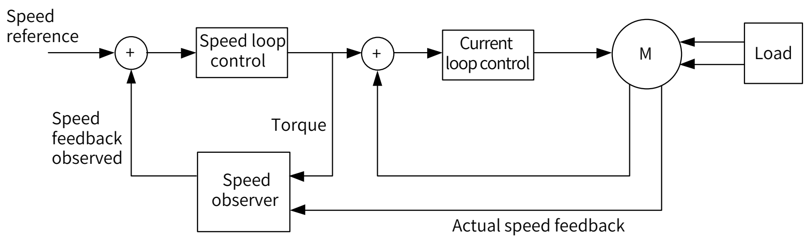
☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-31	Disturbance observer cutoff frequency	10 to 4000	1 Hz	Defines the cutoff frequency of disturbance observer.	During running	Immediately	600
H08-32	Disturbance observer compensation coefficient	0 to 100	1%	Defines the compensation percentage of disturbance observer.	During running	Immediately	0
H08-33	Disturbance observer inertia correction coefficient	1 to 1600	1%	Defines the correction coefficient of the disturbance observer inertia.	During running	Immediately	100

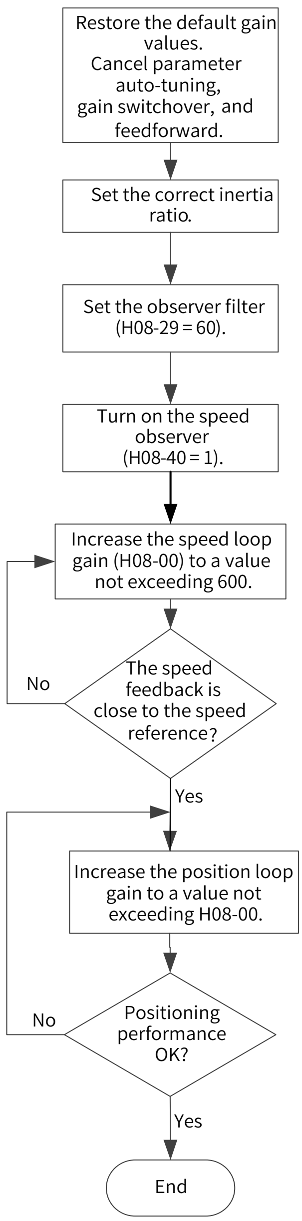
6.5.7 Speed Observer

The speed observer is intended to be used in applications with slight load/inertia changes. It facilitates quick positioning through improving the responsiveness and filtering high frequencies, shortening the positioning time and improving the gain without incurring high-frequency vibration.

The block diagram for the speed observer is as follows.



1 Commissioning procedure



2 Related parameters:

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H08-00	Speed loop gain	Hz	0.1 to 2000	39	During running	Immediately
H08-27	Speed observer cutoff frequency	1 Hz	50 to 600	170	During running	Immediately
H08-28	Speed observer inertia correction coefficient	1%	1 to 1600	100	During running	Immediately
H08-29	Speed observer filter time	1 ms	0 to 10	0.8	During running	Immediately
H08-40	Speed observer 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.

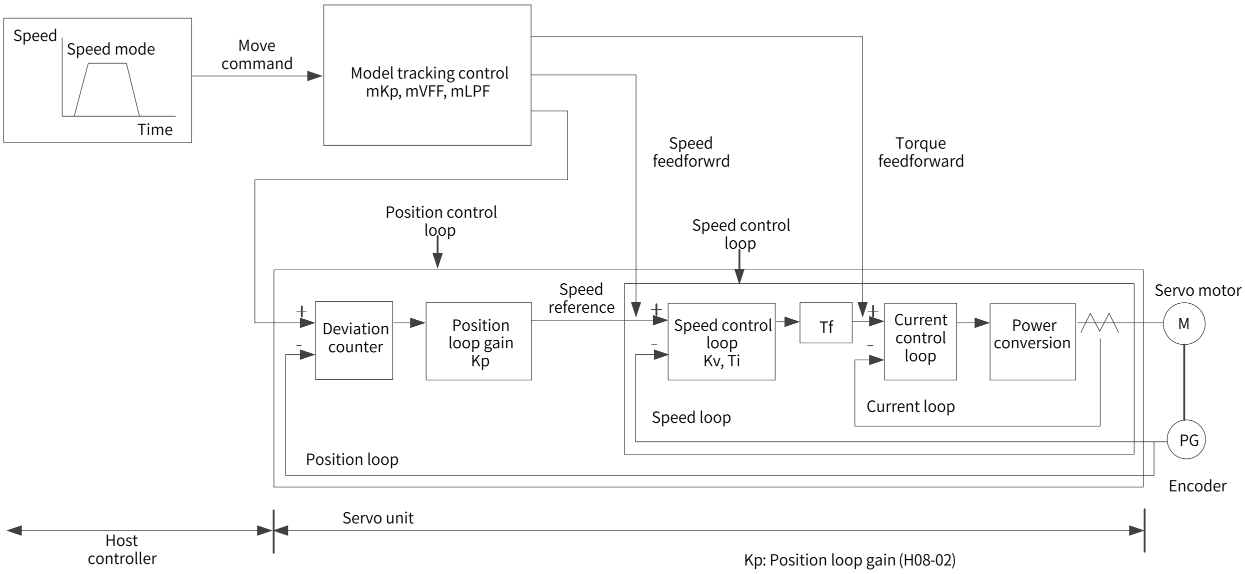
6.5.8 Model Tracking Function

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

The block diagram for model tracking function is as follows.



Kp: Position loop gain (H08-02)

Kv: Speed loop gain (H08-00)

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

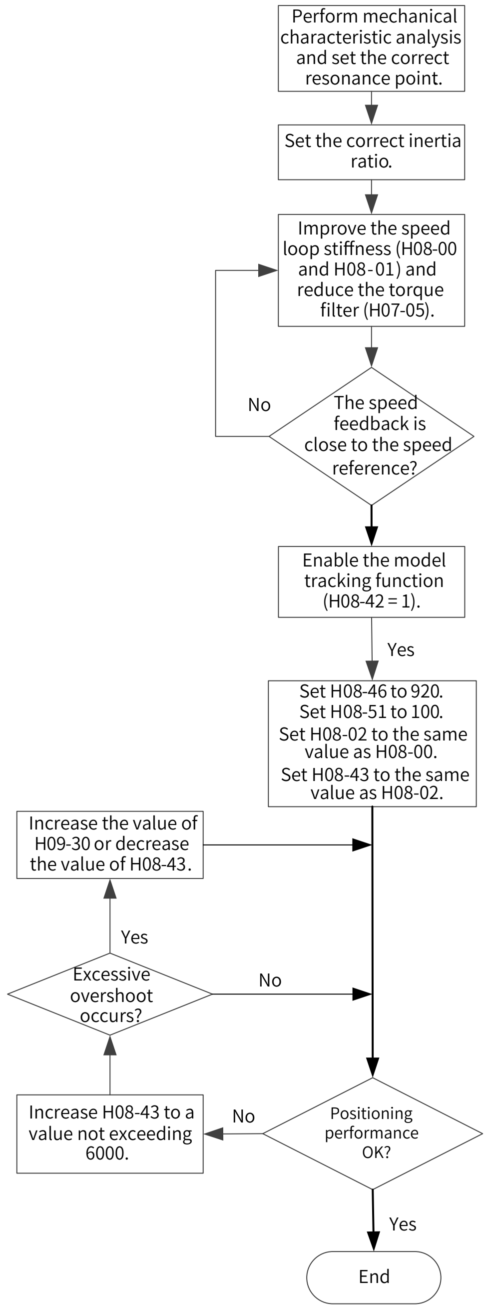
Tf: Torque reference filter time constant (H07-05)

mKp: Model tracking control gain (H08-43)

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

mLPF: Model filter time (H08-51)

1 Commissioning procedure



2 Related parameters

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H07-05	Torque reference filter time constant	1 ms	0 to 30	0.2	During running	Immediately
H08-00	Speed loop gain	Hz	0.1 to 2000	39	During running	Immediately
H08-01	Speed loop integral time constant	ms	0.15 to 512	20.51	During running	Immediately
H08-02	Position loop gain	Hz	0.1 to 2000	55.7	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	1	0.1 to 2000	40	During running	Immediately
H08-46	Model feedforward	1	0 to 102.4	95	During running	Immediately
H08-51	Model filter time 2	0.01 ms	0 to 2000	0	During running	Immediately

CAUTION

Ensure the inertia is set correctly. If the inertia deviates greatly from the actual condition, motor vibration will occur.

6.5.9 Friction Compensation

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

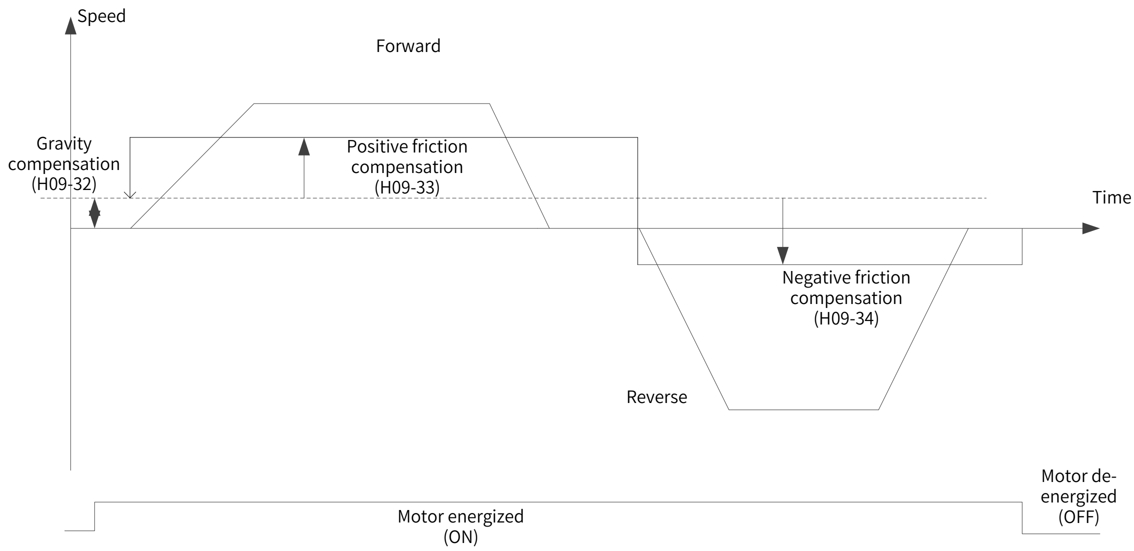
NOTE

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

☆ Related parameters

Para. No.	Para. Name	Value Range	Function
H09-32	Gravity compensation	0% to 100%	Defines the constant compensation torque of vertical gravity load.
H09-33	Positive friction compensation	0% to 100%	Defines the friction compensation for forward position references.
H09-34	Negative friction compensation	–100% to 0%	Defines the friction compensation for reverse position references.
H09-35	Friction compensation speed threshold	0 RPM to 20RPM	Defines the speed value after friction is resisted.
H09-36	Friction compensation speed selection	0: Speed reference 1: Model speed (valid when the model function is activated) 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 a positive compensation value. Reverse direction requires a negative compensation value.

6.6 Parameter Adjustment in Different Control Modes

Perform parameter adjustment in the following sequence:
"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 gain set

Para. No.	Name	Function	Default
H07-05	Torque reference filter time constant	Defines the filter time constant of the torque reference.	0.2 ms
H08-00	Speed loop gain	Defines the proportional gain of the speed loop.	39.0 Hz
H08-01	Speed loop integral time constant	Defines the integral time constant of the speed loop.	20.51 ms
H08-02	Position loop gain	Defines the proportional gain of the position loop.	55.7 Hz

■ 2nd gain set

Para. No.	Name	Function	Default
H07-06	2nd torque reference filter time constant	Defines the filter time constant of the torque reference.	0.27 ms
H08-03	2nd speed loop gain	Defines the proportional gain of the speed loop.	75 Hz
H08-04	2nd speed loop integral time constant	Defines the integral time constant of the speed loop.	10.61 ms

Para. No.	Name	Function	Default
H08-05	2nd position loop gain	Defines the proportional gain of the position loop.	120 ms
H08-08	2nd gain mode	Defines the mode of the 2nd gain set.	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 dead time	Defines the gain switchover dead time.	30
H08-13	Position gain switchover time	Defines the gain switchover time of the position loop.	3.0 ms

■ Common gains

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.	8000 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 of low-frequency resonance suppression	Defines the frequency of the filter used to suppress low-frequency resonance.	100.0 Hz
H09-39	Low-frequency resonance frequency filter setting	Used to set the low-frequency resonance suppression filter.	2
H0A-16	Threshold of low-frequency resonance position deviation	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 set (or 2nd gain set) and common gains.

■ 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 gains (H08-02 and H08-05). See section *"6.6.1 Parameter Adjustment in the Position Control Mode"* for details.

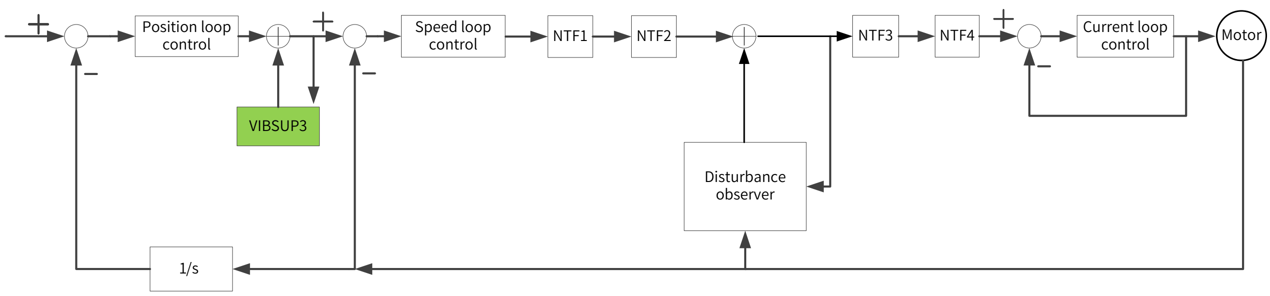
6.6.3 Parameter Adjustment in the Torque Control Mode

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 suppression is as follows.



- NTF1–4: 1st notch to 4th notch
- VIBSUP3: Suppression of medium- and low-frequency vibration
- 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	Hz	0	300	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	100	1%	0	600	During running	Immediately
H08-59	Medium- and low-frequency jitter suppression frequency 4	0	Hz	0	300	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

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

6.7.1 Suppression of Mechanical Resonance

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

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 enable 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.

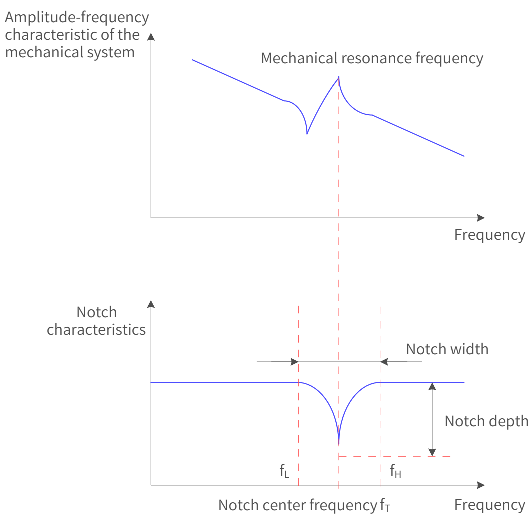


Figure 6-11 Operating principle of the notch

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 an adaptive notch (H09-02 = 1 or 2).

Table 6-8 Description of notch parameters

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.

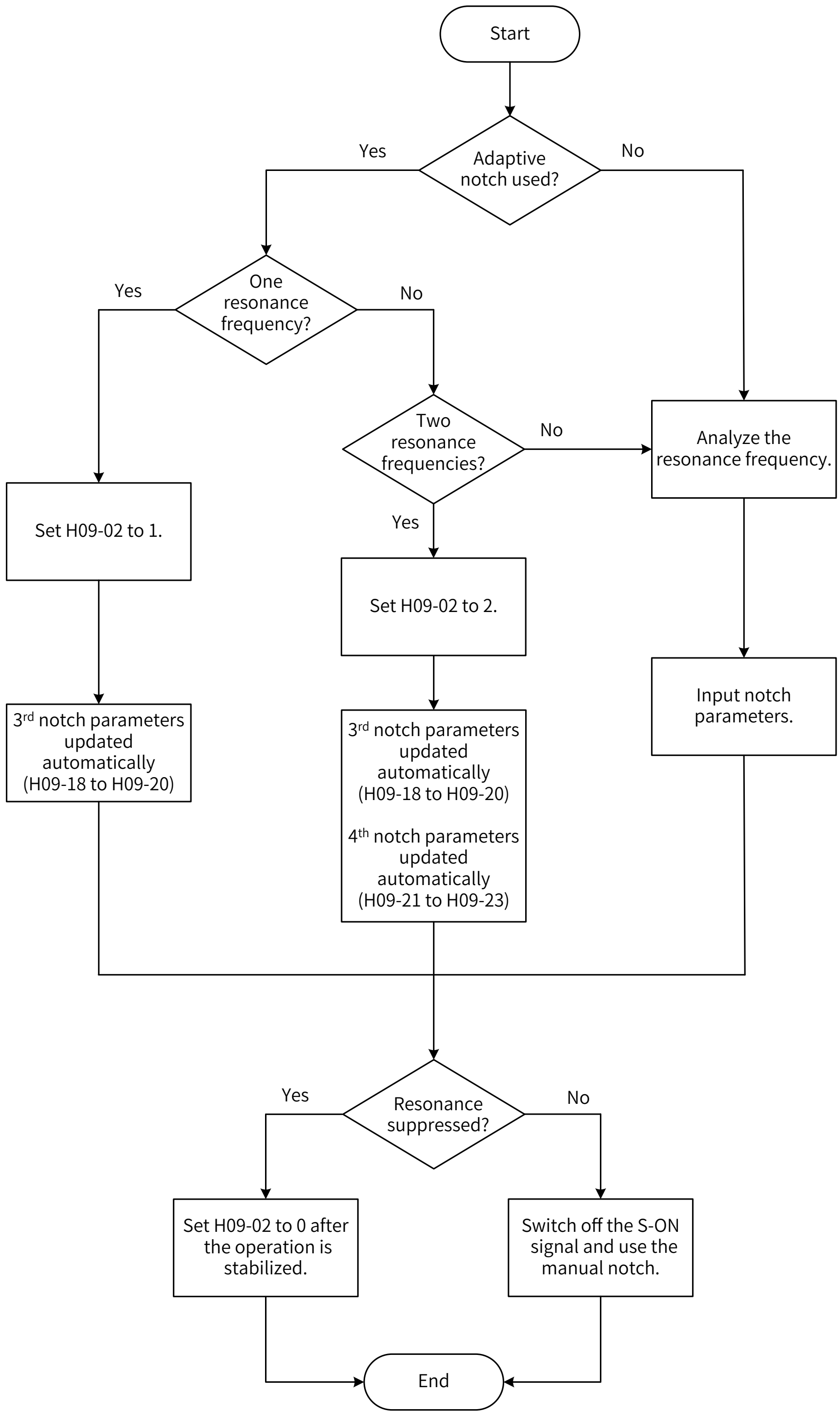


Figure 6-12 Procedure for using the notch

■ Procedure for using 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) Parameters of the 3rd or 4th notches are updated automatically during operation, and parameter values are saved automatically to the corresponding parameters in group H09 every 30 minutes.

4) If resonance is suppressed, it indicates the adaptive notch functions well. After the servo drive operates stably for a period of time, set H09-02 to 0 to fix the adaptive notch parameters to the latest setpoints. This is to prevent notch parameters from being updated to the wrong values, causing malfunction of the servo drive and intensifying vibration.

5) If vibration persists, 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, notch parameters will not be saved into corresponding parameters.

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

■ Procedure for using the manual notch:

1) Step 1: Analyze the resonance frequency.

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

a) Use the "Mechanical characteristic analysis" function in Inovance 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 saves the detected value in H09-24 (Auto-tuned resonance frequency) automatically after start.

3) Step 3: Enter the resonance frequency obtained in step 1 into the parameter of the selected notch, and enter 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 vibration persists, 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 spikes 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, which is not mechanical resonance that normally suppressed by a notch, can be suppressed only by reducing the gains or the torque reference filter time.

Their relation is shown in the following figure.

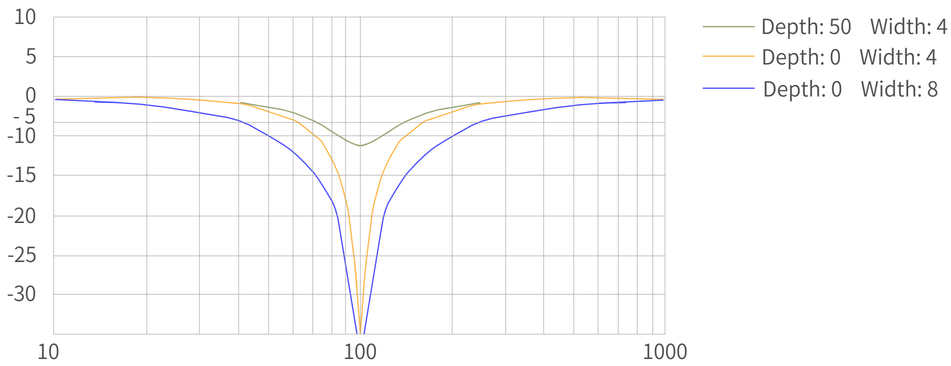


Figure 6-13 Notch frequency characteristics

☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-02	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 detected 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	3
H09-12	Frequency of the 1st notch	50 to 8000	Hz	Defines the frequency of the 1st notch.	During running	Immediately	8000
H09-13	Width level of the 1st notch	0 to 20	-	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 8000	Hz	Defines the frequency of the 2nd notch.	During running	Immediately	8000

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-16	Width level of the 2nd notch	0 to 20	-	Defines the width level of the 2nd notch.	During running	Immediately	2
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 8000	Hz	Defines the frequency of the 3rd notch.	During running	Immediately	8000
H09-19	Width level of the 3rd notch	0 to 20	-	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 8000	Hz	Defines the frequency of the 4th notch.	During running	Immediately	8000
H09-22	Width level of the 4th notch	0 to 20	-	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	0 to 5000	Hz	Displays the resonance frequency detected when H09-02 is set to 3.	-	-	0

6.7.2 Low Frequency Resonance Suppression at the Mechanical Load End

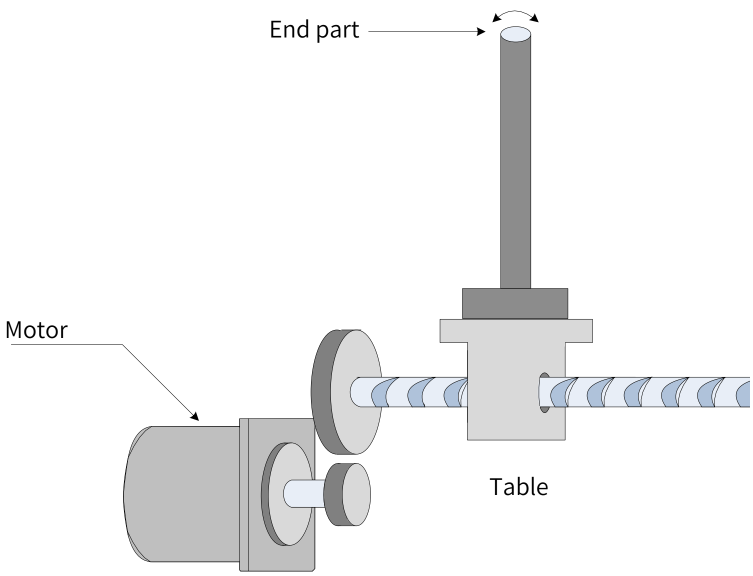


Figure 6-14 Low frequency vibration at the mechanical load end

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 suppress such vibration.

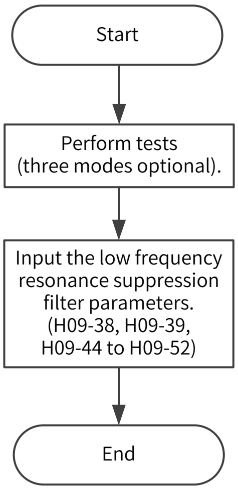


Figure 6-15 Procedure for setting low frequency resonance suppression filter

First, collect the position deviation waveform in the motor positioning mode by using the oscilloscope function in Inovance 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 low-frequency resonance at the mechanical load 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 load 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 invalid.	During running	Immediately	0

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-45	Response of low-frequency resonance suppression 2 at the mechanical load 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 reduces the delay caused by suppression and improves responsiveness. Note that setting H09-45 to a too large value may incur vibration.	During running	Immediately	1.00
H09-47	Width of low-frequency resonance suppression 2 at the mechanical load 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 operation.	During running	Immediately	1.00
H09-49	Frequency of low-frequency resonance suppression 3 at the mechanical load 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 invalid.	During running	Immediately	0
H09-50	Response of low-frequency resonance suppression 3 at the mechanical load end	0.01 to 10.00	Hz	Defines the response of the 3rd group of low-frequency resonance suppression. Increasing the value of H09-50 reduces the delay caused by suppression and improves responsiveness. Note that setting H09-50 to a too large value may incur vibration.	During running	Immediately	1.00
H09-52	Width of low-frequency resonance suppression 3 at the mechanical load 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 operation.	During running	Immediately	1.00

6.8 Mechanical Characteristic Analysis

6.8.1 Overview

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 Procedure

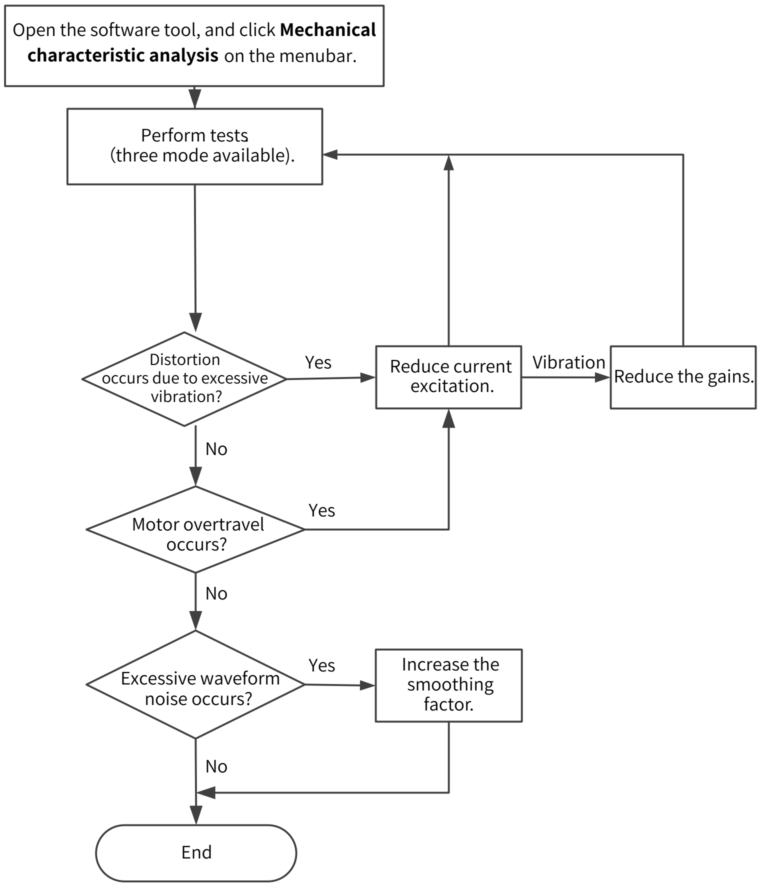


Figure 6-17 Operating procedure for mechanical characteristic analysis

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 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 ratio is too large. Set the inertia ratio properly.
- In the mechanical characteristic test mode, waveforms before and after notch settings are consistent. In the speed closed loop and speed open loop modes, waveforms are attenuated after notch settings.

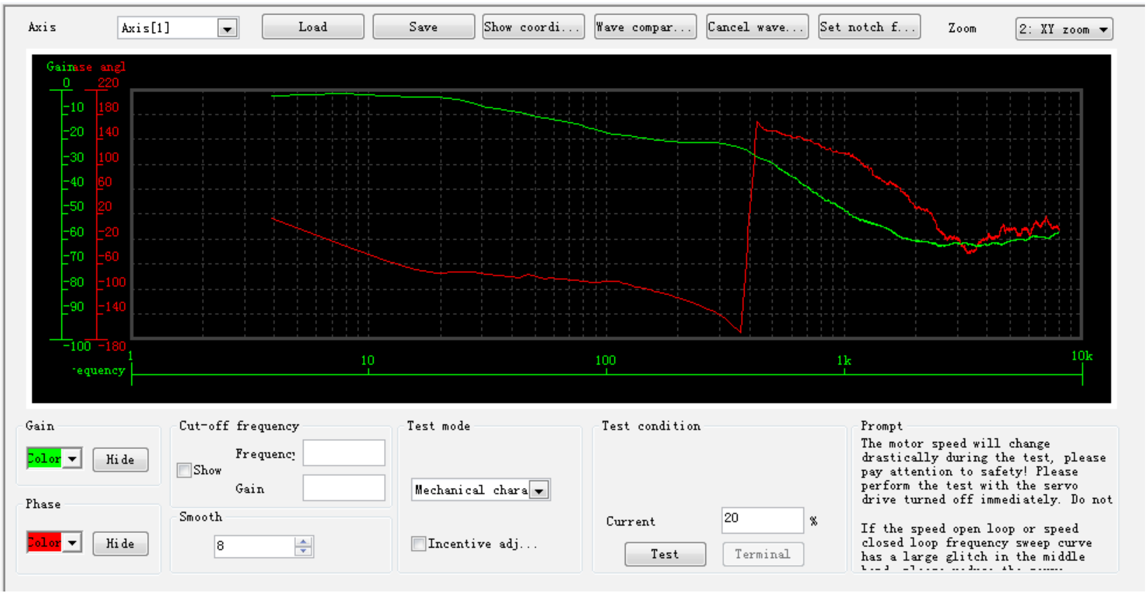


Figure 6-18 Example of the waveform obtained

Figure 6-18 shows an example of the waveform obtained with the mechanical characteristic analysis.

7 Control Modes

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

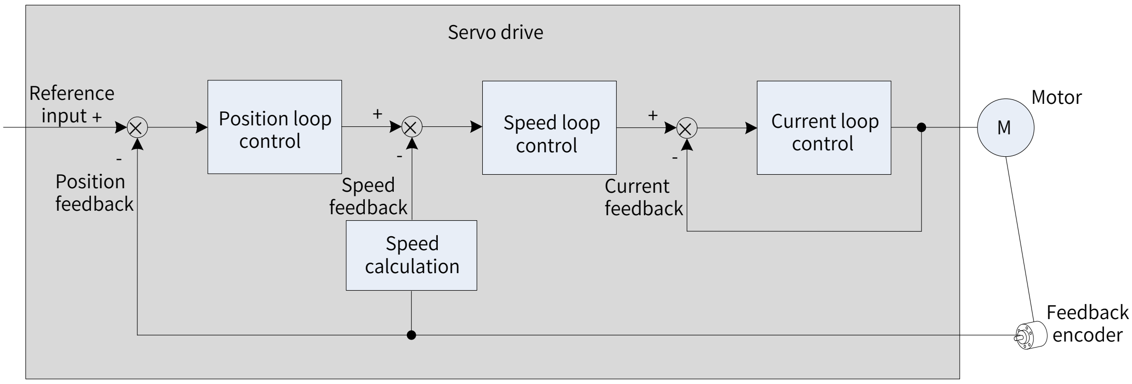


Figure 7-1 Structure of a basic servo system

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 compound (combination of position, speed and torque) control. Position control is the most important control 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 feedback encoder installed on the motor or an external encoder (fully closed-loop control). The position control mode mainly applies to applications requiring positioning control, such as the manipulator, SMT machine, engraving and milling machine, 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 applications 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 relation 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 changes in the winding radius.

7.1 Servo Drive Status 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 operate in the wrong state.

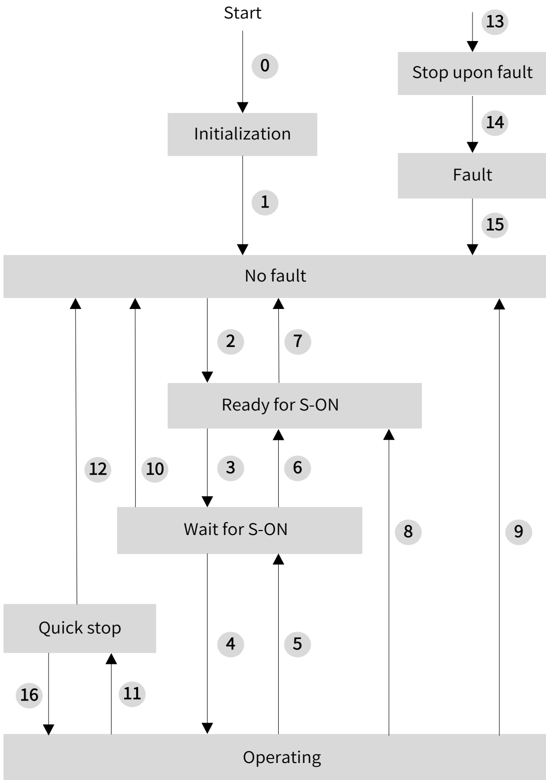


Figure 7-2 CiA402 state machine switchover

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 for S-ON	The servo drive is ready to run. The servo drive parameters can be set.
Wait for S-ON	The servo drive is waiting to be switched on. The servo drive parameters can be set.
Operating	The servo drive is operating properly and a certain operation mode has been enabled. The motor is energized and starts rotating when the speed 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 can be modified for troubleshooting.

The following table describes the switchover between the control commands and servo drive status.

CiA402 Status Switchover		Control Word 6040h	bit0 to bit9[1] of Status Word 6041h
0	Power-on → Initialization	Natural transition, control command not required	0x0000

CiA402 Status Switchover		Control Word 6040h	bit0 to bit9[1] of Status Word 6041h
1	Initialization → No fault	Natural transition, control command not required If an error occurs during initialization, the servo drive directly goes to status 13.	0x0250/0x270
2	No fault -> Ready for S-ON	0x0006	0x0231
3	Ready for S-ON -> Wait for S-ON	0x0007	0x0233
4	Wait for S-ON-> Operating	0x000F	0x0237
5	Operating -> Wait for S-ON	0x0007	0x0233
6	Wait for S-ON -> Ready for S-ON	0x0006	0x0231
7	Wait for S-ON -> No fault	0x0000	0x0250
8	Operating -> Ready for S-ON	0x0006	0x0231
9	Operating -> No fault	0x0000	0x0250
10	Wait for S-ON -> No fault	0x0000	0x0250
11	Operating -> Quick stop	0x0002	0x0217
12	Quick stop -> No fault	Set 605A to a value between 0 to 3. Natural transition applies after stop and no control command is required.	0x0250
13	-> Stop upon fault	Once a fault occurs in any status 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 applies 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 -> Operating	Set 605A to a value between 5 to 7. 0x0F will be sent upon stop.	0x0237

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

7.1.1 Control Word 6040h

<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>

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 operation modes.
10	Reserved	Undefined
11 to 15	Manufacturer-specific	Defined by the manufacturer.

Note:

- ◆ All bits in the control word constitute a control command.
- ◆ 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 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>
</table>

Indicates the servo drive status.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms		oms		ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rtso

MSB LSB

Note: ms=manufacturer-specific; oms=operation mode specific; ila =internal limit actIve; tr=target reached; 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 reached	1: Valid, 0: Invalid
11	Internal limit active	1: Valid, 0: Invalid
12 to 13	Operation mode specific	Related to the servo drive operation modes.
14	Manufacturer-specific	Undefined
15	Home found	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:

- ◆ 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 an acknowledged status.
- ◆ Meanings of bit12 to bit13 vary with the servo drive modes. For details, see parameters related to each mode.
- ◆ 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 Operation Mode Setting

7.2.1 Introduction to Servo Drive Operation Modes

The SV660N supports seven operations 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.</td></tr>
</table>

Bit	Description	Supported or Not (0: No 1: Yes)
0	Profile position (PP) mode	1
1	Velocity (VL) mode	0
2	Profile velocity (PV) mode	1
3	Profile torque (PT) mode	1
4	N/A	0
5	Homing (HM) mode	1
6	Interpolated position (IP) mode	0
7	Cyclic synchronous position (CSP) mode	1
8	Cyclic synchronous velocity (CSV) mode	1
9	Cyclic synchronous torque (CST) mode	1
10 to 31	Defined by the manufacturer	Reserved

If the device supports 6502h, you can get the supported servo drive modes through 6502h.

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

■ 6060h (Modes of operation)

Index 6060h	Name	Modes of operation			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Int8
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 10	Default	0

Defines the mode of servo drive operation.

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

If an operation mode not supported is set through SDO, an SDO error will be returned. For details, see "12.2 List of Object Groups".

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

■ 6061h (Modes of operation display)

Index 6061h	Name	Modes of operation display			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int8
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	0 to 10	Default	0

Displays the present operation mode of the servo drive.

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

7.2.2 Communication Cycles

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

7.3 Cyclic Synchronous Position (CSP) Mode

In CSP mode, the host controller generates position references and sends the target position to the servo drive cyclically. The servo drive executes position control, speed control, and torque control.

7.3.1 Configuration Block Diagram

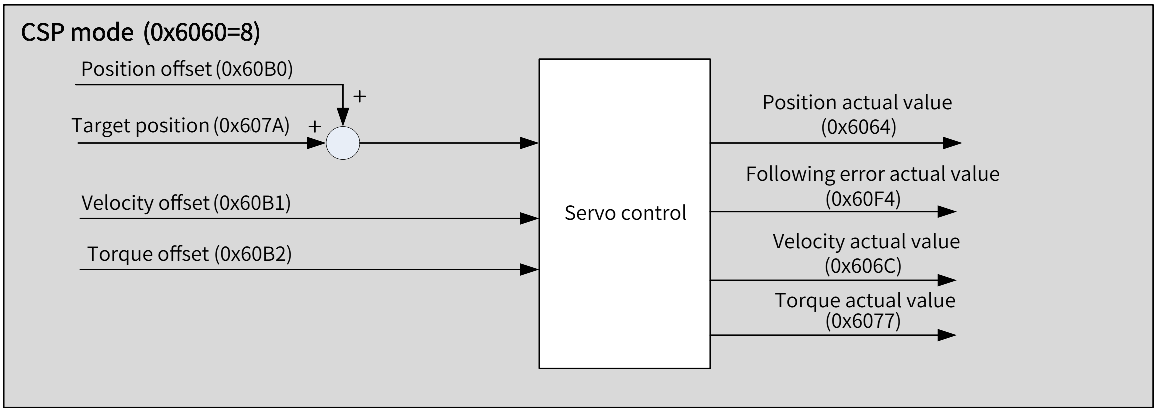


Figure 7-3 CSP mode

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	Reference unit	-	-
606C	00	Velocity actual value	RO	Int32	Reference unit/s	-	-
607A	00	Target position	RW	Int32	Reference unit	-2^{31} to $+(2^{31}-1)$	0
607E	00	Polarity	RW	Uint8	-	0 to 255	0
60B0	00	Position offset	RW	Int32	Reference unit	-2^{31} to $+(2^{31}-1)$	0
60B1	00	Velocity offset	RW	Int32	Reference 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

<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>Uint32</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) (reference unit)</td><td>Default</td><td>3145728</td></tr>
<tr><td colspan="11">Defines the threshold of excessive position deviation (in reference 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>Uint16</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 time lapse to trigger excessive position deviation (EB00.0).
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.</td></tr>
</table>

2 Position reference polarity

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

☆ Related parameter

<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>7</td><td>Position polarity
0: Multiply by 1
1: Multiply by -1
PP: Inverting the target position (607Ah)
CSP: Inverting the position reference (607Ah+60B0h)</td></tr></table></td></tr>
</table>

7.3.4 Recommended Configuration

The basic configuration for 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>
<tr><td colspan="11">Defines the control commands.</td></tr>
</table>

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 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>
<tr><td colspan="11">Shows the servo drive status.</td></tr>
</table>

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	Not supported, always being 1
11	Internal limit active	0: Position reference within the limit 1: Position reference beyond the limit
12	Drive follows 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 found	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 $+(2^{31}-1)$ (reference unit)	Default	0
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 the incremental position or the absolute position as defined by the control word.										

Index 60B0h	Name	Position offset			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Int32
	Access	RW	Mapping	RPDO	Related Mode	CSP	Value Range	-2^{31} to $+(2^{31}-1)$ (reference unit)	Default	0
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										

Index 60B1h	Name	Velocity offset			Setting Condition & Effective Time	During running	Data Structure	VAR	Data Type	Int32
	Access	RW	Mapping	RPDO	Related Mode	CSP/CSV	Value Range	-2^{31} to $+(2^{31}-1)$ (reference unit/s)	Default	0
Defines the external velocity feedforward signal of EtherCAT in the CSP mode 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 CSV mode through 60B1h.										

Index 60B2h	Name	Torque offset			Setting Condition & Effective Time	During running	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 EtherCAT in CSP and CSV modes when 2006-0Ch is set to 2. You can also set the torque reference offset in CST mode through 60B2h.										

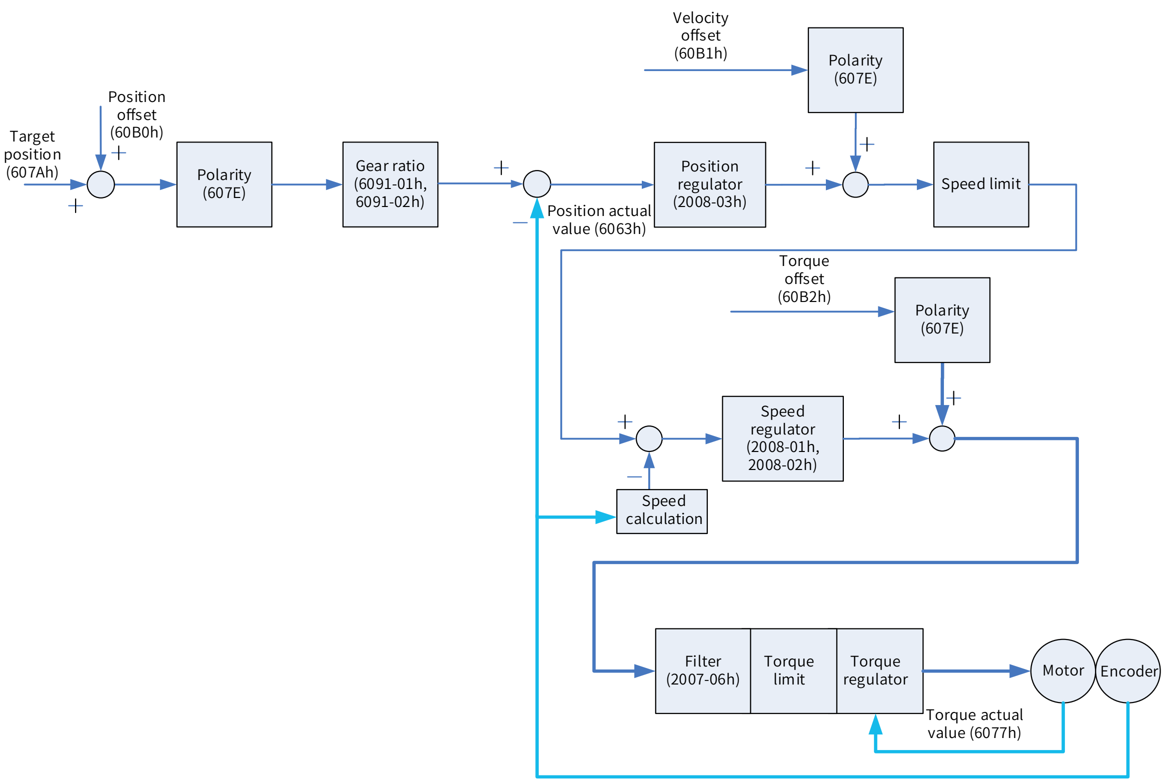
Index 6064h	Name	Position actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (reference unit)	Default	0
Shows the absolute position feedback (reference unit). In case of an absolute encoder used in the rotary mode, 6064h reflects the single-turn position feedback (reference unit) of the mechanical load.										

Index 606Ch	Name	Velocity actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	(reference unit/s)	Default	-
Shows the actual speed feedback value (reference 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 torque of the motor.										

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	(reference unit)	Default	-
Shows the position deviation (reference 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. The servo drive executes speed control and torque control.

7.4.1 Configuration Block Diagram

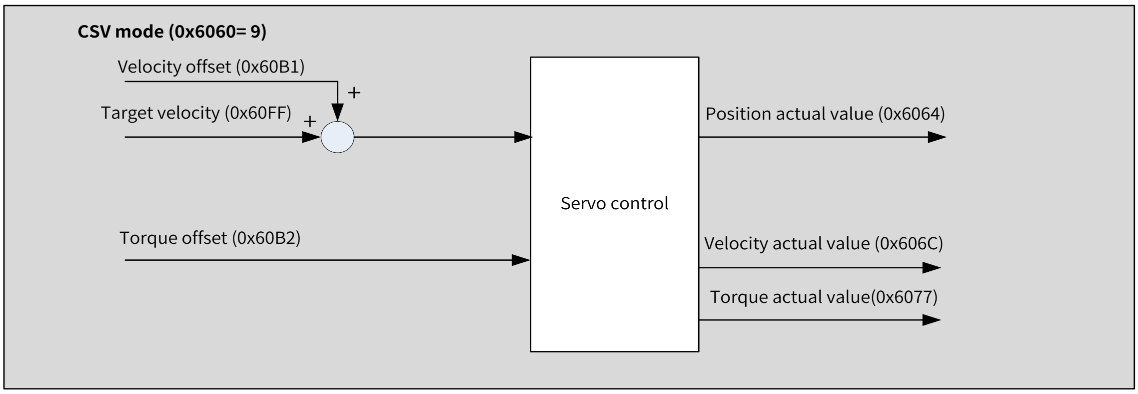


Figure 7-4 CSV mode

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	Reference unit	-	-
606C	00	Velocity actual value	RO	Int32	Reference unit/s	-	-
60B1	00	Velocity offset	RW	Int32	Reference 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	Reference 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 parameter

<table>
<tr><td rowspan="2">Index 607Eh</td><td>Name</td><td colspan="4">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 colspan="2">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="12">Defines the polarity of position, speed, and torque references.
<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: Inverting the target torque (6071h)
CSP: Inverting the velocity offset (60B1h)
CSV: Inverting the speed reference (60FFh + 60B1h)</td></tr></table></td></tr>
</table>

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

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

<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 reached	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 found	0: Homing not completed 1: Homing completed

<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 $+(2^{31}-1)$ (reference unit/s)</td><td>Default</td><td>0</td></tr>
</table>

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

Target speed = 60FFh + 60B1h

<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>
</table>

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

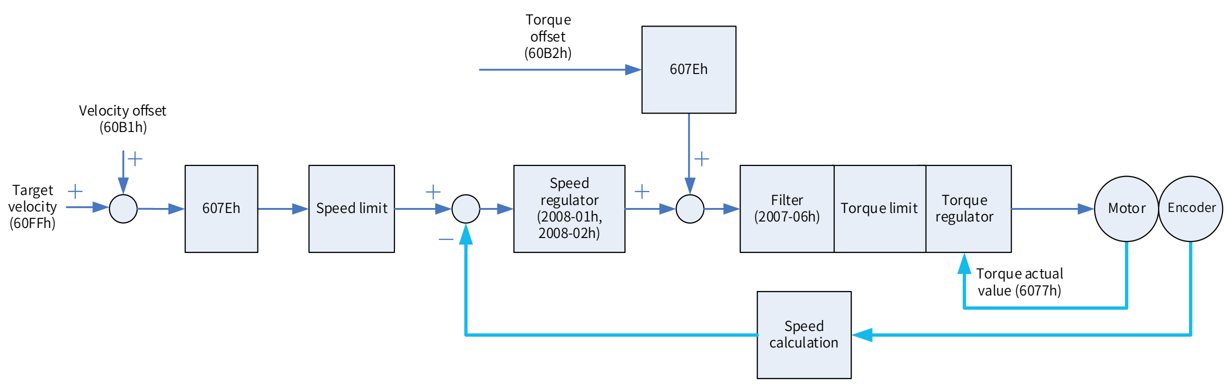
Index 6064h	Name	Position actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (reference unit)	Default	0
Shows the absolute position feedback (reference unit). In case of an absolute encoder used in the rotary mode, 6064h represents the single-turn position feedback (in reference unit) of the mechanical load.										

Index 606Ch	Name	Velocity actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	(reference unit/s)	Default	-
Shows the speed feedback value (reference 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	(0.1%)	Default	-
Represents the internal torque feedback of the servo drive. The value 100.0% corresponds to the rated torque of the motor.										

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 $+(2^{31}-1)$ (reference unit/s)	Default	0
Defines the target speed in PV and CSV modes. The maximum operating speed of the motor in CSV mode is determined by the maximum motor speed.										

7.4.6 Function Block Diagram



7.5 Cyclic Synchronous Torque (CST) Mode

In this mode, the host controller sends the target torque to the servo drive using cyclic synchronization. The servo drive executes torque control.

7.5.1 Configuration Block Diagram

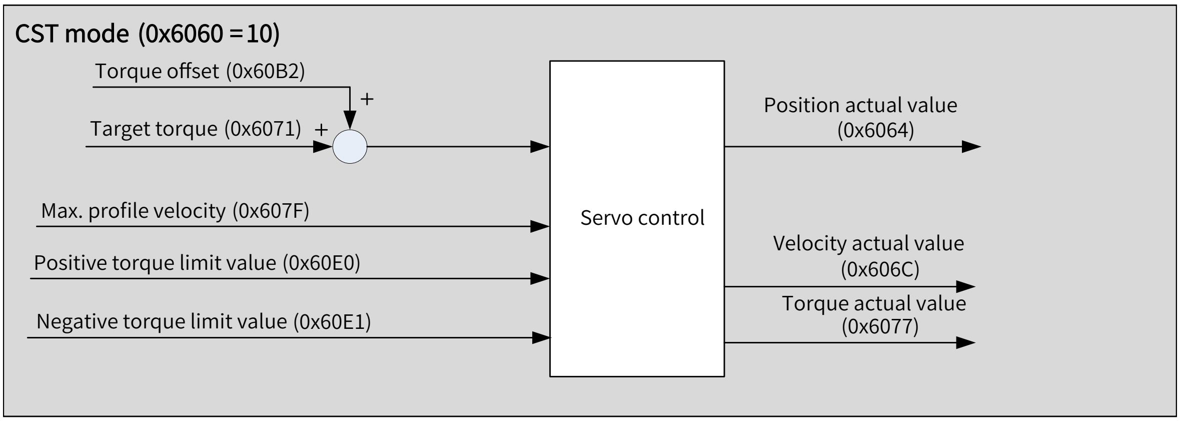


Figure 7-5 CST mode

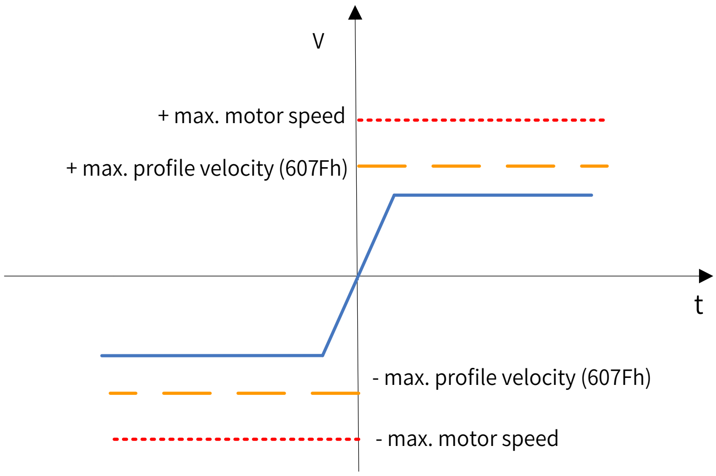
7.5.2 Related Objects

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	Reference 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 the forward and reverse directions. Note that the maximum speed cannot exceed the maximum operating speed allowed by the motor.

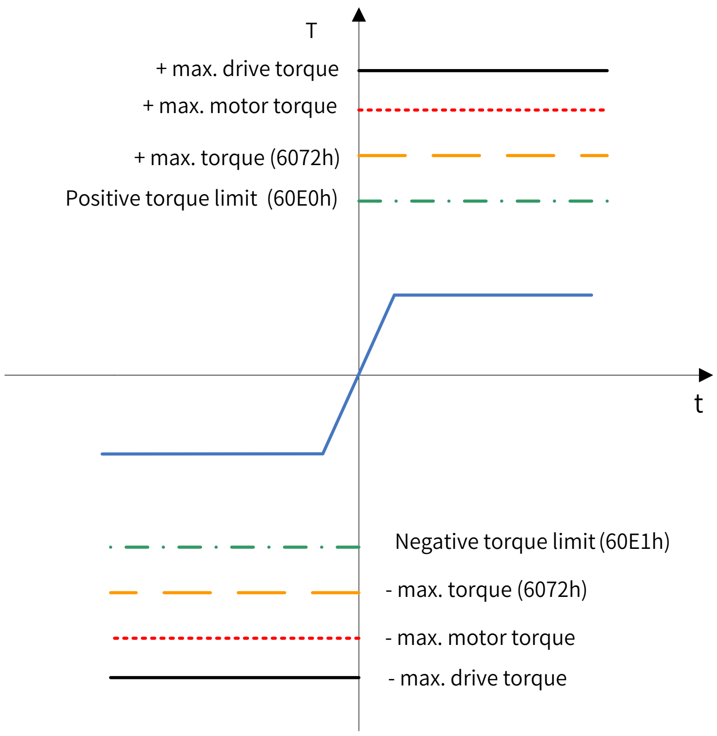


☆ Related parameters

<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) (reference 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 mechanical devices, you can limit 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 motor 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 in the forward and reverse directions.										

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 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 in the reverse direction.										

3 Torque reference polarity

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

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
5	Torque reference polarity: 0: Multiply by 1 1: Multiply by -1 PT: Inverting the target torque (6071h) CSP/CSV: Inverting the torque offset (60B2h) CST: Inverting the torque reference (6071h + 60B2h)

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

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

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

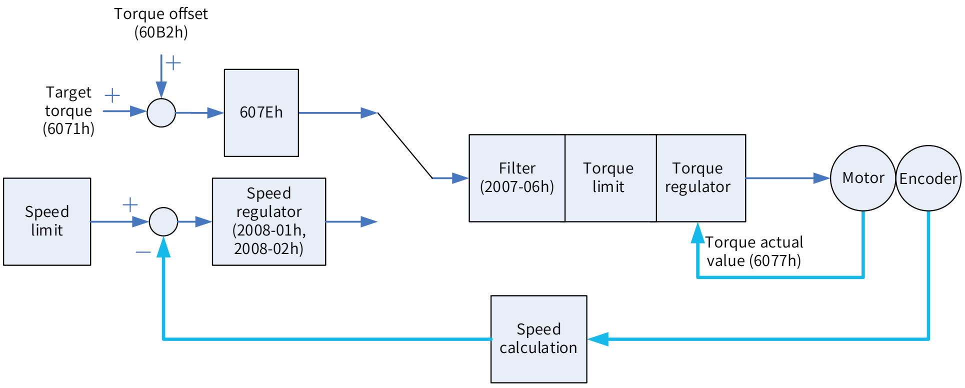
<table>
<tr><td rowspan="2">Index 6071h</td><td>Name</td><td colspan="3">Target torque</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Int16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PT/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 target torque in PT and CST modes.
The value 100.0% corresponds to the rated torque of the motor.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6074h</td><td>Name</td><td colspan="3">Torque demand value</td><td>Setting Condition & Effective Time</td><td>-</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">Shows the torque reference output value during operation.
The value 100.0% corresponds to the rated torque of the motor.</td></tr>
</table>

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 torque of the motor.										

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, CSP, and CSV modes. 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, operating speed, acceleration, 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

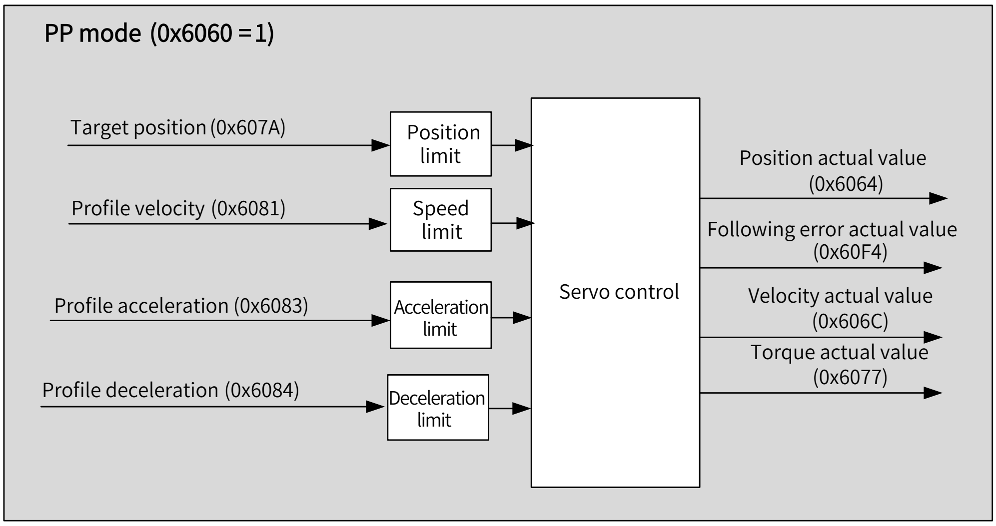
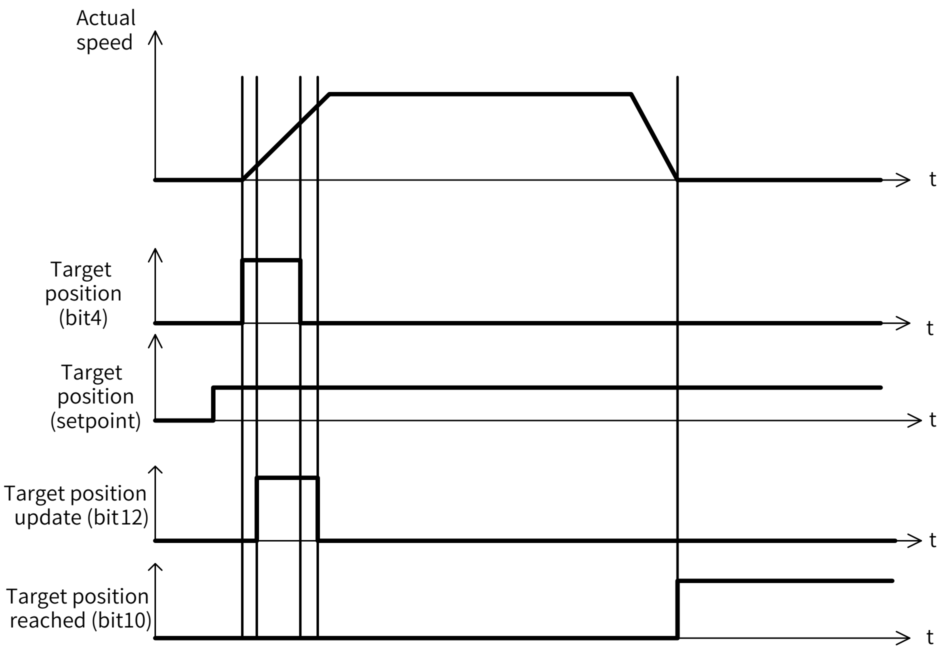


Figure 7-6 PP mode

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 (bit4 of the control word) 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 bit (bit12 of the status word) to 1 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.

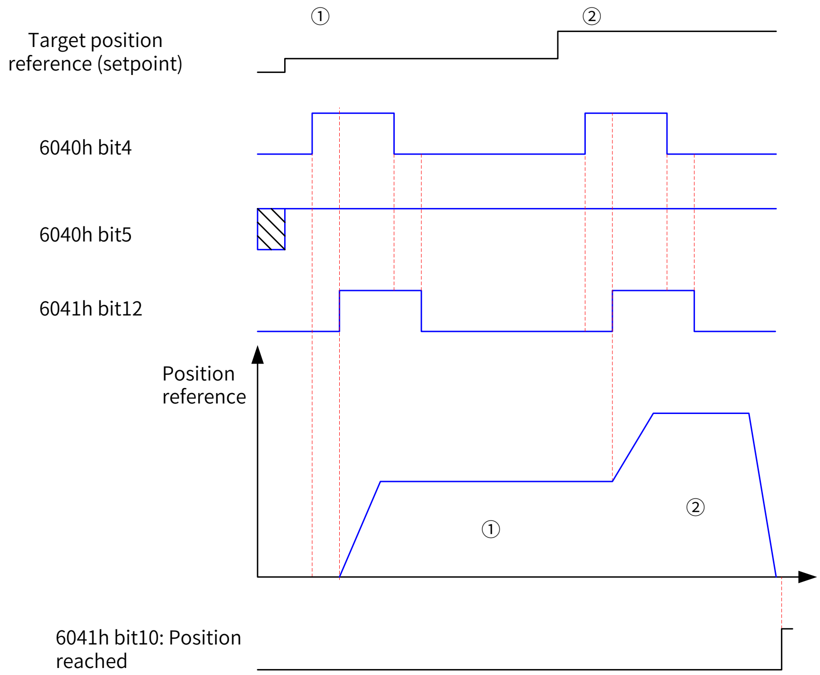


The linkage mode of position references is determined by bit5 (Change set immediately) of the control word. When bit5 is set to 1 (Sequential mode), sequential linkage applies between position references. When bit5 is set to 0 (Single-point mode), linkage applies between position references after reaching zero speed.

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.



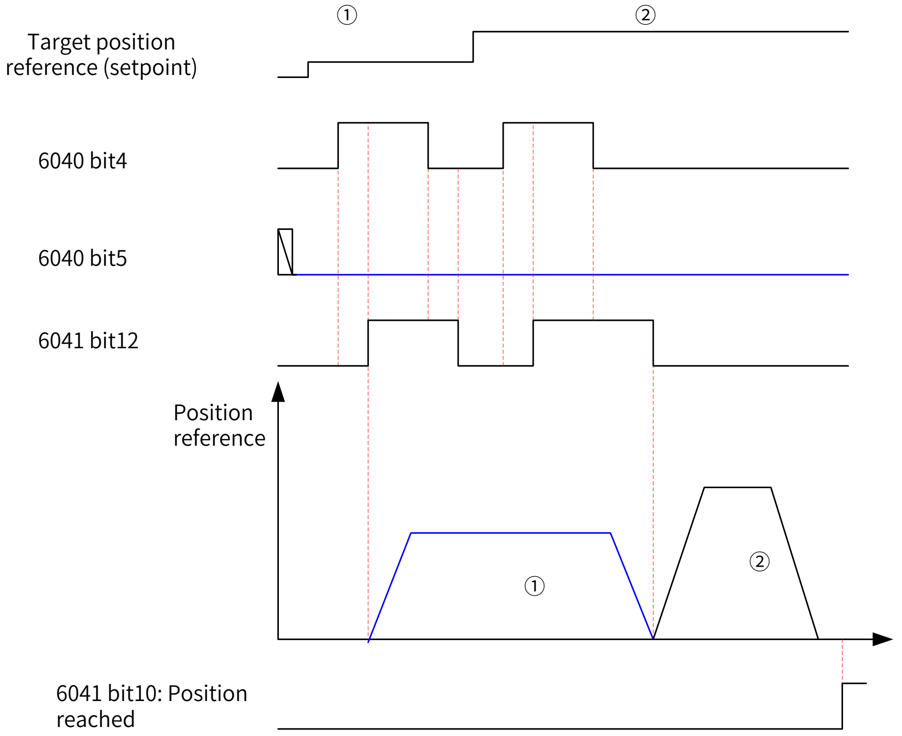
Note: To modify the target position reference (setpoint), the new target position bit (bit4) has to be sent again.

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.

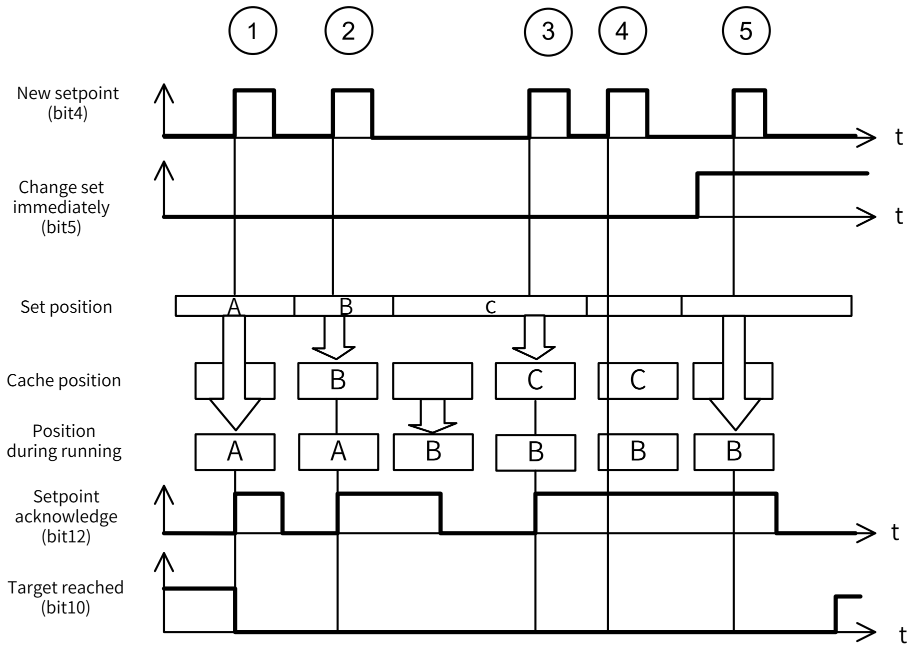
The time sequence of bit4 of the control word (New set-point) and bit12 of the status word (Set-point acknowledge) is as follows.



Note: To modify the target position reference (setpoint), the new target position bit (bit4) has to be sent 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 memorize a new segment of target position when the present target position is being executed. 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 being executed, the new set position will be stored in the cache. After present position reference is transmitted, the cache value will be executed. 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	Reference unit	-	-
607A	00	Target position	RW	Int32	Reference unit	-2^{31} to $(2^{31}-1)$	0
6081	00	Profile velocity	RW	Uint32	Reference unit/s	0 to $(2^{32}-1)$	1747627
6083	00	Profile acceleration	RW	Uint32	Reference unit/s^2	0 to $(2^{32}-1)$	1747626667
6084	00	Profile deceleration	RW	Uint32	Reference unit/s^2	0 to $(2^{32}-1)$	1747626667
607F	00	Max. profile velocity	RW	Uint32	Reference 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 bit10 of the status word, and the host controller, once receives the signal, acknowledges that 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>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 $(2^{32}-1)$ (reference unit)</td><td>Default</td><td>734</td></tr>
<tr><td colspan="11">Defines the threshold for position reach.
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 active 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>Uint16</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 position reach.</td></tr>
</table>

CAUTION

6067h only reflects the value of the threshold of the absolute position deviation to activate the positioning completed signal (bit10). It is not related to the positioning accuracy.

2 Position deviation monitoring function

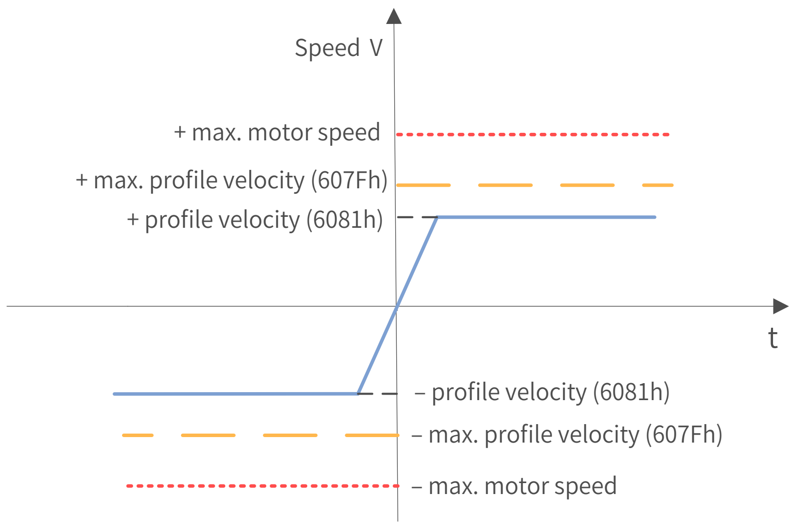
☆ Related parameters

<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>Uint32</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) (reference unit)</td><td>Default</td><td>3145728</td></tr>
<tr><td colspan="11">Defines the threshold of excessive position deviation (reference unit).
If 6065h is set to a too large value, the warning threshold of excessive position deviation will be 2147483647 in encoder unit.</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>Uint16</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 time lapse to trigger excessive position deviation (EB00.0)
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 the forward and reverse directions. Note that the maximum speed cannot exceed the maximum operating 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) (reference unit/s)	Default	104857600
Defines the speed limit in PP, PV, PT, HM, and CST modes.										

4 Acceleration and deceleration limits

In PP mode, the change rate of position references can be limited through the acceleration and deceleration limits.

☆ 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 (reference 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 setpoint 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 (reference 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 setpoint 0 will be forcibly changed to 1.										

5 Polarity

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

☆ Related parameter

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: Inverting 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 position	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

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

Used to set 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: Present operating state maintained 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

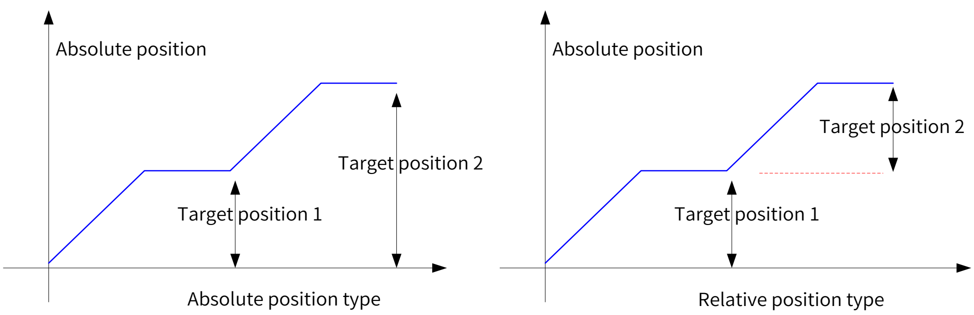
Shows the servo drive status.

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 found	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 $+(2^{31}-1)$ (reference 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.



Index 6081h	Name	Profile velocity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP	Value Range	0 to (2^{32}-1) (reference unit/s)	Default	174762

Defines the constant operating speed for the target position in PP mode.

$$\text{Motor speed (RPM)} = \frac{\text{6081h x 6091h (Gear ratio)}}{\text{Encoder resolution}} \times 60$$

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) (reference unit/s^{2})	Default	17476266667

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 setpoint 0 will be forcibly changed to 1.

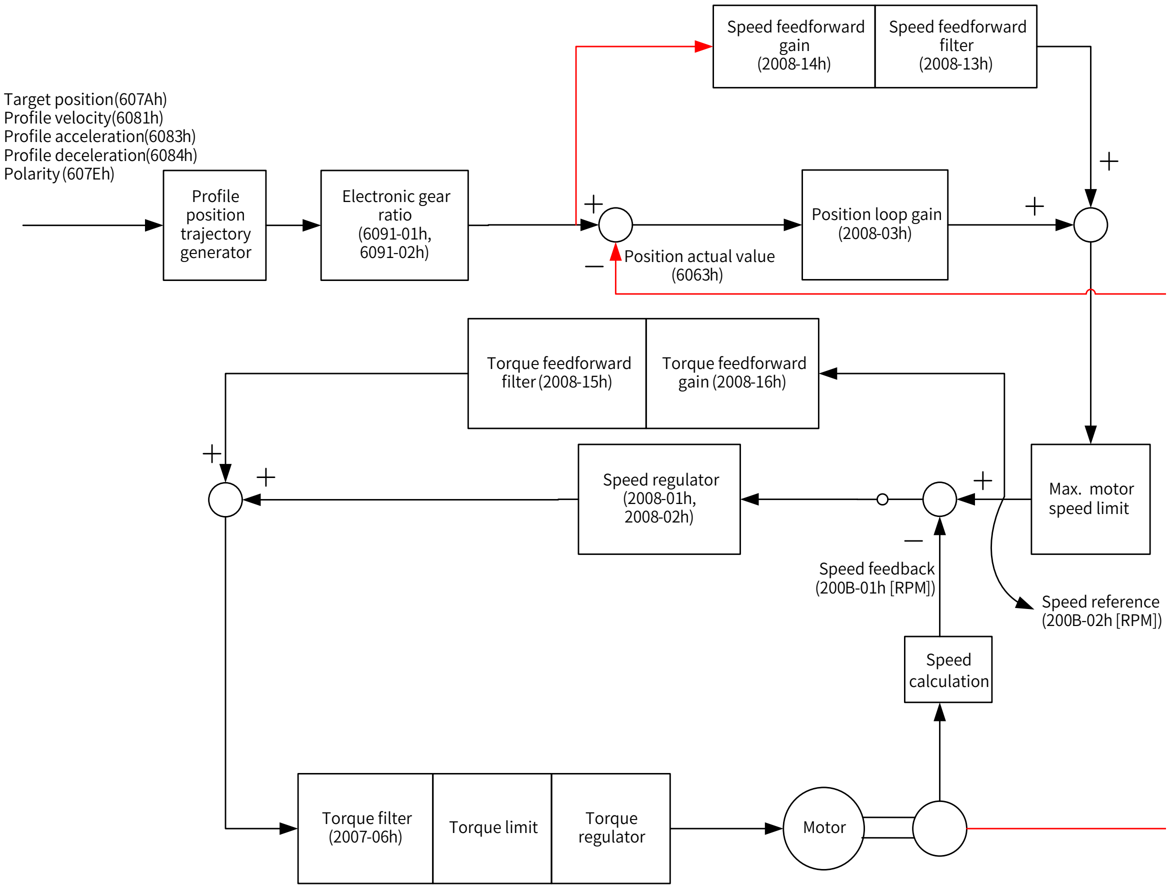
Index 6084h	Name	Profile deceleration			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP/PV	Value Range	0 to (2^{32}-1) (reference unit/s^{2})	Default	17476266667

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 setpoint 0 will be forcibly changed into 1.

7.6.6 Function Block Diagram



7.7 Profile Velocity (PV) Mode

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

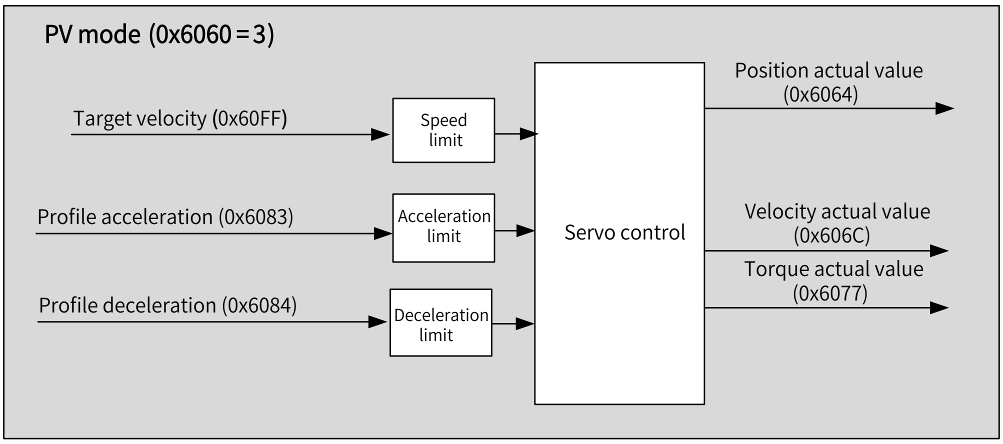


Figure 7-9 PV mode

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
6061	00	Modes of operation display	RO	Int8	-	-	0
606C	00	Velocity actual value	RO	Int32	Reference 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	Reference unit/s	0 to $(2^{32} - 1)$	104857600
6083	00	Profile acceleration	RW	Uint32	Reference unit/s^2	0 to $(2^{32} - 1)$	1747626667
6084	00	Profile deceleration	RW	Uint32	Reference unit/s^2	0 to $(2^{32} - 1)$	1747626667
60FF	00	Target velocity	RW	Int32	Reference unit/s	-2^{31} to $+(2^{31} - 1)$	0

7.7.3 Related Function Settings

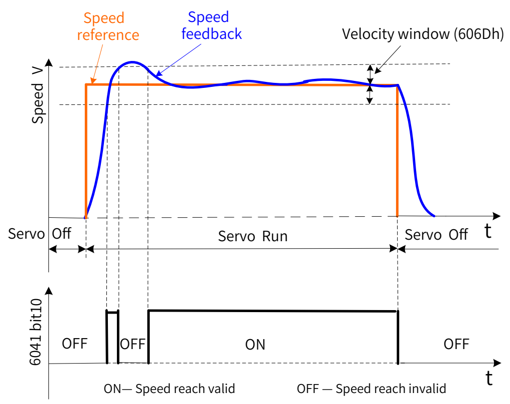
1 Speed reach monitoring

Speed reach monitoring is used to check whether the speed reference of the servo drive matches the motor speed feedback.

☆ 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>Uint16</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>Uint16</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 reach. 606Eh is used to set the window time for speed reach.



If the difference value between the speed reference and speed feedback is within ±606D and such status persists for the time 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.

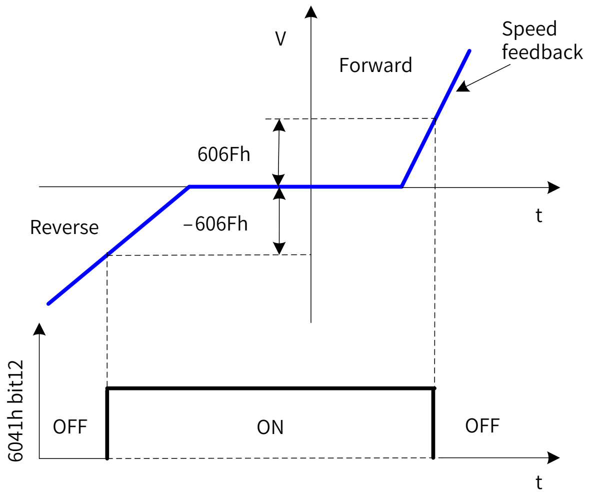
2 Zero speed monitoring

Zero speed monitoring is used to check whether the absolute value of motor speed feedback is less than the set threshold. If this conditions is fulfilled, the motor is approaching the standstill state (zero speed) and bit12 of the status word is set to 1.

☆ Related parameters

Index 606Fh	Name	Velocity threshold			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	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	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PV	Value Range	0 to 65535 (ms)	Default	0

Defines the threshold for zero speed.



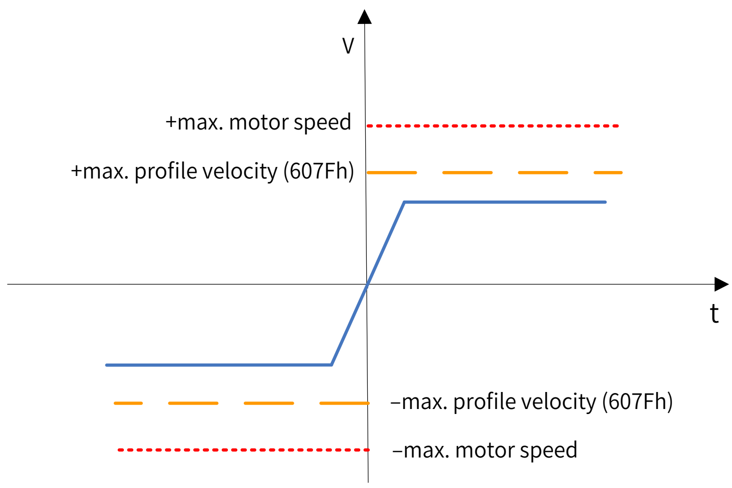
ON — Zero speed signal valid OFF — Zero speed signal invalid

When the speed feedback is within ±606F and such status persists for the time defined by 6070, bit12 of 6041 is set to 1, indicating the motor speed is 0.

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 and reverse directions. Note that the maximum speed cannot exceed the maximum operating 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) (reference unit/s)</td><td>Default</td><td>104857600</td></tr>
<tr><td colspan="11">Defines the speed limits in PP, PV, PT, HM, and CST modes.</td></tr>
</table>

4 Acceleration and deceleration limits

In PV mode, the change rate of speed references can be limited through the acceleration and deceleration limits.

<table>
<tr><td rowspan="2">Index
60C5h</td><td>Name</td><td colspan="3">Max. 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>All</td><td>Value Range</td><td>0 to 4294967295 (reference unit/s^{2})</td><td>Default</td><td>2147483647</td></tr>
<tr><td colspan="11">Defines the maximum (limit) value of acceleration.
In PV mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used.
For 60C5h, the setpoint 0 will be forcibly changed to 1.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index
60C6h</td><td>Name</td><td colspan="3">Max. deceleration</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 4294967295 (reference unit/s^{2})</td><td>Default</td><td>2147483647</td></tr>
<tr><td colspan="11">Defines the maximum (limit) value of deceleration.
In PV mode, if the value of 6084h exceeds that of 60C6h, the value of 60C6h will be used.
For 60C6h, the setpoint 0 will be forcibly changed to 1.</td></tr>
</table>

5 Polarity

You can change the velocity reference direction through setting the velocity 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><td>Bit</td><td>Description</td></tr><tr><td>6</td><td>Velocity reference polarity
0: Multiply by 1
1: Multiply by -1
PV: Inverting 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="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">Used to set control commands.
<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><tr><td>8</td><td>Halt</td><td>0: Present operating state maintained
1: Halt</td></tr></table></td></tr>
</table>

<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>

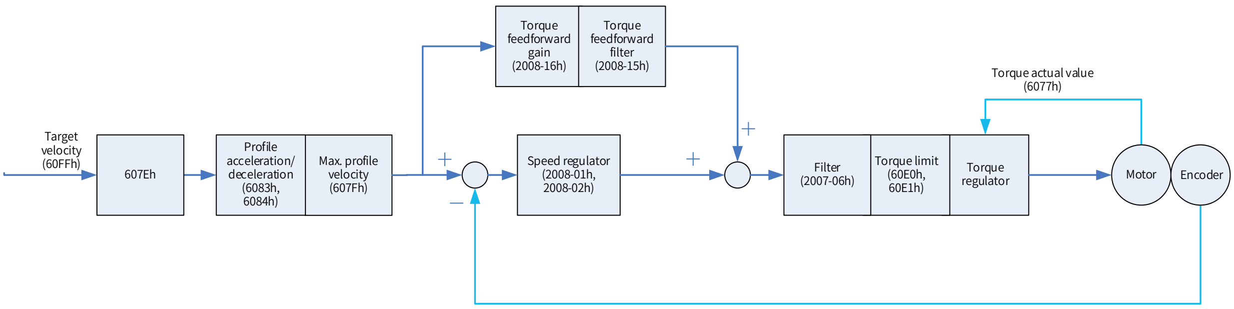
Bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 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 found	0: Homing not completed 1: Homing completed

<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 $+(2^{31}-1)$ (reference unit/s)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the target speed in PV and CSV modes.</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 $(2^{32}-1)$ (reference unit/$s^{2)}$</td><td>Default</td><td>17476266667</td></tr>
<tr><td colspan="11">Defines the speed reference acceleration in PP and PV modes.
In PP mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used.
For 6083h, the setpoint 0 will be forcibly changed to 1.</td></tr>
</table>

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) (reference unit/s^{2})	Default	17476266667
Defines the speed reference deceleration in PP and PV modes. In PP mode, if the value of 6084h exceeds that of 60C6h, the value of 60C6h will be used. For 6084h, the setpoint 0 will be forcibly changed to 1.										

7.7.6 Function Block Diagram



7.8 Profile Torque (PT) Mode

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

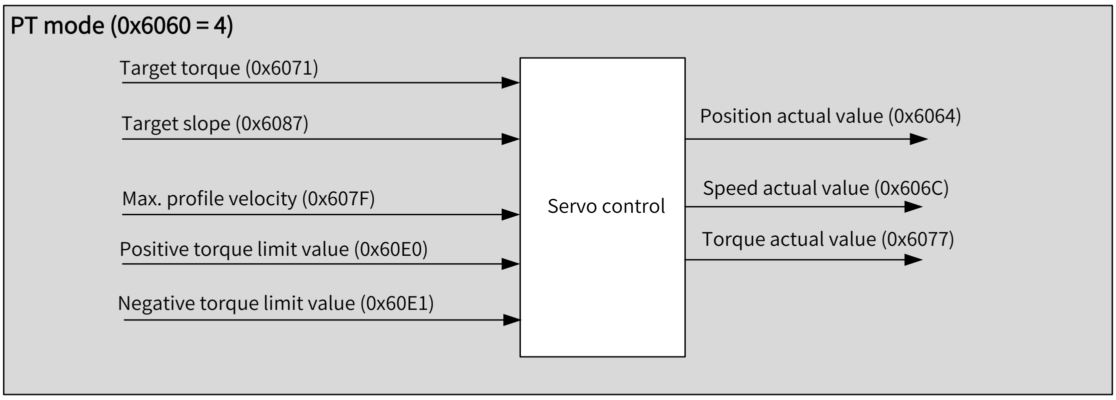


Figure 7-10 PT mode

7.8.2 Related Objects

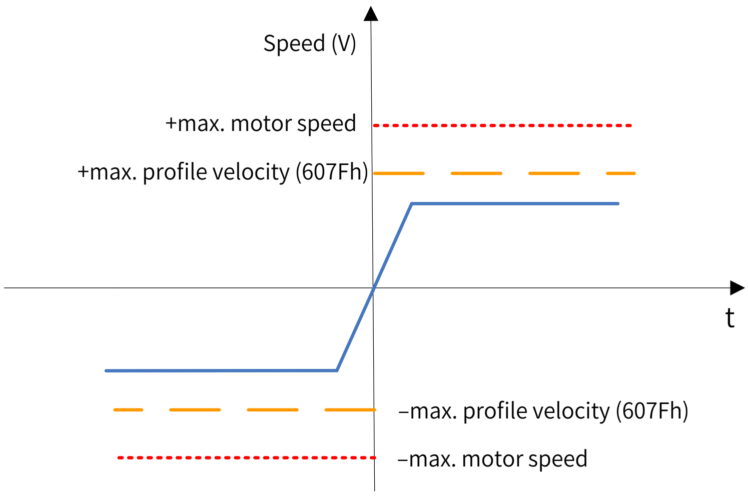
Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	Uint16	-	0 to 65535	0
6041	00	Status word	RO	Uint16	-	-	0

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
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	Reference 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 the forward and reverse directions. Note that the maximum speed cannot exceed the maximum operating speed allowed by the motor.

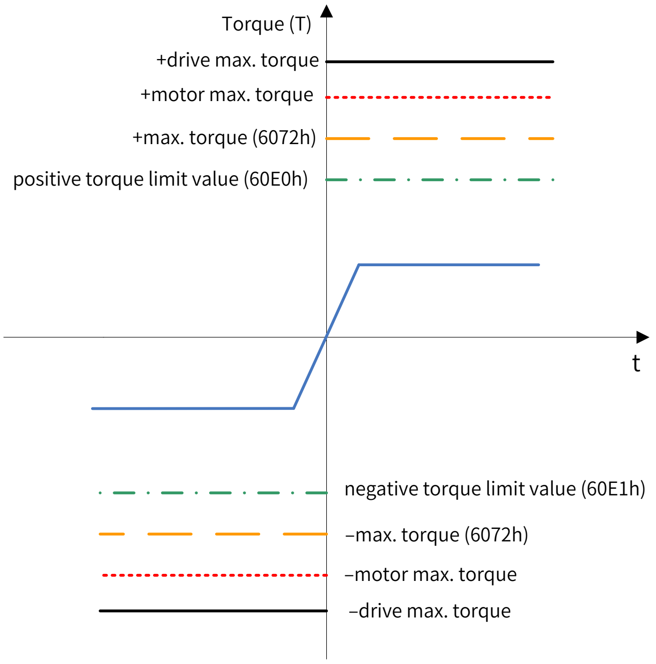


☆ Related parameters

<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) (reference 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

<table>
<tr><td rowspan="2">Index 6072h</td><td>Name</td><td colspan="3">Max. torque</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 (0.1%)</td><td>Default</td><td>3000</td></tr>
<tr><td colspan="11">Defines the maximum torque limit of the servo drive in the forward/reverse direction.</td></tr>
</table>

<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 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 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

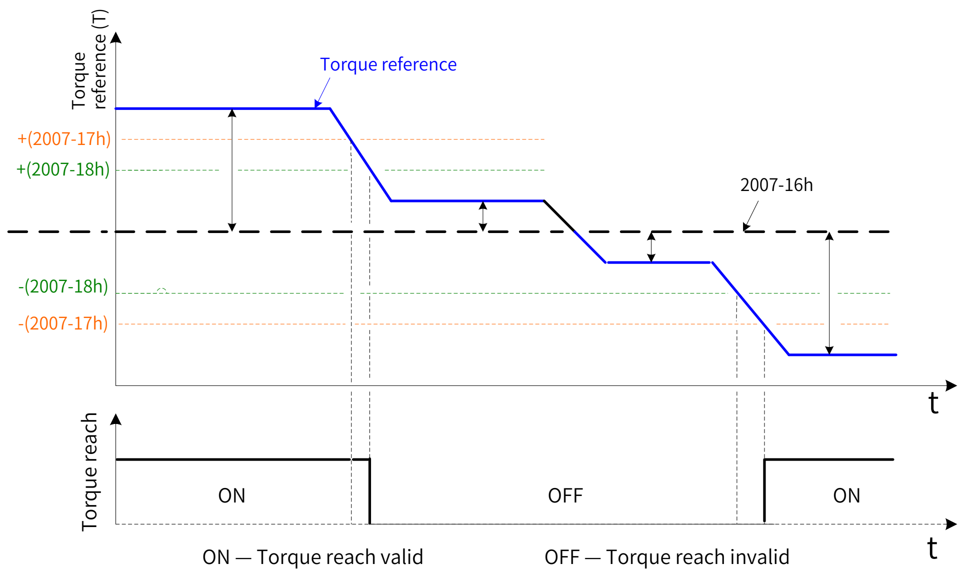
Index 607Eh	Name	Polarity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 255	Default	0

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

Bit	Description
5	Torque reference polarity: 0: Multiply by 1 1: Multiply by -1 CSP/CSV: Inverting the torque offset (60B2h) CST: Inverting the torque reference (6071h + 60B2h)

4 Torque reach monitoring

Torque reach monitoring is used to check 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 (Threshold of valid torque reach), 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 2007-18h (Threshold of invalid torque reach), the torque reached signal is invalid. Otherwise, the original status applies.

☆ Related parameters

Sub-index 16h	Name	Base value for torque reach			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Value Range	0 to 300.0 (%)	Default	0

Sub-index 17h	Name	Threshold of valid torque reach			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Value Range	0 to 300.0 (%)	Default	20.0

Sub-index 18h	Name	Threshold of invalid torque reach			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Value Range	0 to 300.0 (%)	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

Used to set 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
8	Halt	0: Present operating state maintained 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 found	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 torque of the motor.

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 operation.

The value 100.0% corresponds to the rated torque of the motor.

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 torque of the motor.										

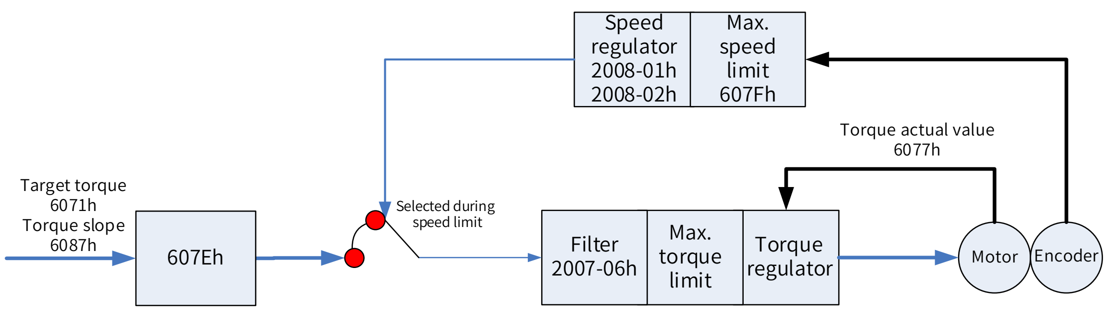
Index 6087h	Name	Torque slope			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PT/CST	Value Range	0 to (2^{32} – 1) (0.1%/s)	Default	2^{32}-1
Defines the acceleration (torque increment per second) of the torque reference in PT mode. For 6087h, the setpoint 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 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 coincide with the mechanical zero.

7.9.1 Configuration Block Diagram

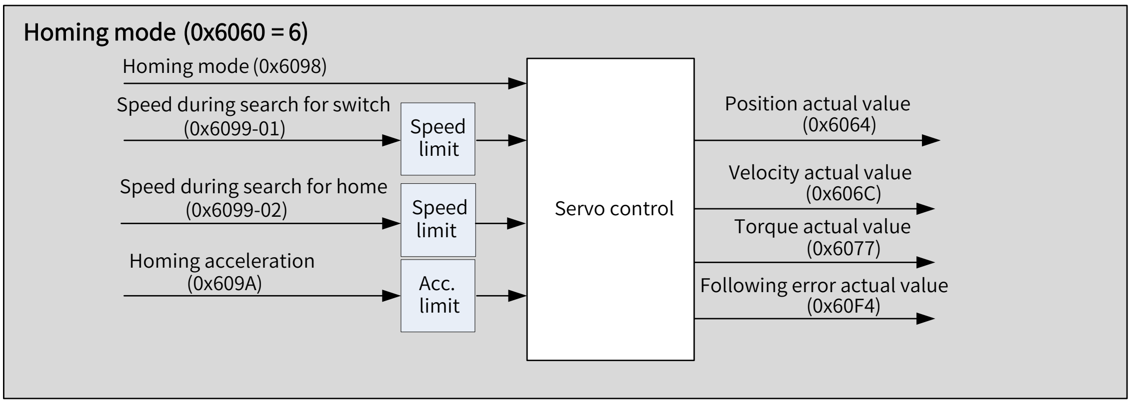


Figure 7-11 HM mode

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	Reference unit	-	-
6098	00	Homing method	RW	Int8	-	1 to 35	1
6099	01	Speed during search for switch	RW	Uint32	Reference unit/s	0 to $(2^{32}-1)$	1747627
	02	Speed during search for zero	RW	Uint32	Reference unit/s	10 to $(2^{32}-1)$	174763
609A	00	Homing acceleration	RW	Uint32	Reference unit/s^2	0 to $(2^{32}-1)$	1747626667
607C	00	Home offset	RW	Int32	Reference 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 setting

When the homing duration exceeds the value defined by 2005-24h (Homing time limit), the servo drive reports E601.0 (Homing timeout).

E601.0 can be used to determine whether the homing speed, the acceleration setpoint, and connections of deceleration point signals and home signals are proper.

☆ Related parameters

Index 2005-24h	Name	Homing time limit			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	HM	Value Range	0 to 65535 (100 ms)	Default	50000
Defines the homing time limit, which is used for detecting E601.0 (Homing timeout).										

2 Position calculation method

After homing, the calculation method for present mechanical position can be defined by 60E6h.

Index 60E6h	Name	Actual position calculation method			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	NO	Related Mode	HM	Value Range	0 to 1	Default	0

Defines the calculation method for the mechanical position after homing.

Value	Actual Position Calculation Method
0	Absolute position homing After homing is done, the following formula applies: 6064h (Position actual value) = 607Ch (Home offset)
1	Relative position homing After homing is done, the following formula applies: 6064h (Position actual value) = Present position feedback value + 607Ch (Home offset)

The value of 60E6h cannot be edited after homing is triggered.

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 $+(2^{31}-1)$ (reference unit)	Default	0

Defines the physical distance between the mechanical zero and the motor home in the homing mode.

The home offset is activated only after the homing operation is done upon power-on and bit15 of 6041h is set to 1.

Home offset is used in the following cases:

◆ Determine the present position of the user after homing based on 60E6h.

◆ Er.D10 (Improper homing offset setting) occurs because 607Ch is set to a value beyond the limit defined by 607Dh (Software position limit).

3 Position deviation monitoring

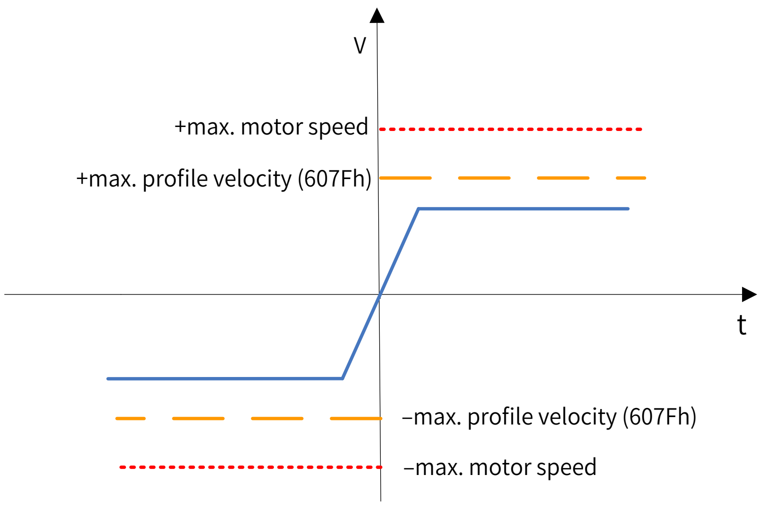
☆ Related parameters

<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>Uint32</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) (reference unit)</td><td>Default</td><td>3145728</td></tr>
<tr><td colspan="11">Defines the threshold of excessive position deviation (reference unit).
For 6065h, setpoints beyond 2147483647 will be forcibly changed to 2147483647.</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>Uint16</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 time lapse to trigger excessive position deviation (EB00.0).
When the position deviation (reference unit) exceeds ±6065h and such status persists after the time defined by 6066h elapses, EB00.0 (Excessive position deviation) will occur.</td></tr>
</table>

4 Speed limit

In the homing mode, 607Fh can be used to limit the maximum speed in the forward and reverse directions. Note that the maximum speed cannot exceed the maximum operating 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) (reference 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>

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 (reference unit/s2)	Default	2147483647
Defines the maximum limit of acceleration. In the homing mode, if the value of 609A exceeds that of 60C5h, the value of 60C5h will be used. For 60C5h, the setpoint 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)

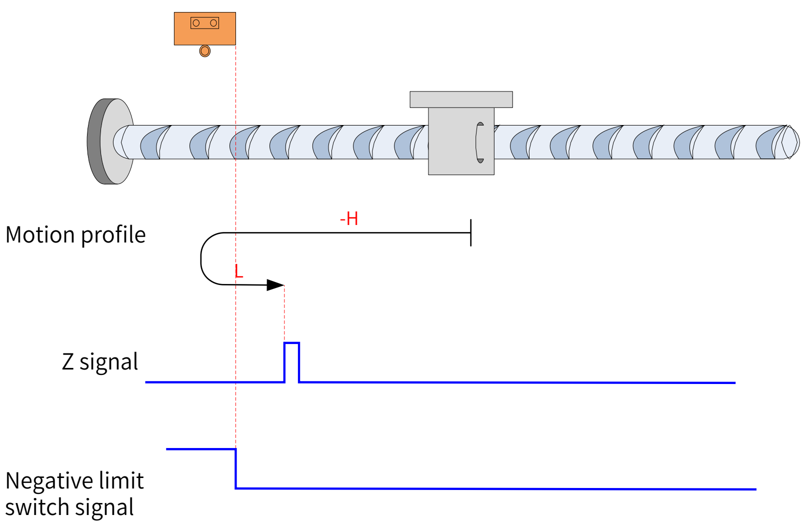


Figure 7-12 N-OT signal inactive at start

Note: In the figures, "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 high speed. After reaching the rising edge of the N-OT signal, the motor decelerates and changes to run in the forward direction at low speed until it stops at the first Z signal after reaching the falling edge of the N-OT signal.

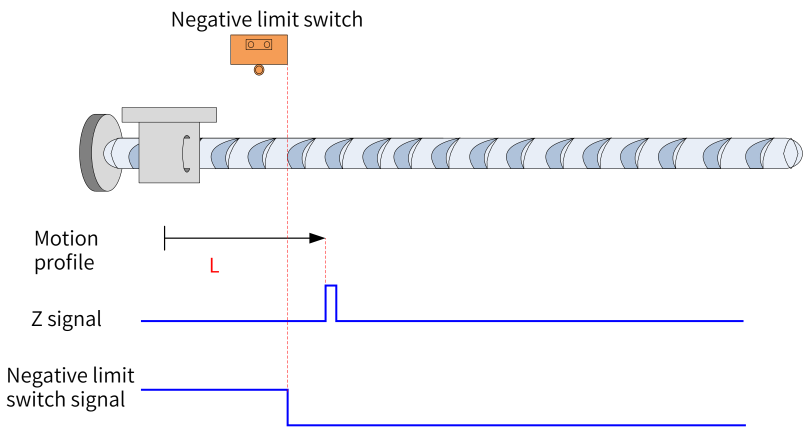


Figure 7-13 N-OT signal active at start

The N-OT signal is active at start, and the motor starts homing in the forward direction at 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)

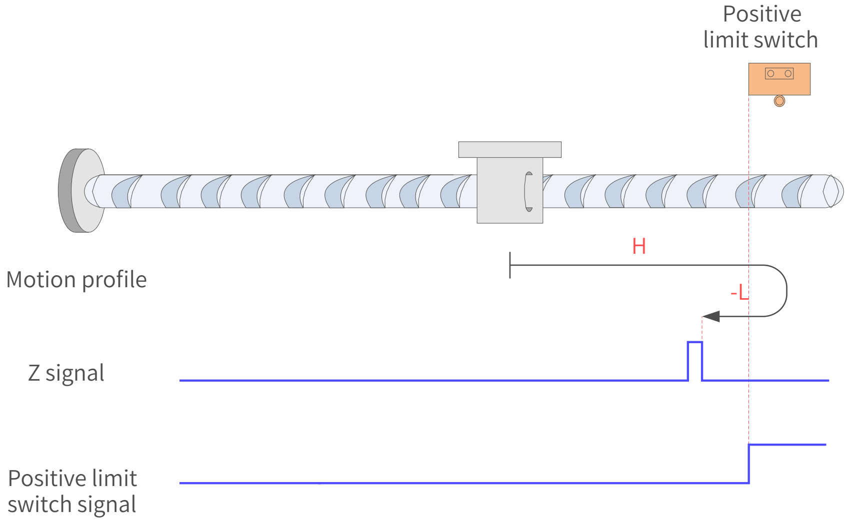


Figure 7-14 P-OT signal inactive at start

The P-OT signal is inactive at start, and the motor starts homing in the forward direction at high speed. After reaching the rising edge of the P-OT signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the falling edge of the P-OT signal.

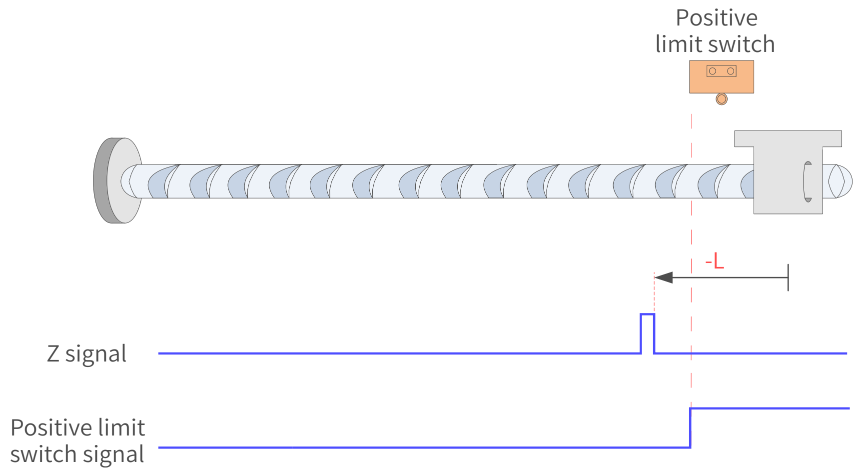


Figure 7-15 P-OT signal active at start

The P-OT signal is active at start, and the motor starts homing in the reverse direction at 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)

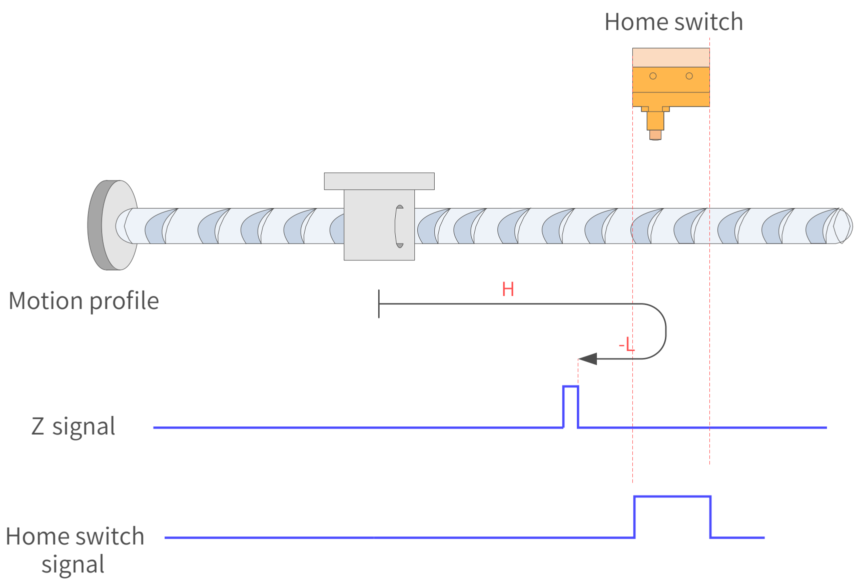


Figure 7-16 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the falling edge of the HW signal.

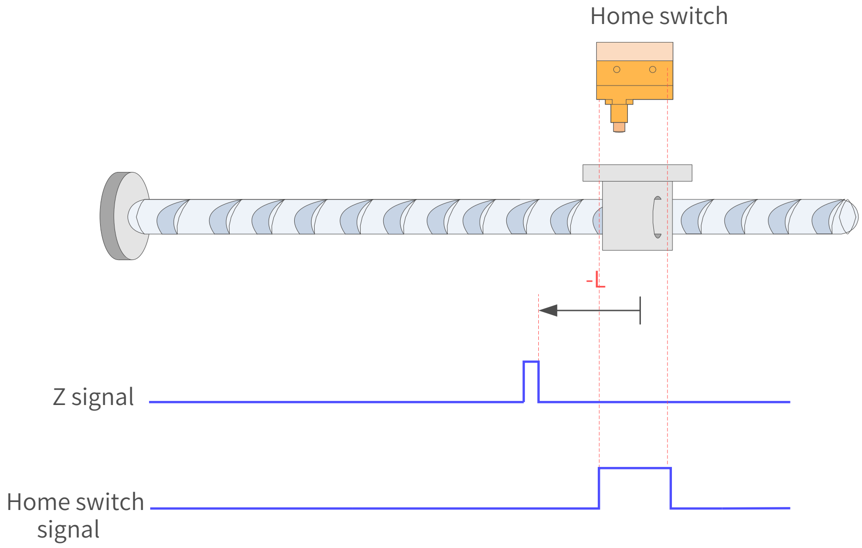


Figure 7-17 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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)

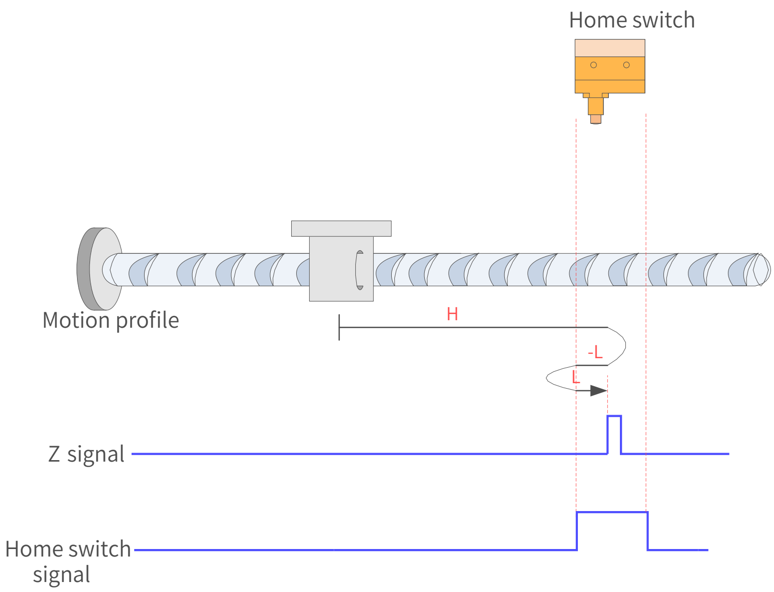


Figure 7-18 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at 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 after reaching the rising edge of the HW signal.

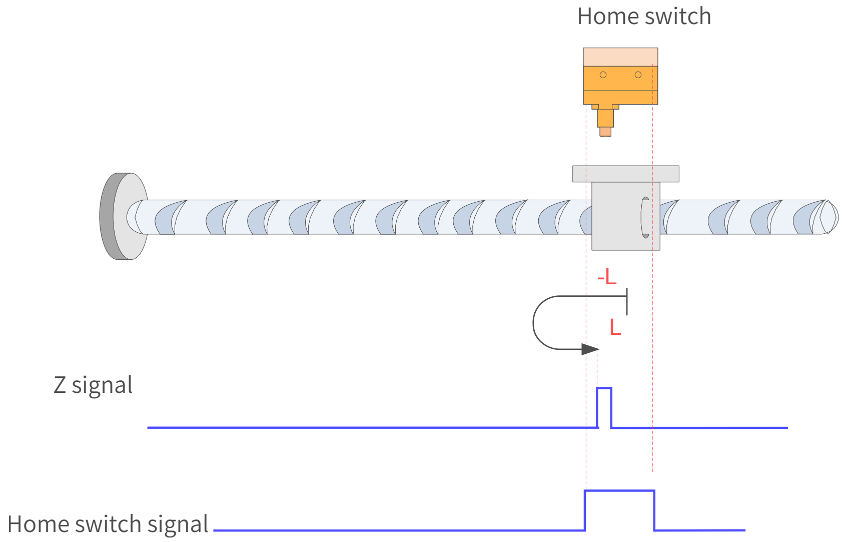


Figure 7-19 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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 after reaching the rising edge of the HW signal.

5) 6098h = 5

Home: Z signal

Deceleration point: home switch (HW)

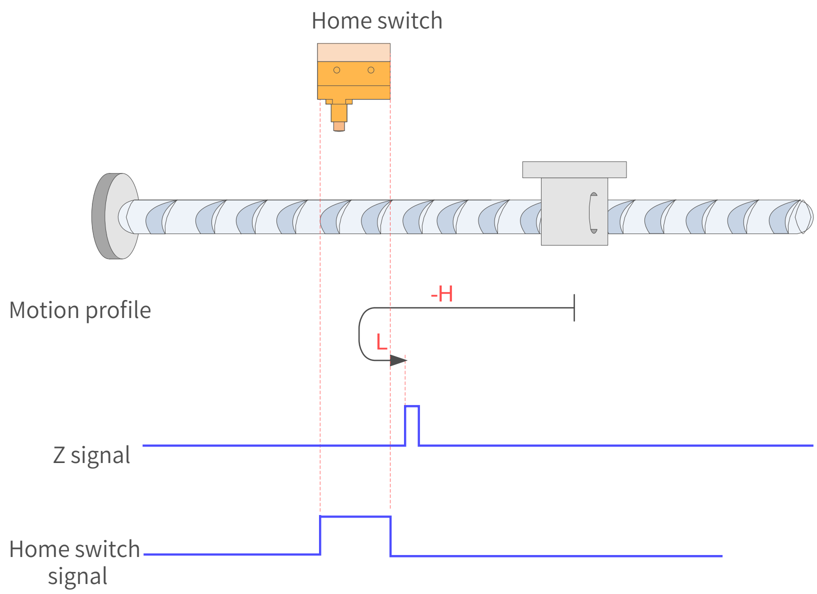


Figure 7-20 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it stops at the first Z signal after reaching the falling edge of the HW signal.

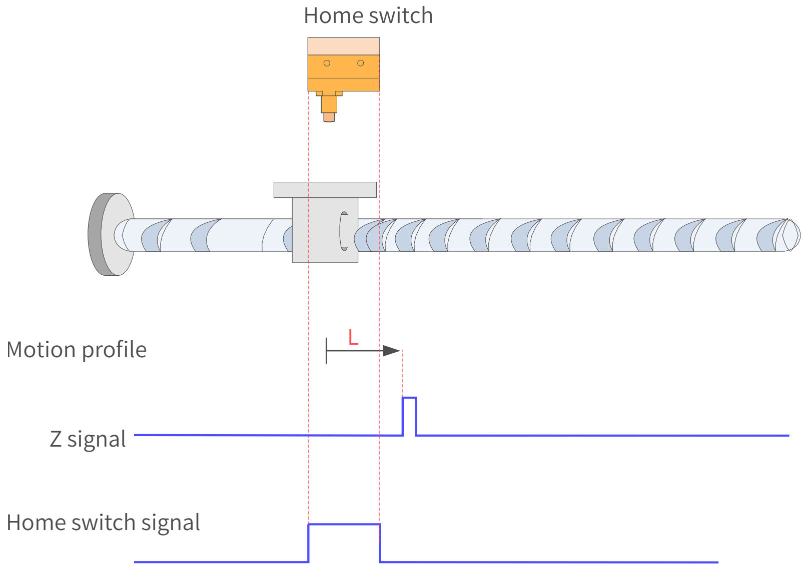


Figure 7-21 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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)

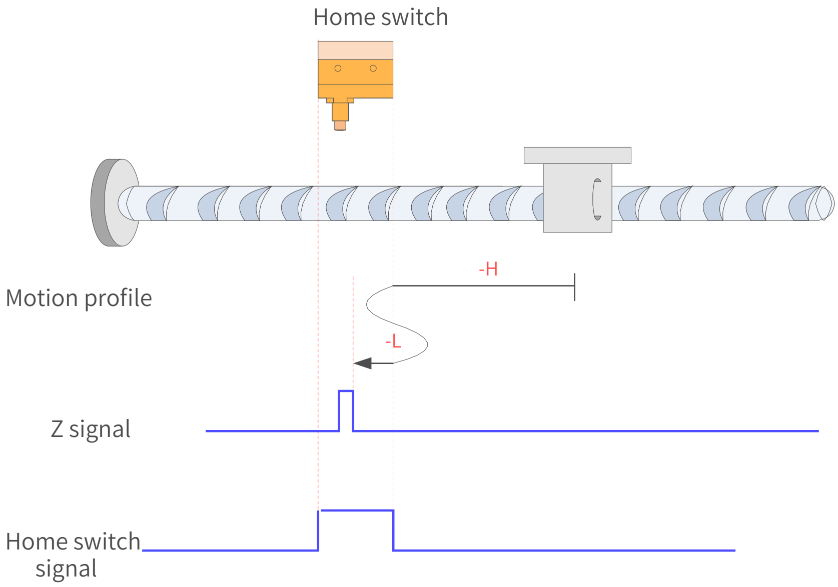


Figure 7-22 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed. Then, after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

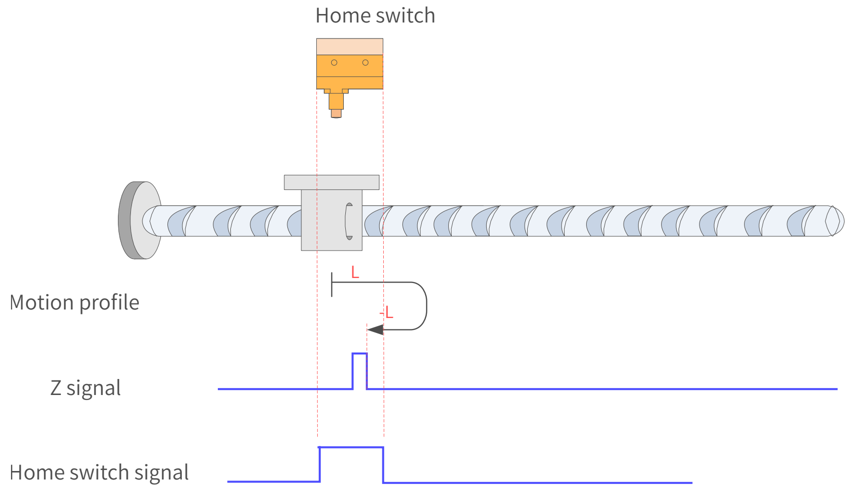


Figure 7-23 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the rising edge of HW signal.

7) 6098 = 7

Home: Z signal

Deceleration point: home switch (HW)

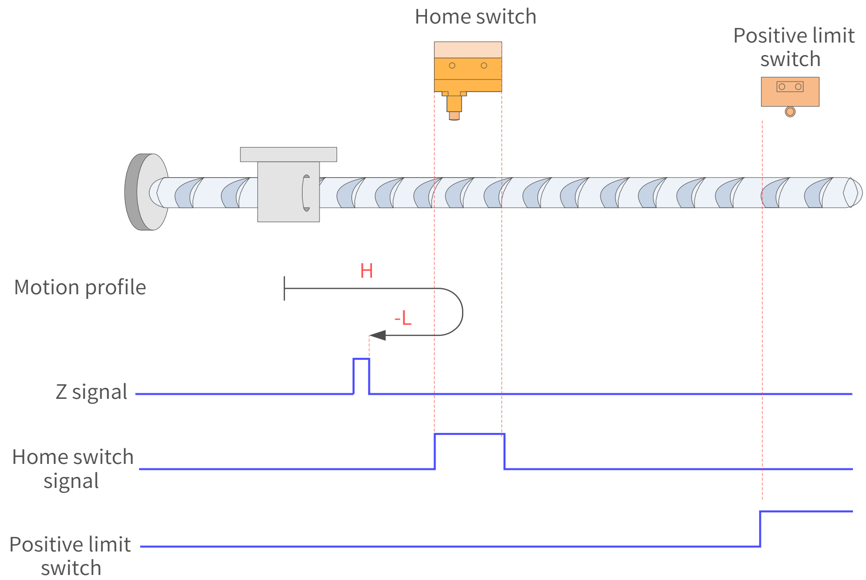


Figure 7-24 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the reverse direction at low speed 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.

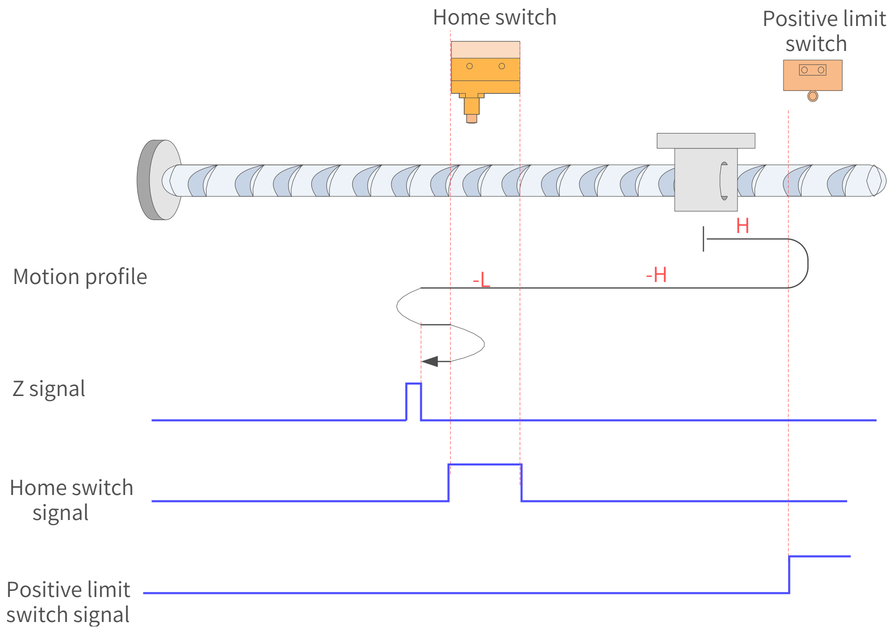


Figure 7-25 HW signal inactive at homing start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis hits the limit switch, it changes to run in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and runs in the reverse direction at low speed. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it reaches the rising edge of HW signal. After that it changes to run in the reverse direction at low speed. Finally, the motor stops at the first Z signal after reaching the falling edge of the HW signal.

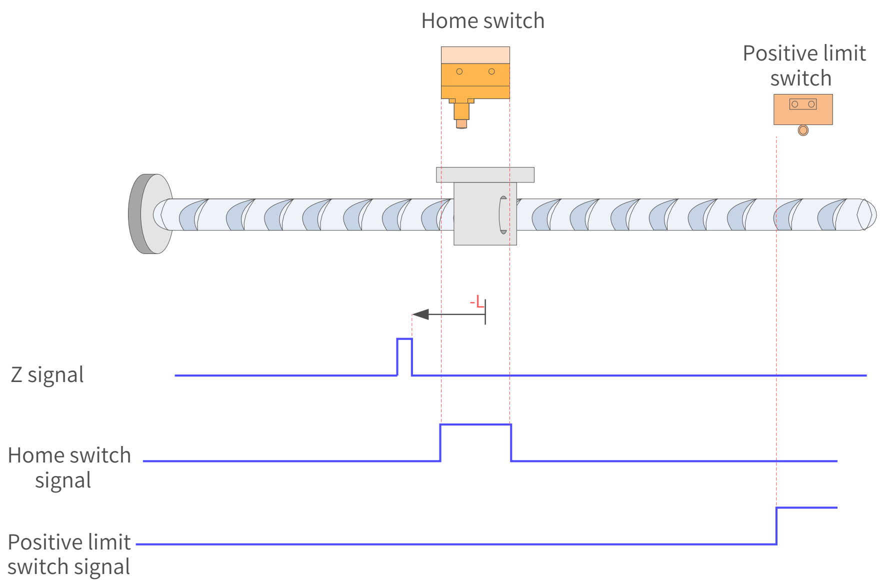


Figure 7-26 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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)

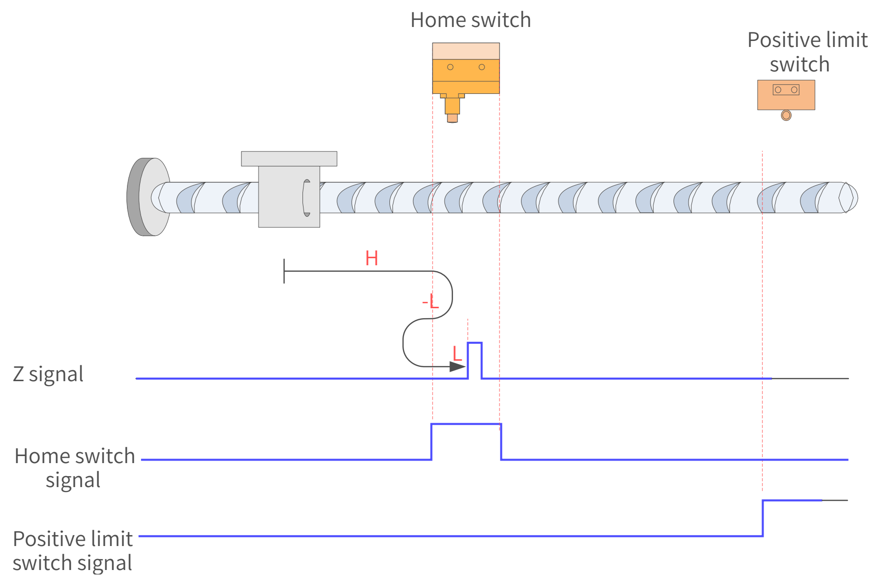


Figure 7-27 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the reverse direction at 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 low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

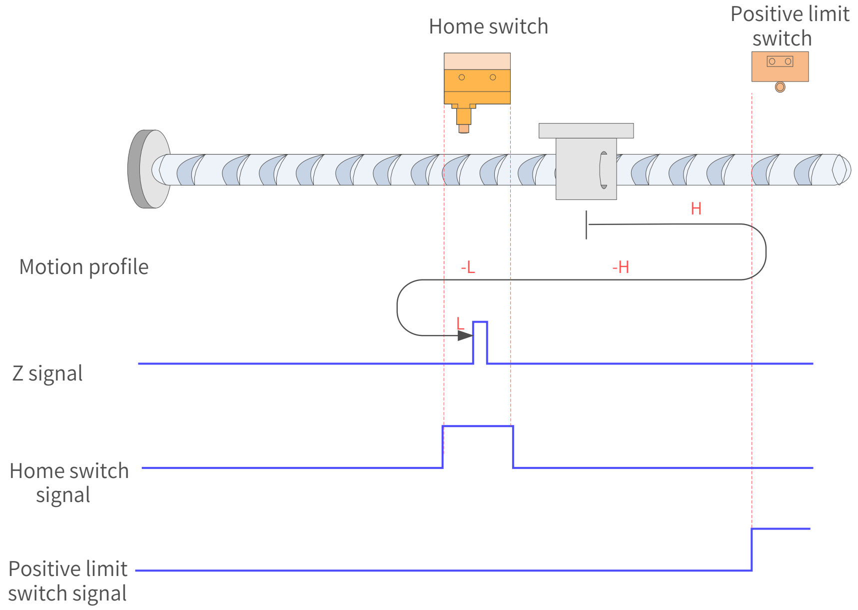


Figure 7-28 HW signal inactive at homing start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis hits the limit switch, it changes to run in the reverse direction at high speed. After reaching the rising edge of HW signal, the motor decelerates and continues running in the reverse direction at low speed. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction at low speed until it stops at the first motor Z signal after reaching the rising edge of the HW signal.

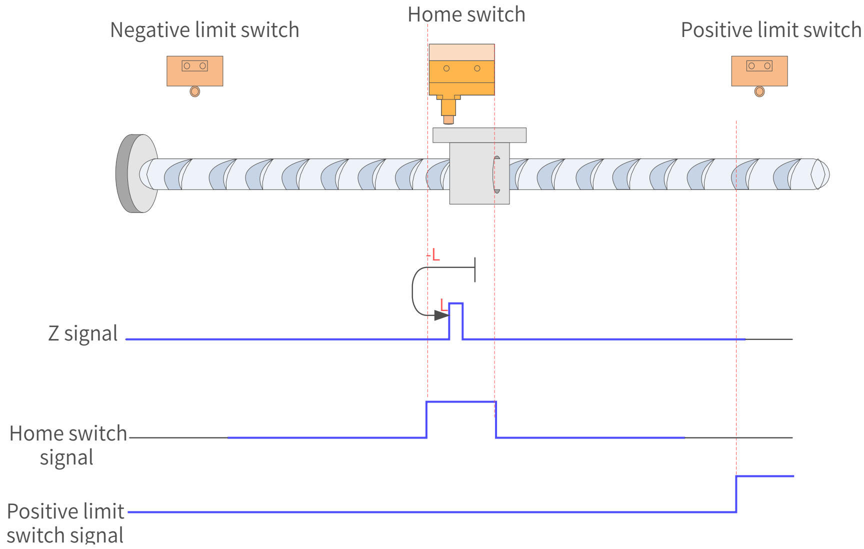


Figure 7-29 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at low speed. After reaching the falling edge of HW signal, the motor changes to run in the forward direction at low speed until it stops at the first Z signal after reaching the rising edge of HW signal.

9) 6098 = 9

Home: Z signal

Deceleration point: home switch (HW)

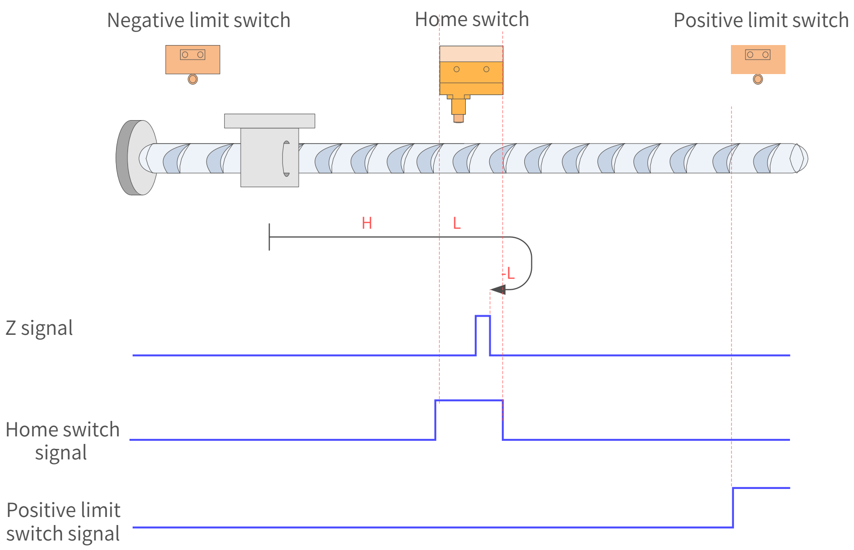


Figure 7-30 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and runs in the forward direction at 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 low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

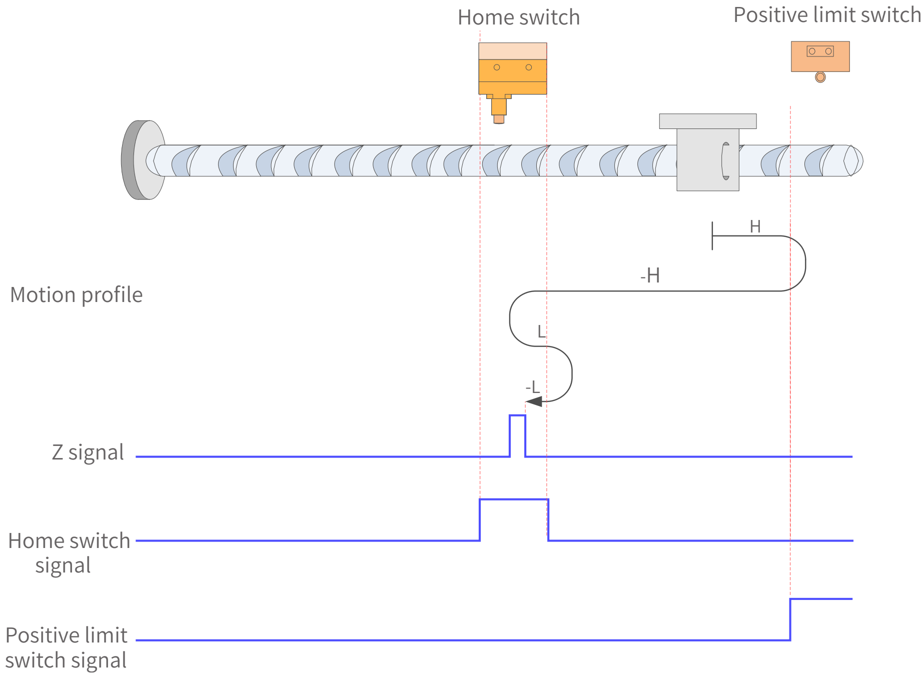


Figure 7-31 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis 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 at low speed. Then after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at low speed. Finally, the motor stops at the first Z signal after reaching the rising edge of HW signal.

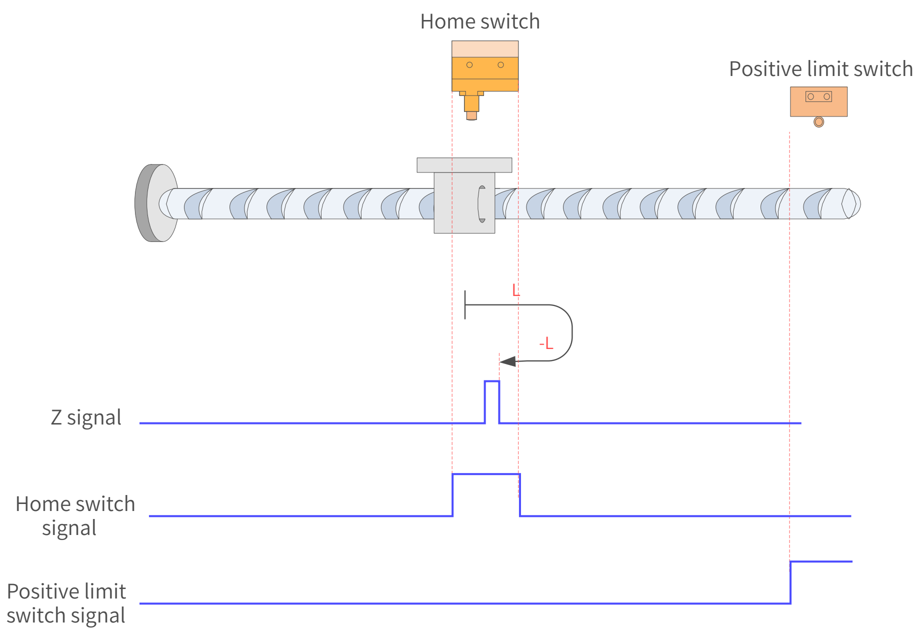


Figure 7-32 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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 after reaching the rising edge of the HW signal.

10) 6098 = 10

Home: Z signal

Deceleration point: home switch (HW)

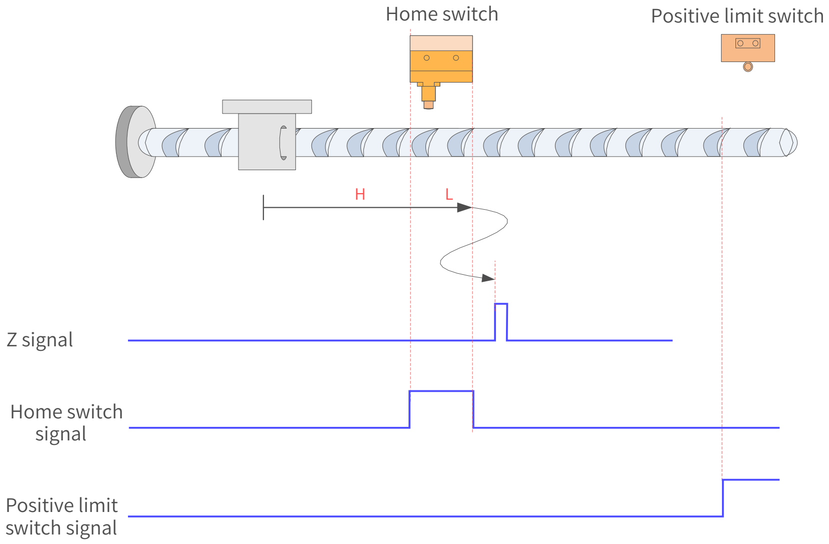


Figure 7-33 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and runs in the forward direction at low speed after 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 at low speed until it reaches the rising edge of the HW signal. After that, it changes to run in the forward direction at low speed. Finally, it stops at the first Z signal after reaching the falling edge of the HW signal.

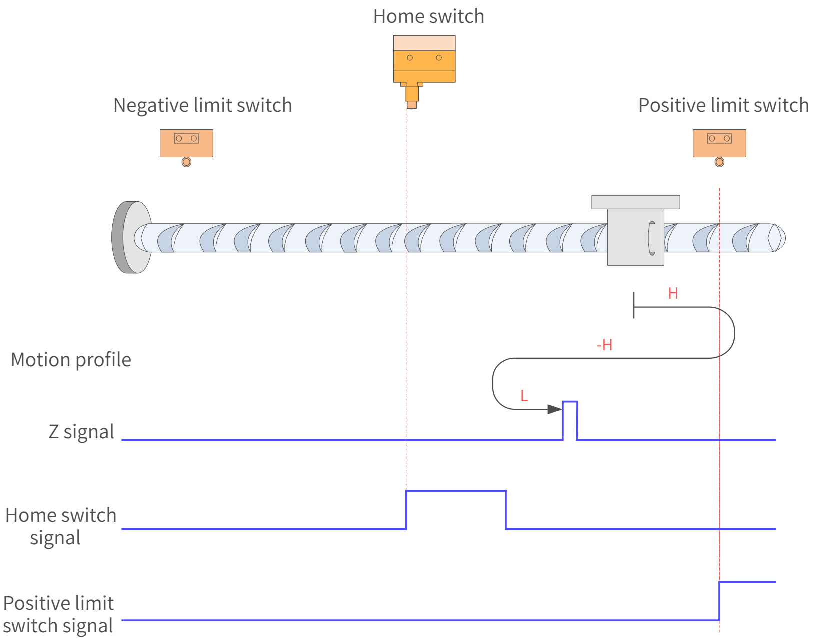


Figure 7-34 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis 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 at low speed until it stops at the first Z signal after reaching the falling edge of the HW signal.

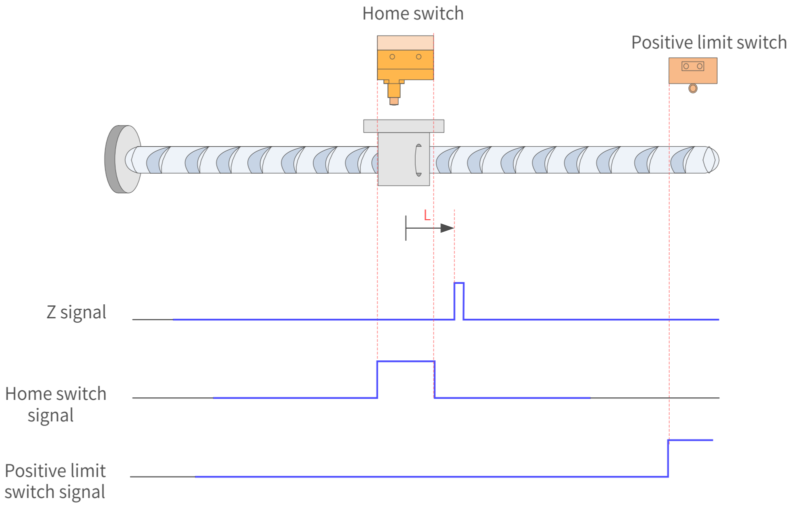


Figure 7-35 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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)

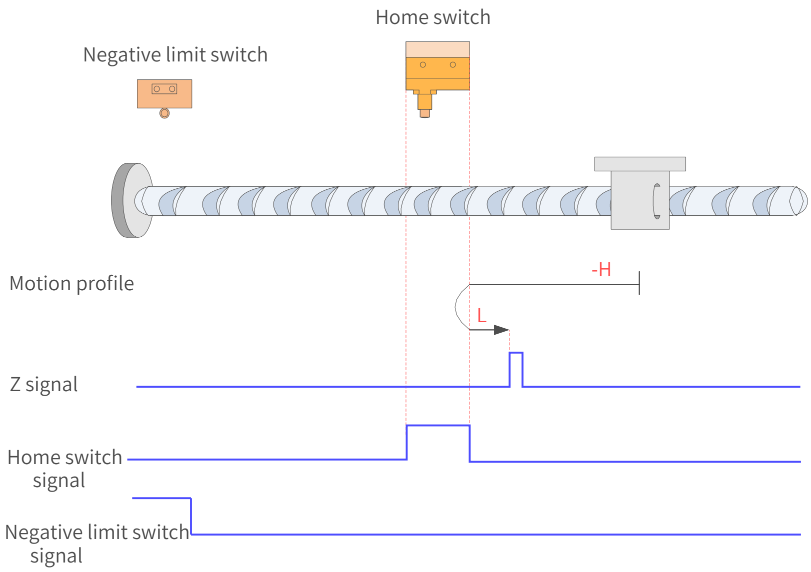


Figure 7-36 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the forward direction at low speed 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.

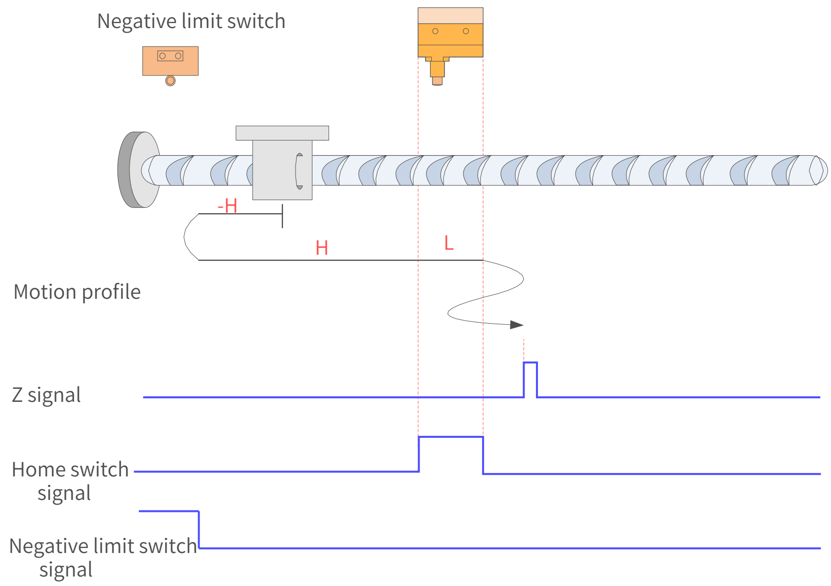


Figure 7-37 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis 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 at low speed. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until reaching the rising edge of the HW signal where it decelerates and changes to run in the forward direction at low speed. Finally, the motor stops at the first Z signal after reaching the falling edge of the HW signal.

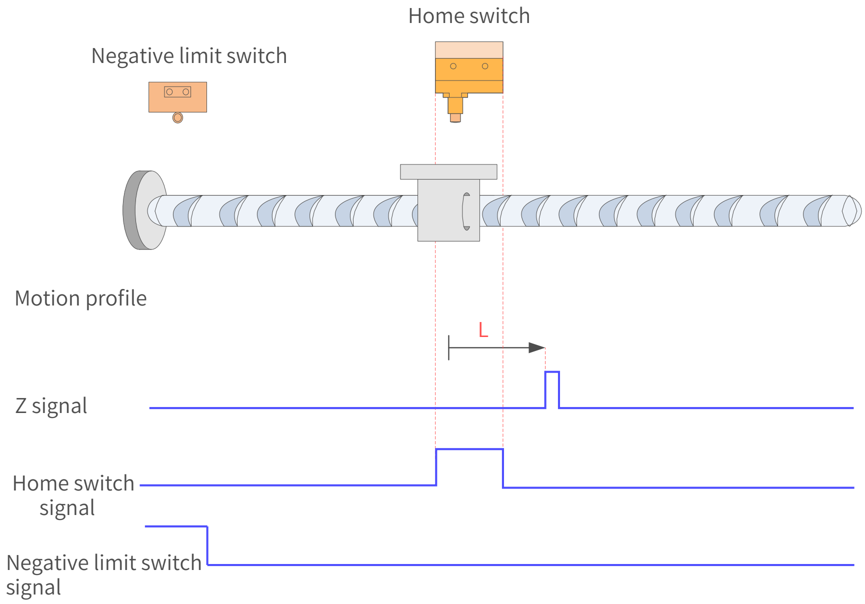


Figure 7-38 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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)

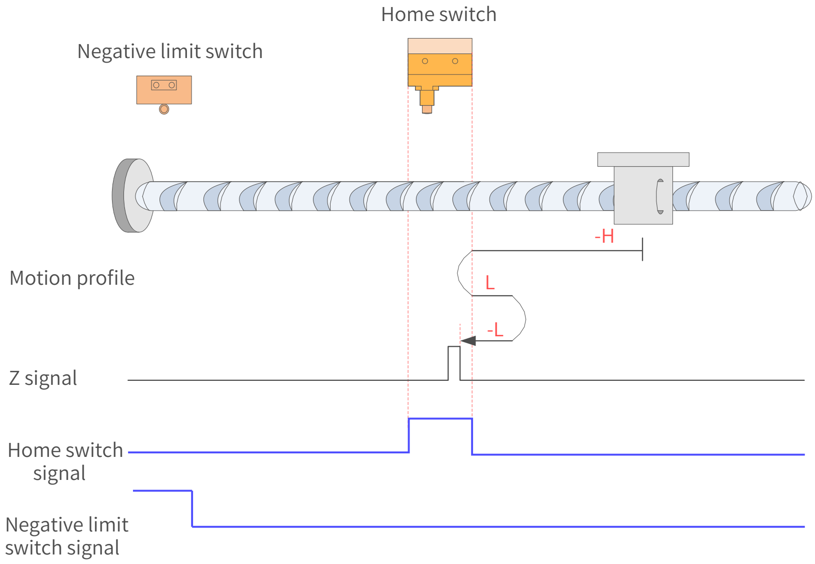


Figure 7-39 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the forward direction at 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 at low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

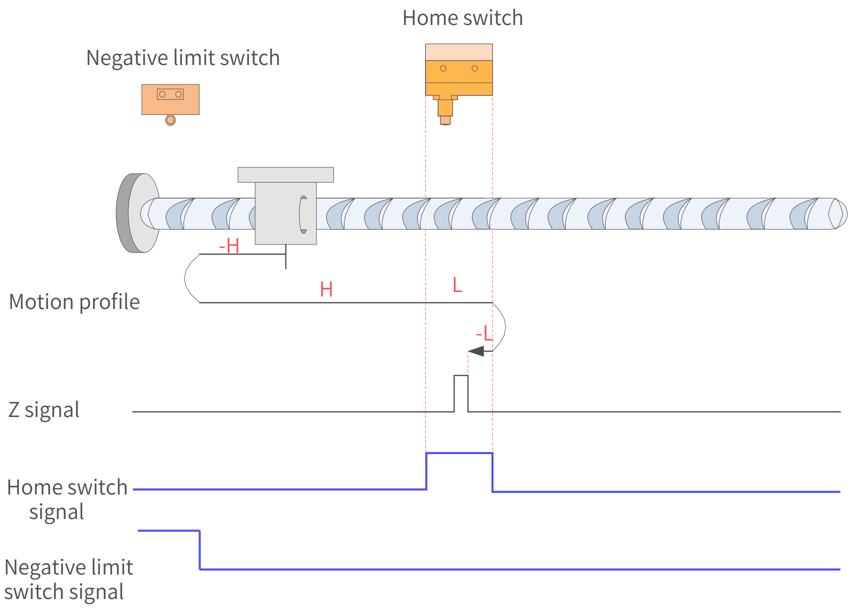


Figure 7-40 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at high speed. After reaching the rising edge of HW signal, the motor decelerates and runs in the forward direction at low speed. Then, after reaching the falling edge of HW signal, the motor changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

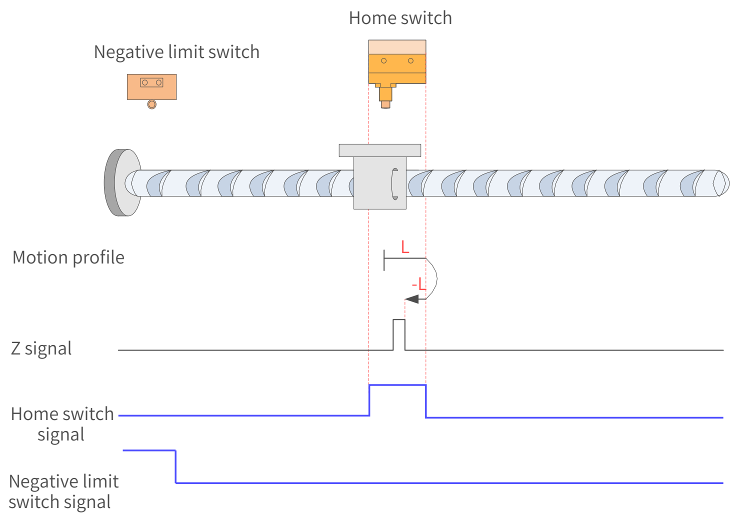


Figure 7-41 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

13) 6098 = 13

Home: Z signal

Deceleration point: home switch (HW)

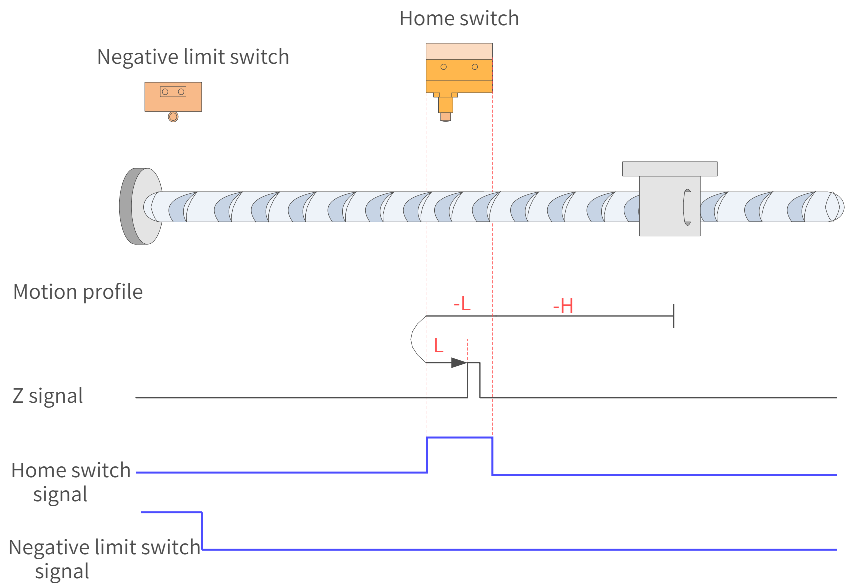


Figure 7-42 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the reverse direction at 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 low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

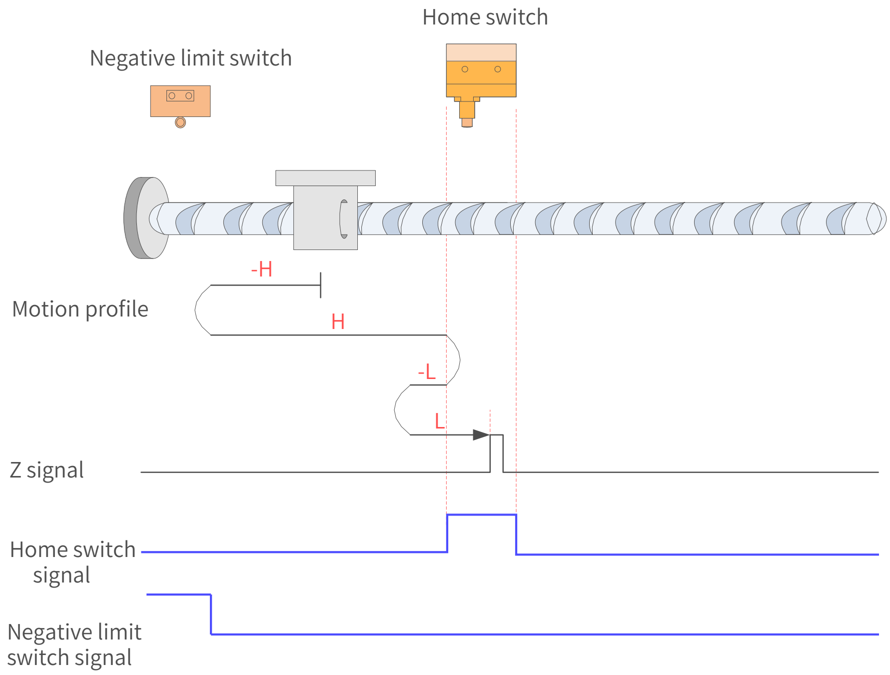


Figure 7-43 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction at low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

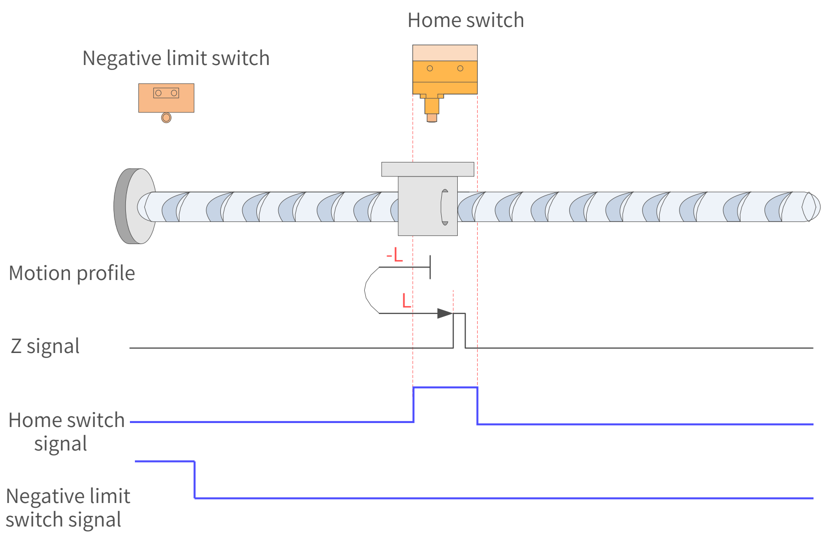


Figure 7-44 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at low speed. After reaching the falling edge of the HW signal, the motor changes to run in the forward direction at low speed until it stops at the first Z signal after reaching the rising edge of the HW signal.

14) 6098 = 14

Home: Z signal

Deceleration point: home switch (HW)

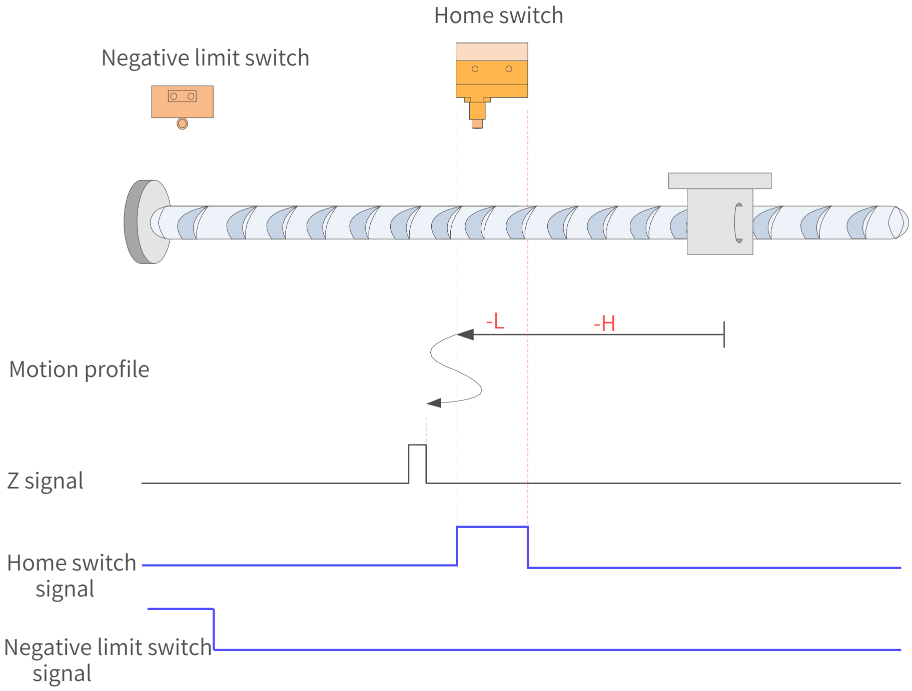


Figure 7-45 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and runs in the reverse direction at low speed 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 at low speed until reaching the rising edge of the HW signal where it decelerates and changes to run in the reverse direction at low speed. Finally, the motor stops at the first Z signal after reaching the falling edge of the HW signal.

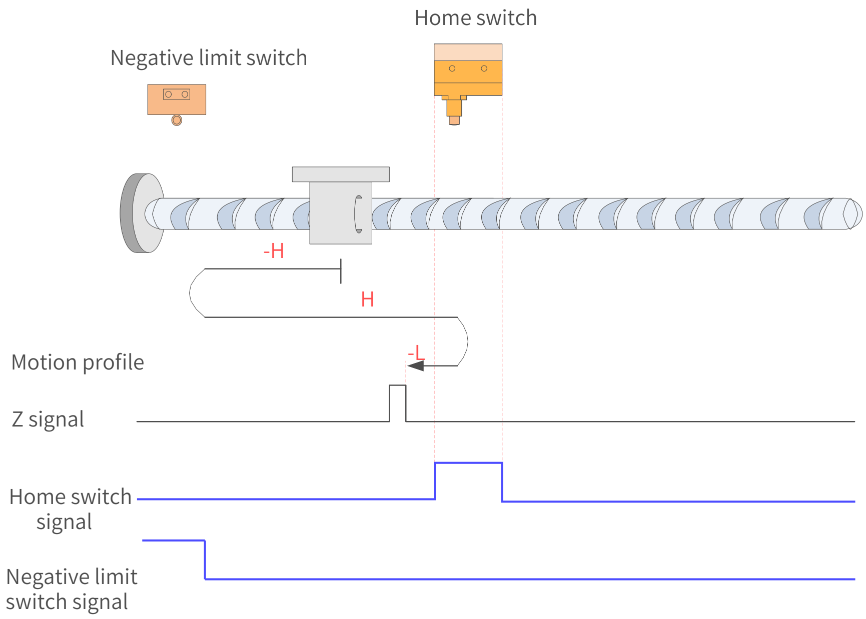


Figure 7-46 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops at the first Z signal after reaching the falling edge of the HW signal.

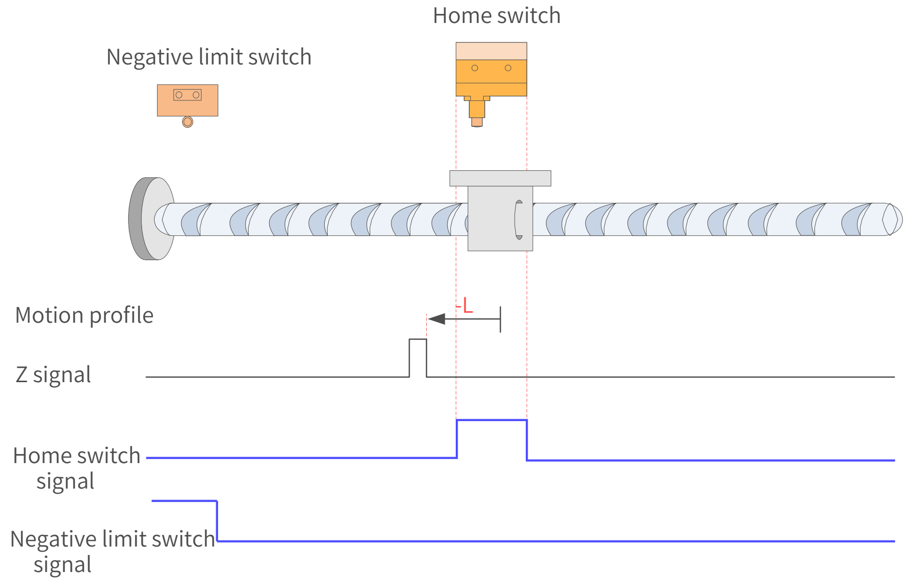


Figure 7-47 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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)

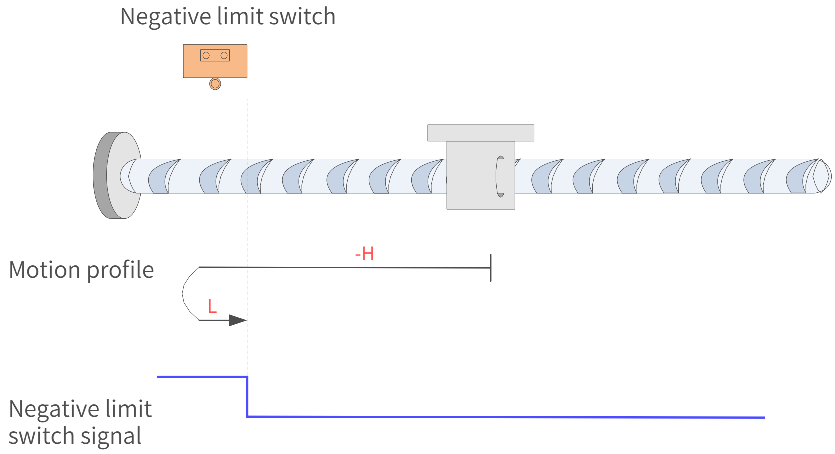


Figure 7-48 N-OT signal inactive at start

The N-OT signal is inactive at start, and the motor starts homing in the reverse direction at high speed. After reaching the rising edge of the N-OT signal, the motor decelerates and changes to run in the forward direction at low speed until it stops after reaching the falling edge of the N-OT signal.

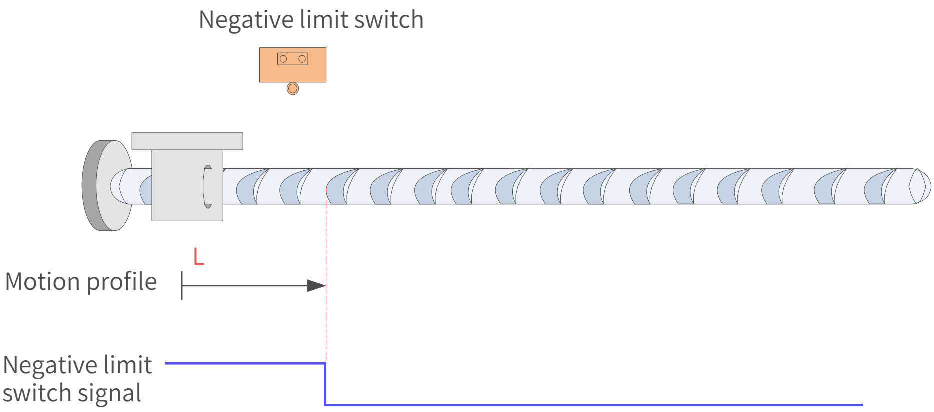


Figure 7-49 N-OT signal active at start

The N-OT signal is active at start, and the motor starts homing in the forward direction at 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)

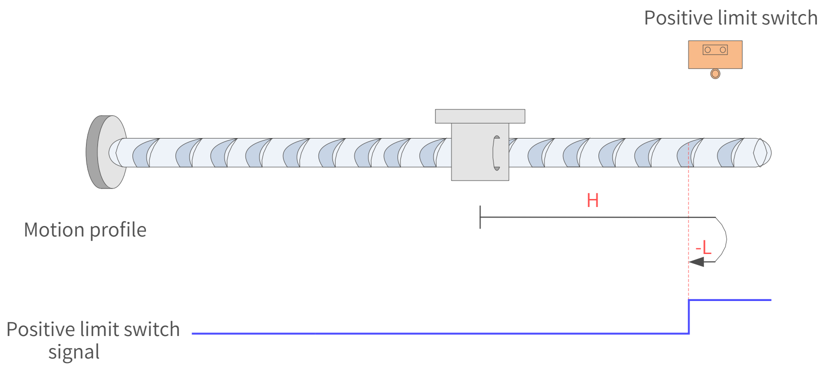


Figure 7-50 P-OT signal inactive at start

The P-OT signal is inactive at start, and the motor starts homing in the forward direction at high speed. After reaching the rising edge of the P-OT signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops after reaching the falling edge of the P-OT signal.

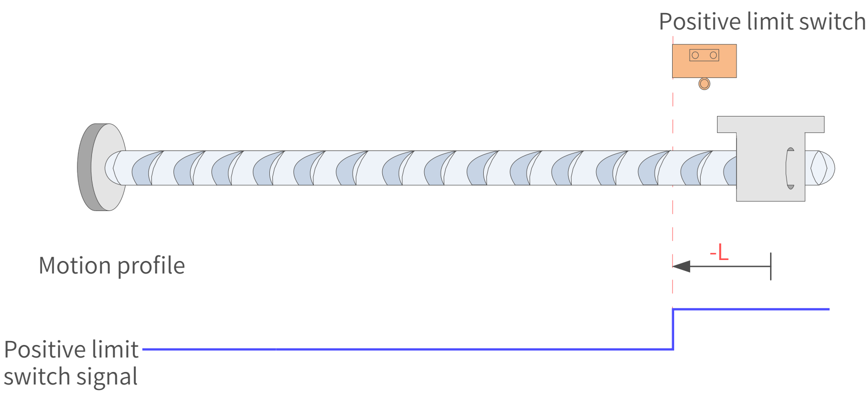


Figure 7-51 P-OT signal active at start

The P-OT signal is active at start, and the motor starts homing in the reverse direction at 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)

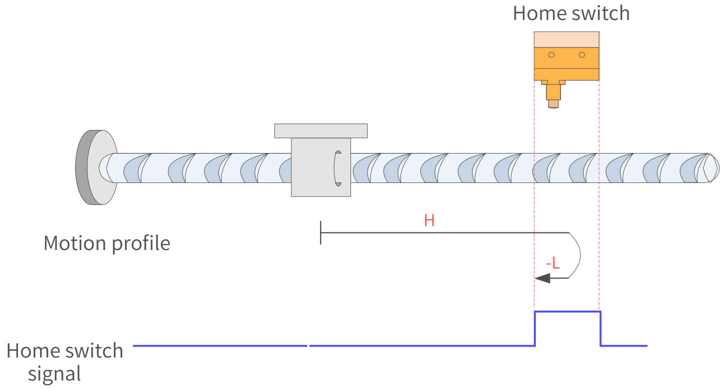


Figure 7-52 HW signal inactive at start

vThe HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops after reaching the falling edge of the HW signal.

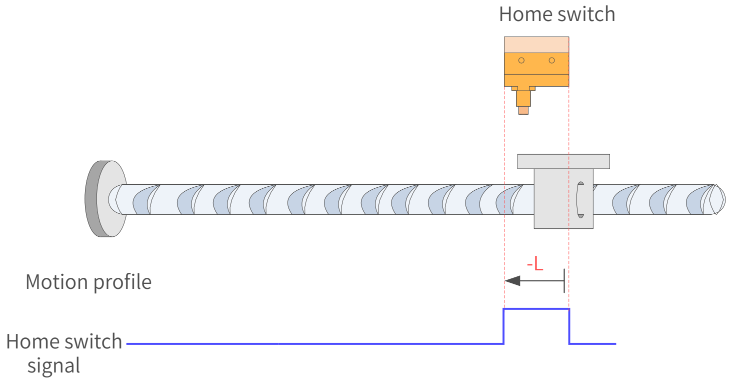


Figure 7-53 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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)

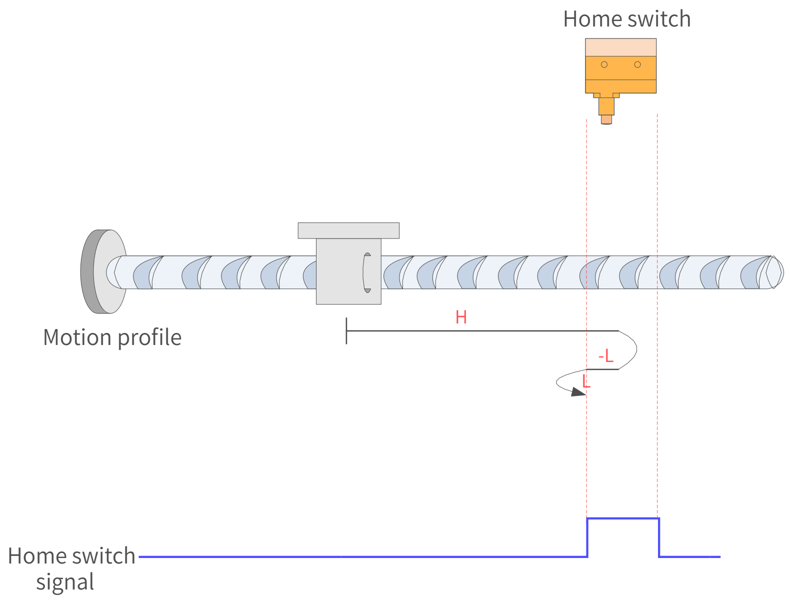


Figure 7-54 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it stops after reaching the rising edge of the HW signal.

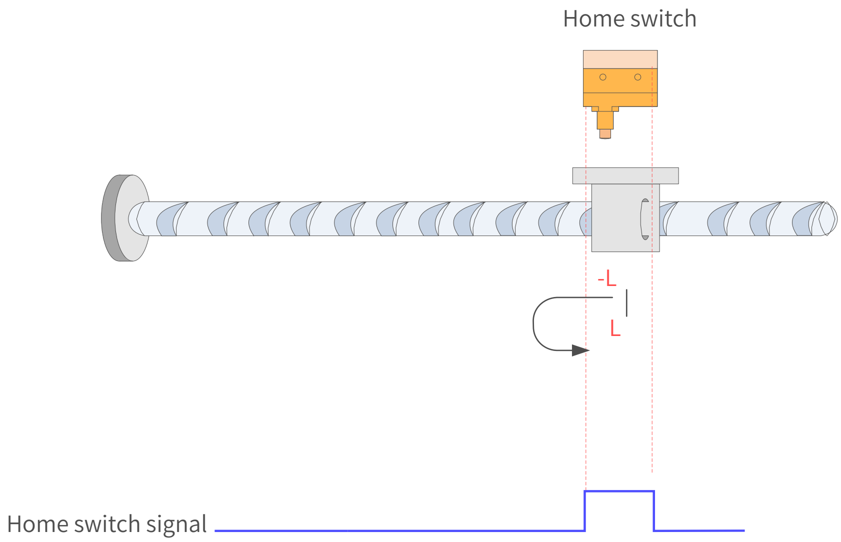


Figure 7-55 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it stops after reaching the rising edge of the HW signal.

19) 6098h = 21

Home: home switch (HW)

Deceleration point: home switch (HW)

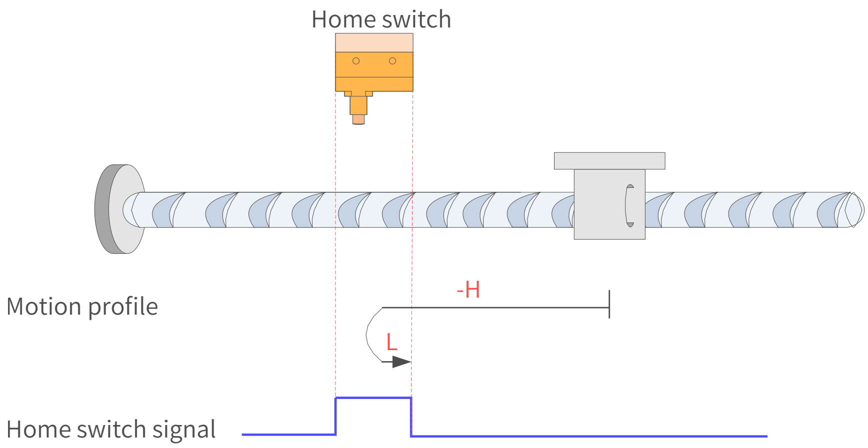


Figure 7-56 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it stops after reaching the falling edge of the HW signal.

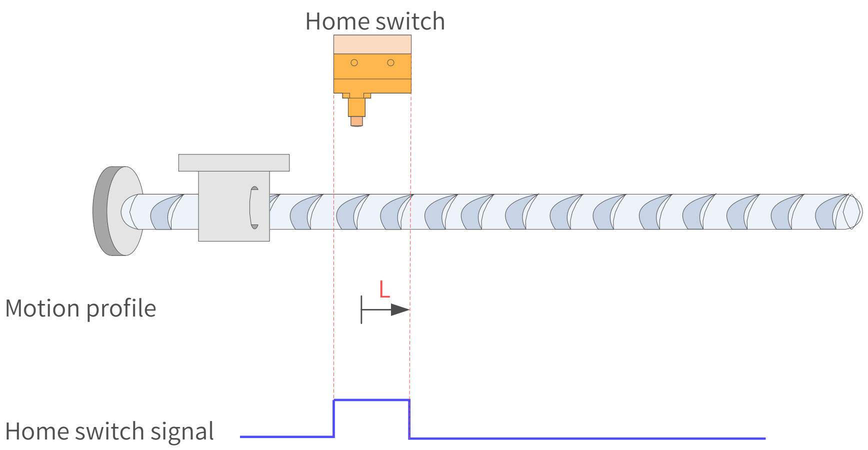


Figure 7-57 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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)

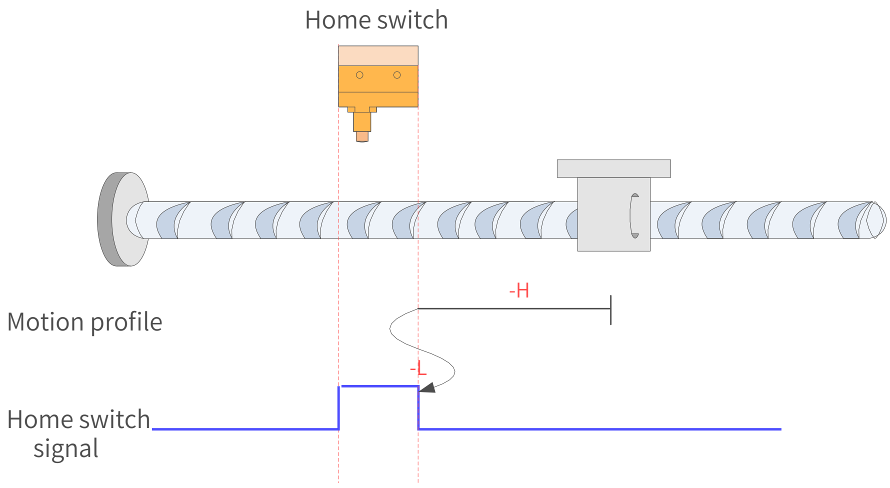


Figure 7-58 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it stops after reaching the rising edge of the HW signal.

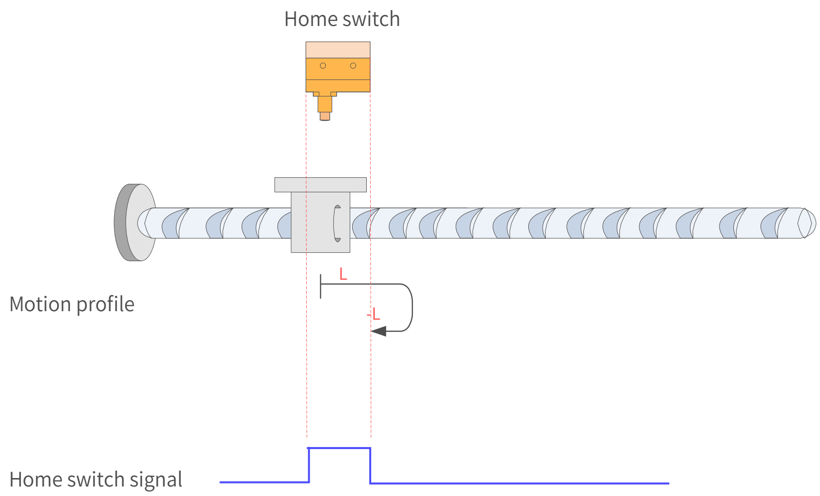


Figure 7-59 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops after reaching the rising edge of the HW signal.

21) 6098 = 23

Home: home switch (HW)

Deceleration point: home switch (HW)

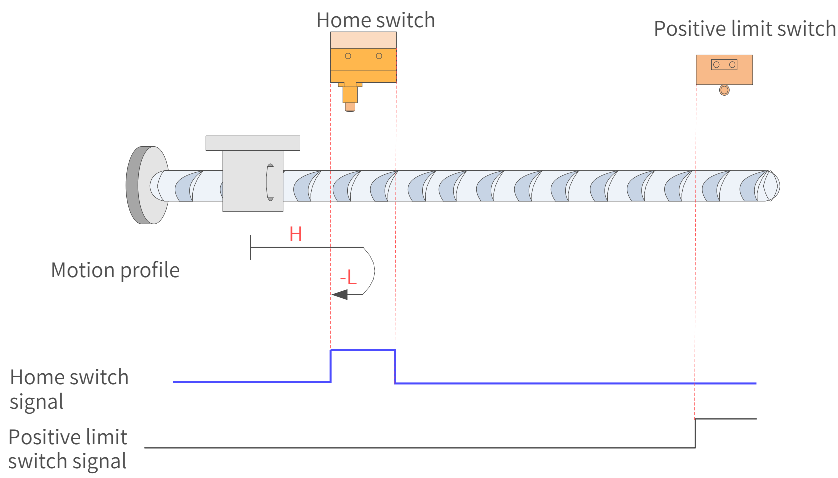


Figure 7-60 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the reverse direction at low speed after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor stops.

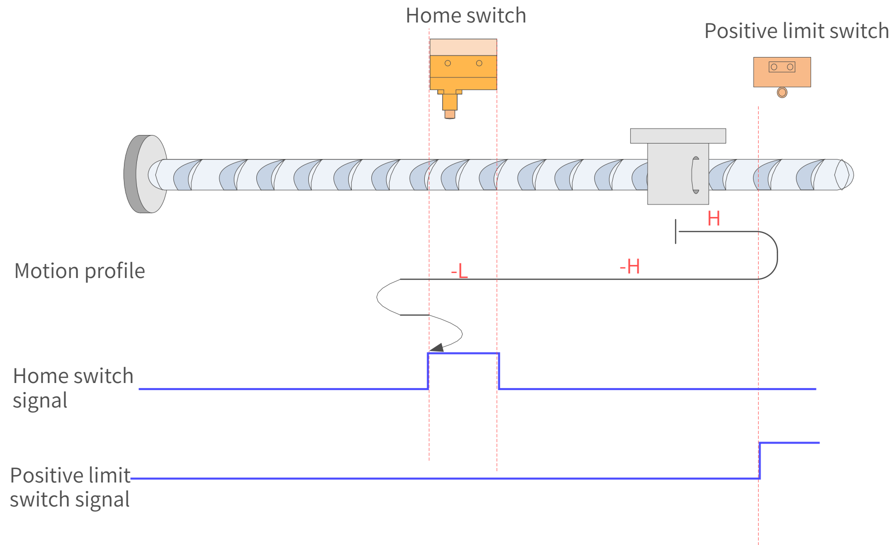


Figure 7-61 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis hits the limit switch, it changes to run in the reverse direction at high speed until it reaches the rising edge of the HW signal, where it decelerates to run in the reverse direction at low speed. Then, after reaching the falling edge of the HW signal, it decelerates and changes to run in the forward direction at low speed until it reaches the rising edge of the HW signal. After that, it decelerates and changes to run in the reverse direction at low speed. Finally, the motor stops after reaching the falling edge of the HW signal.

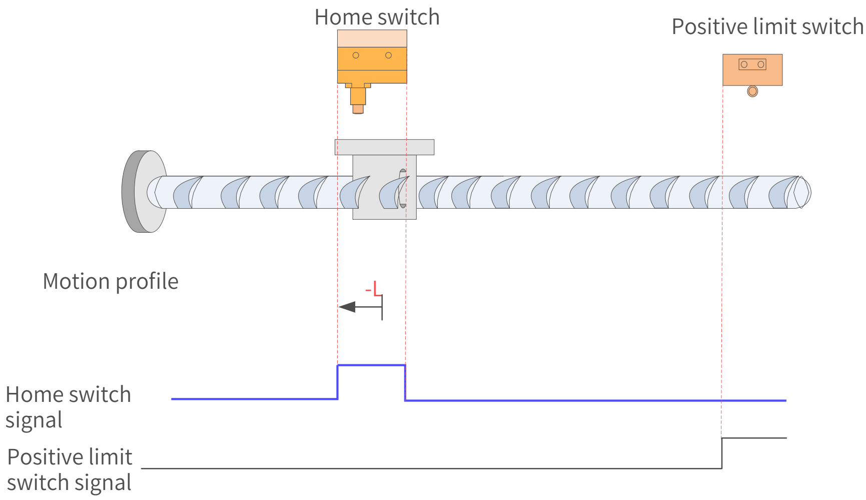


Figure 7-62 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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)

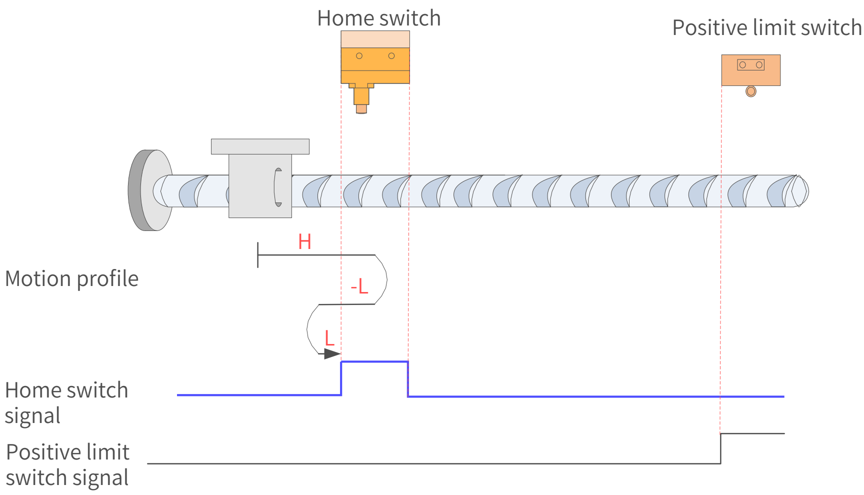


Figure 7-63 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the reverse direction at 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 low speed until it stops after reaching the rising edge of the HW signal.

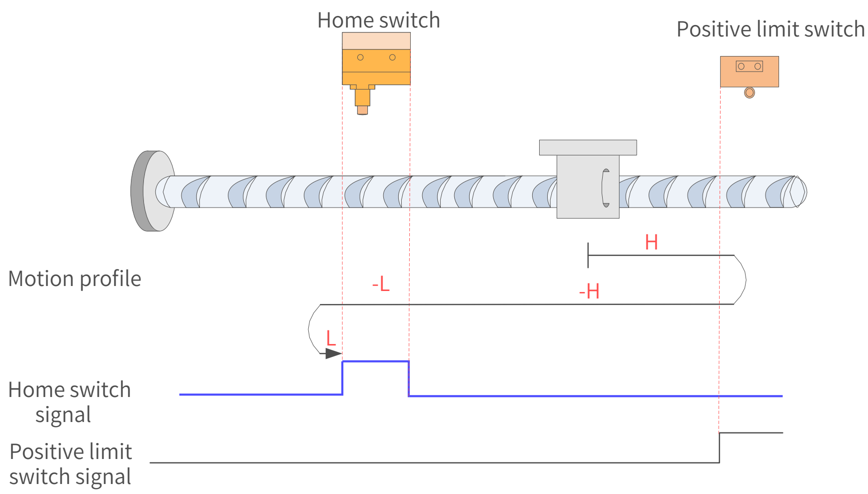


Figure 7-64 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis hits the limit switch, it changes to run in the reverse direction at high speed until it decelerates 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 low speed. Finally, the motor stops after reaching the rising edge of the HW signal.

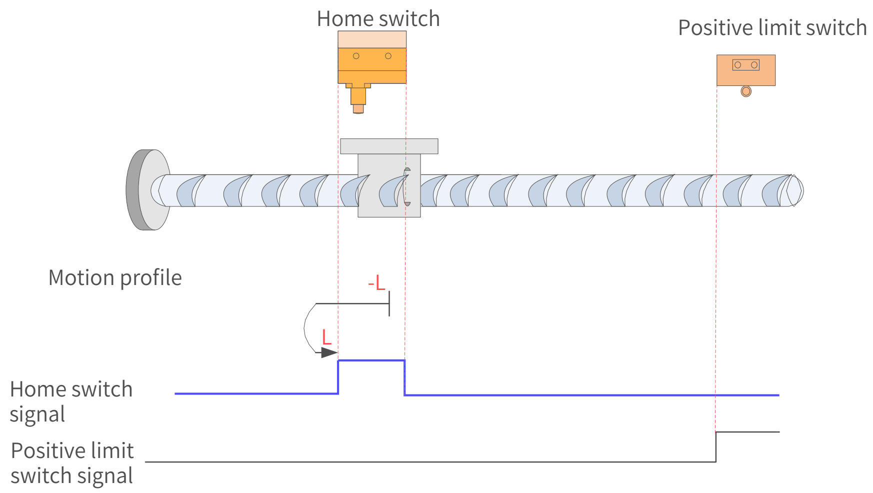


Figure 7-65 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at low speed. After reaching the falling edge of the HW signal, the motor changes to run in the forward direction at low speed until it stops after reaching the rising edge of the HW signal.

23) 6098 = 25

Home: home switch (HW)

Deceleration point: home switch (HW)

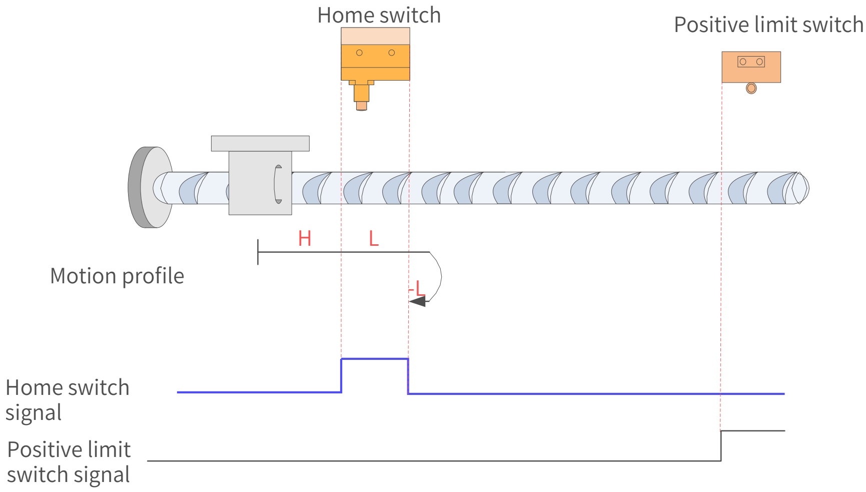


Figure 7-66 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and runs in the forward direction at 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 low speed until it stops after reaching the rising edge of the HW signal.

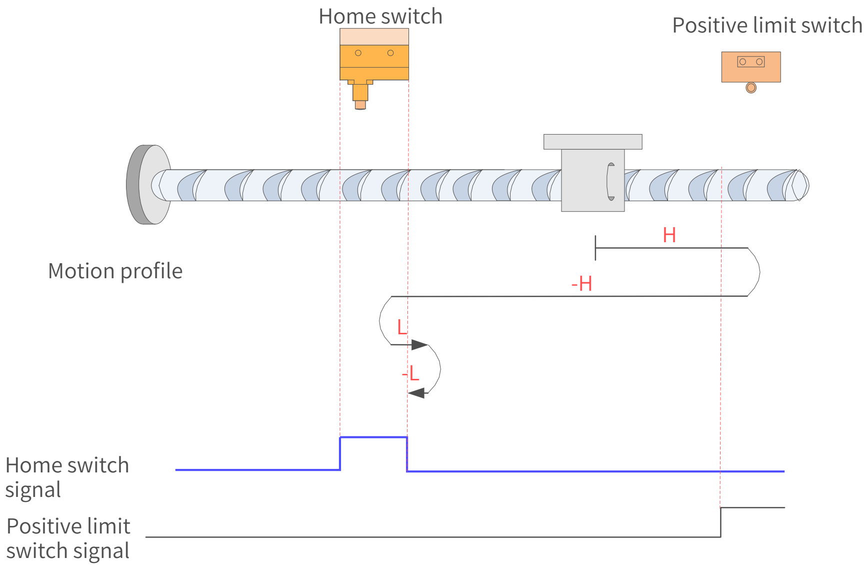


Figure 7-67 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis hits the limit switch, it changes to run in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until reaching the falling edge of the HW signal where it changes to run in the reverse direction at low speed. Finally, the motor stops after reaching the rising edge of the HW signal.

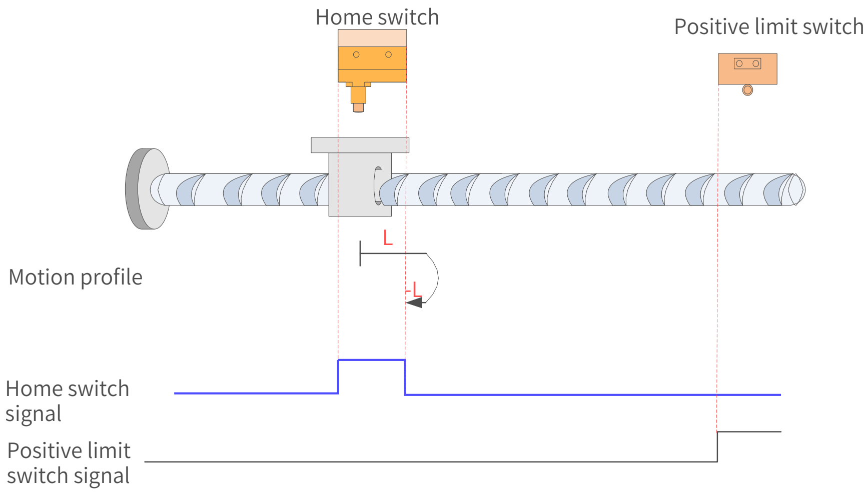


Figure 7-68 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at low speed until it stops after reaching the rising edge of the HW signal.

24) 6098 = 26

Home: home switch (HW)

Deceleration point: home switch (HW)

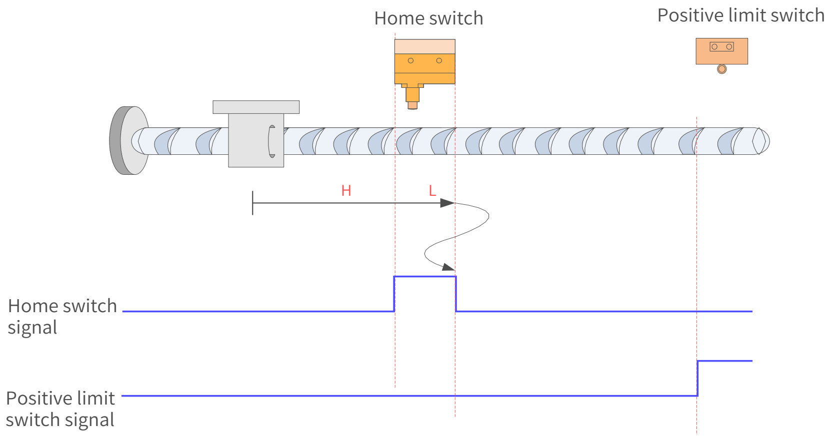


Figure 7-69 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis does not hit the limit switch, it decelerates and runs in the forward direction at low speed 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 at low speed until reaching the rising edge of the HW signal where it decelerates and changes to run in the forward direction at low speed. Finally, the motor stops after reaching the falling edge of the HW signal.

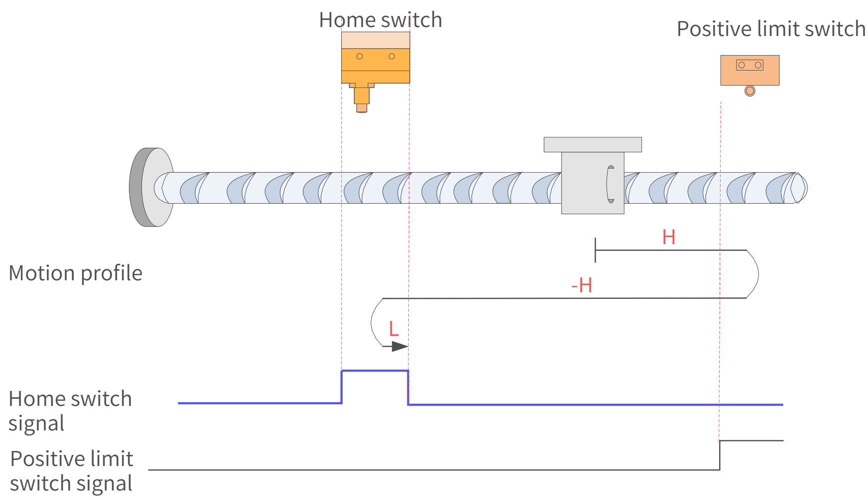


Figure 7-70 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at high speed. If the axis hits the limit switch, it changes to run in the reverse direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it stops after reaching the falling edge of the HW signal.

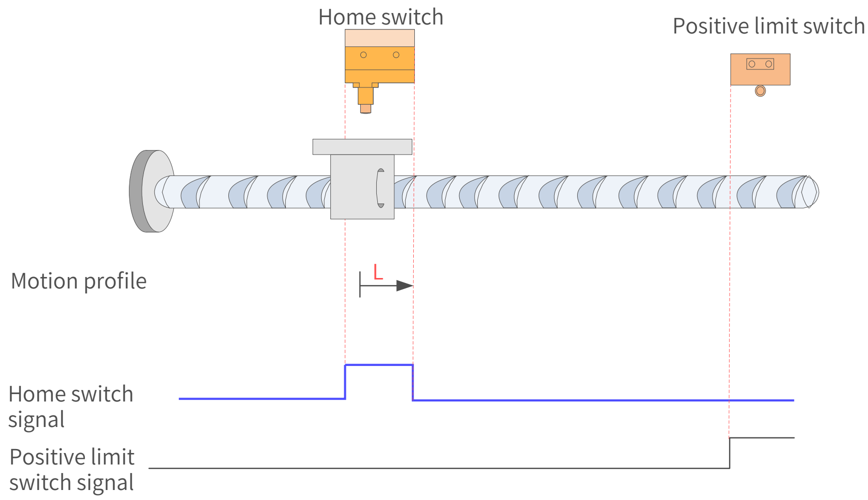


Figure 7-71 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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)

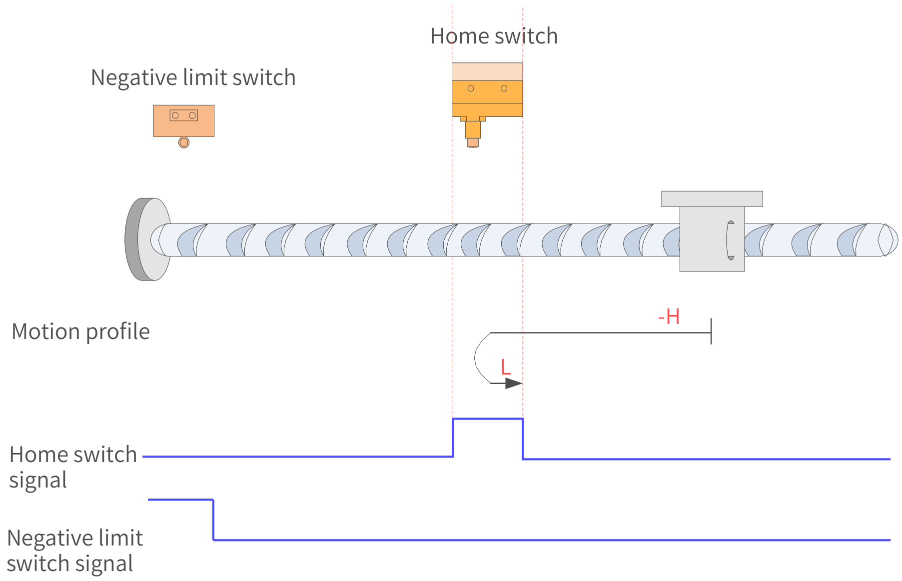


Figure 7-72 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start. The motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the forward direction at low speed after reaching the rising edge of the HW signal. Then, the motor stops after reaching the falling edge of the HW signal.

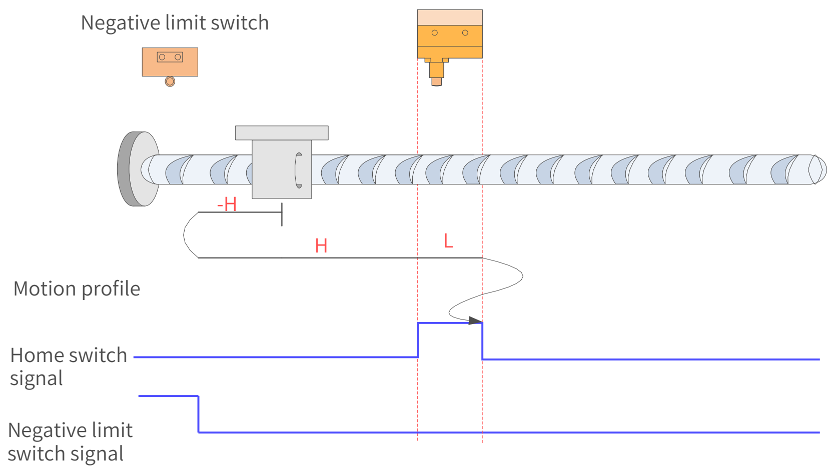


Figure 7-73 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at low speed. After reaching the rising edge of the HW signal, the motor decelerates and keeps running in the forward direction at low speed until reaching the falling edge of the HW signal where it decelerates and changes to run in the reverse direction at low speed. Then, after reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at low speed until it stops after reaching the falling edge of the HW signal.

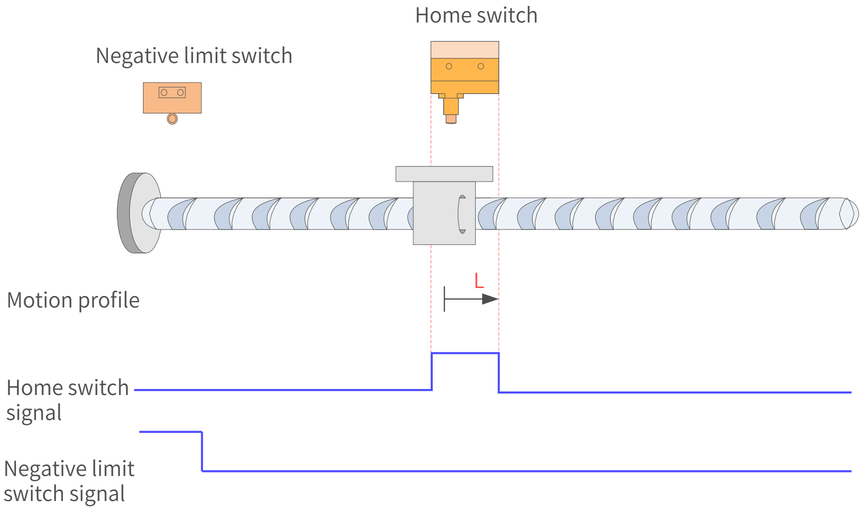


Figure 7-74 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at 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)

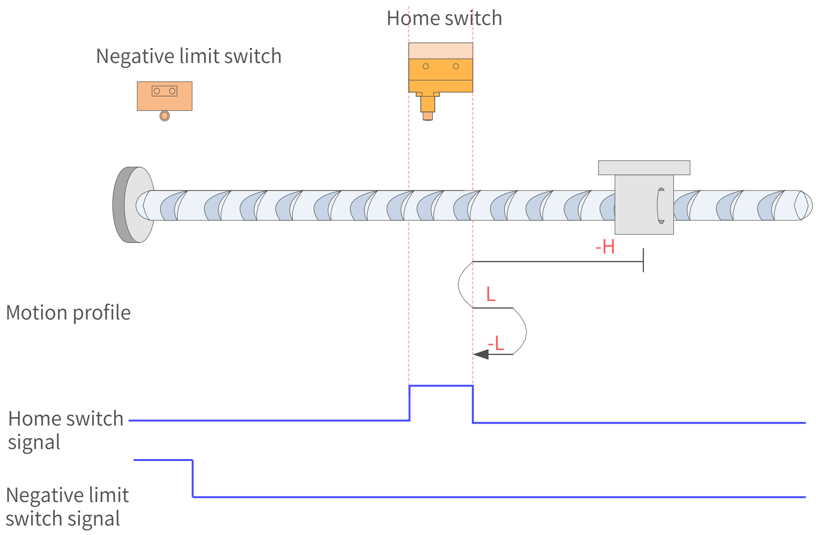


Figure 7-75 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and changes to run in the forward direction at 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 low speed until it stops after reaching the rising edge of the HW signal.

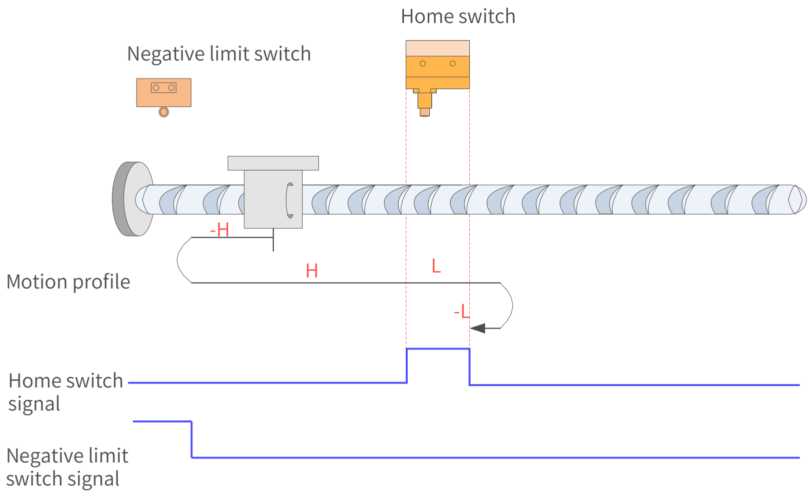


Figure 7-76 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at high speed until it decelerates after 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 at low speed. Finally, the motor stops after reaching the rising edge of the HW signal.

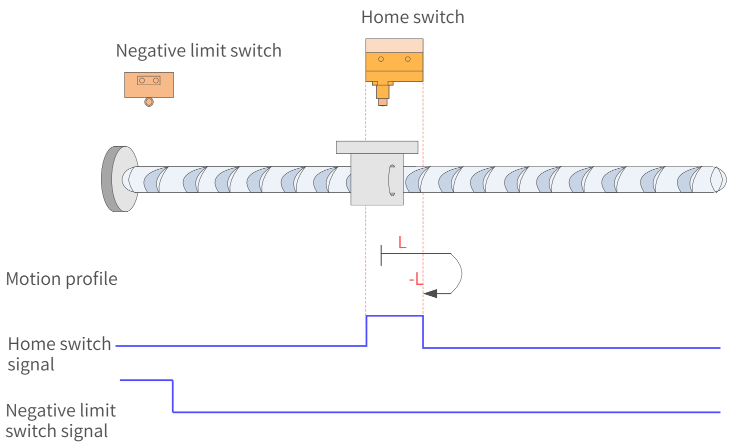


Figure 7-77 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at low speed until it stops after reaching the rising edge of the HW signal.

27) 6098 = 29

Home: home switch (HW)

Deceleration point: home switch (HW)

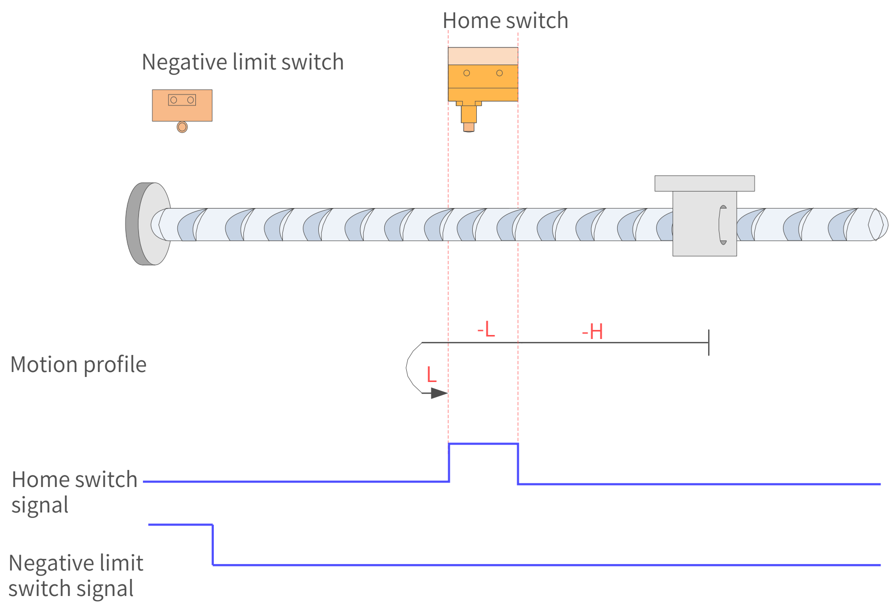


Figure 7-78 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and runs in the reverse direction at 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 low speed until it stops after reaching the rising edge of the HW signal.

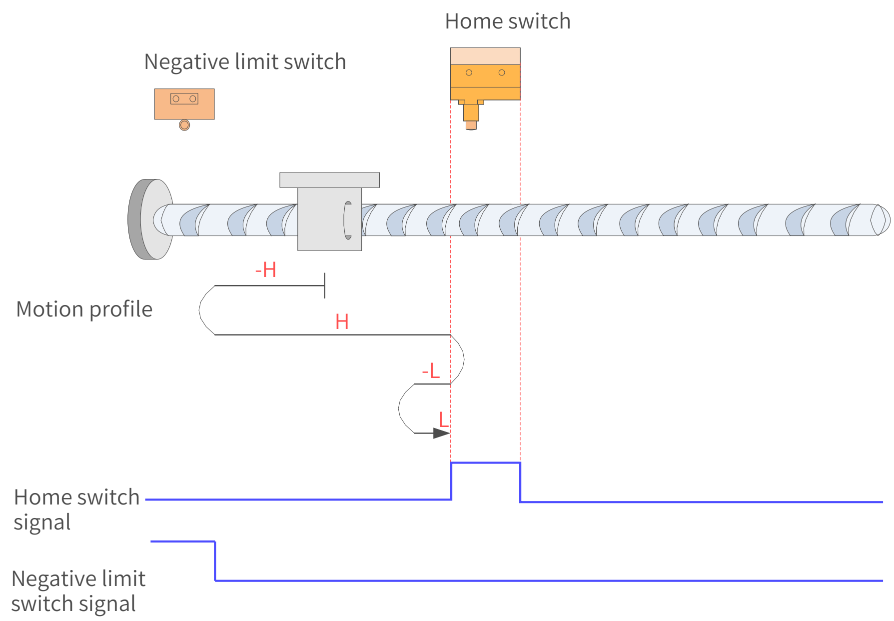


Figure 7-79 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it reaches the falling edge of the HW signal, where it changes to run in the forward direction at low speed. Finally, the motor stops after reaching the rising edge of the HW signal.

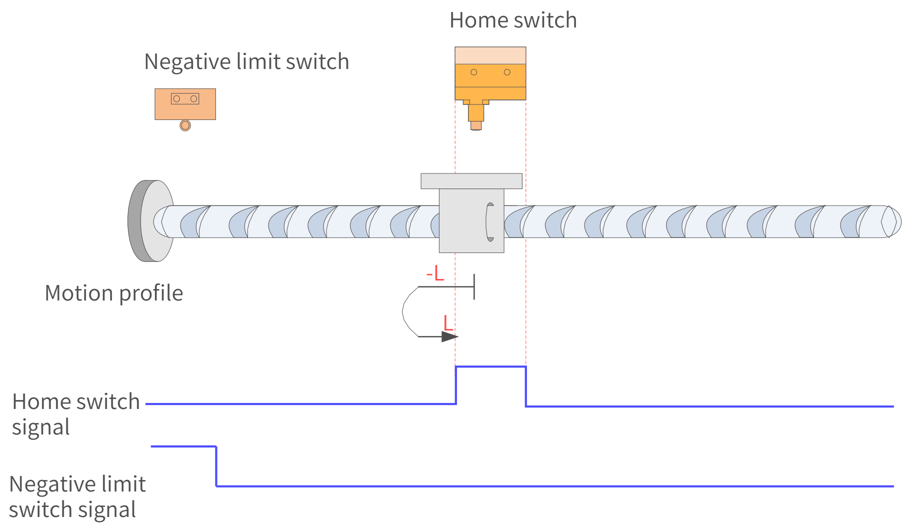


Figure 7-80 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at low speed. After reaching the falling edge of the HW signal, the motor changes to run in the forward direction at low speed until it stops after reaching the rising edge of the HW signal.

28) 6098 = 30

Home: home switch (HW)

Deceleration point: home switch (HW)

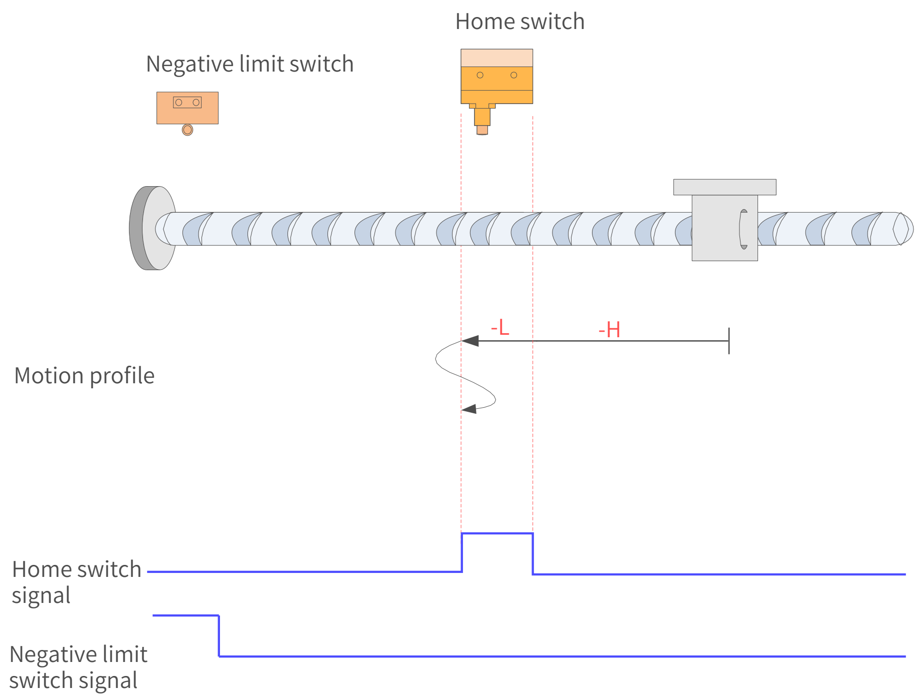


Figure 7-81 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis does not hit the limit switch, it decelerates and keeps running in the reverse direction at low speed 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 at low speed until reaching the rising edge of the HW signal where it changes to run in the reverse direction at low speed. Finally, the motor stops after reaching the falling edge of the HW signal.

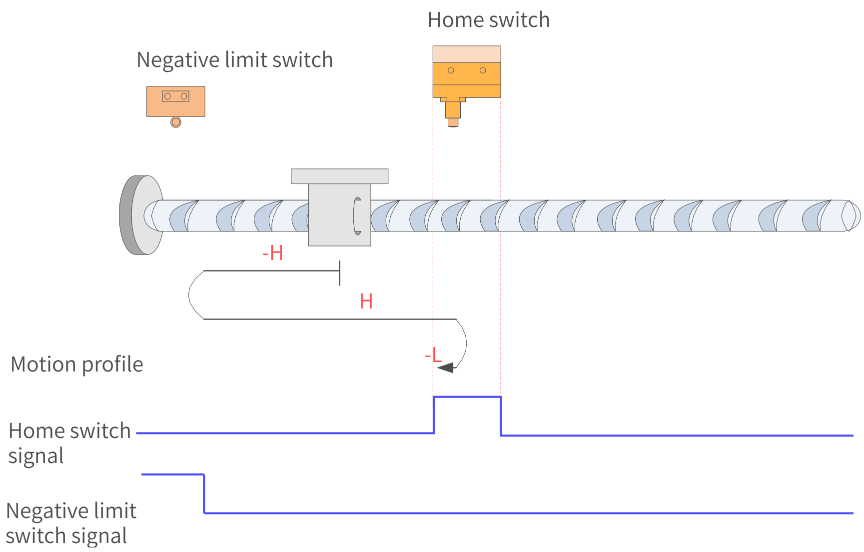


Figure 7-82 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at high speed. If the axis hits the limit switch, it changes to run in the forward direction at high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at low speed until it stops after reaching the falling edge of the HW signal.

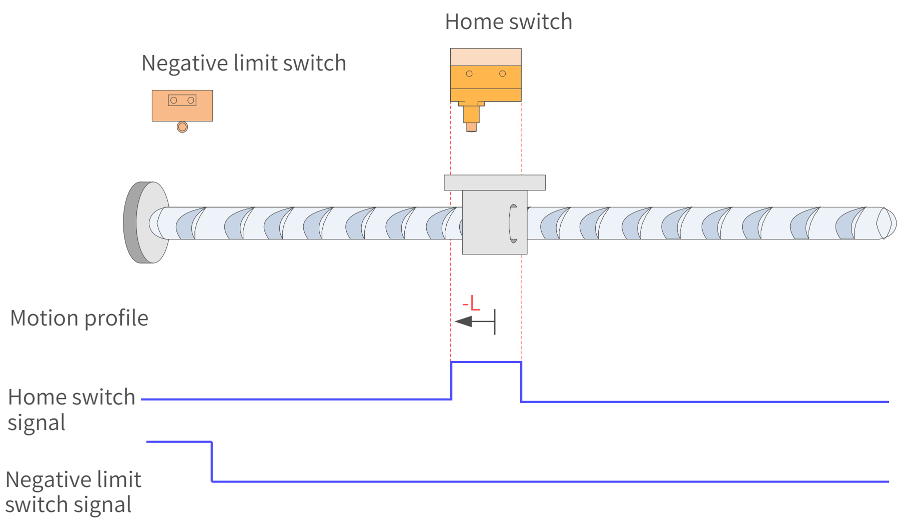


Figure 7-83 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at 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.

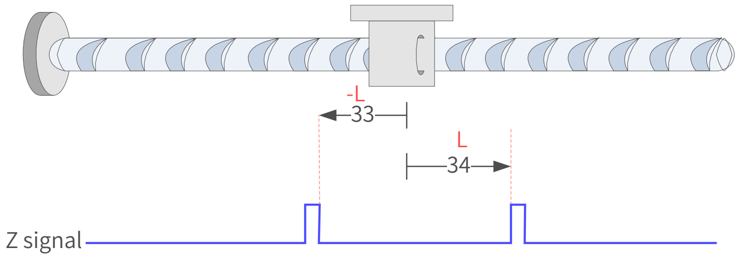
30) 6098h = 33/34

Home: Z signal

Deceleration point: None

Homing mode 33: The motor runs in the reverse direction at low speed and stops at the first Z signal.

Homing mode 34: The motor runs in the forward direction at 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):

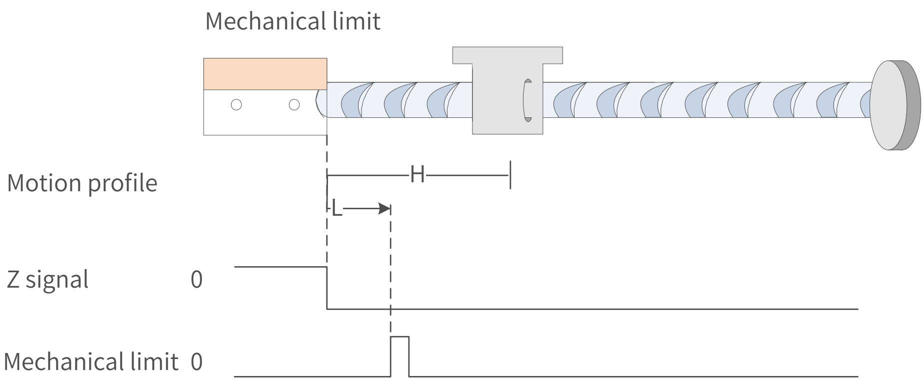
6064h (Position actual value) is equal to 607Ch (Home offset) after homing is done.

60E6h = 1 (Relative homing):

6064h is the sum of the original value plus 607Ch (Home offset) after homing is done.

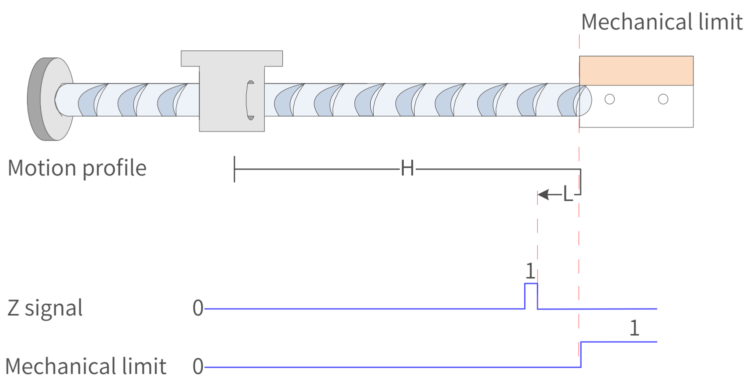
32) 6098 = –1

The servo motor runs in the reverse direction at high speed first. If the torque reaches the limit and the speed is near zero after the axis hits the mechanical limit, and such status persists, it indicates that the axis has reached the mechanical limit position. In this case, the motor runs in the forward direction at low speed and stops after reaching the rising edge of the Z signal for the first time.



33) 6098 = –2

The servo motor runs in the forward direction at high speed first. If the torque reaches the limit and the speed is near zero after the axis 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 low speed and stops after 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: Present operating state maintained 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 found	0: Home not located 1: Home located

<table>
<tr><td rowspan="2">Index 6098h</td><td>Name</td><td colspan="2">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.

<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>
<tr><td colspan="11">
<table>
<tr><td>11</td><td>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.</td></tr>
<tr><td>12</td><td>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.</td></tr>
<tr><td>13</td><td>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.</td></tr>
<tr><td>14</td><td>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.</td></tr>
<tr><td>15 to 16</td><td>N/A</td></tr>
<tr><td>17 to 32</td><td>Similar to 1 to 14. However, the deceleration point overlaps with the home.</td></tr>
<tr><td>33</td><td>Reverse homing. The home is the Z signal.</td></tr>
<tr><td>34</td><td>Forward homing. The home is the Z signal.</td></tr>
<tr><td>35</td><td>The present position is used as the home.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6099h</td><td>Name</td><td colspan="3">Homing speeds</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>ARR</td><td>Data Type</td><td>Uint32</td></tr>
<tr><td>Access</td><td>-</td><td>Mapping</td><td>Yes</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>OD data range</td><td>Default</td><td>OD default value</td></tr>
<tr><td colspan="11">Defines the following two speed values used in the homing mode:
◆ Speed during search for switch
◆ Speed during search for zero</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 0h</td><td>Name</td><td colspan="3">Number of homing speed sub-indexes</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint8</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>2</td><td>Default</td><td>2</td></tr>
</table>

<table>
<tr><td rowspan="2">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>Uint32</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) (reference unit/s)</td><td>Default</td><td>1747627</td></tr>
<tr><td colspan="11">Defines the speed during searching for the deceleration point signal. A large setpoint 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="2">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) (reference unit/s)</td><td>Default</td><td>100</td></tr>
<tr><td colspan="11">Defines the speed during searching for the home signal. A small setpoint helps avoid overshoot during stop at high speed, preventing large deviation between the stop position and the preset mechanical home.</td></tr>
</table>

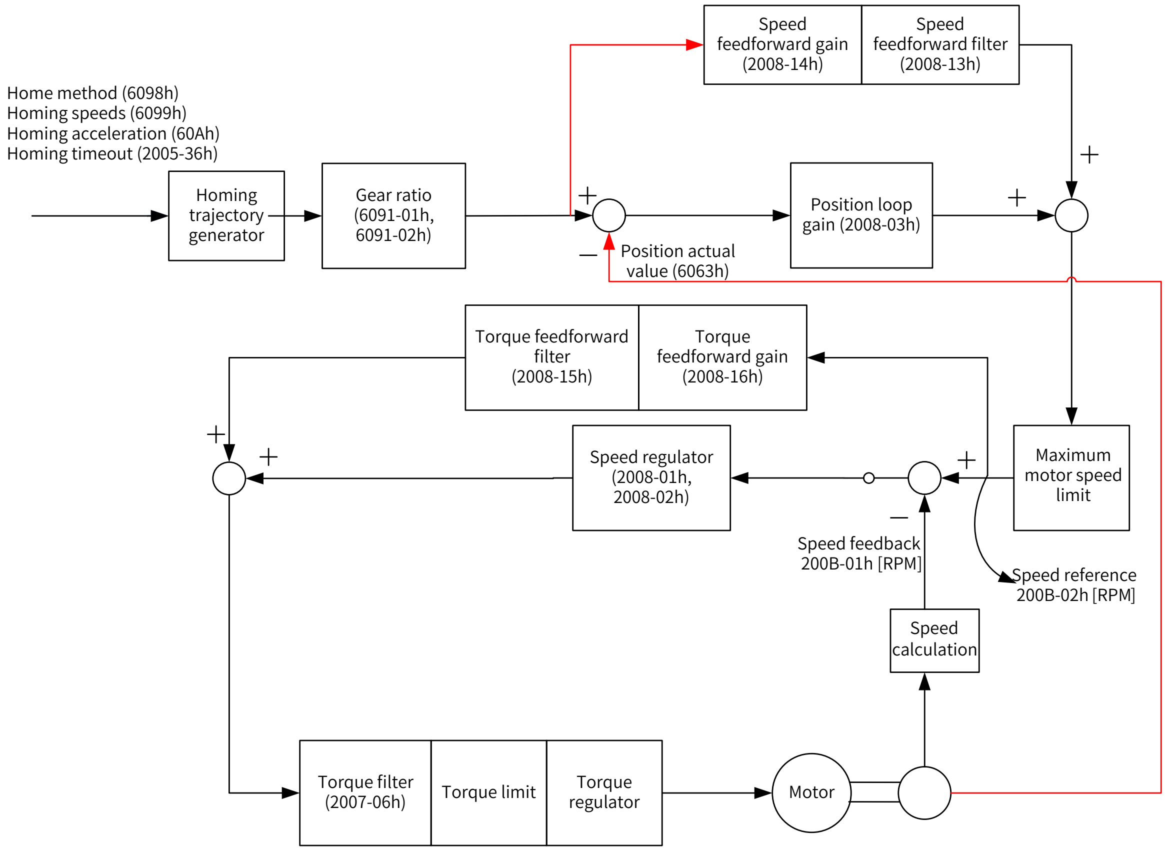
<table>
<tr><td rowspan="2">Index 609Ah</td><td>Name</td><td colspan="3">Homing acceleration</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>DUint32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>0 to (2^{32}-1) (reference unit/s2))</td><td>Default</td><td>100</td></tr>
<tr><td colspan="11">Defines the acceleration rate in the homing mode.
The setpoint is effective 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 setpoint 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
- EtherCAT forced DO function

7.10.1 Touch Probe Function

The touch probe function is used to latch the position actual value (reference 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 falling edge of each touch probe signal, which means four positions can be latched.

CAUTION	
	◆ No specific DI logic is required when a DI is used to trigger the touch probe function. ◆ When a DI is used to trigger the touch probe function, you can set the filter window of the touch probe signal through 200A-14h and 200A-15h.

■ Related Objects

Index (HEX)	Sub-index (HEX)	Name	Access	Data Type	Unit	Value Range	Default
2003	03	DI1 function	RW	Uint16	-	0 to 65535	14
...							
2003	0B	DI5 function	RW	Uint16	-	0 to 65535	39
60B8	00	Touch probe function	RW	Uint16	-	0 to 65535	0
60B9	00	Touch probe status	RO	Uint16	-	-	0
60BA	00	Touch probe 1 positive edge	RO	Int32	Reference unit	-	0
60BB	00	Touch probe 1 negative edge	RO	Int32	Reference unit	-	0
60BC	00	Touch probe 2 positive edge	RO	Int32	Reference unit	-	0
60BD	00	Touch probe 2 negative edge	RO	Int32	Reference 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

■ Operating procedure

Observe the following procedure when using DI5 to trigger the touch probe function.

Requirement: touch probe 1 positive edge, continuous latching

1) Set 0x2003-0B (DI5 function) 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.

Index 60B8h	Name	Touch probe function		Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	-	Data Range	0 to 65535	Default	0

Defines the function of touch probe 1 and touch probe 2.

Definitions of each bit of 60B8 are as follows.

Bit	Description	Remarks
0	Touch probe 1 function selection 0: Switch off touch probe 1 1: Enable touch probe 1	Bit0 to Bit5: settings related to touch probe 1 When a DI is used to trigger the touch probe function, the DI source cannot be changed once the touch probe function is enabled. For an absolute encoder, Z signal refers to the zero point of the single-turn position feedback of the motor.
1	Touch probe 1 trigger mode 0: Single trigger mode (Latches the position at the first trigger event.) 1: Continuous trigger mode	
2	Touch probe 1 trigger signal selection 0: DI signal 1: Z signal	
3	N/A	
4	Touch probe 1 positive edge 0: Switch off latching at positive edge 1: Enable latching at positive edge	
5	Touch probe 1 negative edge 0: Switch off latching at negative edge 1: Enable latching at negative edge	
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 latching at positive edge 1: Enable latching at positive edge	
13	Touch probe 2 negative edge 0: Switch off latching at negative edge 1: Enable latching at negative edge	
14 to 15	N/A	

For absolute encoders, Z signal refers to the zero position of each revolution.

Set 0x60B8 to 0x0013 in this example.

3) Read the touch probe status in 0x60B9.

The definition of each bit of the touch probe status (0x60B9) is shown in the following table.

<table>
<tr><td rowspan="2">Index
60B9h</td><td>Name</td><td colspan="3">Touch probe status</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>-</td><td>Data Range</td><td>-</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">Indicates the status of touch probe 1 and touch probe 2.</td></tr>
</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="4">Bit0 to Bit7: status of touch probe 1</td></tr>
<tr><td>1</td><td>Touch probe 1 positive edge value
0: No positive edge value latched
1: Positive edge value latched</td></tr>
<tr><td>2</td><td>Touch probe 1 negative edge value
0: No negative edge value latched
1: Negative edge value latched</td></tr>
<tr><td>3 to 7</td><td>N/A</td></tr>
<tr><td>8</td><td>Touch probe 2 function selection
0: Switch off Touch probe 2
1: Enable touch probe 2</td><td rowspan="4">Bit8 to Bit15: status of touch probe 2</td></tr>
<tr><td>9</td><td>Touch probe 2 positive edge value
0: No positive edge value latched
1: Positive edge value latched</td></tr>
<tr><td>10</td><td>Touch probe 2 negative edge value
0: No negative edge value latched
1: Negative edge value latched</td></tr>
<tr><td>11 to 15</td><td>-</td></tr>
</table>

In this example, you can read bit1 of 0x60B9 to check whether the touch probe 1 positive edge value is latched.

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 touch probe 1 positive edge value is latched, you can read the position value through 0x60BA (Touch probe 1 positive edge, reference unit). The latch times can be obtained through 0x60D5.

The following figure shows touch probe function settings and status feedback sequence when DI5 is used as the trigger signal in case of latching at positive edge and continuous triggering.

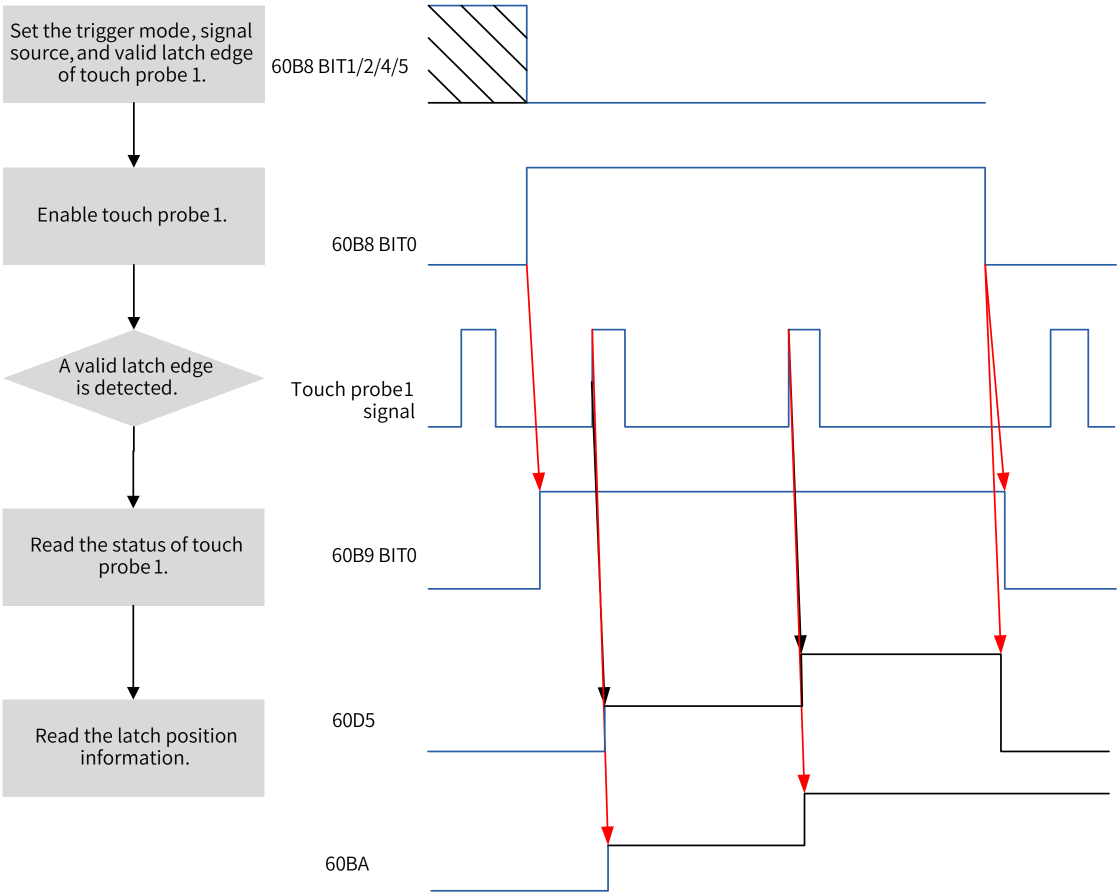


Figure 7-84 Operaing procedure of touch probe function

7.10.2 Software Position Limit

Traditionally, position limits are defined by external sensor signals connected to CN1, which is known as hardware position limits.

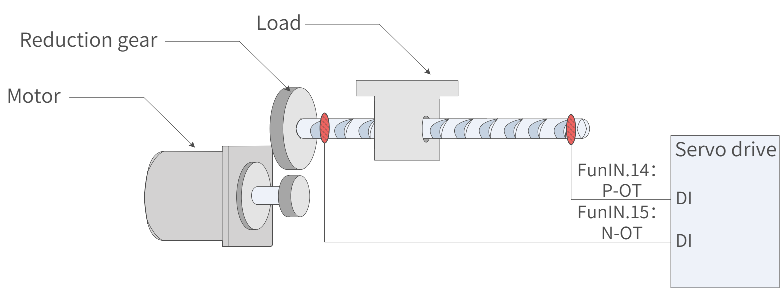


Figure 7-85 Installation of limit switches

■ Comparison between hardware position limit and software position limit

Hardware limit		Software limit	
1	Restricted to linear motion and single-turn rotational motion.	1	Applicable to linear motion and rotational motion.
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	Unable to detect or alarm an overtravel event after power-off.		

The software position 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 after power-on before the software position 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 as defined by 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 $+(2^{31}-1)$ (reference unit)	Default	-2^{31}

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 $+(2^{31}-1)$ (reference unit)	Default	$2^{31}-1$

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 (Software position limit setting error).
- 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 position limit. Otherwise, the servo drive reports EE09.0.

7.10.3 Position Comparison

In position comparison, the actual position of the axis is compared with the position values pre-stored in the data array and, once the comparison conditions are fulfilled, a DO signal with pulse width settable will be outputted for use in subsequent motion control. Such comparison is implemented through FPGA, removing the risk of software communication delay between different processors. Accurate comparison can also be performed on the motion axis rotating at 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 active when the actual position of the axis reaches a comparison point in the specified attribute. When "active low" is selected, the corresponding DO is not active when the actual position of the axis reaches a comparison point in the specified attribute.. Three DOs are available in SV660N series servo drives.

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: Fault (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^{22}. 0: 24-bit 1: 23-bit 2: 22-bit 3: 21-bit 4: 20-bit 5: 19-bit 6: 18-bit 7: 17-bit

Para. No.	Name	Description
H18-03	Position comparison mode	0: Individual comparison 1: Cyclic comparison
H18-04	Present position as zero	1: Enabled
H18-05	Position comparison output pulse 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 value of position comparison 1	Defines the target value of position comparison 1. Value range: -2^{31} to $2^{31} - 1$
H19-02	Attribute value of position comparison 1	Defines the attribute value of position comparison 1. 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 value of position comparison 2	Defines the target value of position comparison 2. Value range: -2^{31} to $2^{31} - 1$
H19-05	Attribute value of position comparison 2	Defines the attribute value of position comparison 2. 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
H19-06	Target value of position comparison 3	Defines the target value of position comparison 3. Value range: -2^{31} to $2^{31}-1$
H19-08	Attribute value of position comparison 3	Defines the attribute value of position comparison 3. 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 value of position comparison 4	Defines the target value of position comparison 4. Value range: -2^{31} to $2^{31} - 1$
H19-11	Attribute value of position comparison 4	Defines the attribute value of position comparison 4. 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
H19-12	Target value of position comparison 5	Defines the target value of position comparison 5. Value range: -2^{31} to $2^{31}-1$
H19-14	Attribute value of position comparison 5	Defines the attribute value of position comparison 5. 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 value of position comparison 6	Defines the target value of position comparison 6. Value range: -2^{31} to $2^{31}-1$
H19-17	Attribute value of position comparison 6	Defines the attribute value of position comparison 6. 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 value of position comparison 7	Defines the target value of position comparison 7. Value range: -2^{31} to $2^{31}-1$
H19-20	Attribute value of position comparison 7	Defines the attribute value of position comparison 7. 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 value of position comparison 8	Defines the target value of position comparison 8. Value range: -2^{31} to $2^{31}-1$
H19-23	Attribute value of position comparison 8	Defines the attribute value of position comparison 8. 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 position comparison start point number. 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 of the position comparison points (defined by group H19), you can reset the comparison value resolution when data overflow occurs on the comparison value. For example: H18-02 = 7 (17-bit) The maximum value of the target position is $2^{31}-1$, and the motor can move by $2^{31}-1/2^{17}$ rotations.

The target position in group H19 is only related to the set resolution.

■ Individual comparison mode (H18-03 = 0)

In the single comparison mode, when the comparison end point is reached, 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 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 end point is reached, and the start point for comparison will be set as the next comparison position value.

In the cyclic comparison mode, the target position is a relative (incremental) value. Each time a comparison point is reached, the real-time position feedback is cleared and reset to zero 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 value of position comparison

There are eight target values of position comparison. The target value is a 32-bit signed number. The target value and attribute value of position comparison 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 position comparison 5.

■ End point for comparison (H18-08)

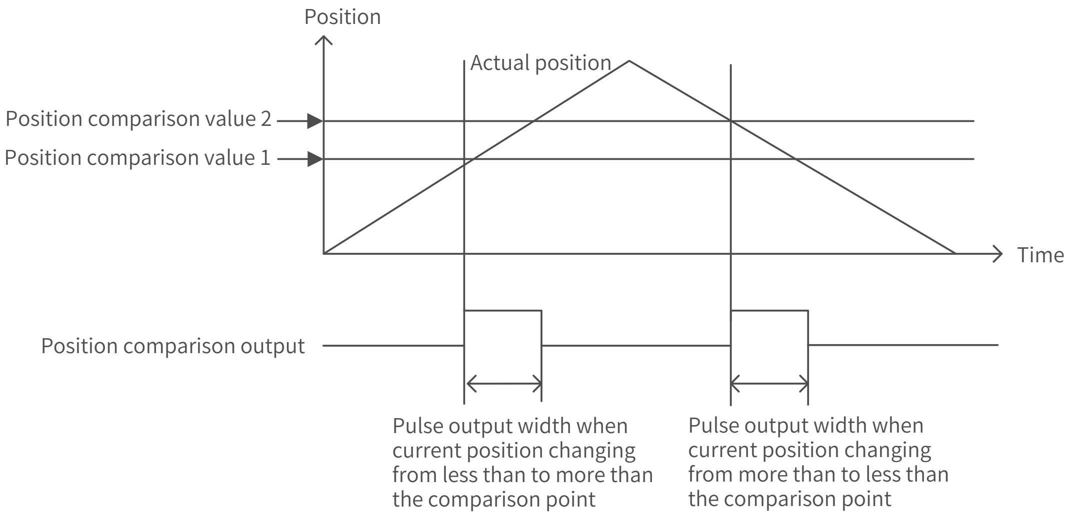
The end point indicates the position of the last comparison point. For example, if the end point is set to 7, the comparison stops or restarts from the start point after position comparison 7 is reached.

■ 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.

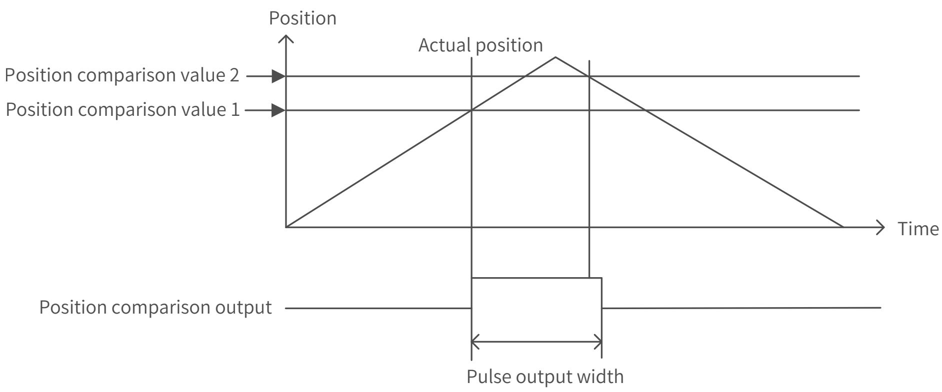


When the attribute of the comparison point is set to 1 (Output DO active signal if current position changes from "less than" to "more than" the comparison point), the DO outputs the position comparison signal when the axis position changes from "less than" to "more than" the comparison point position.

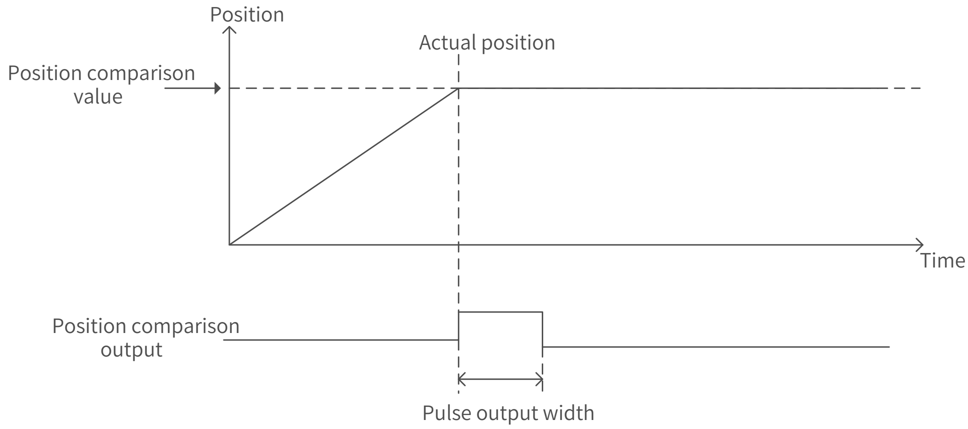
When the attribute of the comparison point is set to 2 (Output DO active signal if current position changing from "more than" to "less than" the comparison point), the DO outputs the position comparison signal when the axis position changes from "more than" to "less than" the comparison point position.

When the attribute of the comparison point is set to 3 (Output DO active signal under both situations), the DO outputs the position comparison signal when the axis position passes the comparison point position in either direction.

- When the direction of rotation 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 comparison 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 comparison points.



- Only one pulse will be output when the stop position is the same with the target value of position comparison, as shown in the following figure.



3) Interface of the software tool

For the convenience of setting the target value of position comparison, 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 the division setting, the target value of position comparison 1 is updated to "Distance x 1/Number of comparison points", the target value of position comparison 2 is updated to "Distance x 2/Number of comparison points", and the target value of position comparison N is updated to "Distance x N/Number of comparison points".
- In the cyclic comparison mode, the distance length setting is used to set the operating distance between two adjacent points; the comparison points setting is used to set the numbers of points to be compared cyclically. After clicking the division setting, the target values of position comparison 1 to N are updated to the values set in the distance length setting.

7.10.4 EtherCAT Forced DO Function

1 Function description

1. Two offline DO output options are available by default in the non-operational (non-OP) status (including network offline) for EtherCAT force DO output:

1) status unchanged upon offline: The servo status switches to the non-OP status and the forced DO status stays the same as the DO status before offline

2) initialization status: There is no forced DO output when the servo drive is in the non-OP status.

When the network switches to operational (OP), the forced DO is determined by 60FE-1 and 60FE-2.

2. Select forced DO function by bits.

You can assign EtherCAT forced DO function to the DO terminal by bits, which means both local functions and EtherCAT forced DO function are supported by DOs.

3. The value of H0D-17 is retentive upon power-off.

2 Setting method

1. Assign the DO to be controlled forcibly by EtherCAT with function 31 and set the bit of H04-23 as needed. This is for the convenience of selecting the forced DO status after offline.

2. Configure 60FE-1 and 60FE-2 as RPDOs and use bit16, bit17, and bit18 to control the DO.

3 Related parameter

H04-23	Name	EtherCAT forced DO offline output logic			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
2004-18h	Access	RW	Mapping	-	Related Mode	-	Data Range	0~7	Default	1

Setpoint	DO Function Name
0	Status of DO1 to DO3 unchanged in the non-OP status
1	No output in DO1 and status of others unchanged in the non-OP status
2	No output in DO2 and status of others unchanged in the non-OP status
3	No output in DO1 or DO2 and status of others unchanged in the non-OP status
4	No output in DO3, status of others unchanged in the non-OP status
5	No output in DO1 or DO3, status of others unchanged in the non-OP status
6	No output in DO2 or DO3 and status of others unchanged in the non-OP status
7	No output in DO1, DO2, or DO3.

7.11 Absolute Encoder System

For the wiring and battery installation of the absolute encoder, see *"3.4 Connecting the Servo Drive and Servo Motor Encoder Cables"*.

7.11.1 Descriptions for Use of the Absolute Encoder 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}) pulses, the encoder can record 16-bit multi-turn data. The absolute encoder 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, avoiding 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 encoder system selection) based on actual conditions. Er.731 will be reported when the battery is connected for the first time. In this case, set 200D-15h (Absolute encoder reset selection) to 1 (Reset the encoder fault) to reset the fault, and then perform the homing operation.

NOTE

If the value of 2002-03h (Direction of rotation), 200D-15h (Absolute encoder reset selection) or the mechanical gear ratio is changed, the mechanical position will change abruptly. In this case, perform the homing operation. After homing is done, the servo drive calculates the difference between the absolute mechanical position and the absolute position fed back by the encoder, and saves the difference into the EEPROM.

■ Related objects

■ Absolute encoder system setting

Set 2000-01h (Motor code) to 14101 (Inovance 23-bit absolute encoder), and select the absolute position mode through 2002-02h (Absolute encoder 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 serial-type incremental encoder without power-off memory.	No battery needed, no battery fault or multi-turn fault
1	Absolute position linear mode	The encoder is used as an absolute encoder with power-off memory. This mode applies to applications with a fixed axis movement range and free from multi-turn data overflow. The multi-turn data range in the absolute position linear mode is –32768 to +32767.	Battery needed, indications of battery fault, multi-turn counting error and overflow fault available
2	Absolute position rotation mode	The encoder is used as an absolute encoder with power-off memory. This mode applies to the applications where the load movement range is unlimited and only single-turn position feedback is needed.	Battery needed, indication of battery fault available, indication of multi-turn overflow fault not available
3	Absolute position linear mode 2	The encoder is used as an absolute encoder with power-off memory. This mode applies to applications where the multi-turn data overflow fault can be left untreated.	Battery needed, indication of battery fault available, indication of multi-turn overflow fault not available
4	Single-turn absolute mode	In this mode, only the single-turn position is recorded.	No battery needed, no battery fault or multi-turn fault

■ Encoder feedback data

The feedback data of an absolute encoder is divided into the number of revolutions and the position within one turn. For the incremental position mode, there is no feedback data concerning the number of revolutions.

H0B-70	Name	Number of revolutions of the absolute encoder			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
200B-47h	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	-

Represents the number of revolutions of the absolute encoder.

H0B-71	Name	Single-turn position feedback of the absolute encoder			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
200B-48h	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (encoder unit)	Default	-

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).

H0B-77	Name	Absolute position (low 32 bits) of absolute encoder			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
200B-4Eh	Access	RO	Mapping	TPDO	Related Mode	All		- (encoder unit)	Default	-
H0B-79	Name	Absolute position (high 32 bits) of absolute encoder			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
200B-50h	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (encoder unit)	Default	-
Represents the absolute position feedback of the encoder.										

7.11.2 Absolute Position Linear Mode

This mode applies to applications where the axis movement range is fixed and multi-turn data overflow will not occur.

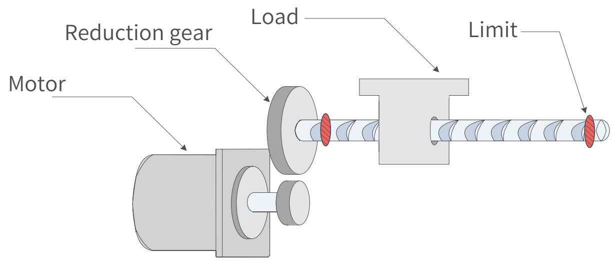


Figure 7-86 Application of the linear mode

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 (in 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 $+(2^{31}-1)$ (in encoder unit)	Default	0
These parameters define the offset of the absolute mechanical position (in encoder unit) relative to the absolute position (in 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	-2^{31} to $+2^{31}$ (reference unit)	Default	0
Represents the current mechanical absolute position (in reference units).										

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	- (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	(encoder unit)	Default	-
Represents the current mechanical absolute position (in encoder units).										

Index 6063h	Name	Position actual value*			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (encoder unit)	Default	0
Represents the absolute position of the motor (in 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	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (reference 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, as shown in the figure below. The number of motor revolutions in one direction is less than 32767 in case of power failure.

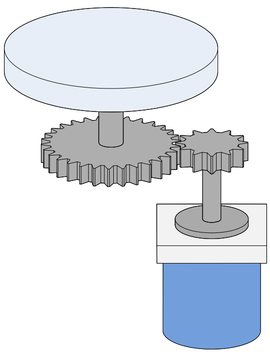
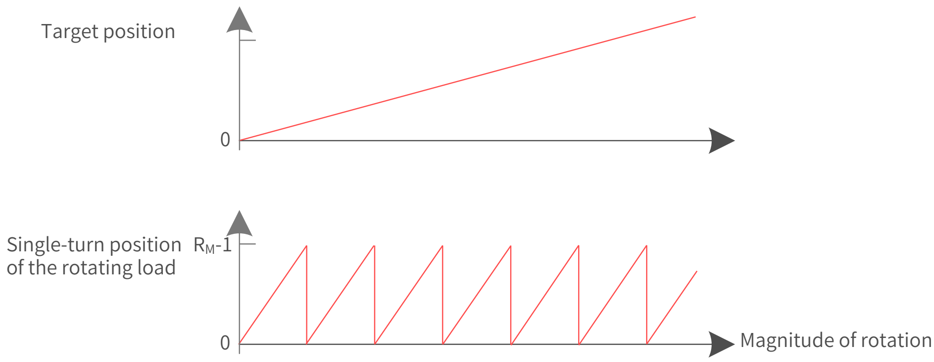
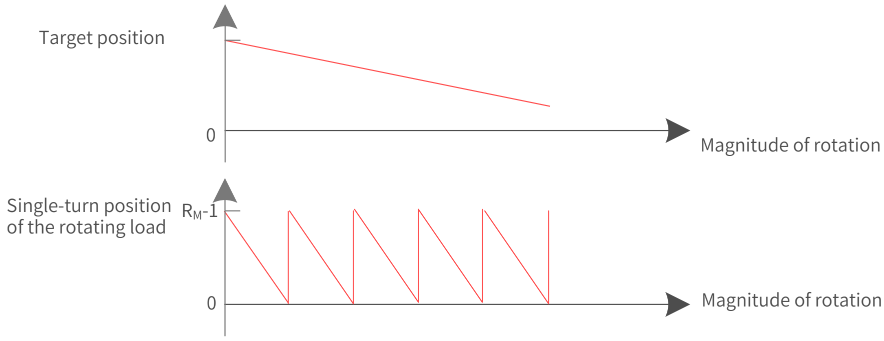


Figure 7-87 Rotating load

The single-turn position range of the rotating load is 0 to (R_M–1) (R_M: encoder pulses per revolution of the rotating load). 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 and the servo drive operates 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 automatically disabled.

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 revolution of the load axis 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	Pulses per revolution of the load axis 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 (in encoder unit)	Default	0

These parameters define the ratio of the feedback pulses (in encoder unit) per revolution of the load axis 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 is set to 0:
R_M = R_E x 2005-33h/2005-34h
when 2005-35h or 2005-37h takes a value different other than 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 axis (low 32 bits)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	(encoder unit)	Default	-
200B-54h	Name	Single-turn position of the rotating load axis (high 32 bits)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (encoder unit)	Default	-
Represents the single-turn position (encoder unit) of the rotating load axis. Value range: $(-R_M + 1)$ to $(R_M - 1)$										

200B-56h	Name	Single-turn position of the rotating load axis			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (reference unit)	Default	-
Represents the single-turn position of the rotating load axis (reference unit).										

Index 6063h	Name	Position actual value*			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (encoder unit)	Default	0
Represents the absolute single-turn position of the rotating load axis (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	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (reference unit)	Default	0
Represents the single-turn absolute position feedback of the rotating load axis 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 applies to applications where the load axis 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:

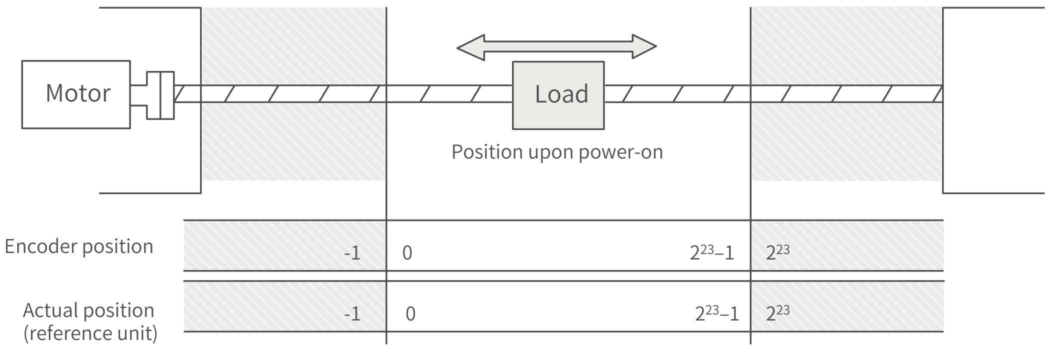
When 607Ch (Home offset) is set to 0, the target position range is 0 to (2^{23}–1).

After homing is done, the target position range is 607Ch to (2^{23}–1 + 607Ch).

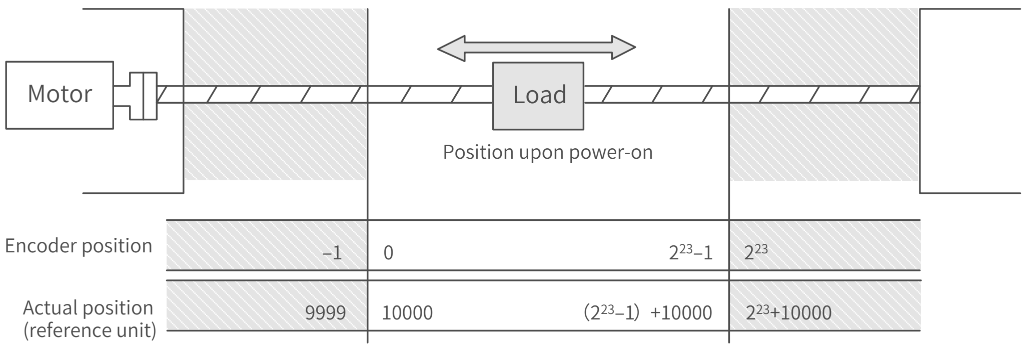
If the target position is set to a value outside the preceding range, EB01.4 (Target position beyond upper/lower limit) will be reported.

2) Example

When the gear ratio is 1:1 and 607Ch is set to 0, the position range is as shown in the following diagram.



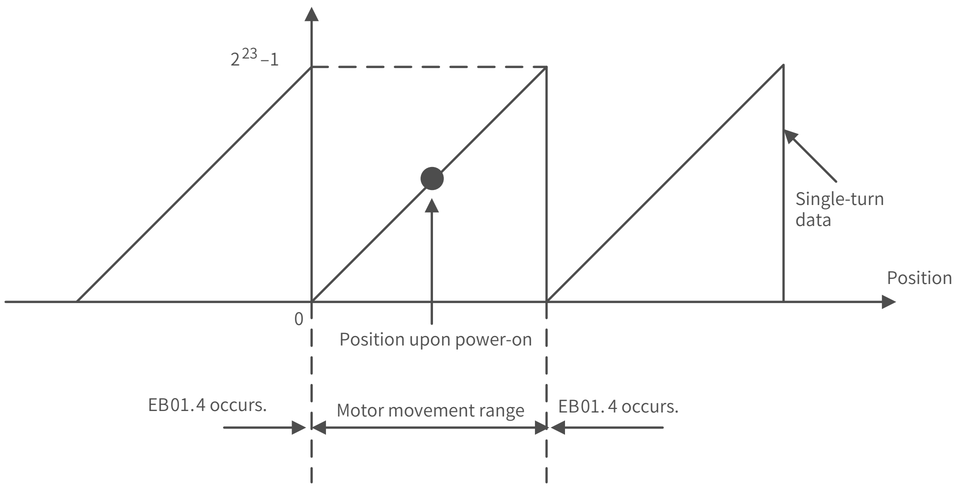
When the gear ratio is 1:1, and 607Ch is set to 10000, the position range is as shown in the following diagram.



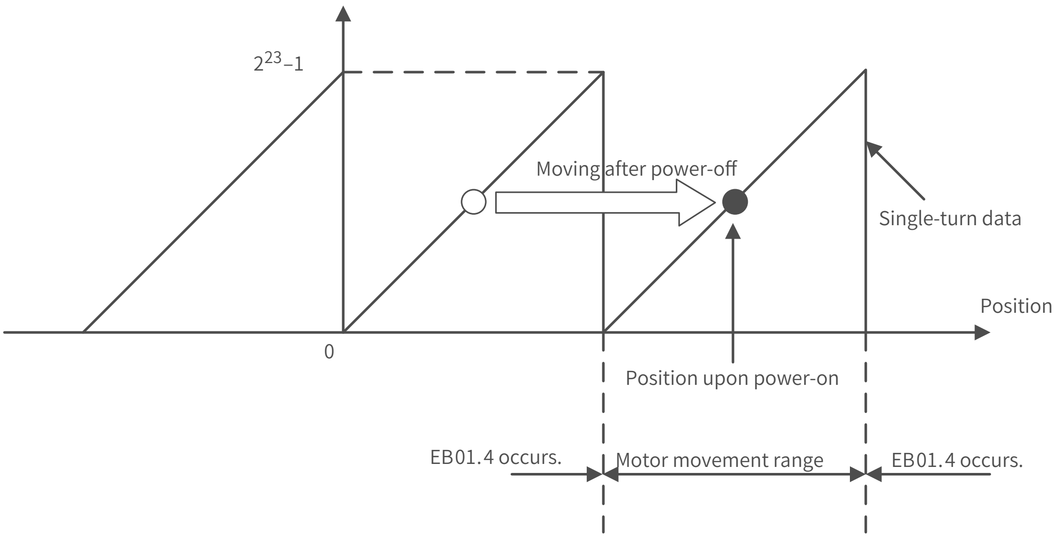
3) Precaution for the motor position upon power-on

The motor movement range is determined by the motor position upon power-on (take the 23-bit absolute encoder as an example).

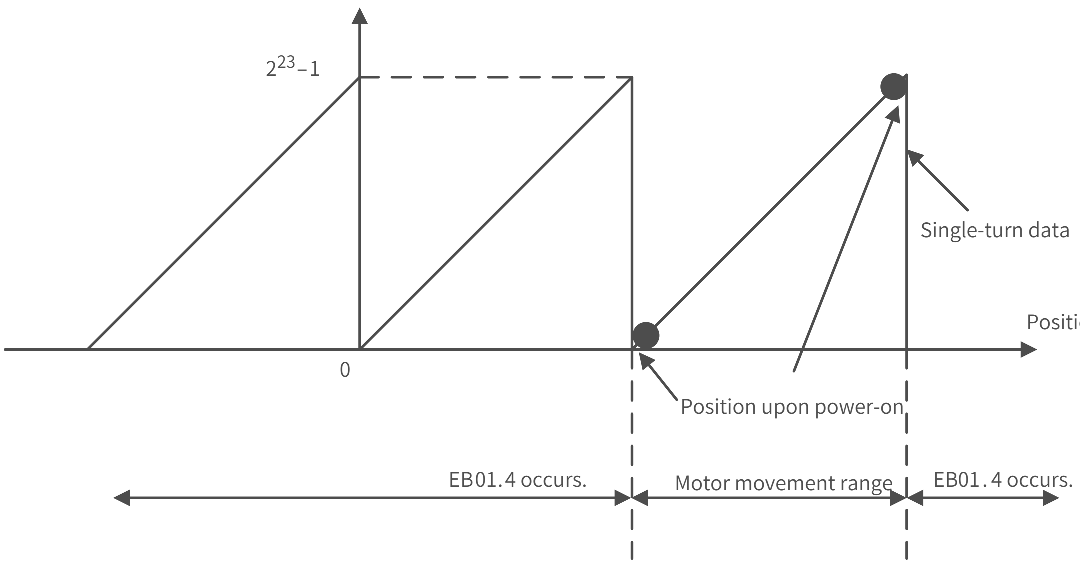
a) Position upon power-on: The motor movement range shown in the following figure is derived from the single-turn data range at the power-on position.



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 moving the motor to the position shown in the following figure.



c) Note: When the power supply is switched on near the motor movement range limits, 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 steps:

Step 1: Power on the servo drive and make it stay in the non-operating state.
Step 2: Replace the battery.
Step 3: After E730.0 (Encoder battery warning) is cleared automatically, if no other warning/fault occurs, you can continue operating the servo drive.

If you replace the battery after power-off, E731.0 (Encoder battery fault) will be reported and the multi-turn data changes abruptly. 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

<table>
<tr><td rowspan="2">200D-15h</td><td>Name</td><td colspan="3">Absolute encoder reset selection</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 2</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines whether to reset the encoder fault and the multi-turn data.</td></tr>
</table>

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 multi-turn data reset. In this case, perform mechanical homing.

8 Parameters

8.1 Object Classification

The object dictionary is the most important part in device specifications. It is an ordered set of parameters and variables and includes all parameters of device descriptions and device network status. A group of objects can be accessed in an ordered and pre-defined way through the network.

The CANopen protocol adopts an object dictionary with 16-bit indexes and 8-bit sub-indexes. The structure of the object dictionary is shown in the following table.

Table 8-1 Structure of the object dictionary

Index	Device
000	Not used
0001h–001Fh	Static data type (standard data type, such as Boolean and Integer16)
0020h–003Fh	Complex data type (predefined structure consisting of simple types, such as PDOCommPar and SDOParmeter)
0040h–005Fh	Complex data type specified by the manufacturer
0060h–007Fh	Static data type specified by the device profile
0080h–009Fh	Complex data type specified by the device profile
00A0h–0FFFh	Reserved
1000h–1FFFh	Communication profile area (such as the device type, error register, and number of supported PDOs)
2000h–5FFFh	Manufacturer-specific profile area (such as parameter mapping)
6000h–9FFFh	Standard device profile area (for example, CiA-402 protocol)
A000h–FFFFh	Reserved

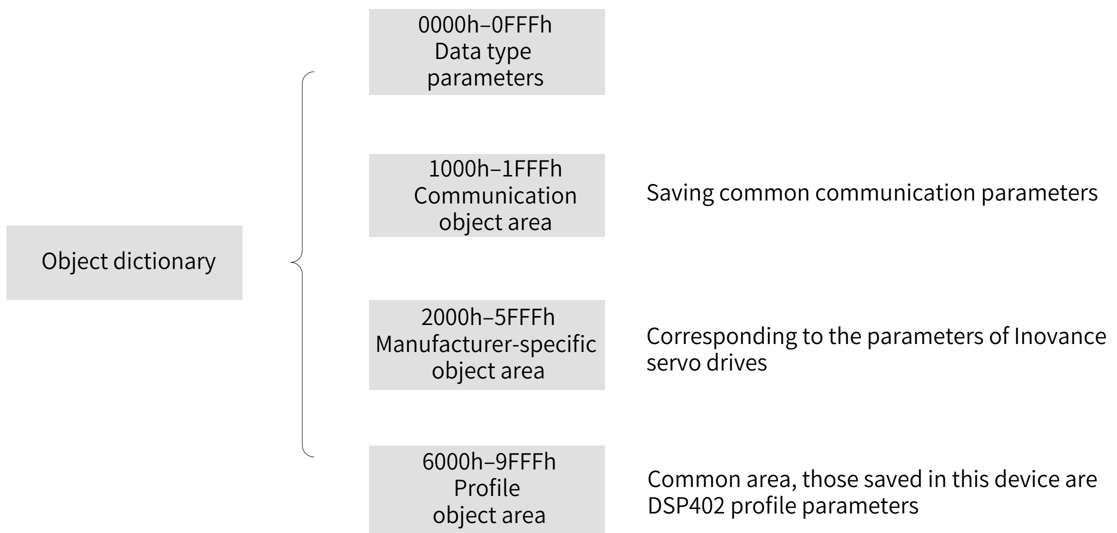


Figure 8-1 Structure of CANopen object dictionary

Objects in the SV660N series servo drive contain the following attributes.

- Index
- Sub-index
- Data Structure
- Data Type
- Access
- Mapping
- Setting Condition & Effective Time
- Related Mode
- Data Range
- Default

★ Definitions of terms

Position of the object dictionary in the parameter list is specified by the "Index" and "Sub-index".

- "Index": This field (in hexadecimal) specifies the position of the same type of objects in the object dictionary.
- "Sub-index": This field specifies the offset of each object under the same index.

The mapping relation between the parameter and the object dictionary is as follows:

- Object dictionary index = 0x2000 + Parameter group number
- Object dictionary sub-index = Hexadecimal offset within the parameter group + 1

For example, parameter H02-10 maps object 2002-0Bh in the dictionary.

Each object in the object dictionary is described based on types. For example, object 607Dh for software position limit describes the maximum and minimum position limits respectively, as shown in the following table.

Index	Sub-index	Name	Meaning
607Dh	00h	Number of elements	Defines the number of the object data (exclusive of the sub-index 00h).
607Dh	01h	Min. position limit	Defines the minimum position limit (absolute position mode).
607Dh	02h	Max. position limit	Defines the maximum position limit (absolute position mode).

"Data Structure": See Table 8-1 for details.

Table 8-2 Object Classification

Type	Meaning	DS301 Value
VAR	Single simple value, including data types Int8, Uint16, and String	7
ARR	Data block of the same type	8
REC	Data block of different types	9

"Data type": See the following table for details.

Table 8-3 Description of data types

Data Type	Value Range	Data Length	DS301 Value
Int8	-128 to +127	1 byte	0002
Int16	-32768 to +32767	2 bytes	0003
Int32	-2147483648 to +2147483647	4 bytes	0004
Uint8	0 to 255	1 byte	0005
Uint16	0 to 65535	2 bytes	0006
Uint32	0 to 4294967295	4 bytes	0007
String	ASCII	-	0009

"Access": See Table 8-4 for details.

Table 8-4 Access

Access	Description
RW	Read/Write
WO	Write-only
RO	Read-only
CONST	Constant, read-only

"Mapping": See Table 8-5 for details.

Table 8-5 Description of "Mapping"

Mapping	Description
No	Not mapped in PDO
RPDO	RPDO
TPDO	TPDO

"Setting Condition & Effective Time": See Table 8-6 for details.

Table 8-6 Description of "Setting Condition & Effective Time"

Setting Condition	Description
At stop	The parameter can be edited when the servo drive is not in the operational state.
During running	The parameter can be edited when the servo drive is in any state.

Effective Time	Description
Immediately	Parameter editing takes effect immediately.
At stop	Parameter editing takes effect after the servo drive is not in the operational state.
Next power-on	Parameter editing takes effect after the servo drive is powered off and on again. Note: The servo drive reports Er.941 after such parameters are modified.

"Related Mode": See Table 8-7 for details.

Table 8-7 Description of "Related Mode"

Related Mode	Description
-	The parameter is not related to the control mode.
All	The parameter is related to all the control modes.
PP/PV/PT/HM/CSP/CSV/CST	The parameter is related to specific control modes.

"Data Range": This field specifies the upper and lower limits of parameters with WO or RW attribute.

If the value of a parameter modified through SDO exceeds the data range, the servo drive returns a SDO transmission abort code to deactivate the modification.

If the value of a parameter is modified through PDO, the servo drive does not detect whether the setpoint exceeds the data range.

"Default": This field specifies the default value of the parameter.

8.2 Communication Parameters (Group 1000h)

Index 1000h	Name	Device Type				Data Structure	VAR	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x00020192
Describes the CoE device profile type.										

Index 1008h	Name	Manufacturer device name					Data Structure	-	Data Type	-
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	SV660-ECAT
Describes the manufacturer device name.										

Index 1009h	Name	Manufacturer hardware version					Data Structure	-	Data Type	-
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	Dependent on the hardware version of the servo drive.
Describes the hardware version of the servo drive.										

Index 100Ah	Name	Manufacturer software version					Data Structure	-	Data Type	-
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	Dependent on the software version of the servo drive.
Describes the software version of the servo drive.										

Index 1018h	Name	Identity object					Data Structure	REC	Data Type	OD data type
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Describes the device information.										

Sub-index 00h	Name	Highest sub-index supported					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	4	Default	4

Sub-index 01h	Name	Vendor ID					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x00100000
Indicates the series number of the servo drive.										

Sub-index 02h	Name	Product code				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	786696
Indicates the internal code of the servo drive.										

Sub-index 03h	Name	Revision number				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	65537
Indicates the software upgrade record number of the servo drive.										

Index 1C00h	Name	Manufacturer software version				Data Structure	REC	Data Type	OD data type
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Describes the device information.										

Sub-index 00h	Name	Number of Sync Manager channels				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	4	Default	4

Sub-index 01h	Name	Communication type SM0				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x01
Communication type SM0: Mailbox receive (master to slave)										

Sub-index 02h	Name	Communication type SM1				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x02
Communication type SM1: Mailbox send (slave to master)										

Sub-index 03h	Name	Communication type SM2				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x03
Communication type SM2: Process data output (master to slave)										

Sub-index 04h	Name	Communication type SM3				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x04
Communication type SM3: Process data input (slave to master)										

Index 1600h	Name	1st receive PDO mapping (RPDO1)					Data Structure	REC	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines the mapping object of RPDO1.										

Sub-index 00h	Name	Number of mapped objects in RPDO1					Data Structure	-	Data Type	Uint8
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 10	Default	3

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60400010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607A0020

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B80010

Sub-index 04h to 0Ah	Name	4th to 10th mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	All	Data Range	0 to 4294967295	Default	-

Index 1701h	Name	258th receive PDO mapping (RPDO258)					Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Indicates the mapped object of RPDO258.										

Sub-index 00h	Name	Number of mapped objects in RPDO258					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	4

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60400010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607A0020

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B80010

Sub-index 04h	Name	4th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FE0120

Index 1702h	Name	259th receive PDO mapping (RPDO259)					Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Indicates the mapped object of RPDO259.										

Sub-index 00h	Name	Number of mapped objects in RPDO259					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	7

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60400010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607A0020

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FF0020

Sub-index 04h	Name	4th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	All	Data Range	0 to 4294967295	Default	60710010

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60600008

Sub-index 06h	Name	6th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B80010

Sub-index 07h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607F0020

Index 1703h	Name	260th receive PDO mapping (RPDO260)					Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Indicates the mapped object of RPDO260.										

Sub-index 00h	Name	Number of mapped objects in RPDO260					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	7

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60400010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607A0020

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FF0020

Sub-index 04h	Name	4th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60600008

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B80010

Sub-index 06h	Name	6th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60E00010

Sub-index 07h	Name	7th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60E10010

Index 1703h	Name	261st receive PDO mapping (RPDO261)				Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Indicates the mapped object of RPDO261.										

Sub-index 01h	Name	1st mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60400010

Sub-index 02h	Name	2nd mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607A0020

Sub-index 03h	Name	3rd mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FF0020

Sub-index 04h	Name	4th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60710010

Sub-index 05h	Name	5th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60600008

Sub-index 06h	Name	6th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B80010

Sub-index 07h	Name	7th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607F0020

Sub-index 08h	Name	8th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60E00010

Sub-index 09h	Name	9th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60E10010

Index 1705h	Name	262nd receive PDO mapping (RPDO262)				Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Indicates the mapped object of RPDO262.										

Sub-index 00h	Name	Number of mapped objects in RPDO262				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	8

Sub-index 01h	Name	1st mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60400010

Sub-index 02h	Name	2nd mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	607A0020

Sub-index 03h	Name	3rd mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FF0020

Sub-index 04h	Name	4th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60600008

Sub-index 05h	Name	5th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B80010

Sub-index 06h	Name	6th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60E00010

Sub-index 07h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60E10010

Sub-index 08h	Name	8th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B20010

Index 1A00h	Name	1st transmit PDO mapping (TPDO1)					Data Structure	Record	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Indicates the mapped object of TPDO1.										

Sub-index 00h	Name	Number of mapped objects in TPDO1					Data Structure	-	Data Type	Uint8
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 10	Default	7

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60410010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60640020

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B90010

Sub-index 04h	Name	4th mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BA0020

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BC0020

Sub-index 06h	Name	6th mapped object					Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	603F0010

Sub-index 07h	Name	7th mapped object				Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	60FD0020

Sub-index 08h	Name	8th mapped object				Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	-

Sub-index 09h	Name	9th mapped object				Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	-

Sub-index 09h	Name	10th mapped object				Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	-

Index 1B01h	Name	258th transmit PDO mapping (TPDO258)				Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode -	Data Range	OD Data Range	Default	OD Default Value
Defines the mapped object of TPDO258.									

Sub-index 00h	Name	Number of mapped objects in TPDO258				Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode -	Data Range	-	Default	8

Sub-index 01h	Name	1st mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	603F0010

Sub-index 02h	Name	2nd mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	60410010

Sub-index 03h	Name	3rd mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	60640020

Sub-index 04h	Name	4th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode -	Data Range	0 to 4294967295	Default	60770010

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60F40020

Sub-index 06h	Name	6th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B90010

Sub-index 07h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BA0020

Sub-index 08h	Name	8th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FD0020

Index 1B01h	Name	259th transmit PDO mapping (TPDO259)					Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines the mapped object of TPDO259.										

Sub-index 00h	Name	Number of mapped objects in TPDO259					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	9

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	603F0010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60410010

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60640020

Sub-index 04h	Name	4th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60770010

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60610008

Sub-index 06h	Name	6th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B90010

Sub-index 07h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BA0020

Sub-index 08h	Name	8th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BC0020

Sub-index 09h	Name	9th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FD0020

Index 1B03h	Name	260th transmit PDO mapping (TPDO260)					Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines the mapped object of TPDO260.										

Sub-index 00h	Name	Number of mapped objects in TPDO260					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	10

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	603F0010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60410010

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60640020

Sub-index 04h	Name	4th mapped object				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60770010

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60F40020

Sub-index 06h	Name	6th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60610008

Sub-index 07h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B90010

Sub-index 08h	Name	8th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BA0020

Sub-index 09h	Name	9th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BC0020

Sub-index 0Ah	Name	10th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60FD0020

Index 1B04h	Name	261st transmit PDO mapping (TPDO261)					Data Structure	REC	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines the mapped object of TPDO261.										

Sub-index 00h	Name	Number of mapped objects in TPDO261					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	10

Sub-index 01h	Name	1st mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	603F0010

Sub-index 02h	Name	2nd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60410010

Sub-index 03h	Name	3rd mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60640020

Sub-index 04h	Name	4th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60770010

Sub-index 05h	Name	5th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60610008

Sub-index 06h	Name	6th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60F40020

Sub-index 07h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60B90010

Sub-index 08h	Name	7th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BA0020

Sub-index 09h	Name	9th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	60BC0020

Sub-index 0Ah	Name	10th mapped object					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	0 to 4294967295	Default	606C0020

Index 1C12h	Name	Sync Manager 2_RPDO assignment					Data Structure	ARR	Data Type	Uint16
	Access	RW	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines the index of the RPDO object assigned to Sync Manager 2.										

Sub-index 00h	Name	Sync Manager 2_Number of assigned RPDOs				Data Structure	-	Data Type	Uint8
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 1	Default	1

Sub-index 01h	Name	Index of RPDO assignment				Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	-	Data Range	0 to 65535	Default	5889

Defines the index of assigned RPDO.

Observe the following procedure:

1. Perform configuration only when the EtherCAT state machine is in the pre-operational ("P" displayed on the keypad) state.

2. If the object assigned to RPDO is selected using twinCAT host controller software, 1C12h needs no setting. If other methods are used to select the object, configure PDOs based on the following steps:

Step 1: Write 0 to 1C12-00h.

Step 2: Write the pre-used RPDOx (1600/1701–1705) to 1C12-01h.

Step 3. If an index among 1701h...1705h is used as RPDO and the mapped object cannot be modified, jump to step 5. If 1600h is used as RPDO, write the value 0 to the sub-index 00h of RPDOx, and write mapped objects to 01h...0Ah. Then, go to step 4.

Step 4: After writing mapped objects in 1600h, write the number of mapped objects in 1600-00h.

Step 5. Write the value 1 to 1C12-00h.

Index 1C13h	Name	Sync Manager 2_TPDO assignment				Data Structure	ARR	Data Type	Uint16
	Access	RW	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value

Defines the index of the TPDO object assigned to Sync Manager 2.

Sub-index 00h	Name	Sync Manager 2_Number of assigned TPDOs				Data Structure	-	Data Type	Uint8
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 1	Default	1

Sub-index 01h	Name	Index of TPDO assignment				Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	-	Data Range	0 to 65535	Default	6913

Defines the index of assigned TPDO.

Observe the following procedure:

1. Perform configuration only when the EtherCAT state machine is in the pre-operational ("P" displayed on the keypad) state.

2. If the object assigned to TPDO is selected using twinCAT host controller software, 1C13h needs no setting. If other methods are used to select the object, configure PDOs based on the following steps:

Step 1: Write 0 to 1C13-00h.

Step 2. Write the pre-used TPDOx (1A00/1B01 to 1B04) to 1C13-01h.

Step 3. If an index among 1B01h...1B04h is used as TPDO and the mapped object cannot be modified, jump to step 5. If 1A00h is used as TPDO, write the value 0 to the sub-index 00h of 1A00h, and write mapped objects to 01h...0Ah. Then, go to step 4.

Step 4: After writing mapped objects in 1A00h, write the number of mapped objects in 1A00-00h.

Step 5. Write the value 1 to 1C13-00h.

Index 1C32h	Name	Sync Manager 2_Output parameters					Data Structure	REC	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Describes output parameters of SM2.										

Sub-index 00h	Name	Sync Manager 2_Number of synchronization parameters					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	32

Sub-index 01h	Name	Synchronization type					Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	2
"0x0002": Distributed clock synchronization mode 0 (DC SYNC mode 0).										

Sub-index 02h	Name	Cycle time (ns)					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0
Indicates the cycle of DC SYNC 0.										

Sub-index 04h	Name	Synchronization types supported					Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	4
Indicates the type of the distributed clock. 0x0004: Distributed clock synchronization mode 0 (DC SYNC mode 0)										

Sub-index 05h	Name	Minimum cycle time					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	125000
Indicates the minimum cycle time in nanoseconds supported by the slave. Note: The minimum cycle time supported by SV660N is 125000 ns. The network cannot enter the OP state if the actual cycle time is less than 125000 ns.										

Sub-index 06h	Name	Calculation and copy time (ns)					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	-
Indicates the time for the microprocessor to copy data from SYNC Manager to local in nanoseconds.										

Sub-index 09h	Name	Delay time (ns)					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	-

Sub-index 20h	Name	Sync error				Data Structure	-	Data Type	BOOL
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	-

Indicates whether there is a synchronization error.

True: synchronization active and synchronization error not exist

False: synchronization inactive and synchronization error occurred

Index 1C33h	Name	Sync Manager 2_Input parameters					Data Structure	REC	Data Type	OD data type
	Access	RO	Mapping	No	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value

Describes input parameters of SM2.

Sub-index 00h	Name	Sync Manager 2_Number of synchronization parameters					Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	32

Sub-index 01h	Name	Synchronization type					Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	2

"0x0002": Distributed clock synchronization mode 0 (DC SYNC mode 0).

Sub-index 02h	Name	Cycle time (ns)					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0

Indicates the synchronization cycle of DC SYNC 0.

Sub-index 04h	Name	Synchronization types supported					Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	4

Indicates the type of the distributed clock.

0x0004: Distributed clock synchronization mode 0 (DC SYNC mode 0)

Sub-index 05h	Name	Minimum cycle time					Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	125000

Indicates the minimum cycle time in nanoseconds supported by the slave.

Note: The minimum cycle time supported by SV660N is 125000 ns. The network cannot enter the OP state if the actual cycle time is less than 125000 ns.

Sub-index 06h	Name	Calculation and copy time (ns)				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	
Indicates the time for the microprocessor to copy data from SYNC Manager to local in nanoseconds.										

Sub-index 09h	Name	Delay time (ns)				Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	

Sub-index 20h	Name	Sync error				Data Structure	-	Data Type	BOOL
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	
Indicates whether there is a synchronization error. True: synchronization active and synchronization error not exist False: synchronization inactive and synchronization error occurred										

8.3 Manufacturer-Specific Parameters (Group 2000h)

Group 2000h: Servo Motor Parameters

Index 2000h	Name	Servo motor parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines servo motor parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	6

Sub-index 1h	Name	Motor code			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	14101

Defines the code of the servo motor.

The SV660N series servo drive is intended to be used with MS1 series motors, which is fixed to "14XXX". For the model of the motor, see 2000-06h.

Setpoint	Motor code	Remarks
14000	Inovance motor equipped with a 20-bit encoder	-
14101	Inovance motor equipped with a 23-bit absolute encoder	For operating procedure of the absolute encoder, see *"7.11 Absolute Encoder System"*.

Setting the motor code to a wrong value will result in E120.1 (Unknown motor model).

Sub-index 03h	Name	Customized motor code			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0H

Displays customized software version in hexadecimal format (XXX.YY).

XXX: Fixed number of customized software

YY: Upgrade record number of customized software

Sub-index 05h	Name	Encoder version			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Displays the encoder software version in the form of 2XXX.Y, with one decimal place.

Sub-index 06h	Name	Serial-type motor code			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Displays the code of the serial-type motor, which is determined by the motor model and unmodifiable.

Group 2001h: Servo Drive parameters

Index 2001h	Name	Servo drive parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value

Defines parameters of the servo drive.

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	32

Sub-index 01h	Name	MCU software version			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0
Displays the MCU software version in the form of XXXX.Y, with one decimal place.										

Sub-index 02h	Name	FPGA software version			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0
Displays the FPGA software version in the form of XXXX.Y, with one decimal place.										

Sub-index 0Bh	Name	Servo drive code			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Defines the code of the servo drive.

SV660N series servo drive codes are listed in the following table.

Setpoint	Servo drive code	Remarks
2	S1R6	Rated power of the servo drive: 0.2 kW; Power supply of the main circuit: Single-phase 220 V
3	S2R8	Rated power of the servo drive: 0.4 kW; Power supply of the main circuit: Single-phase 220 V
5	S5R5	Rated power of the servo drive: 0.75 kW; Power supply of the main circuit: Single-phase 220 V
6	S7R6	Rated power of the servo drive: 1.0 kW; Power supply of the main circuit: Single-phase/Three-phase 220 V [1]
7	S012	Rated power of the servo drive: 1.5 kW; Power supply of the main circuit: Single-phase/Three-phase 220 V [1]
10001	T3R5	Rated power of the servo drive: 1.0 kW; Power supply of the main circuit: three-phase 380 V
10002	T5R4	Rated power of the servo drive: 1.5 kW; Power supply of the main circuit: three-phase 380 V
10003	T8R4	Rated power of the servo drive: 2.0 kW; Power supply of the main circuit: three-phase 380 V
10004	T012	Rated power of the servo drive: 3.0 kW; Power supply of the main circuit: three-phase 380 V
10005	T017	Rated power of the servo drive: 5.0 kW; Power supply of the main circuit: three-phase 380 V
10006	T021	Rated power of the servo drive: 6.0 kW; Power supply of the main circuit: three-phase 380 V
10007	T026	Rated power of the servo drive: 7.5 kW; Power supply of the main circuit: three-phase 380 V

If the voltage input to the main circuit of the servo drive does not comply with the preceding specifications, E420.0 (Main circuit phase loss) will occur.

[1]: The main circuit of the servo drive supports single-phase 220 V power supplies without derating.

Group 2002h: Basic Control Parameters

Index 2002h	Name	Basic control parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines basic control parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	36

Sub-index 01h	Name	Control mode			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 9	Default	9: EtherCAT

Defines the control mode of the servo drive.

When the servo drive is in the EtherCAT bus control mode, bit9 of the status word 6041h is set to 1.

See *"7 Control Modes"* for the operation modes.

Sub-index 02h	Name	Absolute encoder system selection			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 4	Default	0

Defines the mode for using the absolute encoder system.

Value	Absolute encoder system selection	Remarks
0	Incremental position mode	The encoder is used as a bus incremental encoder without power-off memory.
1	Absolute position linear mode	The encoder is used as an absolute encoder with power-off memory. This mode applies to applications where the load movement range is fixed and multi-turn data overflow will not occur.
2	Absolute position rotation mode	The encoder is used as an absolute encoder with power-off memory. This mode applies to applications where the load movement range is not limited and the number of single-direction revolutions is smaller than 32767.
3	Absolute position linear mode	Encoder overflow will not be detected in this mode.
4	Absolute position single-turn mode	-

Note:

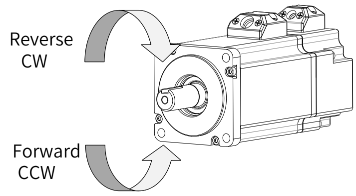
In the absolute position mode, the system automatically detects the motor code to check whether an absolute encoder is used. If not, E122.0 (Multi-turn absolute encoder setting error) will be reported.

See *"7.11 Absolute Encoder System"* for instructions for the absolute position mode.

Sub-index 03h	Name	Direction of rotation			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 1	Default	0

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

Setpoint	Direction of rotation	Remarks
0	CCW as forward direction	The motor rotates counterclockwise when viewed from the motor shaft side, which means the motor rotates counterclockwise upon a forward run command.
1	CW direction as forward direction	The motor rotates clockwise when viewed from the motor shaft side, which means the motor rotates clockwise upon a forward run command.



Sub-index 06h	Name	Stop mode at S-ON OFF			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	-3 to 1	Default	0

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status at S-OFF.

Value	Stop Mode
-3	Stop at zero speed, keeping dynamic braking status
-2	Ramp to stop as defined by 6084h/609Ah, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084h/609Ah, keeping de-energized status

Set a proper stop mode according to the mechanical condition and operating requirements.

For comparison of stop modes, see "5.6 Servo Stop".

After the brake output function is enabled, the stop mode at S-OFF is forcibly set to "Ramp to stop as defined by 6085h, keeping dynamic braking status".

<table>
<tr><td rowspan="2">Sub-index 07h</td><td>Name</td><td colspan="2">Stop mode at No. 2 fault</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Int16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>-5 to 3</td><td>Default</td><td>2</td></tr>
</table>

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status upon occurrence of a No. 2 fault.

After the brake output function is enabled, the stop mode at No. 2 fault is forcibly set to "Ramp to stop as defined by 6085h, keeping dynamic braking status".

Value	Stop Mode
-5	Stop at zero speed, keeping dynamic braking status
-4	Stop at emergency torque, keeping dynamic braking status
-3	Ramp to stop as defined by 6085h, keeping dynamic braking status
-2	Ramp to stop as defined by 6084h/609Ah, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084h/609Ah, keeping de-energized status
2	Ramp to stop as defined by 6085h, keeping de-energized status
3	Stop at emergency torque, keeping de-energized status

<table>
<tr><td rowspan="2">Sub-index 08h</td><td>Name</td><td colspan="2">Stop mode at overtravel</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 7</td><td>Default</td><td>1</td></tr>
</table>

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status upon overtravel.

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

When the servo motor drives a vertical axis, set 2002-08h to 1 or 4 to allow the motor shaft to stay in the locked position upon overtravel.

For comparison of stop modes, see *"5.6 Servo Stop"*.

After the brake output function is enabled, the stop mode at S-OFF is forcibly set to "Ramp to stop as defined by 6085h, keeping position lock status".

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

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status upon occurrence of a No. 1 fault.

Value	Stop Mode
0	Coast to stop, keeping de-energized state
1	Dynamic braking stop, keeping de-energized status
2	Dynamic braking stop, keeping dynamic braking status

For details on No. 1 faults, see *"10 Troubleshooting"*.

For comparison of stop modes, see *"5.6 Servo Stop"*.

After the brake output function is enabled, the stop mode at No. 1 fault is forcibly set to "Dynamic braking stop, keeping de-energized status".

Sub-index 0Ah	Name	Delay from brake output ON to command received			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 500 (ms)	Default	250

Defines the delay from the moment the brake output signal is 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.

See *"5.4.2 Brake Settings"* to check brake time sequence for motor at a standstill.

Sub-index 0Bh	Name	Delay from brake output off to motor de-energized in the standstill state			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	50 to 1000 (ms)	Default	150

Defines the delay from the moment the brake output signal is off to the moment when the motor at a standstill enters the de-energized status.

See *"5.4.2 Brake Settings"* to check brake time sequence for motor at a standstill.

Sub-index 0Ch	Name	Motor speed threshold at brake output OFF in the rotation state			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	20 to 3000 (RPM)	Default	30

Defines the motor speed threshold when the brake output (BK) is off in the rotational state.

See *"5.4.2 Brake Settings"* to check brake time sequence for motor in the rotational state.

Sub-index 0Dh	Name	Delay from S-OFF to brake output OFF in the rotational state			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	1 to 1000 (ms)	Default	500

Defines the delay from the moment the S-ON signal is off to the moment when brake output (BK) signal is off.

See *"5.4.2 Brake Settings"* to check brake time sequence for motor in the rotational state.

<table>
<tr><td rowspan="2">Sub-index 10h</td><td>Name</td><td colspan="3">Warning display on the keypad</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 1</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines whether to switch the keypad to the fault display mode when a No. 3 fault occurs.
For details on No. 3 Warnings, see "10 Troubleshooting".</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 16h</td><td>Name</td><td colspan="3">Minimum permissible resistance of regenerative resistor</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>1 to 1000</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">The minimum permissible resistance of the regenerative resistor is only related to the servo drive model.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 17h</td><td>Name</td><td colspan="3">Power of built-in regenerative resistor</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>1 to 65535</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">The power of the built-in regenerative resistor is only related to the servo drive model, which is unmodifiable.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 18h</td><td>Name</td><td colspan="3">Resistance of built-in regenerative resistor</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>1 to 1000</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">The resistance of built-in regenerative resistor is only related to the servo drive model, which is unmodifiable.
The built-in regenerative resistor comes into rescue when the maximum braking energy calculated is larger than the maximum braking energy that can be absorbed by the capacitor.
When using the built-in regenerative resistor, connect a jumper bar between terminals P and D.
When 2001-0Bh (Servo drive code) is set to 2 or 3, the built-in regenerative resistor is not available.</td></tr>
</table>

<table>
<tr><th colspan="2" rowspan="2">Servo Drive Model</th><th colspan="2">Specifications of Built-in Regenerative Resistor</th></tr>
<tr><th>Resistance (Ω)</th><th>Power (W)</th></tr>
<tr><td rowspan="3">Single-phase 220 V</td><td>SV660NS1R6I</td><td>-</td><td>-</td></tr>
<tr><td>SV660NS2R8I</td><td>-</td><td>-</td></tr>
<tr><td>SV660NS5R5I</td><td>50</td><td>50</td></tr>
<tr><td rowspan="2">Three-Phase 220 V</td><td>SV660NS7R6I</td><td rowspan="2">25</td><td rowspan="2">80</td></tr>
<tr><td>SV660NS012I</td></tr>
<tr><td rowspan="7">Three-Phase 380 V</td><td>SV660NT3R5I</td><td>100</td><td>80</td></tr>
<tr><td>SV660NT5R4I</td><td>100</td><td>80</td></tr>
<tr><td>SV660NT8R4I</td><td rowspan="2">50</td><td rowspan="2">80</td></tr>
<tr><td>SV660NT012I</td></tr>
<tr><td>SV660NT017I</td><td rowspan="3">35</td><td rowspan="3">100</td></tr>
<tr><td>SV660NT021I</td></tr>
<tr><td>SV660NT026I</td></tr>
</table>

Sub-index 19h	Name	Resistor heat dissipation coefficient			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	10 to 100 (%)	Default	30

Defines the heat dissipation coefficient of the regenerative resistor, which is applicable to external and internal regenerative resistors.

Set the heat dissipation coefficient based on actual cooling conditions of the resistor.

Recommendations:

Set 2002-19h to a value lower than or equal to 30% in case of natural ventilation.

Set 2002-19h to a value lower than or equal to 50% in case of forced-air cooling.

Sub-index 1Ah	Name	Regenerative resistor setting			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 3	Default	0

Defines the regenerative resistor type and the mode of absorbing and releasing the braking energy.

See "5.4.3 Regenerative Resistor Settings" to select a proper regenerative resistor.

Sub-index 1Bh	Name	Power of external regenerative resistor			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	1 to 65535 (Unit: W)	Default	40

Defines the power of the external regenerative resistor.

Note: The value of 2002-1Bh cannot be lower than the calculated braking power.

Sub-index 1Ch	Name	Resistance of and external-in regenerative resistor			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	15 to 1000 (Ω)	Default	50

Defines the resistance of the external regenerative resistor.

An external regenerative resistor is needed when the calculated maximum braking energy is larger than the maximum braking energy that can be absorbed by the capacitor, and the calculated braking power is larger than the power of the built-in regenerative resistor.

- ◆ A too large setpoint may incur E400.0 (Main circuit overvoltage) when the bus energy cannot be absorbed immediately.
- ◆ A setpoint lower than 2002-16h (Minimum permissible resistance of regenerative resistor) leads to E922.0 (Resistance of external regenerative resistor too small), which may finally result in E201.4 (Phase-N overcurrent) is no action is taken.

Either use an external regenerative resistor or a built-in one, never the both. To use an external regenerative resistor, remove the jumper bar between terminals P and D first and connect the resistor between terminals P and C.

Sub-index 20h	Name	System parameter initialization			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 2	Default	0

Used to restore default values or clear fault records.

Setpoint	Description	Remarks
0	No operation	-
1	Restore default setting	Restore default values except parameters in groups 2000h and 2001h.
2	Clear fault records	Clear the latest 10 faults and warnings.

If necessary, use Inovance software tool to back up parameters except those in groups 2000h and 2001h.

Sub-index 21h	Name	Default keypad display			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 99	Default	50
The keypad can switch to the monitored parameter display mode (group 200Bh) based on settings. 2002-21h is used to set the offset of the parameter within group 200Bh. If a parameter that does not exist in group 200Bh is set, the keypad does not switch to the monitored parameter display mode.										

Sub-index 24h	Name	Keypad data refresh frequency			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 20	Default	0

Group 2003h: Terminal Input Parameters

Index 2003h	Name	Terminal input parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Used to set terminal input parameters										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	65

<table>
<tr><td rowspan="2">Sub-index 03h</td><td>Name</td><td colspan="3">DI1 function</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 40</td><td>Default</td><td>14</td></tr>
</table>

Defines the function of DI1.

See the following table for descriptions of setpoints.

Value	DI Function
0	No function assigned
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

Note:

- Set 2003-03h to a value listed in the preceding table. If 2003-03h is set to another value, E122.1 will occur.
- Do not assign the same function to different DIs. Otherwise, E122.1 will occur.
- After assigning a certain function to a DI and activate the logic of this DI, this function will remain active even if you cancel the function assignment.
- DI1 to DI4 are normal DIs, requiring the input signal width to be higher than 1 ms.
- DI5 is a high-speed DI, requiring the input signal width to be higher than 0.25 ms.
- When the touch probe function is enabled, DI5 and DI4 are assigned with touch probe 1 and touch probe 2 respectively by default.

<table>
<tr><td rowspan="2">Sub-index 04h</td><td>Name</td><td colspan="3">DI1 logic</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 1</td><td>Default</td><td>0</td></tr>
</table>

Used to set the level logic of DI1 when the function assigned to DI1 is active.

DI1 to DI4 are normal DIs, requiring the input signal width to be higher than 1 ms. Set the level logic based on the host controller and peripheral circuits. See the following table for the input signal width.

Setpoint	DI Logic Upon Active DI Function	Remarks
0	Low level	Low level must remain active for more than 1 ms.
1	High level	High level must remain active for more than 1 ms.

<table>
<tr><td rowspan="2">Sub-index 05h</td><td>Name</td><td colspan="3">DI2 function</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 40</td><td>Default</td><td>15</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 06h</td><td>Name</td><td colspan="3">DI2 logic</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 1</td><td>Default</td><td>0</td></tr>
</table>

Sub-index 07h	Name	DI3 function			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 40	Default	31

Sub-index 08h	Name	DI3 logic			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 09h	Name	DI4 function			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 40	Default	39

Sub-index 0Ah	Name	DI4 logic			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 0Bh	Name	DI5 function			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 39	Default	38

Sub-index 0Ch	Name	DI5 logic			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 3Dh	Name	DI1 filter time			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 50000	Default	50

Sub-index 3Eh	Name	DI2 filter time			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 50000	Default	50

Sub-index 3Fh	Name	DI3 filter time			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 50000	Default	50

Sub-index 40h	Name	DI4 filter time			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 50000	Default	50

Sub-index 41h	Name	DI5 filter time			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 50000	Default	50

Group 2004h: Terminal Output Terminals

Index 2004h	Name	Terminal output parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Used to set terminal output parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	6

Sub-index 01h	Name	DO1 function			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 32	Default	1

Defines the function of DO1.

See the following table for descriptions of setpoints.

Set 2004-01h to a value listed in the preceding table.

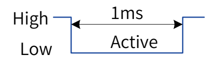
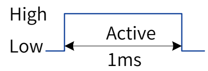
Different VDOs can be assigned with the same function.

Value	Function
0	No function assigned
1	Servo ready
2	Motor rotating
9	Brake
10	Warning
11	Fault
25	Comparison output
31	Forced EtherCAT output
32	EDM safety state output

Sub-index 02h	Name	DO1 logic			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Defines the level logic of DO1 when the function assigned to DO1 is active.

DO1 to DO3 are normal DOs, requiring the minimum output signal width to be 1 ms. The host controller must be able to receive valid DO logic changes.

Setpoint	DO1 Logic Upon Active DO Function	Transistor Status	Minimum Signal Width
0	Low level	ON	
1	High level	OFF	

Before receiving DO logic changes, check the setting of 200D-12h (Forced DI/DO selection) to confirm whether the DO level is determined by the actual operating status of the servo drive or by forced DO (200D-14h or 60FEh).

Sub-index 03h	Name	DO2 function			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 32	Default	11

Sub-index 04h	Name	DO2 logic			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 05h	Name	DO3 function			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 32	Default	9

Sub-index 06h	Name	DO3 logic			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 18h	Name	EtherCAT forced DO output logic in non-OP status		Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 7	Default	1

See the following table for descriptions of setpoints.

Value	Function
0	Status of DO1 to DO3 unchanged in the non-OP status
1	No output in DO1 and status of others unchanged in the non-OP status
2	No output in DO2 and status of others unchanged in the non-OP status
3	No output in DO1 or DO2 and status of others unchanged in the non-OP status
4	No output in DO3, status of others unchanged in the non-OP status
5	No output in DO1 or DO3, status of others unchanged in the non-OP status
6	No output in DO2 or DO3 and status of others unchanged in the non-OP status
7	No output in DO1, DO2, or DO3.

Group 2005h: Position Control Parameters

Index 2005h	Name	Position control parameters		Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value

Used to set position control parameters.

Sub-index 00h	Name	Number of entries		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	55

Sub-index 05h	Name	First-order low-pass filter time constant		Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/HM/CSP	Data Range	0–65535 (unit: 0.1 ms)	Default	0

Sub-index 06h	Name	Moving average filter time constant 1		Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/HM/CSP	Data Range	0-10000 (unit: 0.1 ms)	Default	0

Sub-index 07h	Name	Moving average filter time constant 2			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/HM/CSP	Data Range	0-1280 (unit: 0.1 ms)	Default	0

Sub-index 08h	Name	Numerator of electronic gear ratio			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/HM/CSP/ CSV/PV	Data Range	0-4294967295	Default	1

Sub-index 0Ah	Name	Denominator of electronic gear ratio			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/HM/CSP/ CSV/PV	Data Range	0-4294967295	Default	1

Sub-index 14h	Name	Speed feedforward control			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/HM/CSP	Data Range	0 to 3	Default	1

Defines the source of the speed loop feedforward signal.

Speed feedforward can be applied to position control mode to improve the position reference responsiveness.

Setpoint	Speed feedforward source	Remarks
0	No speed feedforward	-
1	Internal speed feedforward	Use the speed information corresponding to the position reference (encoder unit) as the speed loop feedforward source.
2	60B1h used as speed offset	60B1h is used as the source of external speed offset signal in the CSP mode. The polarity of 60B1h is set in bit6 of 607Eh.
3	Zero phase control	Zero phase control can be used together with H08-17 (zero phase delay) to reduce the position follow-up deviation during startup.

Speed feedforward control parameters include 2008-13h (Speed feedforward filter time constant) and 2008-14h (Speed feedforward gain). See for parameter settings.

Sub-index 1Fh	Name	Local homing			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	Any	Data Range	0,6	Default	0

Used to execute local homing when the homing method in CiA402 profile cannot be called by the host controller through operating bit4 of the control word.

Note: Use this function in the S-OFF state only. Failure to comply may result in malfunction of the motor due to abrupt change in the position feedback. After homing is done successfully, the present position feedback will be cleared.

Sub-index 24h	Name	Homing time limit			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	HM	Data Range	0 to 65535 (unit: 0.1s)	Default	50000

Defines the maximum homing time.

Setting 2005-24h to a too small value or if the home is not found within the time defined by 2005-24h, E601.0 (Homing timeout) will occur.

Sub-index 25h	Name	Local home offset			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Int32
	Access	RW	Mapping	-	Related Mode	HM	Data Range	-1073741824 to +1073741824	Default	0

2005-25h is used together with 2005-1Fh. After homing is done, the present position feedback is the value of 2005-25h.

Sub-index 2Fh	Name	Position offset in absolute position linear mode (low 32 bits)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Int32
	Access	RW	Mapping	-	Related Mode	All	Data Range	-2^{31} to $+(2^{31} - 1)$ (encoder unit)	Default	0

Sub-index 31h	Name	Position offset in absolute position linear mode (high 32 bits)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Int32
	Access	RW	Mapping	-	Related Mode	All	Data Range	-2^{31} to $+(2^{31} - 1)$ (encoder unit)	Default	0

These two parameters define the offset of the mechanical absolute position (encoder unit) relative to the motor absolute position (encoder unit) when the absolute encoder system works in the linear mode (2002-02 = 1).

Position offset in the absolute position linear mode = Motor absolute position - Mechanical absolute position

Note:

Default values of these two parameters are 0 in the absolute position linear mode. After homing is done, the servo drive automatically calculates the deviation between the absolute position fed back by the encoder and the mechanical absolute position, assigns the deviation value to 2005-2Fh and 2005-31h, and saves the deviation in EEPROM.

Sub-index 33h	Name	Mechanical gear ratio (numerator) in the absolute position rotation mode			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	1 to 65535	Default	1

Sub-index 34h	Name	Mechanical gear ratio (denominator) in absolute position rotation mode			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	1 to 65535	Default	1

Defines the ratio of the feedback pulses (encoder unit) per load revolution to the absolute position feedback of the encoder when the absolute encoder system works in the rotation mode (2002-02 = 2).

Assume that the encoder resolution is R_E, the encoder pulses per load revolution is R_M, and 2005-35h and 2005-37h are 0, then the following formula applies:

$R_M = R_E$ x 2005-33h/2005-34h

Note:

The servo drive calculates the upper limit of 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.

Sub-index 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	Data Range	0 to (2^{32} - 1) (encoder unit)	Default	0

Sub-index 37h	Name	Pulses per load revolution in absolute position rotation mode (high 32 bits)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 127 (encoder unit)	Default	0

Defines the feedback pulses (encoder unit) per load revolution when the absolute encoder system works in the rotation mode (2002-02 = 2).

Assume the encoder pulses per load revolution is R_M and 2005-35h or 2005-37h is not 0, the following formula applies:

P_M = 2005-37h x 2^{32} + 2005-35h

Note: The servo drive calculates the upper limit of 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.

Group 2006h: Speed Control Parameters

Index 2006h	Name	Speed control parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value

Used to set speed control parameters

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	16

Sub-index 04h	Name	Speed reference			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Int16
	Access	RW	Mapping	-	Related Mode	Local speed mode	Data Range	-6000 to +6000 (RPM)	Default	200
2006-04h is valid in the local speed mode and invalid in the EtherCAT mode.										

Sub-index 06h	Name	Acceleration ramp time constant of speed reference			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	Local speed mode	Data Range	0 to 65535 (ms)	Default	0
2006-06h is valid in the local speed mode and invalid in the EtherCAT mode.										

Sub-index 07h	Name	Deceleration ramp time of speed reference			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	Local speed mode	Data Range	0 to 65535 (ms)	Default	0
2006-07h is valid in the local speed mode and invalid in the EtherCAT mode.										

Sub-index 09h	Name	Forward speed limit			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	Local speed mode	Data Range	0 to 6000 (RPM)	Default	6000
2006-09h is valid in the local speed mode and invalid in the EtherCAT mode.										

Sub-index 0Ah	Name	Reverse speed limit			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	Local speed mode	Data Range	0 to 6000 (RPM)	Default	6000
2006-0Ah is valid in the local speed mode and invalid in the EtherCAT mode.										

Sub-index 0Bh	Name	Quick stop deceleration coefficient			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	-	Data Range	0 to 2	Default	0

The default value is 0. When 6085h (Quick stop deceleration) is set to the maximum value but the ramp time still exceeds the expected value, enlarge the value of 6085h through 2006-0Bh, thus reducing the stop time.

Note: When the brake function is enabled and the stop mode at S-OFF is set to "Ramp to stop", the maximum time of ramp-to-stop is Min (H02-12, stop time defined by 6085h).

Value	Description
0	x 1
1	x 10
2	x 100

Sub-index 0Ch	Name	Torque feedforward control			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 2	Default	1

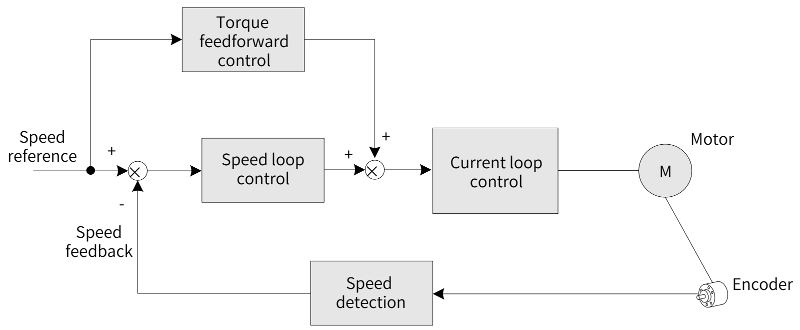
Defines whether to enable internal torque feedforward in the non-torque control mode.

Torque feedforward can be used to improve the torque reference responsiveness and reduce the position deviation during acceleration/deceleration at a constant speed.

Value	Torque feedforward control	Remarks
0	/	-
1	Internal torque feedforward	The torque feedforward signal source is the speed reference, which comes either from the output of the position controller in the position control mode or from the speed references set by the user in the speed control mode.
2	60B2h as external torque feedforward	60B2h is used as the external torque offset signal source in the CSP and CSV modes. The polarity of the torque feedforward signal is set in bit5 of 607Eh. Note: When 60B2h is used as the torque offset signal, you can adjust the operating effect of 60B2h through 2008-16h (Torque feedforward gain) and 2008-15h (Torque feedforward filter).

Parameters of the torque feedforward function include 2008-15h (Torque feedforward gain) and 2008-16h (Torque feedforward filter time constant). For details, see "6.5.4 Feedforward Gain".

In the non-torque control mode, the block diagram for torque feedforwad control is as follows:



Sub-index 0Dh	Name	Acceleration/Deceleration ramp time constant of jog speed reference			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	-	Data Range	0 to 65535 (ms)	Default	10

Defines the acceleration/deceleration time of jog speed references in the jog mode set through H0D-11 or the software tool.

Sub-index 0Eh	Name	Speed feedforward filter time constant			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	-	Data Range	0 to 2000 (us)	Default	0

Defines the speed feedforward filter time constant.

Group 2007h: Torque Control Parameters

<table>
<tr><td rowspan="2">Index 2007h</td><td>Name</td><td colspan="3">Torque control parameters</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>ARR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>-</td><td>Mapping</td><td>Yes</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>OD Data Range</td><td>Default</td><td>OD Default Value</td></tr>
<tr><td colspan="11">Used to set torque control parameters</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 00h</td><td>Name</td><td colspan="3">Number of entries</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>40</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 04h</td><td>Name</td><td colspan="3">Torque reference value set through keypad</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Int16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>Local torque mode</td><td>Data Range</td><td>-4000 to +4000 (unit: 0.1%)</td><td>Default</td><td>0</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 06h</td><td>Name</td><td colspan="3">Torque reference filter time constant 1</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 3000 (unit: 0.01 ms)</td><td>Default</td><td>79</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 07h</td><td>Name</td><td colspan="3">Torque reference filter time constant 2</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 3000 (unit: 0.01 ms)</td><td>Default</td><td>79</td></tr>
<tr><td colspan="11">Defines the torque reference filter time constant.
Low-pass filtering of torque references helps smooth torque references and reduce vibration.
A large setpoint delays the responsiveness, so pay attention to the responsiveness during setting the filter time constant.
Note:
The servo drive offers two low-pass filters, in which the low-pass filter 1 is used by default.
The gain switchover function can be used In the position or speed control mode. Once certain conditions are satisfied, you can switch to low-pass filter 2. For details on gain switchover, see "6.5.2 Gain Switchover".</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 0Ah</td><td>Name</td><td colspan="3">Positive internal torque limit</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>Local torque mode</td><td>Data Range</td><td>0 to 4000 (unit: 0.1%)</td><td>Default</td><td>3500</td></tr>
</table>

Sub-index 0Bh	Name	Negative internal torque limit			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	Local torque mode	Data Range	0 to 4000 (unit: 0.1%)	Default	3500

Note:
1: 2007-0Ah and 2007-0Bh are valid only in the local torque mode (H02-00 = 2). For torque limit in the EtherCAT mode, use 60E0/60E1/6072. Use the torque limit with caution as a too small limit value will cause insufficient motor torque output.

2. If the setpoint exceeds the maximum torque of the servo drive and servo motor, the actual torque will be limited to a value within the maximum torque of the servo drive and servo motor.

Sub-index 10h	Name	Emergency stop torque			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 4000 (unit: 0.1%)	Default	1000

Sub-index 14h	Name	Positive internal speed limit in torque control			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	Local torque mode	Data Range	0 to 6000 (RPM)	Default	3000

Sub-index 15h	Name	Negative internal torque limit in torque control			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	Local torque mode	Data Range	0 to 6000 (RPM)	Default	3000

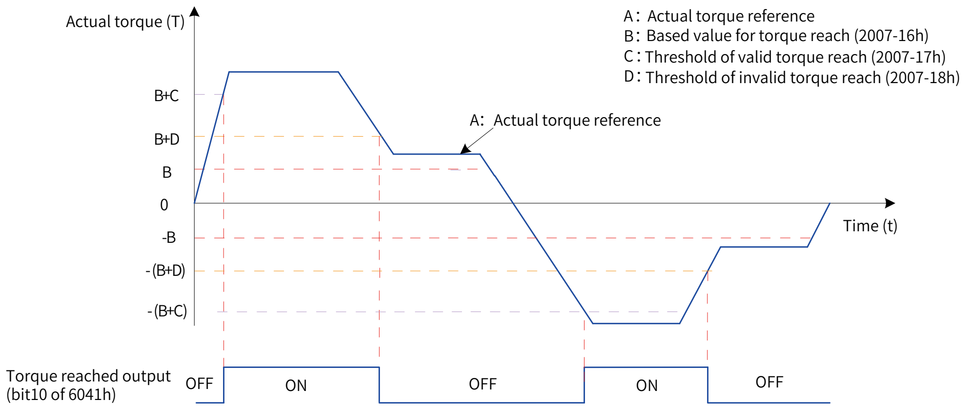
2007-14h and 2007-15h are valid in the local torque mode only (H02-00 = 2). Use 607F for speed limit in the EtherCAT mode, CST mode and PT mode.

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	Data Range	0 to 4000 (unit: 0.1%)	Default	0

Sub-index 17h	Name	Threshold for valid torque reach			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Data Range	0 to 4000 (unit: 0.1%)	Default	200

Sub-index 18h	Name	Threshold for invalid torque reach			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Data Range	0 to 4000 (unit: 0.1%)	Default	100

The torque reach function is used to judge whether the actual torque reference reaches the range of valid torque reach. If yes, the servo drive outputs the corresponding flag (bit10 of status word) to the host controller.



Actual torque reference (viewed in 200B-03h): A

Base value for torque reach (2007-16h): B

Threshold of valid torque reach (2007-17h): C

Threshold of invalid torque reach (2007-18h): D

C and D are the offset based on B.

The torque reached signal is activated only when the actual torque reference meets the following condition:

$|A| \geq B + C$

The torque reach signal is deactivated only when the actual torque reference meets the following condition:

$|A| < B + D$

Sub-index 19h	Name	Field-weakening depth			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	60 to 115 (unit: 100%)	Default	115

This parameter needs no setting generally. Reducing the field-weakening depth increases the dynamic performance of the field-weakening area and reduces the current ripple, but it also leads to rise of the load rate.

Sub-index 1Ah	Name	Max. permissible demagnetizing current			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	1 to 100 (unit: 100%)	Default	100

This parameter needs no setting generally. Increasing the demagnetizing current extends the motor speed range, but it also poses a greater challenge on the bearing capacity of the motor. If you need to increase the setpoint of 2007-1Ah, contact Inovance first.

Sub-index 1Bh	Name	Field-weakening selection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0
0: Disable; 1: Enable										

Sub-index 1Ch	Name	Field-weakening gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	1 to 1000	Default	30

Sub-index 25h	Name	Time constant of low-pass filter 2			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0–1000 (unit: 0.01 ms)	Default	0

Sub-index 26h	Name	Torque reference filter selection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0
0: First-order filter 1: Biquad filter										

Sub-index 27h	Name	Biquad filter attenuation ratio			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 50	Default	16

Group 2008h: Gain Parameters

Index 2008h	Name	Gain parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Used to set gain parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	65

Sub-index 01h	Name	Speed loop gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	1 to 20000 (unit: 0.1 Hz)	Default	400

Defines the proportional gain of the speed loop.

2008-01h determines the responsiveness of the speed loop. The larger the setpoint, the quicker the responsiveness will be. Note that a too large setpoint may cause vibration.

If you increase the position loop gain in the position control mode, increase the speed loop gain as well.

Sub-index 02h	Name	Speed loop integral time constant			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	15 to 51200 (unit: 0.01 ms)	Default	1989

Defines the integral time constant of the speed loop.

The smaller the setpoint, the better the integral action, and the quicker will the deviation value be close to 0.

Note: There is no integral action when 2008-02h is set to 512.00.

Sub-index 03h	Name	Position loop gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/HM/CSP	Data Range	1 to 20000 (unit: 0.1 Hz)	Default	640

Defines the proportional gain of the position loop.

2008-03h determines the responsiveness of the position loop. A large setpoint shortens the positioning time. Note that a too large setpoint may cause vibration.

The first gain set include parameters 2008-01h, 2008-02h, 2008-03h, and 2007-07h.

Sub-index 04h	Name	2nd speed loop gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	1 to 20000 (unit: 0.1 Hz)	Default	750

Sub-index 05h	Name	2nd speed loop integral time constant			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	15 to 51200 (unit: 0.01 ms)	Default	1061

Sub-index 06h	Name	2nd position loop gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/HM/CSP	Data Range	1 to 20000 (unit: 0.1 Hz)	Default	1200

Defines the second gain of the position loop and speed loop. The second gain set include parameters 2008-04h, 2008-05h, 2008-06h and 2007-07h.

For details on gain switchover, see *"6.5.2 Gain Switchover"*.

Sub-index 09h	Name	2nd gain mode setting			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	0 to 1	Default	1

Defines the switchover mode of the 2nd gain set.

Setpoint	Mode
0	0: Fixed to the 1st gain set, switched between P and PI through bit26 of external 60FE (switched to P when bit26 of 60FE set to 1)
1	1: Switched between the 1st gain set (2008-01h to 2008-03h, 2007-06h) and the 2nd gain set (2008-04h to 2008-06h, 2007-07h) as defined by 2008-0Ah

Sub-index 0Ah	Name	Gain switchover condition			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	0 to 10	Default	0

Defines the condition for gain switchover.

Value	Gain switchover condition	Remarks
0	Fixed to the 1st gain set	The 1st gain set always applies.
1	Switched through external DI	Gains are switched through bit26 signal of 60FE. bit26 signal invalid: 1st gain set (2008-01h to 2008-03h, 2007-06h) bit26 signal valid: 2nd gain set (2008-04h to 2008-06h, 2007-07h) If bit26 signal of 60FE cannot be assigned to the DI terminal, the 1st gain set applies.
2	Torque reference too large	If the torque reference absolute value exceeds (Level + Dead time) [%] in the last 1st gain set, the servo drive switches to the 2nd gain set. If the torque reference absolute value keeps lower than (Level - Dead time) [%] within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive returns to the 1st gain set.
3	Speed reference too large	If the speed reference absolute value exceeds (Level + Dead time) [RPM] in the last 1st gain set, the servo drive switches to the 2nd gain set. If the speed reference absolute value keeps lower than (Level - Dead time) [RPM] within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive returns to the 1st gain set.
4	Speed reference too large	Valid only in the non-speed control mode: If the absolute value of the rate of change in the speed reference exceeds (Level + Dead time) [10 RPM/s] in the last 1st gain set, the servo drive switches to the 2nd gain set. If the absolute value of the rate of change in the speed reference keeps lower than (Level - Dead time) [10 RPM/s] within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive returns to the 1st gain set. In speed control mode, the 1st gain set always applies.
5	Speed reference high-speed/ low-speed threshold	If the speed reference absolute value exceeds (Level - Dead time) [RPM] in the last 1st gain set, the servo drive starts to switch to the 2nd gain set, with gains changed gradually. When the speed reference absolute value reaches (Level + Dead time) [RPM], switchover to the 2nd gain set is done. If the speed reference absolute value is lower than (Level + Dead time) [RPM] in the last 2nd gain set, the servo drive starts to return to the 1st gain set, with gains changed gradually. When the speed reference absolute value reaches (Level - Dead time) [RPM], returning to the 1st gain set is done.
6	Position deviation too large	Valid only in the position control mode: If the position deviation absolute value exceeds (Level + Hysteresis) [encoder unit] in the last 1st gain set, the servo drive switches to the 2nd gain set. If the position deviation absolute value keeps lower than (Level - Hysteresis) [encoder unit] within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive switches to the 1st gain set. The 1st gain set applies in other control modes.
7	Position reference available	Valid only in the position control mode: If the position reference is not 0 in the last 1st gain set, the servo drive switches to the 2nd gain set. If the position reference keeps being 0 within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive returns to the 1st gain set. The 1st gain set applies in other control modes.
8	Positioning completed	Valid only in the position control mode: If positioning is not done in the last 1st gain set, the servo drive switches to the 2nd gain set. If positioning is not done within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive switches to the 1st gain set. The 1st gain set applies in other control modes.
9	Actual speed too large	Valid only in the position control mode: If the absolute value of actual motor speed exceeds (Level + Dead time) [RPM] in the last 1st gain set, the servo drive switches to the 2nd gain set. If the absolute value of actual motor speed exceeds (Level - Dead time) [RPM] within the delay defined by 2008-0Bh in the last 2nd gain set, the servo drive switches to the 1st gain set. The 1st gain set applies in other control modes.

<table>
<tr><td rowspan="2">Sub-index 0Ah</td><td>Name</td><td colspan="3">Gain switchover condition</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 10</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">(Continue)</td></tr>
</table>

Value	Gain switchover condition	Remarks
10	Position reference + Actual speed	Valid only in the position control mode: If the position reference is not 0 in the last 1st gain set, the servo drive switches to the 2nd gain set. If the position reference keeps being 0 within the delay defined by 2008-0Bh in the last 2nd gain set, the 2nd gain set applies. When the position reference keeps being 0 after the time defined by 2008-0Bh elapses, if the absolute value of actual speed does not reach (Level) [RPM], the servo drive returns to the 1st gain set (except the speed integral time constant which is fixed to 2008-05h (2nd speed loop integral time constant)); if the actual value of the actual speed is lower than (Level - Dead time) [RPM], the servo drive returns to the 1st gain set. The 1st gain set applies in other control modes.

<table>
<tr><td rowspan="2">Sub-index 0Bh</td><td>Name</td><td colspan="3">Gain switchover delay</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 10000 (unit: 0.1 ms)</td><td>Default</td><td>50</td></tr>
<tr><td colspan="11">Defines the delay when the servo drive returns from the 2nd gain set to the 1st gain set.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 0Ch</td><td>Name</td><td colspan="3">Gain switchover level</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 20000</td><td>Default</td><td>50</td></tr>
<tr><td colspan="11">Defines the gain switchover level.
Switchover is affected by both the level and the dead time. For details, see descriptions of 2008-0Ah. The unit of gain switchover level varies with the switchover condition.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 0Dh</td><td>Name</td><td colspan="3">Gain switchover dead time</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 20000</td><td>Default</td><td>30</td></tr>
<tr><td colspan="11">Defines the dead time of gain switchover.
Switchover is affected by both the level and the dead time. For details, see descriptions of 2008-0Ah. The unit of gain switchover hysteresis varies with the switchover condition.
Note:
Set 2008-0Ch to a value higher than 2008-0Dh. If 2008-0Ch is set to a value lower than 2008-0Dh, the servo drive sets 2008-0Ch to the same value as 2008-0Dh.</td></tr>
</table>

Sub-index 0Eh	Name	Position gain switchover time		Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/CSP/CSV	Data Range	0 to 10000 (unit: 0.1 ms)	Default	30

In the position control mode, if 2008-06h (2nd position loop gain) is set to a value far higher than 2008-03h (Position loop gain), set the time for switching from 2008-03h to 2008-06h.

2008-0Eh can reduce the impact cause by an increase in the position loop gain.

2008-06h is invalid if it is set to a value lower than or equal to 2008-03h. In this case, the servo drive switches to the 2nd gain set immediately.

Sub-index 10h	Name	Load moment of inertia ratio			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 12000 (unit: 1%)	Default	100

Defines the mechanical load inertia ratio relative to the moment of inertia of the motor.

The setpoint 0 indicates the motor is disconnected from the load. The setpoint 1.00 indicates the mechanical load inertia equals the moment of inertia of the motor.

In online inertia auto-tuning (2009-04h ≠ 0), the servo drive sets 2008-10h automatically and manual setting is not allowed. Manual setting is allowed after online inertia auto-tuning (2009-04h = 0) is off.

Note:

◆ When the value of 2008-10h is the same as the actual inertia ratio, the value of speed loop gain (2008-01h/2008-04h) indicates the actual maximum follow-up frequency of the speed loop.

Sub-index 12h	Name	Zero phase delay			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/HM/CSP	Data Range	0 to 40 (unit: 0.1 ms)	Default	0

Sub-index 13h	Name	Speed feedforward filter time constant			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/HM/CSP	Data Range	0 to 6400 (unit: 0.01 ms)	Default	50

Defines the filter time constant of speed feedforward.

Sub-index 14h	Name	Speed feedforward gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/HM/CSP	Data Range	0 to 1000 (unit: 0.1%)	Default	0

In the position control mode, speed feedforward is the value of 2008-14h multiplied by the speed feedforward signal, which is part of a speed reference.

Increasing the value of 2008-14h improves the responsiveness to the position references and reduces the position deviation during operation at a constant speed.

When adjusting speed feedforward parameters, set 2008-13h to a fixed value first, and then gradually increase the value of 2008-14h from 0 to a certain setpoint at which speed feedforward achieves the required effect.

Adjust 2008-13h and 2008-14h repeatedly until a balanced setting is achieved.

Note:

For the speed feedforward function and speed feedforward signal selection, see 2005-14h (Speed feedforward control selection).

Sub-index 15h	Name	Torque feedforward filter time constant			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 6400 (unit: 0.01 ms)	Default	50

Defines the filter time constant of torque feedforward.

Sub-index 16h	Name	Torque feedforward gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 3000 (unit: 0.1%)	Default	0

In the non-torque control mode, torque feedforward is the value of 2008-16h multiplied by the torque feedforward signal, which is part of a torque reference.

Increasing the value of 2008-16h improves the responsiveness to speed references and position references and reduces the position deviation during operation at a constant speed.

When adjusting torque feedforward parameters, use the default value of 2008-15h and increase the value of 2008-16h gradually to enhance the effect of torque feedforward. When speed overshoot occurs, keep the value of 2008-16h unchanged and increase the value of 2008-20h. Adjust 2008-15h and 2008-16h repeatedly until a balanced setting is achieved.

Note:

◆ For the torque feedforward function and torque feedforward signal selection, see 2006-0Ch (Torque feedforward control selection).

Sub-index 17h	Name	Speed feedback filtering option			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 4	Default	0

Defines the moving average filtering times for speed feedback.

The larger the setpoint, the smaller the speed feedback fluctuation, and the larger the feedback delay will be.

Note:

◆ When 2008-17h > 0, 2008-18h (Cutoff frequency of speed feedback low-pass filter) is invalid.

<table>
<tr><td rowspan="2">Sub-index 18h</td><td>Name</td><td colspan="2">Cutoff frequency of speed feedback low-pass filter</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 8000 (Hz)</td><td>Default</td><td>8000</td></tr>
<tr><td colspan="11">Defines the cutoff frequency of speed feedback first-order low-pass filter.
Note:
◆ The smaller the setpoint, the smaller the speed feedback fluctuation, and the larger the feedback delay will be.
◆ Setting 2008-18h to 8000 negates the filtering effect.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 19h</td><td>Name</td><td colspan="2">Pseudo derivative feedback and feedforward control coefficient</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 2000 (unit: 0.1%)</td><td>Default</td><td>1000</td></tr>
<tr><td colspan="11">Defines the control mode of the speed loop.
When 2008-19h is set to 200.0, PI control (default control mode of the speed loop) is applied to the speed loop, which features fast dynamic response.
When 2008-19h is set to 0.0, speed loop integral action is enhanced, which filters low-frequency interferences but also slows down the dynamic response.
2008-19h can be used to keep a good responsiveness of the speed loop, with anti-interference capacity in low-frequency bands improved at the same time and the speed feedback overshoot remaining stable.</td></tr>
</table>

Group 2009h: Gain Auto-tuning Parameters

<table>
<tr><td rowspan="2">Index 2009h</td><td>Name</td><td colspan="3">Gain auto-tuning parameters</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>ARR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>-</td><td>Mapping</td><td>Yes</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>OD Data Range</td><td>Default</td><td>OD Default Value</td></tr>
<tr><td colspan="11">Used to set gain auto-tuning parameters.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 00h</td><td>Name</td><td colspan="3">Number of entries</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>60</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 01h</td><td>Name</td><td colspan="3">Gain auto-tuning mode</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 7</td><td>Default</td><td>4</td></tr>
<tr><td colspan="11">2009-01h is set to 4 (Normal mode+Inertia auto-tuning) by default.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 02h</td><td>Name</td><td colspan="3">Stiffness level of the 1st gain set</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 41</td><td>Default</td><td>15</td></tr>
<tr><td colspan="11">Defines the stiffness level of the servo system. The higher the stiffness level is, the stronger the gains and the quicker the response will be. But an excessively high stiffness level will cause vibration.
The setpoint 0 indicates the weakest stiffness and 41 indicates the strongest stiffness.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 03h</td><td>Name</td><td colspan="3">Adaptive notch mode</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>PP/PV/HM/ CSP/CSV</td><td>Data Range</td><td>0 to 4</td><td>Default</td><td>3</td></tr>
<tr><td colspan="11">Defines the working mode of the adaptive notch.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 04h</td><td>Name</td><td colspan="3">Online inertia auto-tuning mode</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 3</td><td>Default</td><td>2</td></tr>
<tr><td colspan="11">Defines whether to enable online inertia auto-tuning and the inertia ratio update speed during online inertia auto-tuning.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 06h</td><td>Name</td><td colspan="3">Offline inertia auto-tuning mode</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 1</td><td>Default</td><td>1</td></tr>
<tr><td colspan="11">Defines the offline inertia auto-tuning mode. The offline inertia auto-tuning function can be enabled through 200D-03h.
For details on offline inertia auto-tuning, see "6.2 Inertia Auto-tuning".</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 07h</td><td>Name</td><td colspan="3">Maximum speed in inertia auto-tuning</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>100 to 1000 (RPM)</td><td>Default</td><td>500</td></tr>
<tr><td colspan="11">Defines the maximum permissible speed reference in offline inertia auto-tuning mode.
During inertia auto-tuning, the higher the motor speed is, the more accurate the auto-tuned values will be. Use the default value of 2009-07h in general conditions.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 08h</td><td>Name</td><td colspan="3">Time constant for accelerating to the maximum speed during inertia auto-tuning</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>20 to 800 (ms)</td><td>Default</td><td>125</td></tr>
<tr><td colspan="11">Defines the time for the motor to accelerate from 0 RPM to the value defined by 2009-07h during offline inertia auto-tuning.</td></tr>
</table>

Sub-index 09h	Name	Waiting time after an individual inertia auto-tuning		Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	50 to 10000 (ms)	Default	800

Defines the time interval between two consecutive speed references when 2009-06h (Offline inertia auto-tuning mode) is set to 0 (Bidirectional).

Sub-index 0Ah	Name	Number of motor revolutions per inertia auto-tuning		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	All	Data Range	0 to 10000 (unit: 0.01 r)	Default	100

Defines the number of motor revolutions for a single inertia auto-tuning when 2009-06h (Offline inertia auto-tuning mode) is set to 0 (Bidirectional).

Note:

◆ In offline inertia auto-tuning, check whether the motor movable distance at the stop position is larger than the setpoint of 2009-0Ah. If not, decrease the setpoint of 2009-07h or 2009-08h until the motor movable distance at the stop position is larger than the setpoint of 2009-0Ah.

Sub-index 0Ch	Name	Vibration threshold		Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 1000 (unit: 0.1%)	Default	50

Defines the threshold of vibration detected by the notch. When the current feedback exceeds the threshold, the notch starts working.

Sub-index 0Dh	Name	Frequency of the 1st notch		Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	50 to 8000 (Hz)	Default	8000

Defines the center frequency of the notch, which is the mechanical resonance frequency.

In the torque control mode, setting 2009-0Dh to 8000 deactivates the notch function.

Sub-index 0Eh	Name	Width level of the 1st notch		Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 20	Default	2

Defines the width level of the notch. Use the default value of 2009-0Eh in general conditions.

Width level is the ratio of the notch width to the notch center frequency.

Sub-index 0Fh	Name	Depth level of the 1st notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 99	Default	0
Defines the depth level of the notch. The depth level of the notch is the ratio between the input and output at the notch center frequency. The higher the setpoint is, the smaller the notch depth and the weaker the suppression on mechanical resonance will be. Note that an excessively high setpoint may cause system instability. For use of the notch, see *"6.7 Vibration Suppression"*.										

Sub-index 10h	Name	Frequency of the 2nd notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	50 to 8000 (Hz)	Default	8000

Sub-index 11h	Name	Width level of the 2nd notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 20	Default	2

Sub-index 12h	Name	Depth level of the 2nd notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 99	Default	0
Descriptions of the 2nd group of notch parameters are the same as that of the 1st group of notch parameters (2009-0Dh, 2009-0Eh, 2009-0Fh).										

Sub-index 13h	Name	Frequency of the 3rd notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	50 to 8000 (Hz)	Default	8000

Sub-index 14h	Name	Width level of the 3rd notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 20	Default	2

Sub-index 15h	Name	Depth level of the 3rd notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 99	Default	0

Descriptions of the 3rd group of notch parameters are the same as that of the 1st group of notch parameters (2009-0Dh, 2009-0Eh, 2009-0Fh).

Note:

◆ The 3rd notch can be configured as an adaptive notch (2009-03h = 1 or 2). In this case, notch parameters are updated automatically by the servo drive, which cannot be modified manually.
If the notch frequency is 8000 Hz, the notch function is disabled.

Sub-index 16h	Name	Frequency of the 4th notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	50 to 8000 (Hz)	Default	8000

Sub-index 17h	Name	Width level of the 4th notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 20	Default	2

Sub-index 18h	Name	Depth level of the 4th notch			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 99	Default	0

Descriptions of the 4th group of notch parameters are the same as that of the 1st group of notch parameters (2009-0Dh, 2009-0Eh, 2009-0Fh).

Note:

◆ The 4th notch can be configured as an adaptive notch (2009-03h = 1 or 2). In this case, the parameters are updated automatically by the servo drive, which cannot be modified manually.
If the notch frequency is 8000 Hz, the notch function is disabled.

Sub-index 19h	Name	Auto-tuned resonance frequency			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to 5000	Default	0

When 2009-03h (Adaptive notch mode) is set to 3, the present mechanical resonance frequency is displayed.

Group 200Ah: Fault and Protection Parameters

Index 200Ah	Name	Fault and protection parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Used to set the fault and protection parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	60

Sub-index 01h	Name	Power input phase loss protection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

SV660N series servo drives support single-phase 220 V, three-phase 220 V, and three-phase 380 V power supplies. When voltage fluctuation or phase loss occurs on the power supply, power input phase loss protection will be triggered by the servo drive based on the setting of 200A-01h.

Note:

- 200A-01h = 0: The servo drive reports E420.0 (Phase loss fault) when H01-10 (Servo drive series number) is set to 60005 (850 W).
- 200A-01h = 1: E420.0 is hidden. When H01-10 is set to 60005 (850 W), derate 80% during use.
- Three-phase 220 V servo drives (S7R6, S012) need no derating in case of single-phase power input. Three-phase 380 V servo drives enter the NRD status in case of a phase loss fault. In this case, you cannot operate the servo drive by hiding the phase loss fault.

Sub-index 02h	Name	Absolute position limit			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 2	Default	0

Defines whether the absolute position limit is active and the condition for activation.

After the absolute position limit is enabled:
In the position control mode, when the target position reference exceeds the limit, the servo drive takes the limit as the target and stops after reaching the limit.
In non-position control modes, when the absolute position feedback reaches the limit, the servo drive reports an overtravel fault and stops in the mode defined by 2002-08h (Stop mode at overtravel).

Sub-index 05h	Name	Motor overload protection gain			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	50 to 300 (%)	Default	100

Defines the motor overload duration before E620.0 (Motor overload) is reported.

You can change the setpoint to advance or delay the time when overload protection is triggered based on the temperature rise condition. The setpoint 50% indicates the time is cut by half; 150% indicates the time is increased by 50%.

Set 200A-05h based on the temperature rise condition of the motor and take caution during setting.

Sub-index 09h	Name	Overspeed threshold			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 20000 (RPM)	Default	0
Defines the motor speed threshold at which the overspeed fault is detected.										

Sub-index 0Bh	Name	Threshold of excessive local position following deviation			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 2^{32} - 1	Default	25185824
Defines the threshold for reporting EB00.0 (Position deviation too large). The function of 200A-0Bh is the same as 6065h (Following error window), both of which are active.										

Sub-index 0Dh	Name	Runaway protection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 1	Default	1
Used to enable runaway protection.										

Sub-index 13h	Name	Power module over-temperature threshold			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	120 to 175 (°C)	Default	135
Defines the over-temperature threshold of the power module.										

Sub-index 14h	Name	Filter time constant of touch probe 1			Setting Condition & Effective Time	During running & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 630 (unit: 0.01 us)	Default	200

Sub-index 15h	Name	Filter time constant of touch probe 2			Setting Condition & Effective Time	During running & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 630 (unit: 0.01 us)	Default	200
Touch probe 1 and touch probe 2 are high-speed DIs. When external input signals suffer from spike interference, you can set 200A-14h or 200A-15h to filter the spike interference. Note: The oscilloscope in the software tool displays the unfiltered signals of touch probe 1 and touch probe 2. Signals with width lower than 0.25 ms will not be displayed.										

Sub-index 16h	Name	STO function display			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Defines whether to display the STO status or report E150.0 after the STO function is triggered.

0: Displays the STO status. The keypad displays "sto_" after the STO function is triggered. In this case, no fault is reported and no output is generated from the fault DO.

1: Displays the STO failure. The keypad displays "E150.0" after the STO function is triggered. In this case, the servo drive reports E150.0 and the fault DO generates output.

Sub-index 1Ah	Name	Filter time constant of speed feedback display value			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 5000 (unit: ms)	Default	50

Defines the filter time constant of speed feedback signals to smooth the speed display value.

200B-01h displays the motor speed filtered by this parameter.

Sub-index 1Bh	Name	Motor overload warning/ fault selection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Defines whether to enable motor overload detection.

Take caution during setting as improper setting may lead damage the motor.

Sub-index 1Ch	Name	Speed DO filter time constant			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 5000 (ms)	Default	50

Defines the low-pass filter time constant of speed feedback signals.

This parameter is effective only when the speed feedback signals are used to judge the speed-related DO signals.

Sub-index 21h	Name	Motor stall over-temperature protection time window			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	10 to 65535 (ms)	Default	200

Defines the over-temperature duration before E630.0 (Motor stall) is detected by the servo drive.

You can adjust the sensitivity for detecting E630.0 by changing the setpoint of 200A-21h.

Sub-index 22h	Name	Motor stall over-temperature protection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	-	Data Range	0 to 1	Default	1

Defines whether to enable the detection for E630.0.

Sub-index 25h	Name	Absolute encoder multi-turn overflow fault selection			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	No	Related Mode	All	Data Range	0 to 1	Default	1
Defines whether to hide E735.0 (Encoder multi-turn counting overflow) in the absolute position linear mode.										

Sub-index 29h	Name	Overtravel compensation selection			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	CSP	Data Range	0 to 1	Default	0
0: Enabled, used to solve position reference loss caused by interference in position limit signals in CSP mode.										

Sub-index 32h	Name	Regenerative resistor over-temperature threshold			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	100 to 175 (℃)	Default	115

Sub-index 33h	Name	Encoder communication fault tolerance threshold			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 31	Default	3

Sub-index 34h	Name	Phase loss detection filter times			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	3 to 36	Default	20

Sub-index 35h	Name	Encoder temperature protection threshold			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 175	Default	0
0: Disable										

Sub-index 38h	Name	Runaway current threshold			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	1000 to 4000 (unit: 0.1%)	Default	2000

Sub-index 39h	Name	Reset delay			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 60000 (ms)	Default	10000
Faults E620.0, E630.0, E640.0, E640.1, and E650.0 can be reset only after the time defined by 200A-39h elapses.										

Sub-index 3Ah	Name	Runaway speed threshold			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	1 to 1000 (RPM)	Default	50

Sub-index 3Bh	Name	Runaway speed filter time			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	1 to 1000 (0.1 ms)	Default	20

Sub-index 3Ch	Name	Runaway protection detection time			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	10 to 1000 (ms)	Default	30

Sub-index 4Ah	Name	STO disconnection filter time			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 5 (ms)	Default	5
Defines the filter time from the moment when STO1 and STO2 are disconnected from the 24 V power supply to the moment when the STO status is displayed or E150.0 is reported.										

Sub-index 4Bh	Name	STO fault tolerance filter time			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 10 (ms)	Default	10
Defines the filter time from the moment when STO1 and STO2 are input with different voltages to the moment when E150.1 is reported.										

Sub-index 4Ch	Name	STO servo off filter time			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 25 (ms)	Default	20
Defines filter time from the moment when the STO status is displayed or E150.0/E150.1 is reported to the moment when the servo drive is off.										

Sub-index 47h	Name	Overspeed threshold			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 20000	Default	0

Sub-index 49h	Name	Maximum time of ramp-to-stop			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 65535 (ms)	Default	10000

Group 200Bh: Monitoring Parameters

Index 200Bh	Name	Monitoring parameters			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Used to set monitoring parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	65

Sub-index 01h	Name	Motor speed actual value			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (RPM)	Default	-
Displays the actual motor speed after round-off, which is accurate to 1 RPM. You can set the filter time constant for 200B-01h in 200A-1Ah (Filter time constant of speed feedback display value).										

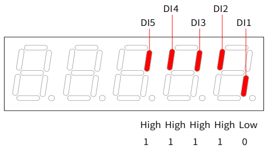
Sub-index 02h	Name	Speed reference			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	PP/PV/HM/CSP/CSV	Data Range	- (RPM)	Default	-
Displays the present speed reference (accurate to 1 RPM) of the servo drive in the position and speed control modes.										

Sub-index 03h	Name	Internal torque reference			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (%)	Default	-
Displays present torque reference accurate to 0.1%. The value 100.0% corresponds to the rated torque of the motor.										

Sub-index 04h	Name	Monitored DI status			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-

Displays the electrical status of DI1 to DI5 without filtering.

Upper LED segments turned on: Not active (indicated by "1")
Lower LED segments turned on: Active (indicated by "0") In the case where DI1 input is active and DI2 to DI5 inputs are not active, the corresponding binary value is 11110, the value of 200B-04h read using the software tool is 30, and the corresponding display status is as follows.

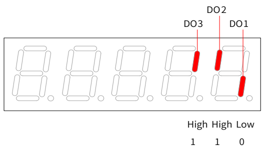


Sub-index 06h	Name	Monitored DO status			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-

Displays the electrical status of DO1 to DO3 without filtering.

Upper LED segments turned on: Not active (indicated by "1")
Lower LED segments turned on: Active (indicated by "0")

In the case where DO1 is active and DO2 to DO3 are not active, the corresponding binary value is 110, the value of 200B-06h read using the software tool is 6, and the corresponding display status is as follows.



Sub-index 08h	Name	Absolute position counter			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	-2^{31} to $+2^{31}-1$ (reference unit)	Default	0

Displays present absolute position (in reference unit) of the motor in the position control mode.

200B-08h is a 32-bit value, which is displayed as a decimal on the keypad.

Sub-index 0Ah	Name	Mechanical angle			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0 to 360.0 (unit: °)	Default	-

Displays present mechanical angle (in encoder unit) of the motor, and the value 0 indicates the mechanical angle is 0°.

Sub-index 0Bh	Name	Electrical angle			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0 to 360.0 (unit: °)	Default	-

Displays the present electrical angle of the motor, which is accurate to 0.1° .

The electrical angle variation range is ±360.0° during rotation. If the motor has four pairs of poles, each revolution generates four rounds of angle change from 0° to 359.9° . Similarly, if the motor has five pairs of poles, each revolution generates five rounds of angle change from 0° to 359.9° .

Sub-index 0Dh	Name	Average load rate			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0 to 800.0 (%)	Default	-

Displays the percentage of the average load torque to the rated torque of the motor, which is accurate to 0.1%. The value 100.0% corresponds to the rated torque of the motor.

Sub-index 10h	Name	Position following deviation (encoder unit)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	PP/HM/CSP	Data Range	-2^{31} to $+2^{31}-1$ (encoder unit)	Default	-

Counts and displays the position deviation value after being divided or multiplied by the electronic gear ratio in the position control mode.

200B-10h is a 32-bit value, which is displayed as a decimal on the keypad.

Sub-index 12h	Name	Feedback pulse counter			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	-2^{31} to $+2^{31}-1$ (encoder unit)	Default	-

Counts the position pulses fed back by the encoder in any control mode.

200B-12h is a 32-bit value, which is displayed as a decimal on the keypad.

Note:

◆ When an absolute encoder motor is used, 200B-12 displays only the low 32-bit value of the motor position feedback. The actual motor position feedback can be obtained in 200B-4E (Absolute position (low 32 bits) of absolute encoder) and 200B-50 (Absolute position (high 32 bits) of absolute encoder).

Sub-index 14h	Name	Total power-on time			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: s)	Default	-

Displays the total operating time of the servo drive.

200B-14h is a 32-bit value, which is displayed as a decimal on the keypad.

Note:

If the servo drive is switched on and off continuously within a short period of time, a deviation within 1h may be present in the total power-on record.

Sub-index 19h	Name	RMS value of phase current			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: A)	Default	-
Displays the RMS value of the phase current of the servo motor, which is accurate to 0.1 A.										

Sub-index 1Bh	Name	Bus voltage			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: V)	Default	-
Displays the DC bus voltage of the main circuit input voltage after rectification, which is accurate to 0.1 V.										

Sub-index 1Ch	Name	Power module temperature			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: °C)	Default	-
Displays the temperature of the module inside the servo drive, which can be used as a reference for the actual temperature of the servo drive.										

Sub-index 22h	Name	Fault log			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 9	Default	-
Used to view any one of the latest 10 faults occurred on the servo drive.										

Sub-index 23h	Name	Fault code of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-

Sub-index 24h	Name	Time stamp of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: s)	Default	-

Sub-index 26h	Name	Motor speed upon occurrence of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: RPM)	Default	-

Sub-index 27h	Name	Motor phase U current upon occurrence of the selected fault		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: A)	Default	-

Sub-index 28h	Name	Motor phase V current upon occurrence of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: A)	Default	-

Sub-index 29h	Name	Bus voltage upon occurrence of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(unit: V)	Default	-

Sub-index 2Ah	Name	DI status upon occurrence of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-

Sub-index 2Bh	Name	DO status upon occurrence of the selected fault			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-
200B-23h to 200B-2Bh display corresponding parameter values when the fault displayed in 200B-23h occurs.										

Sub-index 36h	Name	Position deviation counter			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	PP/HM/CSP	Data Range	(reference unit)	Default	-

Displays the position deviation not divided or multiplied by the electronic gear ratio in the position control mode.

200B-36h is a 32-bit value, which is displayed as a decimal on the keypad.

Note: Position deviation (reference unit) refers to the value reduced by encoder position deviation. The precision may be compromised.

Sub-index 38h	Name	Motor speed actual value			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	(RPM)	Default	-

Displays the actual value of the motor speed, which is accurate to 0.1 RPM.

200B-38h is a 32-bit value, which is displayed as a decimal on the keypad.

You can set the filter time constant for speed feedback through 200A-1Ah (Filter time constant of speed feedback display value).

Sub-index 3Ah	Name	Control circuit bus voltage		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-
Displays the DC bus voltage of the control circuit after rectification.										

Sub-index 3Bh	Name	Mechanical absolute position (low 32 bits)		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (encoder unit)	Default	-
Displays the low 32-bit value (encoder unit) of the mechanical position feedback when the absolute encoder is used.										

Sub-index 3Dh	Name	Mechanical absolute position (high 32 bits)		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	(encoder unit)	Default	-
Displays the high 32-bit value (encoder unit) of the mechanical position feedback when the absolute encoder is used.										

Sub-index 40h	Name	Notrdy (Not ready) state		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0-4	Default	-

Display value	Meaning
0	None
1	Control circuit power supply error (H0B-57)
2	Phase loss detection error
3	Main circuit power supply error (including short-to-ground error)
4	Other servo drive faults

Sub-index 43h	Name	Encoder temperature		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	-100 to +200	Default	-
Displays the encoder temperature value.										

Sub-index 44h	Name	Load rate of regenerative resistor		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0 to 200.0 (%)	Default	-
Displays the load rate of the regenerative resistor. When the load rate exceeds 100%, regenerative resistor stops working.										

Sub-index 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	Data Range	-	Default	-
Displays the number of revolutions of the absolute encoder.										

Sub-index 48h	Name	Single-turn position feedback of the absolute encoder		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (encoder unit)	Default	-
Displays the single-turn position feedback of the encoder.										

Sub-index 4Eh	Name	Absolute position (low 32 bits) of absolute encoder		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (encoder unit)	Default	-
Displays the low 32-bit value of the position feedback of the absolute encoder.										

Sub-index 50h	Name	Absolute position (high 32 bits) of absolute encoder		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (encoder unit)	Default	-
Displays the high 32-bit value of the position feedback of the absolute encoder.										

Sub-index 52h	Name	Single-turn position (low 32 bits) of the rotating load		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	(encoder unit)	Default	-
Displays the low 32-bit value (encoder unit) of the position feedback of the rotating load when the absolute encoder system works in the rotation mode (2002-02h = 2).										

Sub-index 54h	Name	Single-turn position (high 32 bits) of the rotating load		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (encoder unit)	Default	-
Displays the high 32-bit value (encoder unit) of the position feedback of the rotating load when the absolute encoder system works in the rotation mode (2002-02h = 2).										

Sub-index 56h	Name	Single-turn position of the rotating load			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	- (reference unit)	Default	-
Displays the position feedback of the rotating load when the absolute encoder system works in the rotating mode (2002-02h = 2).										

Sub-index 5Bh	Name	Group number of the abnormal parameter			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0 to 0xFFFF	Default	-
Displays the group number of the abnormal parameter when E101 occurs.										

Sub-index 5Ch	Name	Offset of abnormal parameter within the group			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0–65535	Default	
Displays the offset of the abnormal parameter within the group when E101 occurs.										

Group 200Dh: Auxiliary Function Parameters

Index 200Dh	Name	Auxiliary functions			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	-	Mapping	-	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value
Defines the auxiliary function parameters.										

Sub-index 00h	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	21

Sub-index 01h	Name	Software reset			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Defines whether to enable software reset.

Value	Description	Remarks
0	No operation	
1	Enable	Programs in the servo drive are reset automatically (similar to the program reset operation upon power-on) after the software reset function is enabled, without the need for a power cycle.

Software reset is available in the following cases:

- ◆ The servo is in the S-OFF state.
- ◆ A No. 1 non-resettable fault does not occur.
- ◆ No operation is performed on EEPROM. The software reset function is invalid when 200A-04h is set to 1.

Sub-index 02h	Name	Fault reset			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Defines whether to enable fault reset.

Value	Description	Remarks
0	No operation	-
1	Enable	When a No. 1 or No. 2 resettable fault occurs, you can enable the fault reset function in the non-operational state after rectifying the fault cause, stopping the keypad from displaying the fault. When a No. 3 warning occurs, you can enable the fault reset function directly without regard to the operating state of the servo drive.

Note:

◆ For fault classification, see "10 Troubleshooting".

◆ The fault reset function, once enabled, stops the keypad from displaying the fault only, which does not activate modifications made on parameters.

◆ This function is not applicable to non-resettable faults. Take caution with this function if the fault causes are not rectified.

Sub-index 03h	Name	Offline inertia auto-tuning selection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Used to enable offline inertia auto-tuning through the keypad. In the parameter display mode, after switching to "200D-03h", you can press the SET key to enable offline inertia auto-tuning.

For details of offline inertia auto-tuning, see "6.2 Inertia Auto-tuning".

Sub-index 06h	Name	Emergency stop			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Emergency stop operation selection:

Value	Description
0	No operation
1	Emergency stop enabled

When this function is enabled, the servo drive stops immediately as defined by 2002-05h (Stop mode at S-OFF) regardless of the present state.

Sub-index 0Ch	Name	Jog function			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	-	Default	-

Used to enable the jog function through the keypad.

You can perform operations related to the jog function through setting 200D-0Ch by the keypad. For details, see "4.5.1 Jog".

This function is not related to the servo control mode.

Sub-index 12h	Name	Forced DI/DO selection			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 3	Default	0
Defines whether to enable forced DI/DO.										

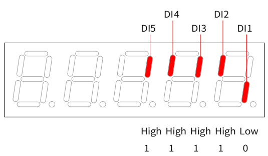
Sub-index 13h	Name	Forced DI setting			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 0x1F	Default	0x1F

Defines whether the DI functions set in group 2003h is active when forced DI is activated (200D-12h = 1 or 3).

The value of 200D-13h is displayed as a hexadecimal on the keypad. When it is converted to a binary value, bit(n) = 1 indicates the level logic is high level; bit(n) = 0 indicates the level logic is low level.

For instance:

The value of 200D-13h is 0x1E, which is converted to the binary value 11110, indicating that DI1 is low level and DI2 to DI5 are high level. You can also monitor the status of DI1 to DI5 through 200B-04h.



Whether the DI function is active depends not only on 200D-13h but also on the DI logic set in group 2003h.

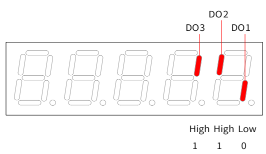
Sub-index 14h	Name	Forced DO setting			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 7	Default	0

Defines whether the DI functions set in group 2004h are active when forced DI is activated (200D-12h = 2 or 3).

The value of 200D-14h is displayed as a hexadecimal on the keypad. When it is converted to a binary value, bit(n) = 1 indicates the DO function is active; bit(n) = 0 indicates the DO function is inactive.

For instance:

The value of 200D-14h is 6, which is converted to the binary value 110. Assume DO1 to DO3 in group 2004h are active low, then 200B-06h is displayed as follows:



<table>
<tr><td rowspan="2">Sub-index 15h</td><td>Name</td><td colspan="3">Absolute encoder reset selection</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 2</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines whether to reset the encoder fault or the multi-turn data of the encoder.
Note: The absolute position of the encoder changes abruptly after multi-turn data reset. In this case, perform the mechanical homing operation.</td></tr>
</table>

Setpoint	Description
0	No operation
1	Reset encoder fault
2	Reset encoder fault and multi-turn data

Group 200Eh: Communication Parameters

<table>
<tr><td rowspan="2">Index 200Eh</td><td>Name</td><td colspan="3">Communication parameters</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>ARR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>-</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>OD Data Range</td><td>Default</td><td>OD Default Value</td></tr>
<tr><td colspan="11">Used to set communication parameters.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 00h</td><td>Name</td><td colspan="3">Number of entries</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>ARR</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>97</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 01h</td><td>Name</td><td colspan="3">Node address</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>1 to 127</td><td>Default</td><td>1</td></tr>
<tr><td colspan="11">Defines the servo drive axis address during RS232 communication.
0: Broadcast address. The host controller performs the write operation on all the servo drives through the broadcast address. The servo drives acts accordingly after receiving the broadcast address frames without responding.
1 to 127: Each of the servo drive networked must have a unique address. Otherwise, communication error or failure will occur.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 02h</td><td>Name</td><td colspan="3">Update parameter values written through communication to EEPROM</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>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 3</td><td>Default</td><td>3</td></tr>
<tr><td colspan="11">Defines whether to save parameters written through RS232 and EtherCAT (writing with SDO only) communication to EEPROM.
Note:
◆ The value of 200E-02h will always be updated and saved to EEPROM.
◆ If the parameters modified need not be saved after power off, set 200E-02h to 0. This is to prevent EEPROM from being damaged by frequent saving of parameters in batches, leading to E108.0 (Parameter write error).</td></tr>
</table>

Sub-index 15h	Name	EtherCAT slave name			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	0–65535	Default	-

Displays the station number assigned to the slave by the master during EtherCAT communication.

Sub-index 16h	Name	EtherCAT slave alias			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to 65535	Default	0

Assigns a station number to the slave during EtherCAT communication in case of a master unable to assign the slave station number automatically.

200E-16h = 0: The master assigns the station number automatically.
200E-16h ≠ 0: Use the set station number, with the one assigned by the master deactivated.

Sub-index 17h	Name	Number of SYNC interrupts allowed by EtherCAT			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	1 to 20	Default	8

Defines the maximum number of master signal loss events allowed by the slave. The slave reports EE08.2 (IRQ loss) if the value of 200E-17h.

Sub-index 19h	Name	SYNC loss counter			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0–65535	Default	0

Sub-index 1Ah	Name	Port 0 invalid frame counter			Setting Condition & Effective Time	Display parameter	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Indicates CRC error of Port0. If there is a counting value, it indicates the frames received by Port0 are damaged. The cause may lie in the cable or PHY port, including 0x301 RX-ER. In normal conditions, 0x300 = 0x301, if 0x300 > 0x301, a CRC error is present in the network.

Sub-index 1Bh	Name	Port 1 invalid frame counter			Setting Condition & Effective Time	Display parameter	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Indicates CRC error of Port1. If there is a counting value, it indicates the frames received by Port1 are damaged. The cause may lie in the cable or PHY port, including 0x301 RX-ER. In normal conditions, 0x300 = 0x301, if 0x300 > 0x301, a CRC error is present in the network.

<table>
<tr><td rowspan="2">Sub-index 1Ch</td><td>Name</td><td colspan="3">Port 0/1 transfer error counter</td><td>Setting Condition & Effective Time</td><td>Display parameter</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">If the received data is wrong and ended with an extra error flag, it indicates the data is being processed by other stations.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 1Dh</td><td>Name</td><td colspan="3">Process unit and PDI error counter</td><td>Setting Condition & Effective Time</td><td>Display parameter</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">If data exchange error occurs between ESC and internal MCU, keep the setpoint to 0. If the counting value increases, the internal anti-interference performance of the board is abnormal.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 1Eh</td><td>Name</td><td colspan="3">Port 0/1 lost counter</td><td>Setting Condition & Effective Time</td><td>Display parameter</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">If data link loss is detected by the ESC port, the counting value of the corresponding link loss counter increases. Such scenario may be caused by poor contact or damaged cables.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 20h</td><td>Name</td><td colspan="3">SYNC mode setting</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 2</td><td>Default</td><td>1</td></tr>
<tr><td colspan="11">Defines the synchronization mode.</td></tr>
</table>

Value	Operation mode	Description
0	Manufacturer function	Manufacturer function
1	Synchronization 1	Applicable to host controllers with a jitter of 1 us in synchronization.
2	Synchronization 2	Applicable to host controllers with a jitter of 1 us in synchronization.

Note:

◆ In synchronization mode, the synchronization cycle must be an integer multiple of 125 us. Otherwise, the servo drive reports EE13.0 (Synchronization cycle setting error).

Sub-index 21h	Name	SYNC error window			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	100 to 4000 (ns)	Default	3000

Defines the permissible jitter range of synchronization signals when the servo drive works in synchronization mode 1 (200E-20h = 1).

Note:

◆ In synchronization mode 1 (200E-20h = 1), if the jitter range of synchronization signals exceeds the value of 200E-20h after the ESM enters the OP state, the servo drive reports EE15.0 (Number of synchronization cycle errors too large).

Sub-index 22h	Name	EtherCAT network state and link state			Setting Condition & Effective Time	Display parameter	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Shows the connection status of the servo state machine and EtherCAT network ports.

Sub-index 23h	Name	Excessive position reference increment counter in CSP mode			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 65535	Default	0

Defines the counting value when the position reference increment exceeds the maximum position reference increment threshold. When the counting value exceeds the threshold, EB01.0 or EB01.1 will be reported.

Sub-index 25h	Name	EtherCAT enhanced link selection			Setting Condition & Effective Time	During running & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 26h	Name	EtherCAT XML reset selection			Setting Condition & Effective Time	During running & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Sub-index 51h	Name	Serial port baud rate		Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 9	Default	9

Defines the communication rate between the servo drive and the host controller.

Value	Baud rate (bps)
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400
8	57600
9	115200

The baud rate set in the servo drive must be the same as that in the host controller. Otherwise, communication will fail.

Sub-index 52h	Name	Modbus data format			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 3	Default	0

Defines the data check mode between the servo drive and the host controller during communication.

The data format set in the servo drive must be the same as that in the host controller. Otherwise, communication will fail.

Sub-index 61h	Name	XML version			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 655.35	Default	0

Group 203Fh: Manufacturer Fault Codes

Index 203Fh	Name	Manufacturer fault code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	0 to (2^{32} - 1)	Default	-

Displays the fault code of the highest level.

The value of 203Fh is a hexadecimal, in which the high 16 bits indicate the manufacturer internal fault code, and the low 16 bits indicate the manufacturer external fault code.

8.4 Parameters Defined by the Device Profile (Group 6000h)

Index 603Fh	Name	Error code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	0 to 65535	Default	-

When an error described in the CiA402 profile occurs on the servo drive, 603Fh is the same as that described in CiA402. For details, see *"10.2 Communication Faults and Warning Codes"*.

The value of 603F is a hexadecimal.

203Fh displays the assistant byte of the error code in the form of hexadecimal. The value of 203Fh is an unsigned 32-bit integer, in which the high 16 bits are manufacturer internal error code, and the low 16 bits are manufacturer external error code.

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	Data 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
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		Not defined
11 to 15	Manufacturer-specific		Defined by the manufacturer.

Note:

- ◆ All bits in the control word constitute a control command.
- ◆ The meanings of bit0...bit3 and bit7 are the same in each servo mode. The servo drive switches to the preset status according to the CiA402 state machine switchover process only when commands are sent in sequence. Each command corresponds to a certain status.
- ◆ bit4 to bit6 are related to each servo mode (see the control commands in different modes for details).
- ◆ bit9 is not defined.

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

Indicates the servo drive status.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms		oms		ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rtso

MSB LSB

Note：ms=manufacturer-specific；oms=operation mode specific；ila =internal limit actIve；tr=target reached；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	Not defined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reached	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	Not defined
15	Home found	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 commands in 6040h are sent in sequence, the servo drive returns a feedback on the servo state.
- ◆ 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.

Index 605Ah	Name	Quick stop option code			Setting Condition & Effective Time	Any condition & At stop	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	0 to 7	Default	2

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status after quick stop.

When the brake function is enabled and the value of 605Ah is lower than 4, the stop mode is forcibly set to "Ramp to stop as defined by 6085h, keeping de-energized state".

Value	Stop Mode
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084h/609Ah (HM), keeping de-energized status
2	Ramp to stop as defined by 6085h, keeping de-energized status
3	Stop at emergency-stop torque, keeping de-energized status
4	N/A
5	Ramp to stop as defined by 6084h/609Ah (HM), keeping position lock status
6	Ramp to stop as defined by 6085h, keeping position lock status
7	Stop at emergency-stop torque, keeping position lock status

605Ch	Name	Stop mode at S-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 for stopping rotating and the servo motor status at S-OFF.

Setpoint	Stop Mode
-4	Ramp to stop as defined by 6085h, keeping dynamic braking status
-3	Stop at zero speed, keeping dynamic braking status
-2	Ramp to stop under all modes, keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop under all modes, keeping de-energized status

Set a proper stop mode according to the mechanical condition and operating requirements.

After the brake output function is enabled, the stop mode at S-OFF is forcibly set to "Ramp to stop as defined by 6085h, keeping dynamic braking status".

Index 605Dh	Name	Halt stop option code			Setting Condition & Effective Time	Any condition & At stop	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	1 to 3	Default	1

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status after halt.

PP/PV/HM mode:

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

PT mode:

Setpoint	Stop Mode
1/2/3	Ramp to stop as defined by 6087h, keeping position lock status

605Eh	Name	Stop mode at No. 2 fault			Setting Condition & Effective Time	Any condition At stop	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	-5 to 3	Default	2

Defines the deceleration mode of the servo motor for stopping rotating and the servo motor status when a No. 2 fault occurs.

Value	Stop Mode
-5	Stop at zero speed, keeping dynamic braking status
-4	Stop at the emergency-stop torque, keeping dynamic braking status
-3	Ramp to stop as defined by 6085h, keeping dynamic braking status
-2	Ramp to stop as defined by 6084h/609Ah (HM), keeping dynamic braking status
-1	Dynamic braking stop, keeping dynamic braking status
0	Coast to stop, keeping de-energized status
1	Ramp to stop as defined by 6084h/609Ah (HM), keeping de-energized status
2	Ramp to stop as defined by 6085h, keeping de-energized status
3	Stop at emergency-stop torque, keeping de-energized status

After the brake output function is enabled, the stop mode at No. 2 fault is forcibly set to "Ramp to stop as defined by 6085h, keeping dynamic braking status".

Index 6060h	Name	Modes of operation			Setting Condition & Effective Time	During running At stop	Data Structure	VAR	Data Type	Int8
	Access	RW	Mapping	RPDO	Related Mode	All	Data Range	0 to 10	Default	0

Defines the servo drive operation mode.

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

If an unsupported operation mode is set through SDO, an SDO error will be returned. For details, see "SDO Abort Transfer Code".

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

<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>Int8</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 10</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Displays the present operation mode of the servo drive.</td></tr>
</table>

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

<table>
<tr><td rowspan="2">Index 6062h</td><td>Name</td><td colspan="3">Position demand value</td><td>Setting Condition & Effective Time</td><td>-</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>PP/HM/ CSP</td><td>Data Range</td><td>- (reference unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Indicates the input position reference (in reference unit) in the S-ON state.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6063h</td><td>Name</td><td colspan="3">Position actual value</td><td>Setting Condition & Effective Time</td><td>-</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>Data Range</td><td>- (encoder unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Indicates the absolute value of motor position in encoder unit.</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>-</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>Data Range</td><td>- (reference unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Indicates user absolute position feedback in real time.
Position actual value (6064h) x Gear ratio (6091h) = Position actual value* (6063h)</td></tr>
</table>

Index 6065h	Name	Following error window			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP/HM/ CSP	Data Range	0 to (2^{32} - 1) (reference unit)	Default	Motor with 20-bit encoder: 3145728 Motor with 23-bit encoder: 25165824

Defines the threshold of excessive position deviation (in reference unit).

If 6065h is set to a too large value, the alarm value of excessive position deviation will be treated as 2147483647 encoder units.

Index 6066h	Name	Following error time out			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PP/HM/CSP	Data Range	0 to 65535 (ms)	Default	0

Defines the threshold of excessive position deviation (in reference 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.

Index 6067h	Name	Position window			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP	Data Range	0 to (2^{32} - 1)	Default	734

Defines the threshold for position reach.

When the position deviation is within ±6067h, and the time defined by 6068h elapses, the position is reached and bit10 of 6041h is set to 1.

This flag bit is valid only when the S-ON signal is active in PP mode.

Index 6068h	Name	Position window time			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PP	Data Range	0 to 65535 (ms)	Default	0

Defines the time window for position reach.

Index 606Ch	Name	Velocity actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	(unit: reference unit/s)	Default	-

Indicates the velocity actual value (in reference unit/s).

Index 606Dh	Name	Velocity window			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PV	Data Range	0 to 65535 (RPM)	Default	10

Defines the threshold for speed reach.

When the difference between 60FFh (converted into motor speed/RPM) and the motor speed actual value is within ±606Dh, and the time defined by 606Eh elapses, the speed is reached and bit10 of 6041h is set to 1.

This flag bit is meaningful only when the servo drive is enabled in PV mode.

Index 606Eh	Name	Velocity window time			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PV/CSV	Data Range	0 to 65535 (ms)	Default	0

Defines the time window for speed reach.

When the difference between 60FFh (converted into motor speed/RPM) and the motor speed actual value is within ±606Dh, and the time defined by 606Eh elapses, the speed is reached and bit10 of 6041h is set to 1.

This flag bit is meaningful only when the servo drive is enabled in PV mode.

Index 606Fh	Name	Velocity threshold			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PV	Data Range	0 to 65535 (RPM)	Default	10

Defines the threshold for zero speed.

When the speed feedback is within ±606F and the time defined by 6070 elapses, it indicates the motor speed is 0, and bit12 of 6041 is set to 1.

This flag bit is valid only in PV mode.

Index 6070h	Name	Velocity threshold time			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	PV	Data Range	0 to 65535 (ms)	Default	0

Defines the time window for zero speed.

When the speed feedback is within ±606F and the time defined by 6070 elapses, it indicates the motor speed is 0, and bit12 of 6041 is set to 1.

This flag bit is valid only in PV mode.

Index 6071h	Name	Target torque			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	RPDO	Related Mode	PT/CST	Data Range	-3000 to +3000 (unit: 0.1%)	Default	0

Defines the target torque of the servo drive in PT mode and CST mode.

The value 100.0% corresponds to the rated torque of the motor.

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

Index 6074h	Name	Torque demand value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	(unit: 0.1%)	Default	-
Shows the torque reference output value during servo drive running. The value 100.0% corresponds to the rated torque of the motor.										

Index 6077h	Name	Torque actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RO	Mapping	TPDO	Related Mode	All	Data Range	(unit: 0.1%)	Default	-
Indicates the internal torque feedback of the servo drive. The value 100.0% corresponds to the rated torque of the motor.										

Index 607Ah	Name	Target position			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Int32
	Access	RW	Mapping	RPDO	Related Mode	PP CSP	Data Range	-2^{31} to $+(2^{31}-1)$ (reference unit)	Default	0
Defines the target position in PP mode and CSP mode. In CSP mode, 607Ah indicates the absolute target position. In PP mode, 607Ah indicates either the incremental position or absolute position as defined by the control word.										

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	Data Range	-2^{31} to $+(2^{31}-1)$ (reference unit)	Default	0
Defines the physical distance between mechanical zero and the motor home in the homing mode. The home offset takes effect in the following conditions: The device is powered on, the homing operation is done, and bit15 of 6041h is set to 1. The home offset has the following effect: ◆ Determines the present position after homing based on 60E6h. ◆ If 607Ch is outside the value of 607Dh (Software position limit), EE09.1 (Home setting error) will occur.										

<table>
<tr><td rowspan="2">Index 607Dh</td><td>Name</td><td colspan="3">Software position limit</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Int32</td></tr>
<tr><td>Access</td><td>-</td><td>Mapping</td><td>Yes</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>OD Data Range</td><td>Default</td><td>OD Default Value</td></tr>
<tr><td colspan="11">Defines the minimum and maximum software position limits.
◆ Minimum software position limit = (607D-1h)
◆ Maximum software position limit = (607D-2h)
The software position limit is used to judge the absolute position. When the homing operation is not performed, the software position limit is invalid.
The condition for activating the software position limit is set in the object dictionary 0x200A-02h.
0: No software position limit
1: Software position limit enabled
2: Software position limit enabled after homing The software position limit takes effect on the condition that the homing operation is done upon power-on and bit15 of status word 6041h is set to 1.
If the minimum software position limit is larger than the maximum software position limit, EE09.0 (Software position limit setting error) will occur.
When the position reference or position feedback reaches the internal software position limit, the servo drive takes the position limit as the target position in the position control mode, stops reaching the limit, and reports an overtravel fault. If a reverse displacement command is input, the motor exits from the overtravel state and this bit is cleared.
When both the external DI limit switch and internal software position limit are activated, the overtravel status is determined by the external DI limit switch.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 0h</td><td>Name</td><td colspan="3">Number of sub-indexes for software absolute position limit</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>2</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 2h</td><td>Name</td><td colspan="3">Maximum position limit</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>All</td><td>Data Range</td><td>-2^{31} to $+(2^{31}-1)$ (reference unit)</td><td>Default</td><td>$2^{31}-1$</td></tr>
<tr><td colspan="11">Defines the maximum software position limit relative to the mechanical zero.
Maximum software position limit = (607D-2h)</td></tr>
</table>

Index 607Eh	Name	Polarity			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	RPDO	Related Mode	All	Data Range	0 to 255	Default	00

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

Bit	Description
0 to 4	Not defined
5	Torque reference polarity: 0: Multiply by 1 1: Multiply by -1 PT: Inverting the target torque (6071h) CSP/CSV: Inverting the torque offset (60B2h) CST: Inverting the torque reference (6071h + 60B2h)
6	Speed reference polarity 0: Multiply by 1 1: Multiply by -1 PT: Inverting the target torque (6071h) CSP: Inverting the velocity offset (60B1h) CSV: Inverting the speed reference (60FFh + 60B1h)
7	Position reference polarity 0: Multiply by 1 1: Multiply by -1 PP: Inverting the target position (607Ah) CSP: Inverting the position reference (607Ah + 60B0h)

Index 607Fh	Name	Maximum profile velocity			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP/PV/PT/HM/CST	Data Range	0 to (2^{32} - 1) (reference unit/s)	Default	104857600

Defines the speed limit in PP, PV, PT, CST, and HM modes.

Index 6081h	Name	Profile velocity			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP	Data Range	0 to (2^{32} - 1) (reference unit/s)	Default	174762

Defines the constant operating speed of the target position in PP mode.

Index 6083h	Name	Profile acceleration			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PP/PV	Data Range	0 to (2^{32} - 1) (reference unit/s^2)	Default	174762666

Defines the acceleration rate in the PP mode and PV mode.

In PP mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used.

For 6083h, the setpoint 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 CSP/CSV	Data Range	0 to (2^{32} - 1) (reference unit/s^2)	Default	174762666

Defines the deceleration rate in PP mode and PV mode.

In PP mode, if the value of 6084h exceeds that of 60C6h, the value of 60C6h will be used.

For 6084h, the setpoint 0 will be forcibly changed to 1.

Index 6085h	Name	Quick stop deceleration			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	Yes	Related Mode	PP/PV/HM/ CSP/CSV	Data Range	0 to (2^{32} - 1) (reference unit/s^2)	Default	2147483647

Defines the deceleration rate of ramp-to-stop when the quick stop command is active in the PP, CSV, PV, and HM modes, with 605Ah (Quick stop option code) set to 2 or 6.

Defines the deceleration rate of ramp-to-stop when the quick stop command is active in the PP, CSV, PV, and HM modes, with 605Dh (Quick stop option code) set to 2.

For 6085h, the setpoint 0 will be forcibly changed to 1.

Index 6087h	Name	Torque slope			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	PT/CST	Data Range	0 to (2^{32} - 1) (unit: 0.1%/s)	Default	2^{32} - 1

Defines the acceleration rate (torque increment per second) of the torque reference in PT mode.

In PT and CST modes, if 605A (Quick stop option code) is set to 1, 2, 5, or 6 or 605D (Stop option code) is set to 1 or 2, the servo drive decelerates to stop as defined by 6087h.

If the value of 6087h exceeds the torque reference limit, the limit value will be used.

For 6087h, the setpoint 0 will be forcibly changed to 1.

Index 6091h	Name	Gear ratio			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	-	Mapping	Yes	Related Mode	PP/PV/HM/CSP/CSV	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 electronic gear ratio must be within the following range:

0.001 x Encoder resolution/10000, 4000 x Encoder resolution/10000

If this range is exceeded, EE09.2 (Gear ratio beyond the limit) will occur.

The relation between the motor position feedback (in encoder unit) and the load shaft position feedback (in 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.

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

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

Sub-index 1h	Name	Motor revolutions			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

Defines the resolution of the motor.

Sub-index 2h	Name	Shaft resolutions Shaft revolutions			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

Defines the resolution of the load shaft.

The gear ratio is within the following range: 0.001 x Encoder resolution/10000 to 4000 x Encoder resolution/10000.

If this range is exceeded, EE09.2 (Gear ratio beyond the limit) will occur.

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	Data Range	-2 to +35	Default	0

Defines the homing method.

Value	Description
-2	Forward homing, positive mechanical limit as the deceleration point, and motor Z signal as the home
-1	Reverse homing, negative mechanical limit as the deceleration point, and motor Z signal as the home
1	Reverse homing, negative limit switch as the deceleration point, and motor Z signal as the home. The falling edge of the N-OT signal must be reached before Z signal.
2	Forward homing, positive limit switch as the deceleration point, and motor Z signal as the home. The falling edge of the P-OT signal must be reached before Z signal.
3	Forward homing, home switch as the deceleration point, and motor Z signal as the home. The falling edge on the same side of the home switch must be reached before Z signal.
4	Reverse homing, home switch as the deceleration point, and motor Z signal as the home. The rising edge on the same side of the home switch must be reached before Z signal.
5	Reverse homing, home switch as the deceleration point, and motor Z signal as the home. The falling edge on the same side of the home switch must be reached before Z signal.
6	Forward homing, home switch as the deceleration point, and motor Z signal as the home. The rising edge on the same side of the home switch must be reached before Z signal.
7	Forward homing, home switch as the deceleration point, and motor Z signal as the home. The falling edge on the same side of the home switch must be reached before Z signal.
8	Forward homing, home switch as the deceleration point, and motor Z signal as the home. The rising edge on the same side of the home switch must be reached before Z signal.
9	Forward homing, home switch as the deceleration point, and motor Z signal as the home. The rising edge on the other side of the home switch must be reached before Z signal.
10	Forward homing, home switch as the deceleration point, and motor Z signal as the home. The falling edge on the other side of the home switch must be reached before Z signal.
11	Reverse homing, home switch as the deceleration point, and motor Z signal as the home. The falling edge on the same side of the home switch must be reached before Z signal.
12	Reverse homing, home switch as the deceleration point, and motor Z signal as the home. The rising edge on the same side of the home switch must be reached before Z signal.
13	Reverse homing, home switch as the deceleration point, and motor Z signal on the other side of the home switch as the home. The rising edge on the other side of the home switch must be reached before Z signal.
14	Reverse homing, home switch as the deceleration point, and motor Z signal on the other side of the home switch as the home. The falling edge on the other side of the home switch must be reached before Z signal.
15 to 16	N/A
17 to 32	Similar to 1 to 14, except that the deceleration point coincides with the home.
33	Reverse homing, motor Z signal as the home
34	Forward homing, motor Z signal as the home
35	Current position as the home

Index 6099h	Name	Homing speeds			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	-	Mapping	Yes	Related Mode	HM	Data Range	OD Data Range	Default	OD Default Value

Defines the two speed values used in the homing mode.

1. Speed during search for switch

2. 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	-	Data Range	2	Default	2

Sub-index 1h	Name	Speed during search for switch			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	HM	Data Range	0 to (2^{32} - 1) (reference unit/s)	Default	1747627
Defines the speed during search for the deceleration point signal. A large setpoint helps prevent E601.0 (Homing timeout) Note: ◆ After finding the deceleration point, the slave decelerates and blocks the change of the home signal during deceleration. To prevent the slave from 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.										

Sub-index 2h	Name	Speed during search for zero			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Int32
	Access	RW	Mapping	RPDO	Related Mode	HM	Data Range	10 to (2^{32} - 1) (reference unit/s)	Default	100
This sub-index defines the speed during search for the home signal. Set this sub-index to a small value to prevent overshoot during stop at a high speed. This is to avoid large deviation between the stop position and the preset mechanical home.										

Index 609Ah	Name	Homing acceleration			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	HM	Data Range	0 to (2^{32} - 1) (reference unit/s^2)	Default	100
Defines the acceleration rate in the homing mode. The setpoint takes effect after the homing operation is started. In the homing mode, if 605Dh (Stop option code) is set to 2, the servo drive decelerates to stop as defined by 609Ah. This object dictionary indicates the position reference (in reference unit) increment per second. For 609Ah, the setpoint 0 will be forcibly changed to 1.										

Index 60B0h	Name	Position offset			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Int32
	Access	RW	Mapping	RPDO	Related Mode	CSP	Data Range	-2^{31} to +(2^{31} - 1) (reference unit)	Default	0
Defines the position reference offset in CSP mode. The target position of the servo drive is the sum of 607Ah and 60B0h.										

<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 & At stop</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>Data Range</td><td>-2^{31} to $+(2^{31} - 1)$ (reference unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the external speed feedforward signal of EtherCAT in CSP mode (activated when 2005-14h is set to 2). 60B1h can be used to reduce the position deviation during positioning. After positioning is done, set the velocity offset to 0. Failure to comply will lead to deviation between the target position and the position feedback.
You can also set the speed reference offset in the CSV 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 & 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>RPDO</td><td>Related Mode</td><td>CSP/CSV/CST</td><td>Data Range</td><td>-3000 to +3000 (unit: 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).
Defines the torque reference offset in CST mode. The target torque is the sum of 6071h and 60B2h.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index
60B8h</td><td>Name</td><td colspan="3">Touch probe function</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>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
</table>

Defines the functions of touch probe 1 and touch probe 2.

The definition of each bit of 60B8h is shown in the following table.

For absolute encoders, Z signal refers to zero position of each revolution.

<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 the touch probe 1
When a DI is used to trigger the touch probe function, the DI source is non-modifiable once the touch probe function is enabled.
For an absolute encoder, Z signal refers to the zero point of the single-turn position feedback.</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 latching at positive edge
1: Enable latching at positive edge</td></tr>
<tr><td>5</td><td>Touch probe 1 negative edge
0: Switch off latching at negative edge
1: Enable latching at negative edge</td></tr>
<tr><td>6 to 7</td><td>N/A</td><td></td></tr>
<tr><td>8</td><td>Touch probe 2 function selection
0: Switch off touch probe 2
1: Enable touch probe 2</td><td rowspan="6">Bit8 to Bit13: settings related to the touch probe 2</td></tr>
<tr><td>9</td><td>Touch probe 2 trigger mode
0: Single trigger mode (Latches the position at the first trigger event.)
1: Continuous trigger mode</td></tr>
<tr><td>10</td><td>Touch probe 2 trigger signal selection
0: DI signal
1: Z signal</td></tr>
<tr><td>11</td><td>N/A</td></tr>
<tr><td>12</td><td>Touch probe 2 positive edge
0: Switch off latching at positive edge
1: Enable latching at positive edge</td></tr>
<tr><td>13</td><td>Touch probe 2 negative edge
0: Switch off latching at negative edge
1: Enable latching at negative edge</td></tr>
<tr><td>14 to 15</td><td>N/A</td><td></td></tr>
</table>

Index 60B9h	Name	Touch probe status			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	-	Default	-

Indicates the status of touch probe 1 and touch probe 2.

Bit	Description	
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 latched 1: Positive edge value latched	
2	Touch probe 1 negative edge value 0: No negative edge value latched 1: Negative edge value latched	
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 latched 1: Positive edge value latched	
10	Touch probe 2 negative edge value 0: No negative edge value latched 1: Negative edge value latched	
11 to 15		

Index 60BAh	Name	Touch probe 1 positive edge			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	- (reference unit)	Default	-

Indicates the position value of the touch probe 1 at positive edge (reference unit).

Index 60BBh	Name	Touch probe 1 negative edge			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	- (reference unit)	Default	-

Indicates the position value of the touch probe 1 at negative edge (reference unit).

Index 60BCh	Name	Touch probe 2 positive edge			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	- (reference unit)	Default	-
Indicates the position value of the touch probe 2 at positive edge (reference unit).										

Index 60BDh	Name	Touch probe 2 negative edge			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	- (reference unit)	Default	-
Indicates the position value of the touch probe 2 at negative edge (reference unit).										

Index 60E0h	Name	Positive torque limit value			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Data Range	0 to 3000 (unit: 0.1%)	Default	3000
Defines the maximum torque limit of the servo drive in the forward direction.										

Index 60E1h	Name	Negative torque limit value			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Data Range	0 to 3000 (unit: 0.1%)	Default	3000
Defines the maximum torque limit of the servo drive in the reverse direction.										

Index 60E3h	Name	Supported homing methods			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	HM	Data Range	OD Data Range	Default	OD Default Value
Indicates the supported homing methods.										

Sub-index 00h	Name	Number of homing mode sub-indexes			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	31

<table>
<tr><td rowspan="2">Sub-index 01h</td><td>Name</td><td colspan="3">Supported homing method 1</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>0301h</td></tr>
<tr><td colspan="11">
<table>
<tr><td>bit0 to bit7</td><td>The low 8 bits indicate the supported homing method. Set 6098h to the corresponding value.</td></tr>
<tr><td>bit8</td><td>Relative homing supported or not:
No
Yes</td></tr>
<tr><td>bit9</td><td>Absolute homing supported or not:
No
Yes</td></tr>
<tr><td>bit10 to bit15</td><td>N/A</td></tr>
</table>
Defines whether to use relative homing or absolute homing.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 02h</td><td>Name</td><td colspan="3">Supported homing method 2</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>0302h</td></tr>
<tr><td colspan="11">The low 8 bits indicate the supported homing method.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 03h</td><td>Name</td><td colspan="3">Supported homing method 3</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>0303h</td></tr>
<tr><td colspan="11">The low 8 bits indicate the supported homing method.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 04h</td><td>Name</td><td colspan="3">Supported homing method 4</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>0304h</td></tr>
<tr><td colspan="11">The low 8 bits indicate the supported homing method.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 05h</td><td>Name</td><td colspan="3">Supported homing method 5</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>0305h</td></tr>
<tr><td colspan="11">The low 8 bits indicate the supported homing method.</td></tr>
</table>

<table>
<tr><td rowspan="2">Sub-index 06h</td><td>Name</td><td colspan="3">Supported homing method 6</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>-</td><td>Default</td><td>0306h</td></tr>
<tr><td colspan="11">The low 8 bits indicate the supported homing method.</td></tr>
</table>

Sub-index 07h	Name	Supported homing method 7		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0307h
The low 8 bits indicate the supported homing method.										

Sub-index 08h	Name	Supported homing method 8		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0308h
The low 8 bits indicate the supported homing method.										

Sub-index 09h	Name	Supported homing method 9		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0309h
The low 8 bits indicate the supported homing method.										

Sub-index 0Ah	Name	Supported homing method 10		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	030Ah
The low 8 bits indicate the supported homing method.										

Sub-index 0Bh	Name	Supported homing method 11		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	030Bh
The low 8 bits indicate the supported homing method.										

Sub-index 0Ch	Name	Supported homing method 12		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	030Ch
The low 8 bits indicate the supported homing method.										

Sub-index 0Dh	Name	Supported homing method 13		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	030Dh
The low 8 bits indicate the supported homing method.										

Sub-index 0Eh	Name	Supported homing method 14		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	030Eh
The low 8 bits indicate the supported homing method.										

Sub-index 0Fh	Name	Supported homing method 15		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	030Fh
The low 8 bits indicate the supported homing method.										

Sub-index 10h	Name	Supported homing method 16		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0310h
The low 8 bits indicate the supported homing method.										

Sub-index 11h	Name	Supported homing method 17		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0311h
The low 8 bits indicate the supported homing method.										

Sub-index 12h	Name	Supported homing method 18		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0312h
The low 8 bits indicate the supported homing method.										

Sub-index 13h	Name	Supported homing method 19		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0313h
The low 8 bits indicate the supported homing method.										

Sub-index 14h	Name	Supported homing method 20		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0314h
The low 8 bits indicate the supported homing method.										

Sub-index 15h	Name	Supported homing method 21		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0315h

The low 8 bits indicate the supported homing method.

Sub-index 16h	Name	Supported homing method 22		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0316h

The low 8 bits indicate the supported homing method.

Sub-index 17h	Name	Supported homing method 23		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0317h

The low 8 bits indicate the supported homing method.

Sub-index 18h	Name	Supported homing method 24		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0318h

The low 8 bits indicate the supported homing method.

Sub-index 19h	Name	Supported homing method 25		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0319h

The low 8 bits indicate the supported homing method.

Sub-index 1Ah	Name	Supported homing method 26		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	031Ah

The low 8 bits indicate the supported homing method.

Sub-index 1Bh	Name	Supported homing method 27		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	031Bh

The low 8 bits indicate the supported homing method.

Sub-index 1Ch	Name	Supported homing method 28		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	031Ch

The low 8 bits indicate the supported homing method.

Sub-index 1Dh	Name	Supported homing method 29		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	031Dh

The low 8 bits indicate the supported homing method.

Sub-index 1Eh	Name	Supported homing method 30		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	031Eh

The low 8 bits indicate the supported homing method.

Sub-index 1Fh	Name	Supported homing method 31		Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	031Fh

The low 8 bits indicate the supported homing method.

Index 60E6h	Name	Actual position calculation method		Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	No	Related Mode	HM	Data Range	0 to 1	Default	0

Defines the mode for processing the position offset after homing is done.

Setpoint	Actual position calculation mode
0	Absolute homing After homing is done, the following formula applies: 6064h (Position actual value) = 607Ch (Home offset)
1	Relative homing After homing is done, the following formula applies: 6064h (Position actual value) = Present position feedback value + 607Ch (Home offset)

After homing is triggered, any change on this object will be blocked.

Index 60F4h	Name	Following error actual value		Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	PP/HM/CSP	Data Range	(reference unit)	Default	-

Indicates the position deviation (reference unit).

Index 60FCh	Name	Position demand value*		Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	PP/HM/ CSP	Data Range	(encoder unit)	Default	-

Indicates the position reference (encoder unit).

If no warning is detected when the S-ON signal is active, the relation between position references in reference unit and those in encoder unit is as follows:

60FCh (in encoder unit) = 6062h (reference unit) x 6091h

Index 60FDh	Name	Digital input			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Related Mode	-	Data Range	0 to FFFFFFFF	Default	0

Indicates current DI logic of the servo drive.

0: Inactive

1: Active

The DI signal indicated by each bit is described as follows:

Bit	Signal
0	1: Reverse overtravel active
1	1: Forward overtravel active
2	1: Home signal active
3 to 15	N/A
16	1: DI1 function active
17	1: DI2 function active
18	1: DI3 function active
19	1: DI4 function active
20	1: DI5 function active
21 to 26	N/A
27	1: STO1 signal input
28	1: STO2 signal input
29	1: EDM output active
30 to 31	N/A

Index 60FEh	Name	Digital output			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	-	Mapping	Yes	Related Mode	-	Data Range	OD Data Range	Default	OD Default Value

Indicates the current DO logic of the servo drive.

Sub-index 0h	Name	Number of digital output sub-indexes			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	x02

Sub-index 1h	Name	Physical output			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	-	Data Range	0 to FFFFFFFF	Default	0

Indicates the DO logic.

The signal indicated by each bit is described as follows:

Bit	Related Signal	Description
0 to 15	N/A	
16	DO1	Forced output (0: OFF; 1: ON), only when H0D-17 is set to 4 and bit16 of 60FE-02 is set to 1
17	DO2	Forced output (0: OFF; 1: ON), only when H0D-17 is set to 4 and bit17 of 60FE-02 is set to 1
18	DO3	Forced output (0: OFF; 1: ON), only when H0D-17 is set to 4 and bit18 of 60FE-02 is set to 1
19 to 25	N/A	
26	Gain switchover	Switched between P and PI, only when bit26 of 60FE-02 is set to 1
27 to 31	N/A	

Sub-index 2h	Name	Bit mask			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	No	Related Mode	-	Data Range	0 to FFFFFFFF	Default	0

Defines whether to enable the forced DO function.

The signal indicated by each bit is described as follows:

Bit	Related DO	Description
0 to 15	N/A	
16	DO1	H0D-17 = 4, forced output enabled in DO1
17	DO2	H0D-17 = 4, forced output enabled in DO2
18	DO3	H0D-17 = 4, forced output enabled in DO3
19 to 25	N/A	
26	Gain switchover	Switchover between P and PI enabled
27 to 31	N/A	

Index 60FFh	Name	Target velocity			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	Int32
	Access	RW	Mapping	Yes	Related Mode	PV/CSV	Data Range	-2^{31} to $+(2^{31} - 1)$ (reference unit/s)	Default	0

Defines the target velocity in PV and CSV modes.

The maximum operating speed of the motor in CSV mode is determined by the maximum rotational speed of the motor.

Index 6502h	Name	Supported drive modes			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	0x000003ADh

Shows the servo drive modes supported.

Bit	Description	Supported or Not (0: No 1: Yes)
0	Profile position (PP) mode	1
1	Variable frequency velocity (VL) mode	0
2	Profile velocity (PV) mode	1
3	Profile torque mode (PT)	1
4	N/A	0
5	Homing (HM) mode	1
6	Interpolated position (IP) mode	0
7	Cyclic synchronous position (CSP) mode	1
8	Cyclic synchronous velocity (CSV) mode	1
9	Cyclic synchronous torque (CST) mode	1
10 to 31	Defined by the manufacturer.	Reserved

If the device supports 6502h, you can get the supported servo drive modes through 6502h.

9 Communication Configurations

9.1 Overview of 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 sub-bus 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: synchronization jitter < 1 μs (number of nodes up to 300, cable length within 120 m)
- 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 bytes IN + 8 bytes 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 have been 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.

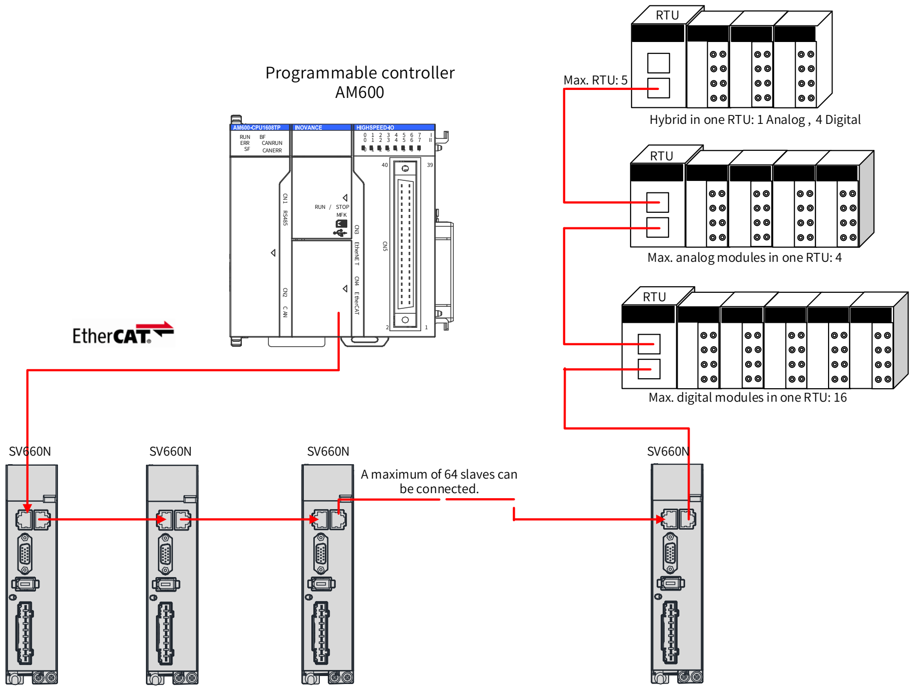


Figure 9-1 EtherCAT network

NOTE

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

9.2 System Parameters

9.2.1 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

9.2.2 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 control mode 1: Position control mode 2: Torque control mode 9: EtherCAT mode 255: This axis is not used.	9
200E	02h	Save objects written through communication to EEPROM	0: Not save 1: Save parameters only 2: Save object dictionaries only 3: Save both parameters and object dictionaries	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 default values at next power-on.

9.3 EtherCAT Communication Basis

9.3.1 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)

9.3.2 Communication Structure

Multiple kinds of application protocols can be transmitted using EtherCAT communication. The IEC 61800-7 (CiA 402)-CANopen motion control profile is used in the SV660N servo drive.

The following figure shows the EtherCAT communication structure with CANopen application layer.

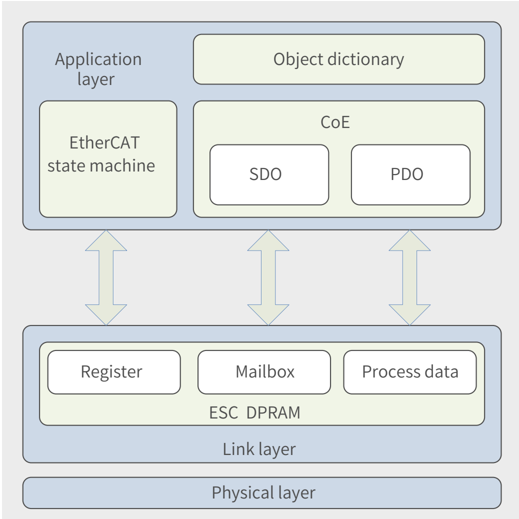


Figure 9-2 EtherCAT communication structure with CANopen application layer

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 operation, which is read and written cyclically. In the SDO mailbox communication, the communication parameter objects and PDO objects are accessed and modified non-cyclically.

9.3.3 State Machine

The following figure shows the state transition diagram of the EtherCAT state machine.

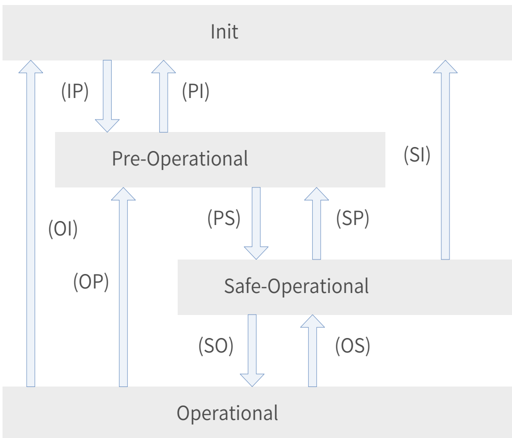


Figure 9-3 EtherCAT state machine

The EtherCAT state machine must support the following four states and coordinate the state relation between the master and slave application programs during initialization and operation.

These four states are Init (I), Pre-Operational (P), Safe-Operational (S), and Operational (O).

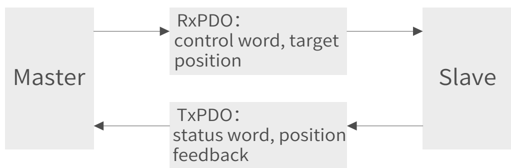
Transition from Init state to Operational state must be in the sequence of "Init → Pre-Operational → Safe-Operational → Operational". Transition from Operational state to Init state can be done with certain states skipped. The following table lists the state transition and initialization process.

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 address, 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 operating state Both the inputs and outputs are valid. Mailbox communication can still be used.

9.3.4 Process Data

The real-time data transmission of EtherCAT is achieved through PDO. The PDO can be divided into RPDO (Receive PDO) and TPDO (Transmit 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

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 (4 mapping objects, 12 bytes)
	6040h (Control word) 607Ah (Target position) 60B8h (Touch probe function) 60FEh sub-index 1 (Physical outputs)
1B01h (Inputs)	Mapping objects (9 mapping objects, 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 mapping objects, 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 mapping objects, 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 mapping objects, 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 mapping objects, 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 mapping objects, 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 mapping objects, 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 mapping objects, 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 mapping objects, 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 variable RPDO and one variable 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

The process data can contain multiple PDO mapping objects during EtherCAT cyclic data communication. The CoE protocol defines the PDO mapping object list of the sync manager using data objects 0x1C10 to 0x1C2F. Multiple 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...0x1705 used as the actual RPDO
0x1C13	01h	One of 0x1A00 and 0x1B01...0x1B04 used as the actual TPDO

5 PDO configuration

PDO mapping parameters contain 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 procedure 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 of the servo drive.

An SDO fault code will be returned during the following operations:

- PDO parameters are modified in a state other than Pre-Operational.
- A value outside 1600/1701...1705 is written to 1C12h or a value outside 1A00/1B01...1B04 is written to 1C13h.

9.3.5 Service Data Object (SDO)

EtherCAT SDO is used to transfer non-cyclic data, such as communication parameter configuration and servo drive 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

SV660N series servo drives support SDO request and SDO response.

9.3.6 Distributed Clock (DC)

The DC enables all EtherCAT devices to use the same system time and allows synchronous execution of slave tasks. 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.

9.3.7 Status Indication

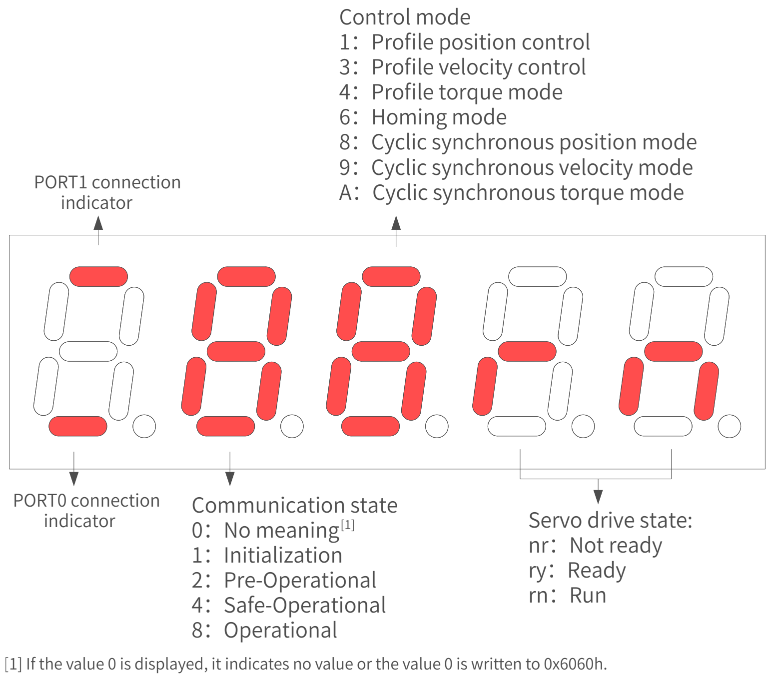


Figure 8-2 Status indication

■ Communication connection status

The connection status of the two RJ45 ports are indicated by segment "-" 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 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	Keypad Display
Init	No	No	No	Communication initialization	"1": solid ON
Pre-Operational	Yes	No	No	Network configuration initialized SDO available	"2": blinking at an interval of 400 ms
Safe-Operational	Yes	No	Yes	SDO and TPDO available, distributed clock mode available	"4": blinking at an interval of 1200 ms, ON for 200 ms and OFF for 1000 ms
Operational	Yes	Yes	Yes	Normal operational state	"8": solid ON

■ Servo mode display

The 3rd LED on the keypad indicates the present control mode of the servo drive, as described in the following table.

Modes of operation (6060h)	Keypad 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 on the keypad indicate the servo (slave) status, as described in the following table.

Status	Description	Keypad Display
Reset	Init	"Reset"
Not ready	Initialization is done. The control circuit is switched on but the main circuit is still off. Not ready	"nr"
Ready	The main circuit is switched on but the S-ON signal is inactive. 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 active 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.

9.3.8 Overview of CiA402 Control

The SV660N servo drive can run in the specified status only when it is commanded according to the flowchart defined in the standard CiA402 protocol.

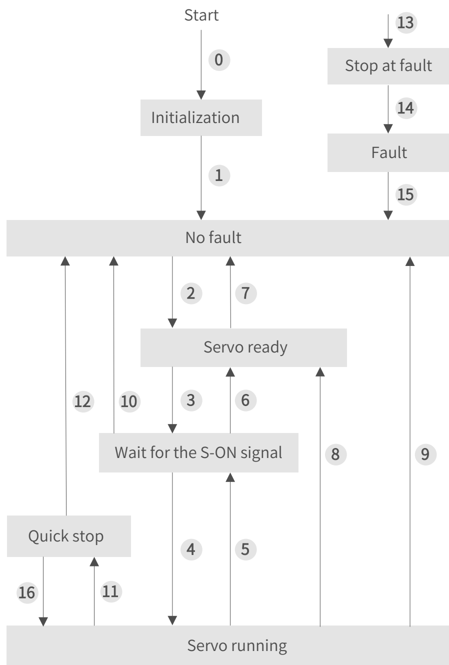


Figure 8-3 Switchover of CiA402 state machine

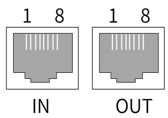
The states are described in the following table.

Initialization	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.
Servo ready	The servo drive is ready. Parameters can be set.
Wait for the S-ON signal	The servo drive is waiting to be switched on. Parameters can be set.
Servo running	The servo drive is running properly and a certain operation 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.

9.3.9 Basic Characteristics

■ Interfaces

EtherCAT cables are connected to the network ports (IN and OUT) equipped with metal shield. The electrical characteristics are compliant with IEEE 802.3 and ISO 8877 standards.

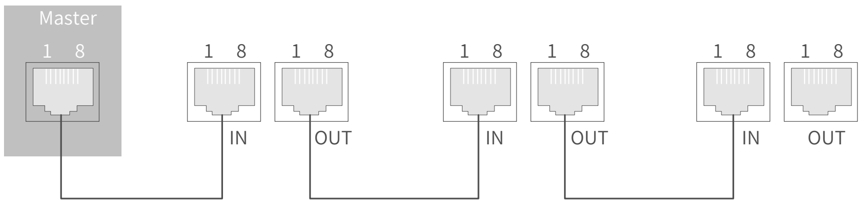


Pin	Definition	Description
1	TX+	Data transmitting (+)
2	TX-	Data transmitting (-)
3	RX+	Data receiving (+)
4	NULL	Not connected
5	NULL	Not connected
6	RX-	Data receiving (-)
7	NULL	Not connected
8	NULL	Not connected

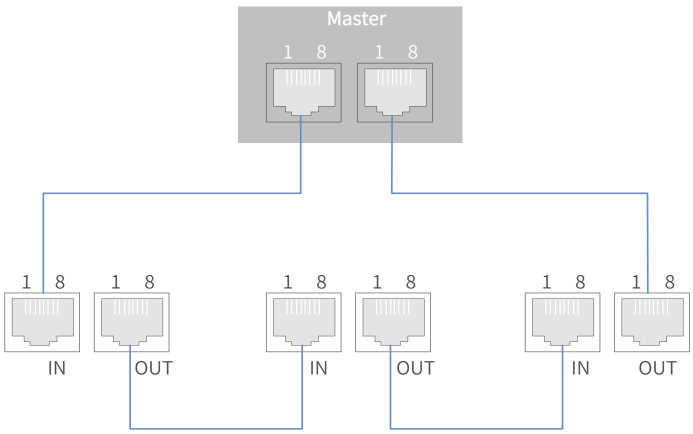
■ Topology connection

EtherCAT features flexible communication topological structure without any limit, as shown in the following figures. The SV660N series servo drive carries IN and OUT ports.

■ Linear connection



■ Redundancy ring connection



■ Communication cable

The EtherCAT communication cable must be Ethernet Category 5 (100BASE-TX) network cable or high-strength shielded network cable. The network cables used for the servo drive must also be shielded with cable length not exceeding 100 m. The shielded network cable enhances the anti-interference capacity of the system.

■ EMC standards

The servo drive complies with the following standards:
IEC 61800-3:2004/A1:2011 (Adjustable speed electrical power drive systems---part 3:EMC requirements and specific test methods) and GB/T12688.3.

10 Troubleshooting

10.1 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 once receiving the reset signal.

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 or No. 2 fault, turn off the S-ON signal and send a fault reset signal.

For 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	Used to stop the keypad from displaying the fault/warning when a resettable fault/warning occurs. After fault/warning reset, 200Dh-02h is restored to 0 (No operation) immediately.	At stop	Immediately	0

- Solutions to faults and warnings occurred upon start

Start Process	Fault Symptom	Cause	Confirming Method
Switch on the control power supply (L1C, L2C) and main power supply (L1, L2, L3).	The LED neither lights up nor displays "ry".	1. The voltage of the control circuit power supply is abnormal.	Check whether the value of H0B-63 is 1. Measure the AC voltage between L1C and L2C.
		2. Phase loss occurs on the input power supply.	Check whether the value of H0B-63 is 2. Voltage must be present in all the phases of a three-phase 380 V power supply.
		3. The voltage of the main circuit power supply is abnormal.	Check whether the value of H0B-63 is 3. ◆ For single-phase 220 V models, measure the AC voltage between L1 and L2. The keypad displays "nr" when the DC bus voltage amplitude (between terminals P and N) of the main circuit power supply is lower than 235 V. ◆ For three-phase 220 V/380 V models, measure the AC voltage among L1, L2, and L3. The keypad displays "nr" when the DC bus voltage amplitude (between terminals P and N) of the main circuit power supply is lower than 235 V/451 V.
		4. The servo drive is faulty.	-
	The keypad displays "Exxx.x".	See "10.3 Solutions to Faults" and "10.4 Solutions to Warnings" for solutions.	
	The keypad displays "ry" when preceding faults are cleared.		

10.2 Communication Faults and Warning Codes

■ List of fault codes

Fault	Display	Name	Type	Reset	Fault Range	Error Code (603Fh)	Auxiliary Code (203Fh)
E101	E101.0	System parameter error	No.1	No	Servo drive fault	0x6320	0x01010101
	E101.1	2000h/2001h parameter error	No.1	No	Servo drive fault	0x6320	0x11010101
E102	E102.0	FPGA communication initialization error	No.1	No	Servo drive fault	0x7500	0x01020102
	E102.8	Software version mismatch	No.1	No	Servo drive fault	0x7500	0x81020102
E104	E104.1	MCU operation timeout	No.1	No	Servo drive fault	0x7500	0x11040104
	E104.2	Current loop operation timeout	No.1	No	Servo drive fault	0x7500	0x21040104
	E104.4	MCU reference update timeout	No.1	No	Servo drive fault	0x7500	0x41040104
E108	E108.0	Parameter write error	No.2	Yes	Servo drive fault	0x5530	0x01080108
	E108.1	Parameter read error	No.2	Yes	Servo drive fault	0x5530	0x11080108
	E108.2	Invalid check on data written in EEPROM	No.2	Yes	Servo drive fault	0x5530	0x21080108
	E108.3	Invalid check on data read in EEPROM	No.2	Yes	Servo drive fault	0x5530	0x31080108
E120	E120.0	Unknown encoder type	No.1	No	Axis fault	0x7122	0x01200120
	E120.1	Unknown motor model	No.1	No	Axis fault	0x7122	0x11200120
	E120.2	Unknown drive model	No.1	No	Axis fault	0x7122	0x21200120
	E120.5	Motor current and drive current mismatch	No.1	No	Axis fault	0x7122	0x51200120
	E120.6	FPGA and motor model mismatch	No.1	No	Axis fault	0x7122	0x61200120
E122	E122.0	Multi-turn absolute encoder setting error	No.2	Yes	Axis fault	0x6320	0x01220122
	E122.1	Different DIs assigned with the same function	No.2	Yes	Axis fault	0x6320	0x11220122
	E122.3	Upper limit invalid	No.2	Yes	Axis fault	0x6320	0x31220122
E136	E136.0	Encoder parameter error	No.1	No	Axis fault	0x7305	0x01360136
	E136.1	Encoder communication error	No.1	No	Axis fault	0x7305	0x11360136
E140	E140.0	Encryption chip check error	No.1	No	Servo drive fault	0x0140	0x01400140
	E140.1	Encryption chip check failure	No.1	No	Servo drive fault	0x0140	0x01400140
E150	E150.0	STO signal input protection activated	No.1	Yes	Servo drive fault	0x0150	0x01500150
	E150.1	STO signal input error	No.1	Yes	Servo drive fault	0x0150	0x11500150
	E150.2	Abnormal voltage detected	No.1	Yes	Servo drive fault	0x0150	0x21500150
	E150.3	STO upstream optocoupler detection failure	No.1	Yes	Servo drive fault	0x0150	0x31500150
	E150.4	PWM Buffer detection failure	No.1	Yes	Servo drive fault	0x0150	0x41500150
E201	E201.0	Phase-P overcurrent	No.1	No	Servo drive fault	0x2312	0x02010201
	E201.1	Phase-U overcurrent	No.1	No	Axis fault	0x2312	0x12010201
	E201.2	Phase-V overcurrent	No.1	No	Axis fault	0x2312	0x22010201
	E201.4	Phase-N overcurrent	No.1	No	Servo drive fault	0x2312	0x42010201

Fault	Display	Name	Type	Reset	Fault Range	Error Code (603Fh)	Auxiliary Code (203Fh)
E208	E208.0	MCU position reference updated frequently	No.1	Yes	Axis fault	0x0208	0x02080208
	E208.2	Encoder communication timeout	No.1	Yes	Axis fault	0x0208	0x22080208
	E208.3	Current sampling fault	No.1	Yes	Axis fault	0x0208	0x32080208
	E208.4	FPGA current loop operation timeout	No.1	Yes	Axis fault	0x0208	0x42080208
E210	E210.0	Output short-circuited to ground	No.1	No	Axis fault	0x2330	0x02100210
E234	E234.0	Runaway protection	No.1	No	Axis fault	0x0234	0x02340234
E400	E400.0	Main circuit overvoltage	No.1	Yes	Servo drive fault	0x3210	0x04000400
E410	E410.0	Main circuit undervoltage	No.1	Yes	Servo drive fault	0x3220	0x04100410
E420	E420.0	Phase loss fault	No.2	Yes	Servo drive fault	0x3130	0x04200420
E430	E430.0	Control circuit undervoltage	No.2	Yes	Servo drive fault	0x0430	0x04300430
E500	E500.0	Motor overspeed	No.1	Yes	Axis fault	0x8400	0x05000500
	E500.1	Speed feedback overflow	No.1	Yes	Axis fault	0x8400	0x15000500
	E500.2	FPGA position feedback pulse overspeed	No.1	Yes	Axis fault	-	0x25000500
E602	E602.0	Angle auto-tuning error	No.1	Yes	Axis fault	0x0602	0x06020602
	E602.2	Wrong UVW phase sequence detected during angle auto-tuning	No.1	Yes	Axis fault	0x0602	0x26020602
E605	E605.0	Speed upon S-ON too high	No.1	Yes	Axis fault	0x8400	0x06050605
E620	E620.0	Motor overload	No.1	Yes	Axis fault	0x3230	0x06200620
E630	E630.0	Motor stall	No.1	Yes	Axis fault	0x7121	0x06300630
E640	E640.0	IGBT over-temperature	No.1	Yes	Axis fault	0x4210	0x06400640
	E640.1	Flywheel diode over-temperature	No.1	Yes	Axis fault	0x4210	0x06400640
E650	E650.0	Heatsink over-temperature	No.1	Yes	Axis fault	0x4210	0x06500650
E660	E660.0	Air-cooled motor over-temperature	No.1	Yes	Axis fault	0x4210	0x06600660
E661	E661.0	Auto-tuned gains too low	No.2	Yes	Axis fault	0x4210	0x06610661
E731	E731.0	Encoder battery failure	No.2	Yes	Axis fault	0x0661	0x07310731
E733	E733.0	Encoder multi-turn counting error	No.2	Yes	Axis fault	0x7305	0x07330733
E735	E735.0	Encoder multi-turn counting overflow	No.2	Yes	Axis fault	0x7305	0x07350735
E740	E740.2	Absolute encoder error	No.1	No	Axis fault	0x7305	0x27400740
	E740.3	Absolute encoder single-turn calculation error	No.1	No	Axis fault	0x7305	0x37400740
	E740.6	Encoder write error	No.1	No	Axis fault	0x7305	0x67400740
E755	E755.0	Nikon encoder communication failure	No.1	No	Axis fault	-	0x07550755
E760	E760.0	Encoder over-temperature	No.2	Yes	Axis fault	0x4210	0x07600760
E765	E765.0	Nikon encoder beyond the limit	No.1	No	Axis fault	-	0x07650765
EB00	EB00.0	Position deviation too large	No.2	Yes	Axis fault	0x8611	0x0B000B00
	EB00.1	Position deviation overflow	No.2	Yes	Axis fault	0x8611	0x1B000B00
EA33	EA33.0	Encoder read/write check error	No.1	No	Axis fault	0x7305	0x0A330A33

Fault	Display	Name	Type	Reset	Fault Range	Error Code (603Fh)	Auxiliary Code (203Fh)
EB01	EB01.1	Position reference increment too large for once	No.2	Yes	Axis fault	0x6320	0x1B010B01
	EB01.2	Position reference increment too large continuously	No.2	Yes	Axis fault	0x6320	0x2B010B01
	EB01.3	Reference overflow	No.2	Yes	Axis fault	0x6320	0x3B010B01
	EB01.4	EB01.4: Target position beyond upper/lower limit	No.2	Yes	Axis fault	0x6320	0x4B010B01
EE09	EE09.0	Software position limit setting error	No.2	Yes	Axis fault	0x6320	0x0E090E09
	EE09.1	Home setting error	No.2	Yes	Axis fault	0x6320	0x1E090E09
	EE09.2	Gear ratio beyond the limit	No.2	Yes	Axis fault	0x6320	0x2E090E09
	EE09.3	No synchronization signal	No.2	Yes	Axis fault	0x6320	0x3E090E09
	EE09.5	PDO mapping beyond the limit	No.2	Yes	Axis fault	0x6320	0x5E090E09
EE08	EE08.0	SYNC signal loss	No.2	Yes	Axis fault	0x0FFF	0x0E086E08
	EE08.1	Network status switchover error	No.2	Yes	Axis fault	0x0FFF	0x1E080E08
	EE08.2	IRQ loss	No.2	Yes	Axis fault	0x0FFF	0x2E080E08
	EE08.3	LAN cable connected improperly	No.2	Yes	Axis fault	0x0FFF	0x3E080E08
	EE08.4	Data frame loss protection error	No.2	Yes	Axis fault	0x0FFF	0x4E080E08
	EE08.5	Data frame transfer error	No.2	Yes	Axis fault	0x0FFF	0x5E080E08
	EE08.6	Data update timeout	No.2	Yes	Axis fault	0x0FFF	0x6E080E08
EE11	EE11.0	ESI check error	No.2	Yes	Servo drive fault	0x5530	0x0E110E11
	EE11.1	EEPROM read failure	No.2	Yes	Servo drive fault	0x5530	0x1E110E11
	EE11.2	EEPROM update failure	No.2	Yes	Servo drive fault	0x5530	0x2E110E11
EE12	EE12.0	EtherCAT external device error	No.1	No	Servo drive fault	0x0E12	0x0E120E12
EE13	EE13.0	Synchronization cycle setting error	No.2	Yes	Servo drive fault	0x6320	0x0E130E13
EE15	EE15.0	Number of synchronization cycle errors too large	No.2	Yes	Servo drive fault	0x0E15	0x0E150E15

■ List of warning codes

Warning	Display	Name	Type	Resettable or not	Fault Range	Error Code (603Fh)	Auxiliary Code (203Fh)
E121	E121.0	Invalid S-ON command	No.3	Yes	Warning	0x0121	0x01210121
E600	E600.0	Inertia auto-tuning failure	No.3	Yes	Warning	0x0600	0x06000600
E601	E601.0	Homing timeout	No.3	Yes	Warning	0x0601	0x06010601
	E601.1	Home switch error	No.3	Yes	Warning	0x0601	0x16010601
	E601.2	Homing mode setting error	No.3	Yes	Warning	0x6320	0x2601E602
E730	E730.0	Encoder battery warning	No.3	Yes	Warning	0x7305	0x07300730
E900	E900.0	Emergency stop	No.3	Yes	Warning	0x0900	0x09000900
E902	E902.0	Invalid DI setting	No.3	Yes	Warning	0x6320	0x09020902
	E902.1	Invalid DO setting	No.3	Yes	Warning	0x0902	0x19020902
E908	E908.0	Model identification check byte invalid	No.3	Yes	Warning	0x0908	0x09080908
E909	E909.0	Motor overload warning	No.3	Yes	Warning	0x3230	0x09090909
E920	E920.0	Regenerative resistor overload	No.3	Yes	Warning	0x3210	0x09200920

Warning	Display	Name	Type	Resettable or not	Fault Range	Error Code (603Fh)	Auxiliary Code (203Fh)
E922	E922.0	Resistance of external regenerative resistor too small	No.3	Yes	Warning	0x6320	0x09220922
E924	E924.0	Braking transistor over-temperature	No.3	Yes	Warning	0x3230	0x09240924
E941	E941.0	Parameter modifications not activated	No.3	Yes	Warning	0x6320	0x09410941
E942	E942.0	Parameter saved frequently	No.3	Yes	Warning	0x7600	0x09420942
E950	E950.0	Forward overtravel warning	No.3	Yes	Warning	0x5443	0x09500950
E952	E952.0	Reverse overtravel warning	No.3	Yes	Warning	0x5444	0x09520952
EA41	EA41.0	Torque ripple compensation failure	No.3	Yes	Warning	0x0A41	0x0A410A41

10.3 Solutions to Faults

■ E101.0: System parameter error

Direct cause:

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

Parameter values 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 system parameters to default values (2002-20h = 1), and write parameters again.
	Measure whether the voltage input to the control circuit cable during operation is within the following range: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Increase the power capacity or replace with a power supply of larger capacity. Restore system parameters to default values (2002-20h = 1), and write parameters again.
2. Instantaneous power failure occurs during parameter saving.	Check whether instantaneous power failure occurs during parameter saving.	Power on the system again, restore system parameters to default values (2002-20h = 1), and write parameters again.
3. The number of write operations exceeds the limit.	Check whether parameters are updated frequently through the host controller.	Change the write mode and write parameters again. If the servo drive is faulty, replace it.
4. The software has been updated.	Check whether the software has been updated.	Reset the servo drive model and the servo motor model, and restore system parameters to default values (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: 2000h/2001h parameter error

Direct cause:

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

Parameter values in group 2000h or 2001h exceed the limit, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1. Instantaneous power failure occurs during parameter saving.	Check whether instantaneous power failure occurs during parameter saving.	Set the servo drive model (2001-0Bh) to a wrong value first and perform a power cycle, and then set the servo drive model to a correct value and perform a power cycle.
2. Instantaneous power failure occurs during the write operation.	Check whether instantaneous power failure occurs during writing motor parameters.	Write motor parameters using the software tool.
3. The software has been updated.	Check whether the software has been updated.	Set the servo drive model (2001-0Bh) to a wrong value first and perform a power cycle, and then set the servo drive model to a correct value and perform a power cycle.
4. The servo drive is faulty.	If the fault persists after repeated execution of steps 1 and 2 and multiple times of restart, the servo drive is faulty.	Replace the servo drive.

■ E102.0: FPGA communication initialization error

Direct cause:

The FPGA- or MCU-related hardware is damaged, resulting in communication failure between the MCU and FPGA.

Root Cause	Confirming Method	Solution
1. The FPGA is faulty. 2. The MCU cannot communicate with the FPGA.	The fault persists after the servo drive is powered off and on several times.	1. Confirm whether the FPGA has been upgraded. Ensure the programming is successful. 2. 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 version (H01-00) is 9xx.x (the fourth digit displayed on the keypad is 9). Check whether the FPGA version (H01-01) is 9xx.x (the fourth digit displayed on the keypad is 9).	Contact Inovance for technical support and update to mutually-matching FPGA or MCU software.

■ E104.1: MCU operation timeout

Direct cause:

The access to MCU times out.

Root Cause	Confirming Method	Solution
1. The FPGA is faulty.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.
2. The communication handshake between FPGA and HOST is abnormal.		
3. Access timeout occurs between HOST and the coprocessor.		

■ E104.2: Current loop operation timeout

Direct cause:

The operating 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 when entering the interrupt as the starting time, if the duration of the command-write operation in MCU is longer than the FPGA position and speed regulators start 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 through the software tool.	Hide unnecessary functions.

■ E108.0: Parameter write error

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 off and 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 error

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

Root Cause	Confirming Method	Solution
The check on the data written in EEPROM fails.	Modify a certain parameter value, power off and 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

Root Cause	Confirming Method	Solution
The check on the data read in EEPROM fails.	Modify a certain parameter value, power off and 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 model during initialization upon power-on. If the encoder type does not comply with the requirements, the servo drive reports E120.0.

Root Cause	Confirming Method	Solution
The encoder model 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 number) is set properly.	Set H01-10 to a proper value that matches the servo drive model.

■ E120.5: Motor current and drive current mismatch

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 rated current of the set servo drive model is larger than the rated current of the motor, calculation overflow will occur.	Replace with a servo drive of lower rated output current or a motor with higher rated current.

■ E120.6: FPGA and motor model mismatch

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 motor encoder is supported by the FPGA version (H01-01).	Update FPGA software or replace the motor encoder.

■ 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 code 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 assigned with the same function

Root Cause	Confirming Method	Solution
1. The same function is assigned to different DIs.	View 2003-03h, 2003-05h...2003-15h, 2017-01h, and 2017-03h...2017-1Fh to check whether they are assigned with the same DI function No..	Assign different DI functions to parameters that have been assigned with the same DI function. To enable such assignments, restart the control circuit or switch off the S-ON signal and send a "RESET" signal.
2. The DI function No. exceeds maximum setting number allowed for DI functions.	Check whether the MCU software has been updated.	Restore system parameters to default values (2002-20h = 1) and power off and on the servo drive again.

■ E122.3: Upper limit invalid

Root 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 mechanical gear ratio setpoint, the upper limit of the mechanical single-turn position and the electronic gear ratio in the absolute position rotation mode (H02-01 = 2).	Reset the mechanical gear ratio, the upper limit of 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 expected 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. Measure signals PS+, PS-, +5V and GND at both ends of the encoder cable and observe whether signals at both ends are consistent. For signal definitions, 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 encoder cables together with power cables (RST, UVW). Lay 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 suffers from interference.

Root Cause	Confirming Method	Solution
A fault occurs on the communication between FPGA and the motor encoder during initialization upon power-on.	Observe the value of H0B-28 to see whether it is not 0.	Check whether the encoder cable is connected properly. Check whether the motor model is set properly. Check whether H01-00 (MCU software version) and H01-01 (FPGA software version) are the correct ones.

■ E140.0: Encryption chip check error

Direct cause:

The check on the encryption chip fails.

Rout Cause	Confirming Method	Solution
The encryption software is not programmed.	Power off and on again to check whether the fault persists.	Contact Inovance to program the encryption software again.

■ E140.1: Encryption chip check failure

Direct cause:

The check on the encryption chip fails.

Rout Cause	Confirming Method	Solution
The key of the encryption chip is incorrect, causing failure in decrypting the Renesas chip.	1. Check the softwrae version. Check whether the encryption program is programmed in the servo drive. 2. Check whether the encryption chip is abnormal.	Power off and on the servo drive again, if the fault persists, contact Inovance for maintenance.

■ 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 the fault reset function after the STO terminal is restored.
2. The STO power supply is abnormal.	Check whether the 24 V power supply of the STO works normally.	Measure the 24 V power supply of the STO to check whether it is stable. Tighten the cables that are loose or disconnected.
3. The STO is inactive.	The fault persists after preceding actions are taken.	Replace the servo drive.

NOTE

When H0A-21 is set to 0, STO displays the STO state. When H0A-21 is set to 1, STO displays E150.0.

■ 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 of the STO works normally.	Measure the 24 V power supply of the STO to check whether it is stable. Tighten the cables that are loose or disconnected.
2. The STO input resistor is abnormal.	After STO is triggered, only one STO signal is sent to MCU after the 24 V power supply is cut off due to input resistor drift.	Replace the servo drive.
3. The STO is inactive.	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 error occurs on the PWM Buffer integrated circuit during initialization detection upon power-on (the PWM signal cannot be blocked).

Root Cause	Confirming Method	Solution
The Buffer fails to block the PWM signals.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E201.0: Phase-P overcurrent

Direct cause:

A excessively high current flows through the positive pole of the DC-AC circuit.

Root Cause	Confirming Method	Solution
1. Gains are set improperly, leading to motor oscillation. 2. The encoder is wired improperly, aging, or connected loosely. 3. The servo drive is faulty. 4. Overcurrent occurs on the regenerative resistor.	◆ Check whether vibration or sharp noise occurs during start and operation of the motor, or view the "Current feedback" in the software tool. ◆ Check whether encoder cables provided by Inovance are used. Check whether the encoder cable is aging, corroded, or connected loosely. ◆ Switch off the S-ON signal and rotate the motor shaft manually, observing whether the value of 200B-12h changes when the shaft rotates. ◆ Unplug the motor cable but the fault persists after the servo drive is powered off and on again. ◆ Check whether the resistance of the external regenerative resistor is too small or the regenerative resistor is short-circuited (between terminals P and C).	◆ Adjust the gains. ◆ Re-solder, tighten or replace encoder cables. ◆ Replace the servo drive. ◆ Select the resistance and model of the regenerative resistor again. ◆ Perform wiring again.

■ E201.1: Phase-U overcurrent

■ Direct cause: A large current exceeding the threshold is detected in phase U.

Cause	Confirming Method	Solution
1. Motor cables are in poor contact. 2. Motor cables are grounded. 3. UVW cables of the motor are short-circuited. 4. The motor is damaged due to over-temperature.	◆ Check whether both ends of servo drive power cables and motor cables on servo drive UVW sides are loose and fall off. ◆ After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive UVW ends and the PE cable is at MΩ level. ◆ Unplug the motor cables and check wehther short circuit occurs among UVW cables and whether burrs exist in the wiring. ◆ Unplug the motor cables and measure whether the resistance among UVW cables of the motor are balanced.	◆ Tighten the cables that are loose or fall off. ◆ Replace the motor in case of poor insulation. ◆ Connect the motor cables properly. ◆ Replace the motor if the resistance among UVW cables of the motor is unbalanced.

■ E201.2: Phase-V overcurrent

■ Direct cause: A large current exceeding the threshold is detected in phase V.

Root Cause	Confirming Method	Solution
1. Motor cables are in poor contact. 2. Motor cables are grounded. 3. UVW cables of the motor are short-circuited. 4. The motor is damaged due to over-temperature.	◆ Check whether both ends of servo drive power cables and motor cables on servo drive UVW sides are loose and fall off. ◆ After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive UVW ends and the PE cable is at MΩ level. ◆ Unplug the motor cables and check wehther short circuit occurs among UVW cables and whether burrs exist in the wiring. ◆ Unplug the motor cables and measure whether the resistance among UVW cables of the motor are balanced.	◆ Tighten the cables that are loose or fall off. ◆ Replace the motor in case of poor insulation. ◆ Connect the motor cables properly. ◆ Replace the motor if the resistance among UVW cables of the motor is unbalanced.

■ E201.4: Phase-N overcurrent

Direct cause:

■ Direct cause: A large current exceeding the threshold is detected in phase N

Root Cause	Confirming Method	Solution
1. Motor cables are in poor contact. 2. Motor cables are grounded. 3. UVW cables of the motor are short-circuited. 4. The motor is damaged due to over-temperature.	◆ Check whether both ends of servo drive power cables and motor cables on servo drive UVW sides are loose and fall off. ◆ After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive UVW ends and the PE cable is at MΩ level. ◆ Unplug the motor cables and check wehther short circuit occurs among UVW cables and whether burrs exist in the wiring. ◆ Unplug the motor cables and measure whether the resistance among UVW cables of the motor are balanced.	◆ Tighten the cables that are loose or fall off. ◆ Replace the motor in case of poor insulation. ◆ Connect the motor cables properly. ◆ Replace the motor if the resistance among UVW cables of the motor is unbalanced. ◆ Perform wiring again.

■ 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 integrated circuit is damaged.	Replace the servo drive.
2. FPGA operation times out.	200B-2Eh = 0208: Figure out the cause according to cause 1.	

■ E208.2: Encoder communication timeout

Root Cause	Confirming Method	Solution
The servo drive fails to receive the data fed back by the encoder in three consecutive cycles.	◆ Check bit12 of H0B-30. ◆ The encoder cable is connected improperly. ◆ The encoder cable is loose. ◆ The encoder cable is too long. ◆ The encoder communication suffers from interference. ◆ The encoder is faulty.	◆ Check whether the motor model is correct. ◆ Check whether encoder cable is in proper condition. ◆ Check whether the encoder version (H00-04) is set properly. ◆ If servo drive operates improperly, replace it.

■ E208.3: Current sampling fault

Root Cause	Confirming Method	Solution
Phase-U and phase-V current samplings 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 integrated circuit 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.

Root Cause	Confirming Method	Solution
The FPGA operation times out.	200B-2Eh (Internal fault code) = 4208: The current loop operation times out.	Turn off some unnecessary functions to reduce the operating time of the current loop.

■ E210.0: Output short-circuited 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 cables (UVW) of the servo drive are short-circuited to ground.	Unplug motor cables and check whether the servo drive power cables (UVW) are short circuited to ground (PE).	Re-connect or replace the servo drive power cables.
2. The motor is short-circuited to ground.	After confirming servo drive power cables and motor cables are connected securely, check whether the insulation resistance between servo drive UVW terminals and the grounding cable (PE) is at MΩ-level.	Replace the servo motor.
3. The servo drive is faulty.	Disconnect servo drive 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 opposite to the speed feedback direction in the torque control mode.

The speed feedback direction is opposite to the speed reference direction in the position or speed control mode.

Root Cause	Confirming Method	Solution
1. The UVW cables are connected in the wrong phase sequence.	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. An error occurs on the initial phase detection of the motor rotor due to interference signals upon power-on.	The UVW phase sequence is correct, but E234.0 occurs when the servo drive is enabled.	Power off and on the servo drive again.
3. The encoder model is wrong or the wiring is incorrect.	Check 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. Check the motor model, encoder model, and encoder cable connections again.

Root Cause	Confirming Method	Solution
4. The encoder cable is connected improperly, corroded or loose.	Check whether the encoder cable provided by Inovance is used. Check whether the cable is aging, corroded or loose. Switch off the S-ON signal, rotate the motor shaft manually, and check whether the value of 200B-0Bh (Electrical angle) changes when the motor shaft rotates.	Re-solder, tighten or replace the encoder cable.
5. The gravity load is too heavy in vertical axis applications.	Check whether the vertical axis load is too heavy. Adjust brake parameters 2002-0Ah...2002-0Dh and check whether the fault can be cleared.	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 too high, leading to excessive vibration.	Set a proper stiffness level to avoid excessive vibration.

■ E400.0: Main circuit overvoltage

Direct cause:

The DC bus voltage between terminals 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 voltage input to the main circuit is too high.	Check the power input specifications of the servo drive and measure whether the voltage input to main circuit cables (RST) on the servo drive side is within the following range: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Replace or adjust the power supply according to the specified ranges.
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 is within the preceding range.	Connect a surge protection device and then switch on the control circuit and main circuit. 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 terminals P and D are jumpered. If yes, measure the resistance between terminals C and D. If an external regenerative resistor is used (2002-1Ah = 1, 2), measure the resistance between terminals P and C. For specifications 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 terminals P and D. Select an external regenerative resistor of the same resistance and equal or higher power than the internal one. ◆ If an external regenerative resistor is used, replace with a new one and connect the new one between terminal P and C. Set 2002-1Bh (Power of external regenerative resistor) and 2002-1Ch (Resistance of external regenerative resistor) 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 terminals P and C, and compare the measured value with the recommended value.	Connect a new external regenerative resistor of the recommended resistance between terminals P and C. Set 2002-1Bh (Power of external regenerative resistor) and 2002-1Ch (Resistance of external regenerative resistor) according to the specifications of the external regenerative resistor 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 operation and measure whether the DC bus voltage between terminals 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) detected is within the following range: 220 V servo drive: 200B-1Bh > 420 V 380 V servo drive: 200B-1Bh > 760 V Measure whether the DC bus voltage detected between terminals P and N is close to the value displayed in 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 terminals P and N is lower than the undervoltage threshold.

220 V servo drive:
Normal value: 310 V
Undervoltage threshold: 200 V (or 180 V for 7.5 W servo drives)

380 V servo drive:

Normal value: 540 V
Undervoltage threshold: 380 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 power input specifications of the servo drive. Measure whether the voltage input to the main circuit cables is within the following range:
◆ 220 V servo drive:
Effective value: 220 V to 240 V
Allowable deviation: –10% to +10% (198 V to 264 V)
◆ 380V 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="3">Increase the power capacity.</td></tr>
<tr><td>2. Instantaneous power failure occurs.</td></tr>
<tr><td>3. Voltage drop occurs on the power supply during operation.</td><td>Monitor 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 main circuit cables are connected properly 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: R, S, T</td></tr>
<tr><td>5. The servo drive is faulty.</td><td>Check whether the bus voltage (200B-1Bh) detected is within the following range:
220 V servo drive: 200B-1Bh < 200 V (or < 180 V for 750 W servo drives)
380 V servo drive: 200B-1Bh < 380 V
The fault persists after the main circuit is powered off and on several times.</td><td>Replace the servo drive.</td></tr>
</table>

■ E420.0: Phase loss fault

Direct cause:

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 cables between the power supply side and main circuit input terminals (R/S/T) 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">Check the power input specifications of the servo drive and measure whether the voltage input to the main circuit is within the following range:
◆ 220 V servo drive:
Effective value: 220 V to 240 V
Allowable deviation: –10% to +10% (198 V to 264 V)
◆ 380 V servo drive:
Effective value: 380 V to 440 V
Allowable deviation: –10% to +10% (342 V to 484 V)
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 is 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>

■ E430.0: Control circuit undervoltage

Direct cause:

The control circuit power supply is lower than the undervoltage threshold.

220 V servo drive:
Normal value: 310 V
Undervoltage threshold: 190 V

380 V servo drive:

Normal value: 540 V
Undervoltage threshold: 350 V

Root Cause	Confirming Method	Solution
1. The power supply of the control circuit is unstable or the voltage of the power supply drops.	Check whether the fault occurs during control circuit power supply (L1C, L2C) cutoff or during instantaneous power failure.	Restore system parameters to default values (2002-20h = 1), and write parameters again.
	Measure whether the voltage input to the control circuit cable is within the following range: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Increase the power capacity.
2. The control circuit cables are in poor contact	Check whether control circuit cables are connected properly and measure whether the voltage of the control circuit cable on the servo drive side is within the preceding range.	Re-connect or replace the cables.

■ 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 lower than the maximum motor speed required in actual applications. Overspeed threshold = 1.2 x Maximum motor speed (200A-09h = 0) Overspeed threshold = 200A-09h (the setpoint 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.

Root Cause	Confirming Method	Solution
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 position reference increment per synchronization cycle and convert it to the corresponding speed value. In PP mode, view the gear ratio 6091-01h/6091-02h and determine the value of 6081h (Profile velocity). In HM mode, view the gear ratio 6091-01h/6091-02h, and determine the values 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 limits.	◆ Position control mode In CSP mode, decrease the position reference increment per synchronization cycle. The host controller should handle the position ramp when generating references. In PP mode, decrease the value of 6081h or increase the acceleration and deceleration ramps (6083h and 6084h). HM: Decrease the values of 6099-01h and 6099-02h, or increase the acceleration/deceleration ramp (609Ah). Reduce the gear ratio according to actual conditions. ◆ Speed mode: Decrease the target velocity, speed limit, and gear ratio. In PV mode, increase the speed ramps in 6083h and 6084h. In CSV mode, the host controller should handle the speed ramp. ◆ Torque control mode: Set the speed limit to a value lower than the overspeed threshold.
4. The motor speed overshoots.	Check whether the speed feedback exceeds the overspeed threshold using the software tool.	Adjust the gains or operating conditions of the machine.
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 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 on the encoder cable.

■ E500.2: FPGA position feedback pulse overspeed

Direct cause:

Overspeed occurs on the FPGA position feedback pulse.

Root Cause	Confirming Method	Solution
The MCU detects excessive pulse increment fed back by the FPGA.	1. Check whether the value of H0B-17 changes abruptly. 2. Check whether the communication between the servo drive and the encoder suffers from interference.	Modify the value of H0A-70 (Overspeed threshold). The default value of H0A-70 is 0. Use the maximum motor speed as the threshold for excessive pulse increment.

■ 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 whether the encoder communication suffers from interference.	Check the wiring of the encoder.

■ 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 of UVW and perform auto-tuning again.

■ E605.0: Speed upon S-ON too high

Root Cause	Confirming Method	Solution
Speeds of servo drives in sizes A and B exceed the rated speed upon servo ON.	Check whether the motor is in the power generating state.	Reduce the speed and switch on the S-ON signal 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 cable is 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 wiring instructions.
2. The load is too heavy. The motor keeps outputting an 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 servo drive of large capacity and a matching servo motor, or reduce the load and increase the acceleration/deceleration time.
3. 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 individual operation cycle for cyclic operation.	Increase the acceleration/ deceleration time of an individual operation cycle.
4. Gains are improper or the stiffness level is too high.	Observe whether the motor vibrates and generates abnormal noise during operation.	Adjust the gains.
5. The servo drive or motor models are set improperly.	Check the motor model in 2000-06h and servo drive model in 2001-0Bh.	Read the servo drive nameplate and set the servo drive model and motor model properly.

Root Cause	Confirming Method	Solution
6. The motor is stalled due to mechanical factors, resulting in overload during operation.	Check the reference and motor speed (200B-01h) through the software tool or the keypad: ◆ Reference in the position control mode: 200B-0Eh (Input position reference counter) ◆ Reference in the speed control mode: 200B-02h (Speed reference) ◆ Reference in the torque control mode: 200B-03h (Internal torque reference) Check whether the reference value 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.

NOTE

When E620.0 occurs, stop the servo drive for at least 30s before further operations.

■ E630.0: Motor stall

Direct cause:

The motor speed actual value is lower than 10 RPM but the torque reference reaches the limit, and such status persists for the time 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 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 remains unchanged.	Modify 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.
4. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0B-00) through the software tool or the keypad. ◆ Reference in the position control mode: H0B-13 (Input position reference counter) ◆ Reference in the speed control mode: H0B-01 (Speed reference) ◆ Reference in the torque control mode: H0B-02 (Internal torque reference) Check whether the reference value 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.

NOTE

When E630.0 occurs, stop the servo drive for at least 30s before further operations.

■ E640.0: IGBT over-temperature

Direct cause: The IGBT temperature reaches the fault threshold defined by H0A-18.

Root Cause	Confirming Method	Solution
1. The ambient temperature is too high. 2. The servo drive is powered off frequently to reset the overload fault. 3. The fan is damaged. 4. The installation direction and clearance of the servo drive are improper. 5. The servo drive is faulty.	◆ Measure the ambient temperature. ◆ View the fault log (set 200B-22h and check 200B-23h) to see whether an overload fault or warning (E620.0, E630.0, E650.0, E909.0, E920.0, and E922.0) is reported. ◆ Check whether the fan rotates during operation. ◆ Check whether the servo drive is installed properly. ◆ The servo drive is restarted 5 min after power-off, but the fault persists.	◆ Improve cooling conditions to lower down the ambient temperature. ◆ Change the fault reset mode and perform reset 30s after overload. Increase the capacities of the servo drive and servo motor. Increase the acceleration/deceleration time and reduce the load. ◆ Replace the servo drive. ◆ Install the servo drive according to the installation requirements. ◆ Replace the servo drive.

NOTE

When E640.0 occurs, stop the servo drive for at least 30s before further operations.

■ E640.1: Flywheel diode over-temperature

Direct cause: The temperature of the flywheel diode reaches the fault threshold defined by H0A-18.

Root Cause	Confirming Method	Solution
1. The ambient temperature is too high. 2. The servo drive is powered off frequently to reset the overload fault. 3. The fan is damaged. 4. The installation direction and clearance of the servo drive are improper. 5. The servo drive is faulty.	◆ Measure the ambient temperature. ◆ View the fault log (set 200B-22h and check 200B-23h) to see whether an overload fault or warning (E620.0, E630.0, E650.0, E909.0, E920.0, and E922.0) is reported. ◆ Check whether the fan rotates during operation. ◆ Check whether the servo drive is installed properly. ◆ The servo drive is restarted 5 min after power-off, but the fault persists.	◆ Improve cooling conditions to lower down the ambient temperature. ◆ Change the fault reset mode and perform reset 30s after overload. Increase the capacities of the servo drive and servo motor. Increase the acceleration/deceleration time and reduce the load. ◆ Replace the servo drive. ◆ Install the servo drive according to the installation requirements. ◆ Replace the servo drive.

NOTE

When E640.1 occurs, stop the servo drive for at least 30s before further operations.

■ 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.

Root Cause	Confirming Method	Solution
2. The servo drive is powered off frequently to reset the overload fault.	View the fault records: Check whether overload fault (set 200B-22h and view 200B-23h) or warning (E620.0, E630.0, E650.0, E909.0, E920.0, and E922.0) is reported.	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 operation.	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 requirements.
5. The servo drive is faulty.	The servo drive is restarted 5 min after power-off, but the fault persists.	Replace the servo drive.

NOTE

When E650.0 occurs, stop the servo drive for at least 30s before further operations.

■ E660.0: Air-cooled motor over-temperature

Direct cause:

The temperature of the air-cooled motor is too high.

Root Cause	Confirming Method	Solution
The temperature of the air-cooled motor is too high.	Measure whether the temperature of the air-cooled motor is too high.	Cool the motor down.

■ E661.0: Auto-tuned gains too low

<table>
<tr><th>Root Cause</th><th>Confirming Method</th><th>Solution</th></tr>
<tr><td>1. Gains obtained from STune or ETune are wrong.</td><td rowspan="2">-</td><td rowspan="2">1. Set the notch manually if vibration cannot be suppressed.
2. Check whether the positioning threshold is too small. Increase the reference acceleration/deceleration time.
3. Modify the electronic gear ratio to improve the reference resolution, or increase the reference filter time in the parameter configuration interface and check whether cyclic vibration occurs on the machine.</td></tr>
<tr><td>2. Vibration cannot be suppressed and the internal gains reach the lower limit.</td></tr>
</table>

■ 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:

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 the encoder cable is connected properly. ◆ Check whether the servo drive and servo motor are grounded properly. You can install a magnetic ring on the encoder cable 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 the encoder cable is 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.

■ E755.0: Nikon encoder communication failure

Direct cause:

Nikon encoder communication fails.

Root Cause	Confirming Method	Solution
1. An encoder communication error or encoder fault is detected after servo drive initialization is done upon power-on. 2. E755.0 will be reported when a multi-turn Nikon encoder that carries no battery for a long time is powered on again.	◆ Check whether the encoder is wired correctly. ◆ Check whether there is large equipment generating interferences on site and whether connectors are loose or cables are broken.	◆ Ensure the encoder cable is connected properly. ◆ Take proper shielding measures if the interference source does exist.

■ E760.0: Encoder over-temperature

Root Cause	Confirming Method	Solution
The temperature of the absolute encoder is too high.	Measure the encoder or motor temperature.	Switch off the S-ON signal to cool the encoder down.

■ E765.0: Nikon encoder beyond the limit

Root Cause	Confirming Method	Solution
Over-temperature, overspeed, or EEPROM access error is detected in the encoder.	The fault is detected by the Nikon encoder, and the servo drive only displays the fault.	Set H0D-21 to 1 to clear the fault.

■ 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 cable is disconnected.	Check the wiring.	Re-connect the 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 is stalled due to mechanical factors.	Check the reference and motor speed (200B-01h) through the software tool or the keypad: Reference in the position control mode: 200B-0Eh (Input position reference counter) Reference in the speed control mode: 200B-02h (Speed reference) Reference in the torque control mode: 200B-03h (Internal torque reference) Check whether the reference value is not 0 but the motor speed is 0.	Eliminate mechanical factors.
4. The servo drive gains are too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: 2008-01h to 2008-03h 2nd gain set: 2008-04h to 2008-06h	Adjust the gains 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 position reference increment per synchronization cycle and convert it to the corresponding speed value. ◆ In PP mode, view the gear ratio 6091-01h/6091-02h and determine the value of 6081h (Profile velocity). ◆ In HM mode, view the gear ratio 6091-01h/6091-02h, and determine the values of 6099-01h and 6099-02h.	◆ In CSP mode, decrease the position reference increment per synchronization cycle. The host controller should handle the position ramp when generating references. ◆ In PP mode, decrease the value of 6081h or increase the acceleration/deceleration ramp (6083h/6084h). ◆ In HM mode, decrease the values 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 operating 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 operating 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.

■ EB00.1: Position deviation overflow

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 cable is disconnected.	Check the wiring.	Re-connect the 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 is stalled due to mechanical factors.	Check the reference and motor speed (200B-01h) through the software tool or the keypad: Reference in the position control mode: 200B-0Eh (Input position reference counter) Reference in the speed control mode: 200B-02h (Speed reference) Reference in the torque control mode: 200B-03h (Internal torque reference) Check whether the reference value is not 0 but the motor speed is 0.	Eliminate mechanical factors.
4. The servo drive gains are too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: 2008-01h to 2008-03h 2nd gain set: 2008-04h to 2008-06h	Adjust the gains 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 position reference increment per synchronization cycle and convert it to the corresponding speed value. ◆ In PP mode, view the gear ratio 6091-01h/6091-02h and determine the value of 6081h (Profile velocity). ◆ In HM mode, view the gear ratio 6091-01h/6091-02h, and determine the values of 6099-01h and 6099-02h.	◆ In CSP mode, decrease the position reference increment per synchronization cycle. The host controller should handle the position ramp when generating references. ◆ In PP mode, decrease the value of 6081h or increase the acceleration/deceleration ramp (6083h/6084h). ◆ In HM mode, decrease the values 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 operating 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 operating 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 loose.	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.
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
The target position increment is too large.	Check the variation value between two adjacent target positions using the software tool.	1. Check whether the maximum motor speed fulfills the application requirements. If yes, reduce the target position reference increment, in order to lower the profile reference speed. If not, replace the servo motor. 2. Before switching the mode 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 reception 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
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 requirements. If yes, reduce the target position reference increment, in order to lower the profiled reference speed. If not, replace the servo motor. 2. Before switching the mode 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 reception 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 continues sending commands after the overtravel warning occurs.	1. Check the servo limit signal (bit0 and bit1 of 60FD recommended) through the host controller. 2. Stop sending limit direction references when the servo limit signal is detected to be active by the host controller.

■ EB01.4: Target position beyond upper/lower limit

Cause	Confirming Method	Solution
The target position exceeds the upper/lower limit of the position in the single-turn absolute mode.	Check whether the target position setpoint is within the single-turn upper/lower limit.	Set the target position to a value within the upper/lower limit.

■ EE09.0: Software position 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 values of 607D-01 and 607D-02.	Reset the values of 607D-01 and 607D-02 and ensure the former is lower 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 mechanical single-turn upper/low limit.

■ EE09.2: Gear ratio beyond the limit

Direct cause:

The electronic gear ratio exceeds the following limit:
(0.001, 4000 x Encoder resolution/10000)

Root Cause	Confirming Method	Solution
The set electronic gear ratio exceeds the preceding range.	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 status.

Root Cause	Confirming Method	Solution
1. The communication synchronization clock is configured improperly.	Replace with another master (such as Beckhoff or Omron PLCs) and perform tests to compare between different masters.	Rectify improper configurations.
2. The IN/OUT port of 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.
3. The slave controller integrated circuit is damaged.	If the problem persists after the master is replaced, measure the synchronization signal generated from the slave controller integrated circuit with an oscilloscope. If there is no signal, the slave controller integrated circuit is damaged.	Contact Inovance for replacing the slave controller integrated circuit.
4. The MCU pins are damaged.	Test the synchronization signal generated from the slave controller integrated circuit with an oscilloscope. If there is a signal, the pin of the MCU integrated circuit is damaged.	Contact Inovance for replacing the MCU integrated circuit.

■ EE09.5: PDO mapping beyond the limit

Root Cause	Confirming Method	Solution
The number of the mapping objects in TPDO or RPDO exceeds 10.	Check the number of self-indexes configured in 1600h or 1A00h.	The number of the mapping objects in TPDO or RPDO cannot exceed 10.

10.4 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 at 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 auxiliary functions (200D-03h, 200D-04h, 200D-0Ch) are used.	Switch off the S-ON signal sent from the host controller.
2. 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 causes and solutions:

1. The vibration cannot be suppressed. Enable vibration suppression manually (H09-12 to H09-23) to eliminate the vibration.

2. The auto-tuned values fluctuate dramatically. Increase the maximum operating speed and reduce the acceleration/deceleration time during ETune operation. For screw mechanisms, shorten the stroke.

3. Mechanical connections of the load are loose or eccentric. Rectify 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 not saturated.

■ E601.0: Homing timeout

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 searching for the home, the servo drive keeps low-speed searching in the reverse direction.	1. If the home switch is used as the home signal, a hardware DI is used as the deceleration point, check whether FunIN.31 (HomeSwitch) is assigned to a certain DI in group 2003h and then check the wiring of the DI. Manually change the DI logic and observe the value of 200B-04h to see whether the servo drive receives the corresponding DI level changes. If not, the DI is wired improperly. If yes, a fault occurs during homing. Perform the homing operation correctly. 2. If Z signal is used as the home signal, a hardware DI is used as the deceleration point, check whether DI functions (FunIN.14 for positive position limit; FunIN.15 for negative position limit; FunIN.31 for home switch) are set properly and then check the wiring of the DI. Manually change the DI logic and observe the value of 200B-04h to see whether the servo drive receives the corresponding DI level changes. If not, the DI is wired improperly. If yes, a fault occurs during homing. Perform the homing operation correctly.
2. The set homing duration is too short.	Check whether the value of 2005-24h (Homing time limit) is too small.	Increase the value of 2005-24h.
3. The speed in high-speed searching 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 both activated.	Set the position of the hardware switch properly.

■ E601.2: Homing mode setting error

Root Cause	Confirming Method	Solution
The homing method (0x6098) is set to a value outside the range of [-2 to 14] in the absolute position single-turn mode (H02-01 = 4).	Check the setpoint of 0x6098.	Set 0x6098 to a value within the range.
The homing method (0x6098) is set to a value outside the ranges of [-2, 14], [17, 30], and [33,35] when the absolute position single-turn mode is not used.	Check the setpoint of 0x6098.	Set 0x6098 to a value within the range.

■ 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 virtual DI) assigned with FunIN.34 (EmergencyStop) is active.

Root Cause	Confirming Method	Solution
The DI function 34 (FunIN.34: Emergency stop) is triggered.	Check whether the logic of the DI assigned with FunIN.34 is valid.	Check the operating mode and clear the DI signal without affecting the safety performance.

■ E902.0: Invalid DI setting

Direct cause:

The DI function is set to an invalid value.

Root Cause	Confirming Method	Solution
The function of either DI1 to DI5 is set to an invalid value.	Check whether 2003-03h, 2003-05h, 2003-07h...2003-09h, and 2003-0Bh are set to invalid values.	Set the DI function to a valid value.

■ E902.1: Invalid DO setting

Direct cause:

The DO function is set to an invalid value.

Root Cause	Confirming Method	Solution
The function of either DO1 to DO3 is set to an invalid value.	Check whether 2004-01h, 2004-03h, and 2004-05h are set to invalid values.	Set the DO function to a valid value.

■ E908.0: Model identification check failure

Direct cause:

The first two check bytes of model identification are incorrect, indicating the attempt to read model identification parameters fails.

Root Cause	Confirming Method	Solution
1. The model identification parameters are not written.	The warning persists after the servo drive is powered off and on again.	1. Write the model identification parameters again.
2. The check bytes 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 wiring instructions.
2. The load is too heavy. The motor keeps outputting an 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 servo drive of large capacity and a matching servo motor, or reduce the load and increase the acceleration/deceleration time.
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 individual operation cycle when the servo motor operates cyclically.	Increase the acceleration/deceleration time.
4. The gains are improper or the stiffness level is too high.	Observe whether the motor vibrates and generates abnormal noise during operation.	Adjust the gains.
5. The servo drive or motor models are set improperly.	Check the motor model in 2000-06h and the servo drive model in 2001-0Bh.	Read the servo drive nameplate and set the servo drive model and motor model properly.
6. The motor is stalled due to mechanical factors, resulting in overload during operation.	Check the reference and motor speed (200B-01h) through the software tool or the keypad: ◆ Reference in the position control mode: 200B-0Eh (Input position reference counter) ◆ Reference in the speed control mode: 200B-02h (Speed reference) ◆ Reference in the torque control mode: 200B-03h (Internal torque reference) Check whether the reference value is not 0 but the motor speed is 0.	Rectify 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.

NOTE

When E909.0 occurs, stop the servo drive for at least 30s before further operations.

■ 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 loose.	Remove the external regenerative resistor and measure whether the resistance of the resistor is " ∞ " (infinite). Measure whether the resistance between terminals P and C is " ∞ " (infinite).	Replace with a new external regenerative resistor and measure its resistance. If its resistance is consistent with the nominal value, connect it between terminals P and C. Prepare a new cable and connect the external regenerative resistor between terminals P and C.
2. The cable between terminals P and D is shorted or disconnected when an internal regenerative resistor is used.	Measure whether the resistance between terminals P and D is " ∞ " (infinite).	Prepare a new cable to short terminals P and D.
3. The setting of 2002-1Ah is incorrect when an external regenerative resistor is used.	Check the setpoint of 2002-1Ah.	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.	Measure the resistance of the external regenerative resistor connected between terminals 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".	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 used.	Check whether the value of 2002-1Ch is larger than the resistance of the external regenerative resistor connected between terminals P and C.	Set 2002-1Ch according to the resistance of the external regenerative resistor used.
6. The voltage input to the main circuit exceeds the specified range.	Check whether the voltage input to the main circuit cable on the servo drive side is within the following range: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Adjust or replace the power supply according to the specified range.

Root Cause	Confirming Method	Solution
7. The load moment of 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 larger capacity. Reduce the load if allowed. Increase the acceleration/deceleration time if allowed. Increase the cyclic deceleration interval of the servo drive if allowed.
8. The motor speed is too high, and deceleration is not done 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), 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 terminals P and C and check whether it is smaller than the value of 2002-16h.	◆ If yes, replace with an external regenerative resistor that matches the servo drive and set 2002-1Ch (Resistance of external regenerative resistor) according to the resistance of the external regenerative resistor used. ◆ If not, set 2002-1Ch according to the resistance of the external regenerative resistor 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 effective

Root Cause	Confirming Method	Solution
The parameters modified are those whose "Effective time" is "Next power-on".	Check whether modifications of these parameters can be effective 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 operation mode. For parameters that need not be saved in EEPROM, set 200E-02h to 0.

■ E950.0: Forward overtravel warning

Cause	Confirming Method	Solution
1. The logic of the DI assigned with FunIN.14 is valid (Forward driving inhibited).	Check whether a DI in group 2003h is assigned with FunIN.14 and check whether the DI logic of the corresponding bit of 200B-04h (Monitored DI status) is valid.	Check the operation mode and on the prerequisite of ensuring safety, send a reverse run command or rotate the motor to deactivate the logic of the DI assigned with FunIN.14.
2. The servo drive position feedback reaches the positive software position limit.	Check whether the position feedback (0x6064) is close to the value of 0x607D-02.	Ensure the travel distance of the load is within the software position limit.

■ E952.0: Reverse overtravel warning

Root Cause	Confirming Method	Solution
1. The logic of the DI assigned with FunIN.15 (Reverse driving inhibited) is valid.	Check whether a DI in group 2003h is assigned with FunIN.15 and check whether the DI logic of the corresponding bit of 200B-04h (Monitored DI status) is valid.	Check the operation mode and on the prerequisite of ensuring safety, send a forward run command or rotate the motor to deactivate the logic of the DI assigned with FunIN.15.
2. The servo drive position feedback reaches the negative software position limit.	Check whether the position feedback (0x6064) is close to the value of 0x607D-02.	Ensure the travel distance of the load is within the software position limit.

■ EA41.0: Torque ripple compensation failure

Root Cause	Confirming Method	Solution
The attempt to write torque ripple compensation parameters to the encoder fails. An encoder data read/write error occurs.	Check the wiring of the encoder.	If the fault persists after several attempts, contact Inovance for technical support.

10.5 Solutions to Communication Faults

This section describes solutions to communication faults.

■ EE08.0: SYNC signal loss

Direct cause:

The SYNC signal is turned off when the EtherCAT network is in the OP state.

Root Cause	Confirming Method	Solution
The SYNC signal is not generated due to hardware errors.	Check whether the SYNC signal cycle is 0 through the oscilloscope in the software tool.	Replace the servo drive. Contact Inovance for maintenance.

■ EE08.1: Network status switchover error

Direct cause:

The EtherCAT network status switches from OP to other status when the servo drive is enabled.

Cause	Confirming Method	Solution
This fault is caused by mal-operation of the master or the operator.	Check whether the master switches the network status when the servo drive is enabled.	Check the network status switchover program of the host controller.

■ EE08.2: IRQ loss

For servo drives with H01-00 (MCU software version) = 902.0 or earlier, the fault causes include all the causes for EE08.0, EE08.01, and EE08.3...EE08.6, without differentiation.

For servo drives with H01-00 (MCU software version) = 902.1 or later, fault causes are further differentiated, which means EE08.2 will not be reported.

■ EE08.3: LAN cable connected improperly

Direct cause:

The LAN cable is connected to the servo drive network port improperly. (The low 16 bits of H0E-29 is the number of IN port loss events. The high 16 bits of H0E-29 is the number of OUT port loss events.)

Cause	Confirming Method	Solution
The physical connection of the data link is unstable or the process data is lost due to plug-in/plug-out of the LAN cable.	Check: 1) whether the LAN cable of the servo drive is connected securely. 2) whether violent vibration occurs on site. 3) whether the LAN cable is plugged in or out. 4) whether the LAN cable provided by Inovance is used.	Check the connection condition of the network port through the value change of H0E-29 and replace with a new LAN cable.

■ EE08.4: Data frame loss protection error

Direct cause:

The PDO data is corrupted due to EMC interference or inferior LAN cable.

Cause	Confirming Method	Solution
The data is lost due to EMC interference, poor quality of the LAN cable or poor connection.	Check whether the high 16 bits of H0E-25 have values that are increasing.	Check whether the servo drive is grounded properly and rectify the EMC intereference. Check whether the LAN cable used is the one designated by Inovance. Check whether the LAN cable is connected properly.

■ EE08.5: Data frame transfer error

Direct cause:

As error data frames are generated from the upstream slave, the downstream device receives invalid data frames.

Cause	Confirming Method	Solution
The upstream station detectes that the data frame has been corrupted and marked, which is then transfered to the slave, leading to a warning report.	Check wehther a process unit error occurs due to transfer error (H0E-27) or invalid frame (H0E-28) upon occurrence of the fault and check whether no counting is performed in RX-ERR of Port0.	Check the upstream station to locate the fault cause.

■ EE08.6: Data update timeout

Direct cause:

The slave is in the OP status and does not receive the data frame in a long time.

Cause	Confirming Method	Solution
The data frame is lost or aborted in the upstream station or the performance of the master is poor.	Check through the software tool whether the phase difference between SYNC and IRQ exceeds the value of H0E-22 multiplied by the communication cycle.	Check wehther the operation load of the master CPU is too large. Increase the communication time or set H0E-22 to a large value. Check whether link loss occurs on the upstream station.

■ EE11.0: ESI check error

Direct cause:

The attempt to upload the XML file during EtherCAT communication fails.

Root Cause	Confirming Method	Solution
1. The XML file is programmed in the EEPROM. 2. The XML file in the EEPROM is modified unexpectedly.	Check whether the XML version displayed in H0E-96 is normal.	Program the XML file.

■ EE11.1: EEPROM read failure

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: EEPROM update failure

Direct cause:

The communication is normal but the message in the EEPROM is wrong or lost.

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.	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 integer multiple of 125 µs or 250 µs.	Check the setpoint of the synchronization cycle in the controller.	Set the value of synchronization cycle to an integer multiple of 125 µs or 250 µs.

■ EE15.0: Number of synchronization cycle errors too large

Direct cause:

The number of synchronization cycle errors exceed the threshold.

Root Cause	Confirming Method	Solution
Excessive number of synchronization cycle errors occur on the controller.	Measure the synchronization cycle of the controller using a digital oscilloscope or the oscilloscope function in the software tool.	Increase the value of 200E-21h.

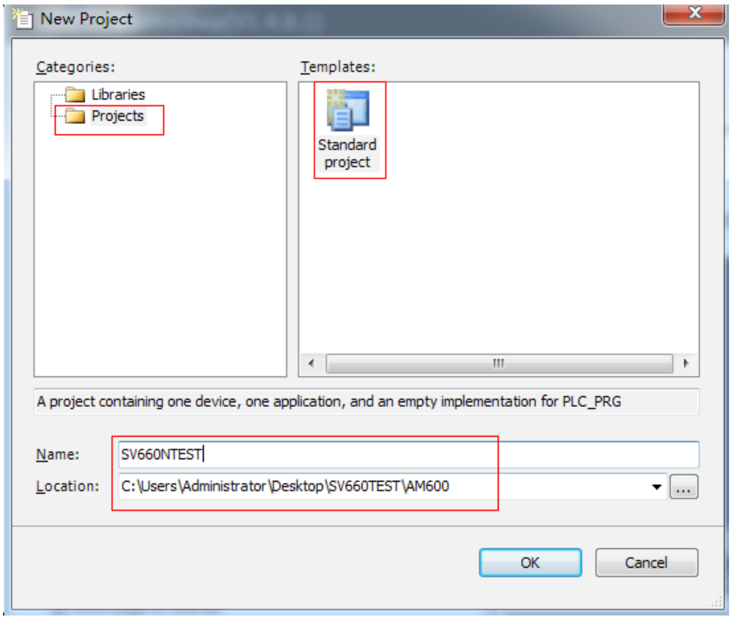
11 Application Cases

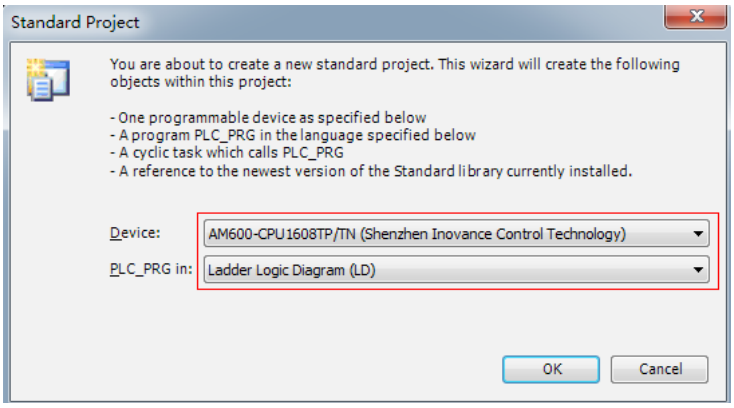
Case 1 AM600 Series Controller as the Host Controller

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

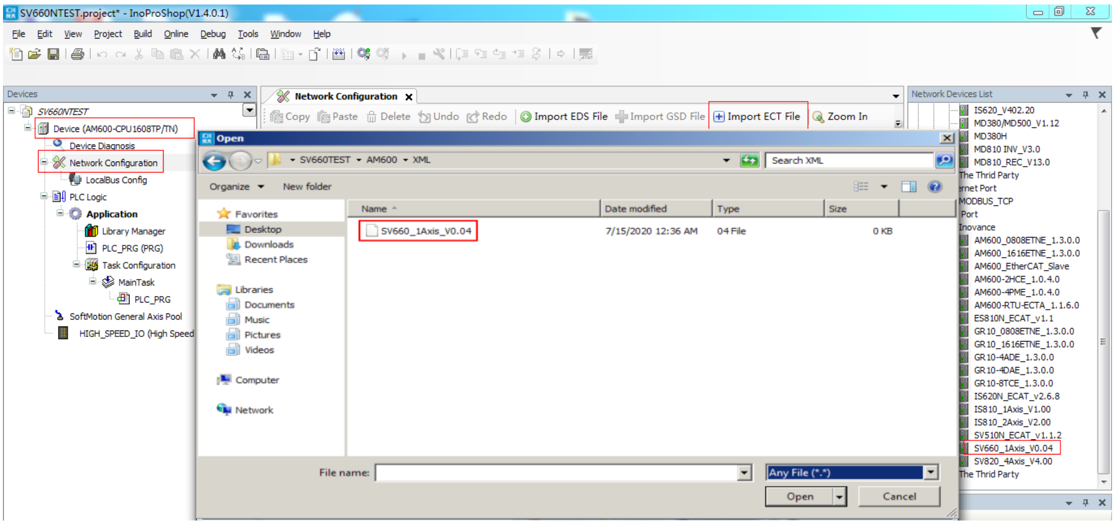
Select **AM600-CPU1608TP**, the corresponding interface is shown below.

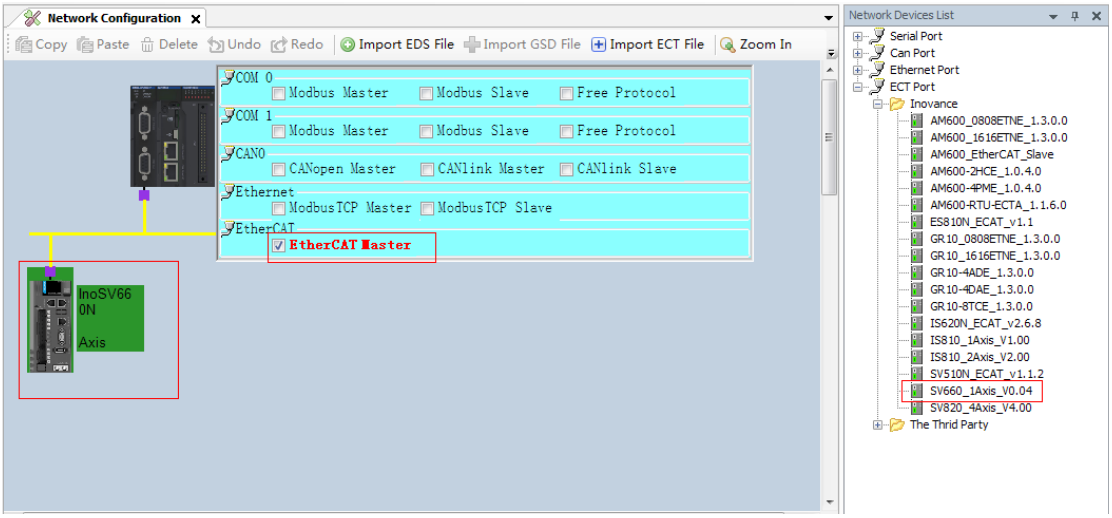




2) Adding a SV660N servo drive as a slave

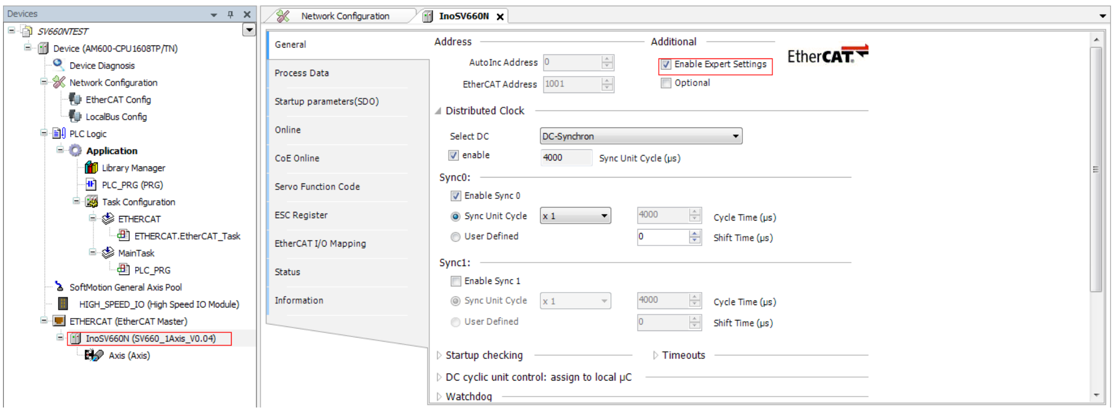
Open the network configuration and import the ECT file of SV660N. Add a SV660N servo drive as a slave, as shown below.

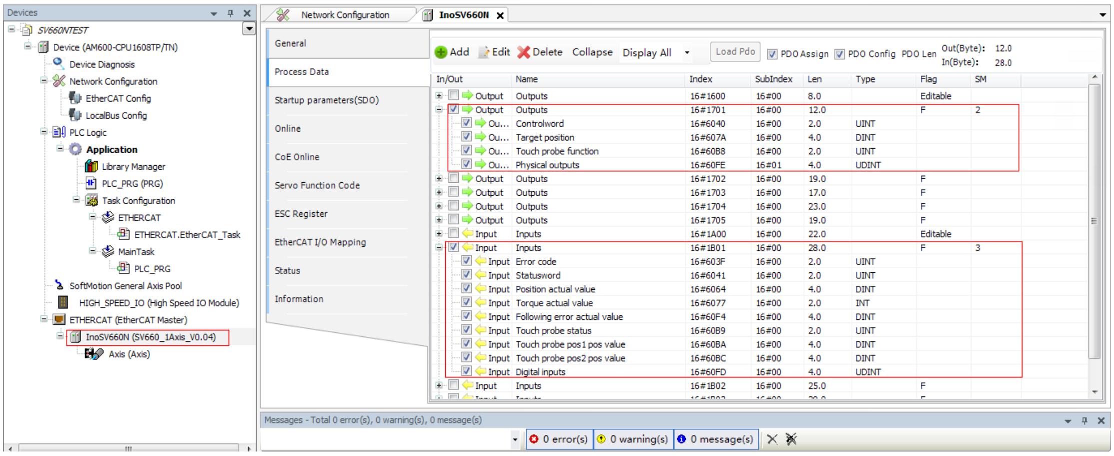




3) PDO mapping

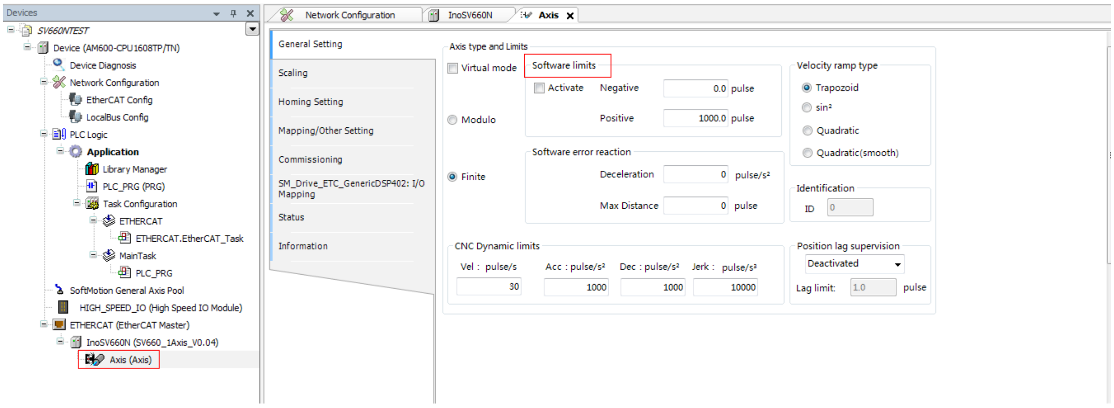
Select **Enable Expert Settings** and perform PDO mapping in the process data according to the control needs. In Case 1, CSP is used as the control mode and the default values of 1600 and 1A00 are used for PDO parameters.



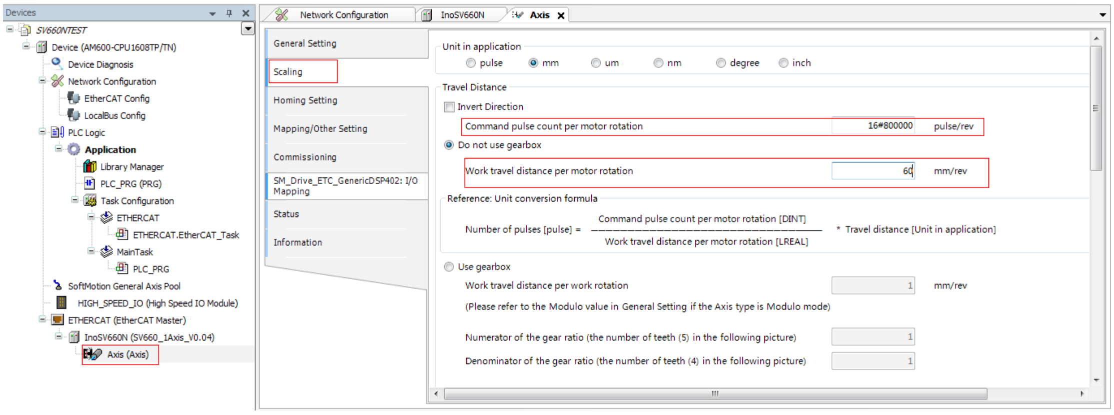


4) Configuring axis parameters

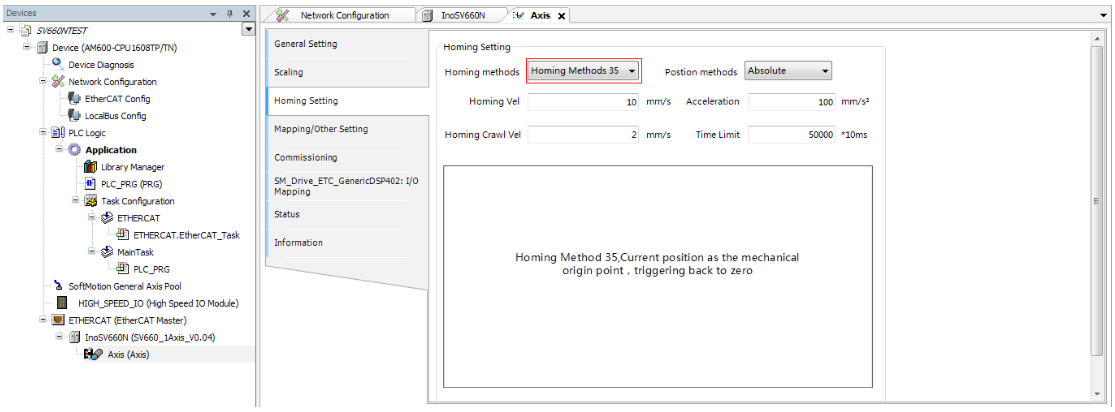
Set the software limit and the running mode in basic axis settings.



Select **16#800000** for the 23-bit encoder and **16#100000** for the 20-bit encoder during unit conversion. In Case 1, the single-turn stroke is set to 60 mm, and 1 mm/s equals to 1 RPM of the motor.

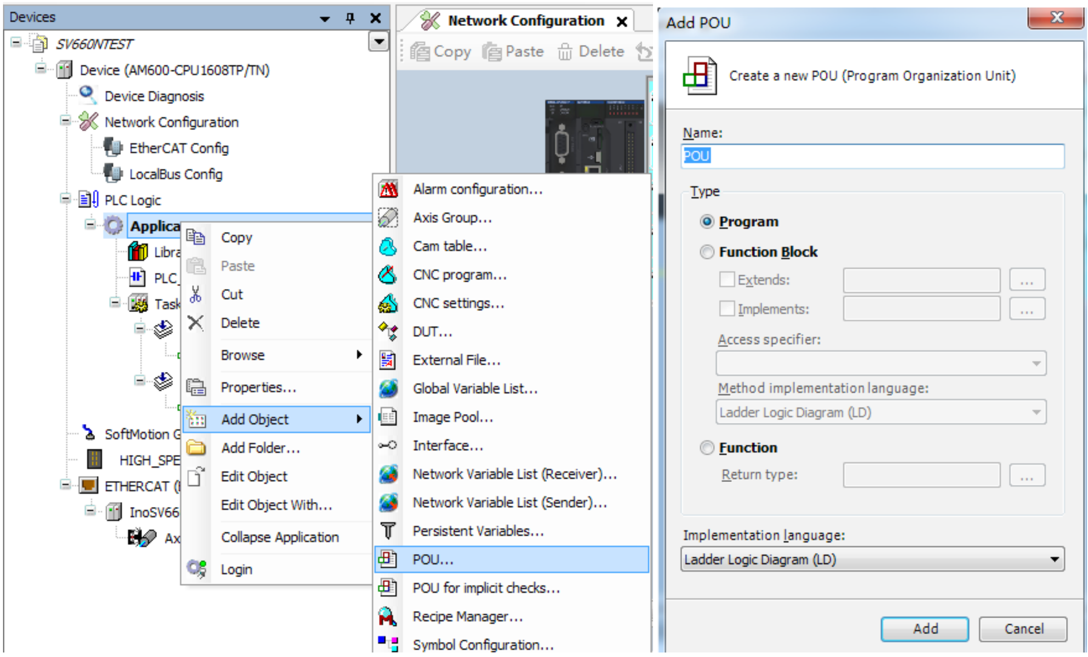


Select the homing mode according to actual needs. See "7.9.4 Homing Operation" for details on the homing mode.

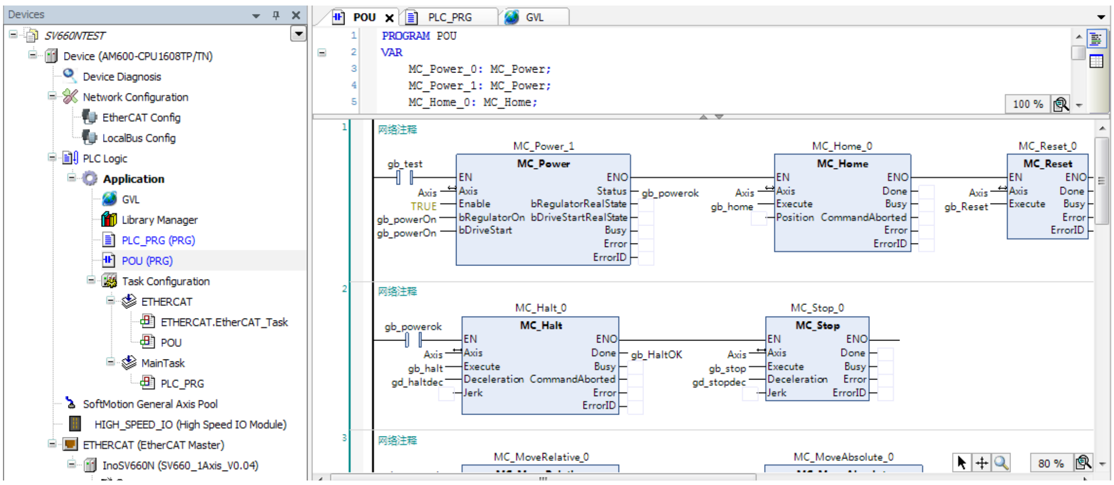


5) Adding a program

Add a program to control the servo axis position, as shown below.

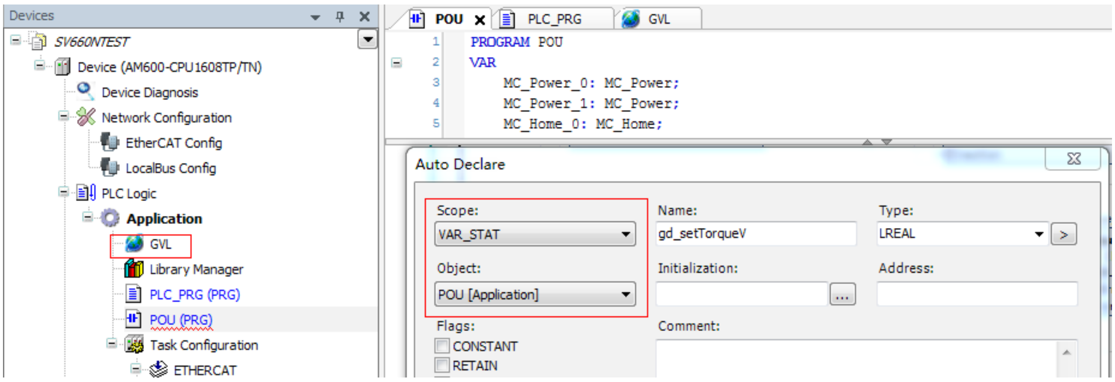


Implement the basic functions such as homing and positioning through adding the function blocks.

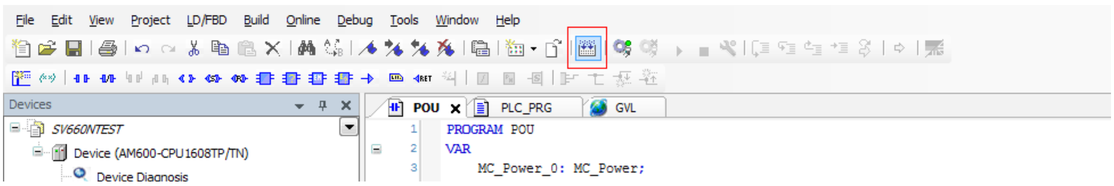


To implement directional motion through the logic program, call variables through different POUs and set the variables as global variables.

```
CASE iStatus OF
    10:
    gb_powerOn:=TRUE;
    IF gb_powerok THEN
    iStatus:=20;
    END_IF
    20:
    gd_MoveAbsPos:=1000;gd_MoveAbsVel:=200;gd_MoveAbsVelacc:=200;gd_MoveAbsVeldec:=200;gb_moveAbs:=TRUE;
    IF gb_moveAbsOK THEN
    gb_moveAbs:=FALSE;iStatus:=30;
    END_IF
    30:
    gd_MoveAbsPos:=2000;gd_MoveAbsVel:=400;gd_MoveAbsVelacc:=400;gd_MoveAbsVeldec:=400;gb_moveAbs:=TRUE;
    IF gb_moveAbsOK THEN
    gb_moveAbs:=FALSE;iStatus:=40;
    END_IF
    40:
    gd_MoveAbsPos:=0;gd_MoveAbsVel:=1000;gd_MoveAbsVelacc:=1000;gd_MoveAbsVeldec:=1000;gb_moveAbs:=TRUE;
    IF gb_moveAbsOK THEN
    gb_moveAbs:=FALSE;iStatus:=50;
    END_IF
    50:
    gb_powerOn:=FALSE;
```

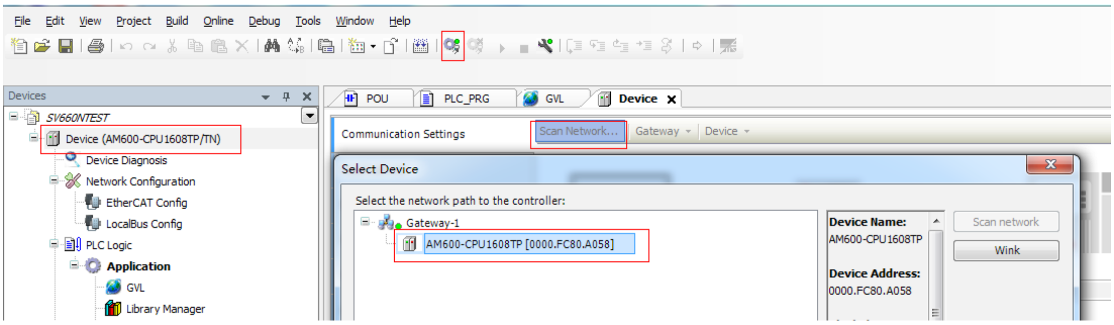


After editing the program, click the icon indicated by the red square box to detect whether the program is correct.

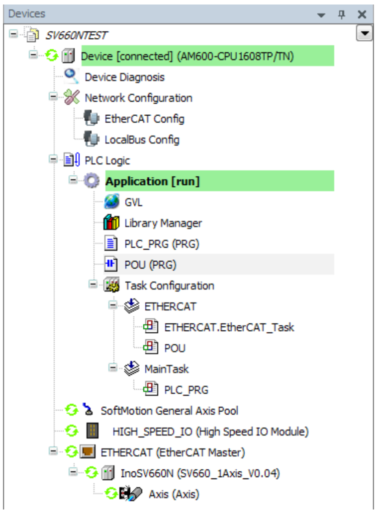


6) Downloading and performing commissioning of the program

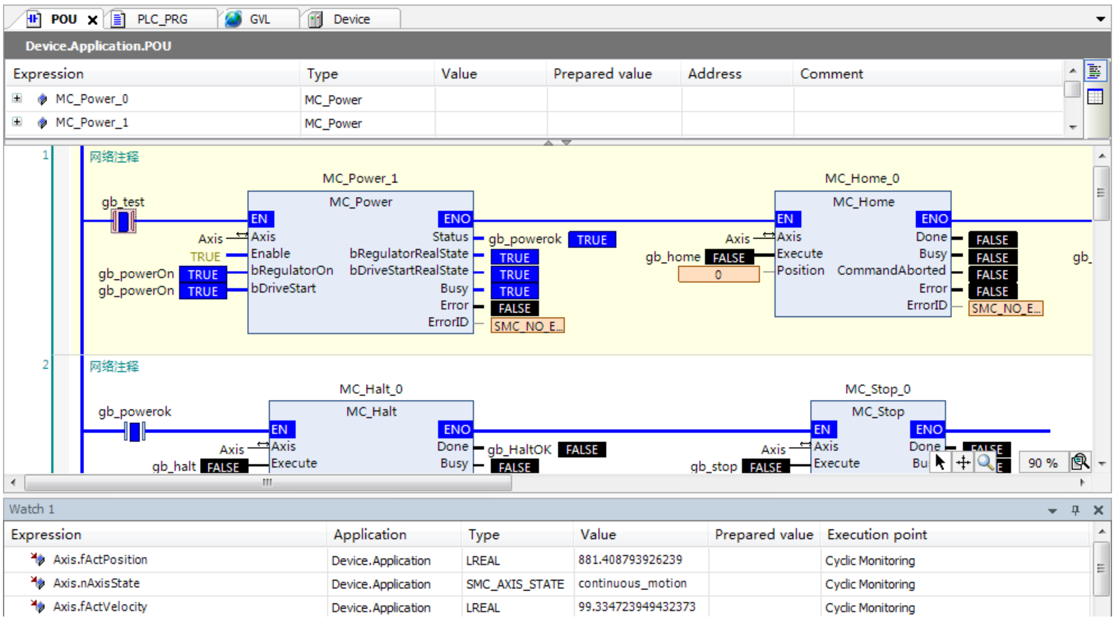
After the program detection is done, download the program to PLC. The program can be activated upon running. Before downloading, scan the PLCs first to select the target PLC, and then click the download icon, as shown below.



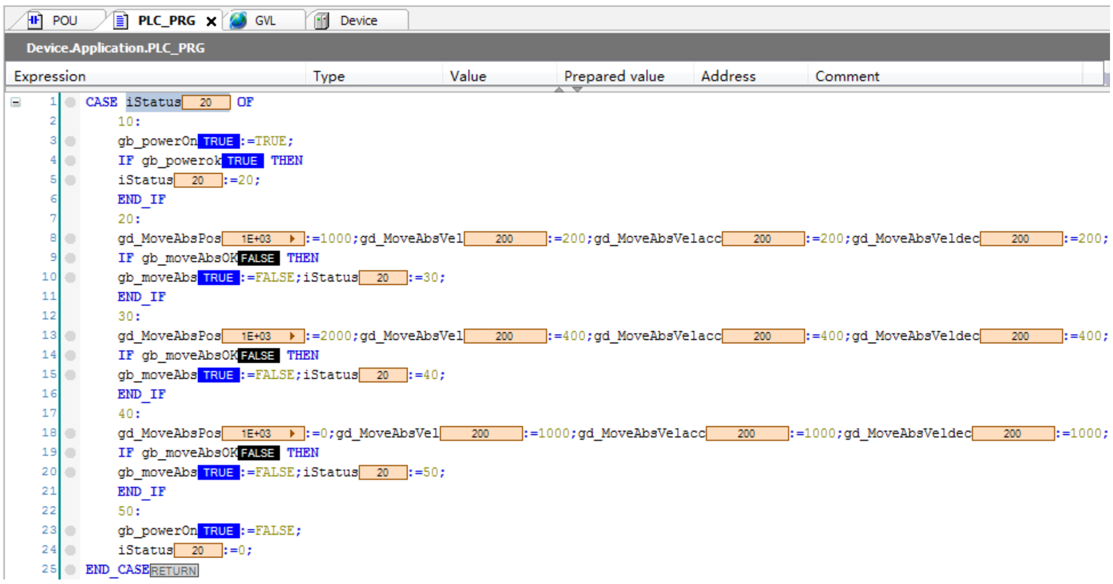
After log-in, ensure the servo drive and the axis are in normal state.



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 directed 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:

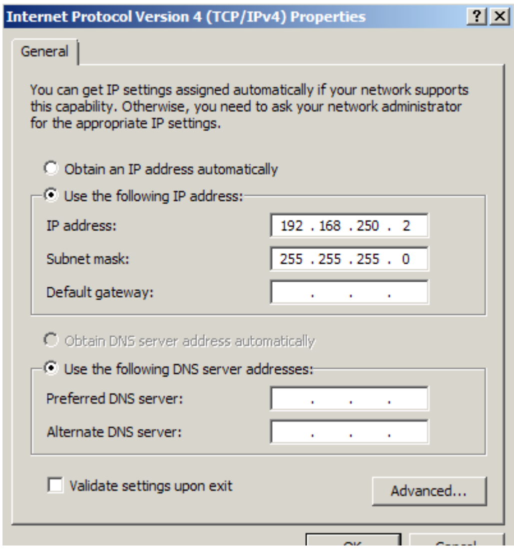
OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

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:

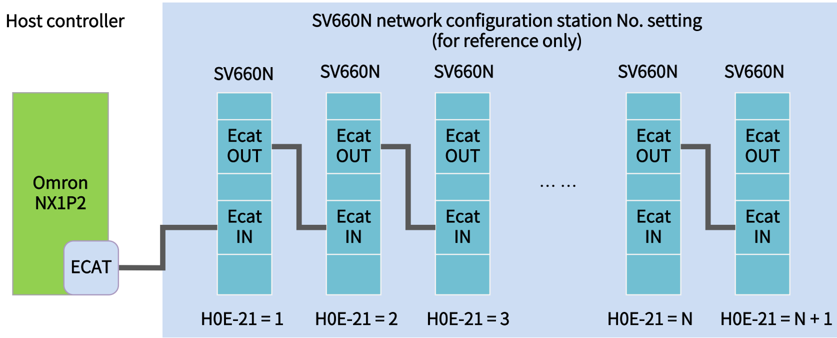
The MCU version of the PCB software is “H0100 = 0900.1” or higher.

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	Non-zero

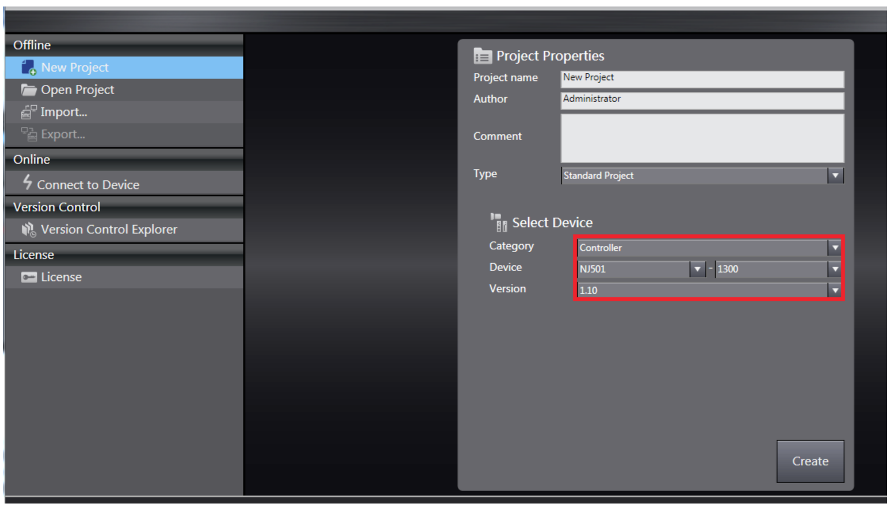
Para. No.	Name	Value Range	Unit	Default	Related Mode	Setting Condition	Effective Time	Value
When an Omron controller is used, set the EtherCAT communication station number in H0E-21. It is recommended to set the station number according to the actual physical connection sequence to facilitate management.								



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.

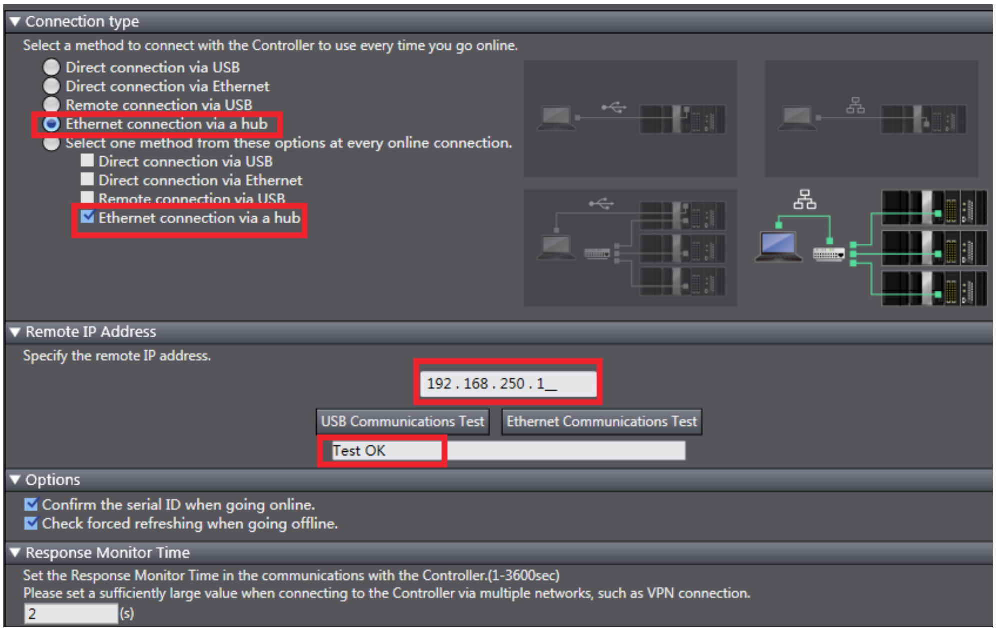


6) Communication settings

After entering the main interface, set the connection mode between the computer and the controller in **Controller → Connection type**.

You can select **Remote connection via USB** to perform **USB Communication Test** directly. If the test is succeeded, go to the next step.

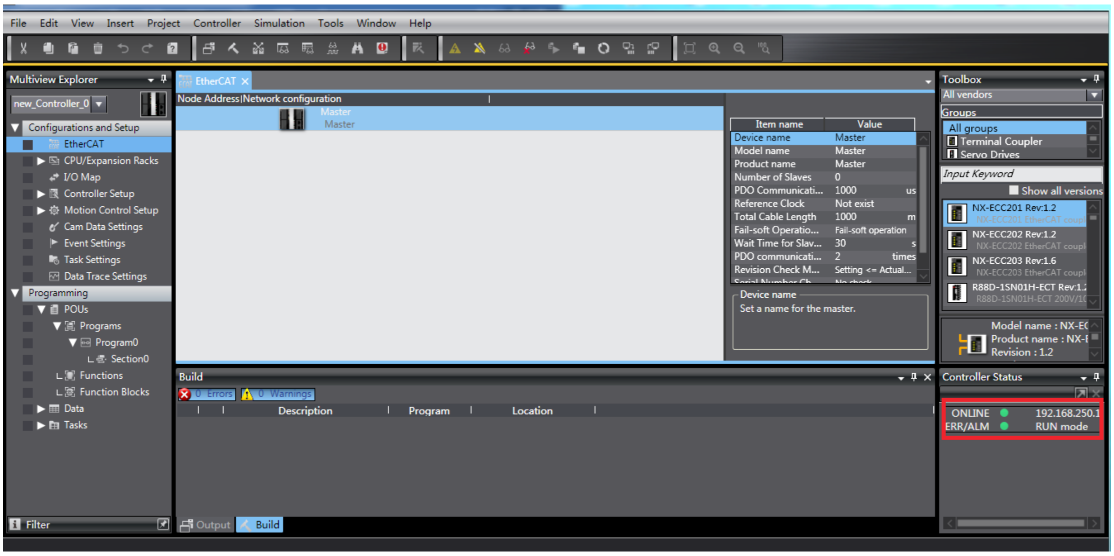
You can also select **Ethernet connection via a hub**, in this case, set the IP to 192.168.250.1 (IP controlled by NX), and then perform **Ethernet Communication Test**. If the test is succeeded, go to the next step.



7) Scanning the device

Switch the controller to the online running mode.

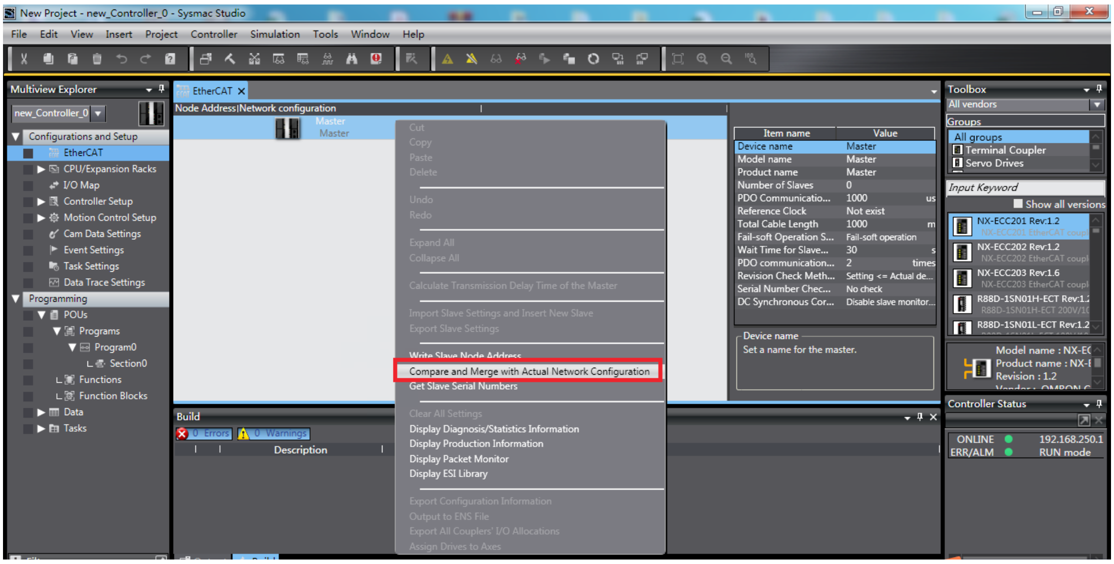
Observe the controller status in the lower right corner: online, running mode.

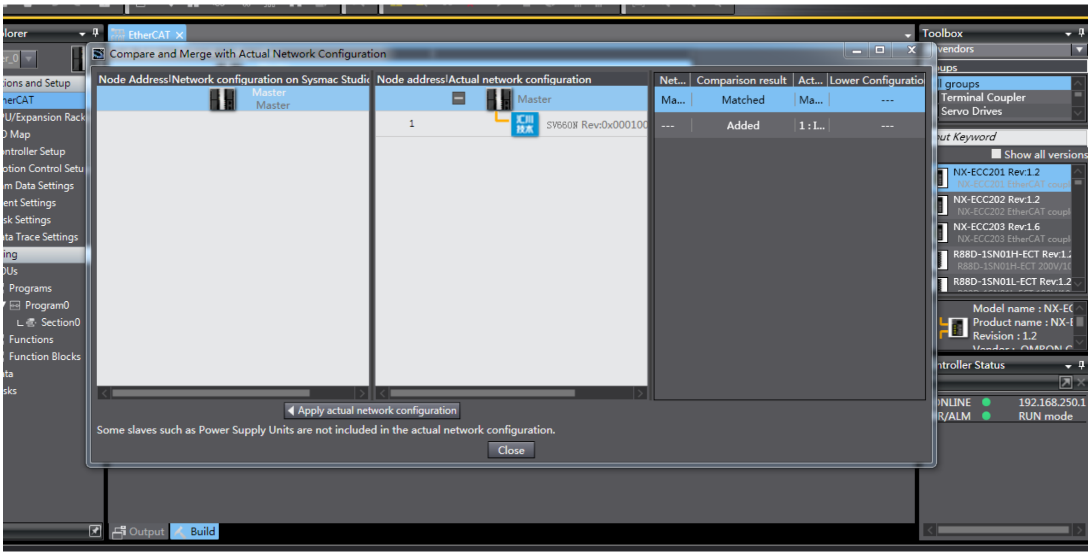


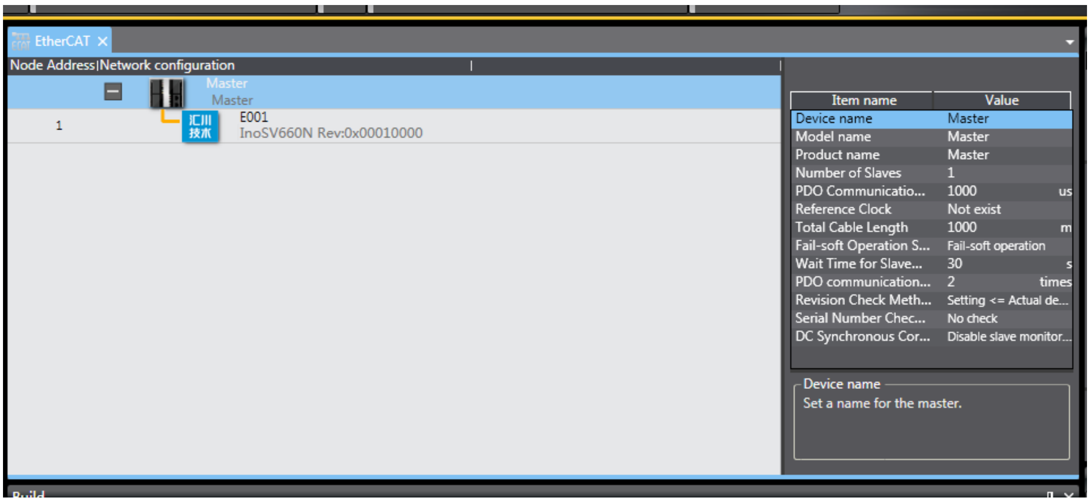
A window is displayed if it is a new controller. Click **Yes** in this window. The name shown in the window is the project name.

Scan the devices and add slaves.

Right click **Configurations and Setup→EtherCAT→Master**, and select **Compare and Merge with Actual Network Configuration**. The controller scans all the slaves within the network (an error will be reported if the station number is 0). After scanning, click **Apply actual network configuration** in the pop-up window to add the slave. You can view in the main page for the slaves added .



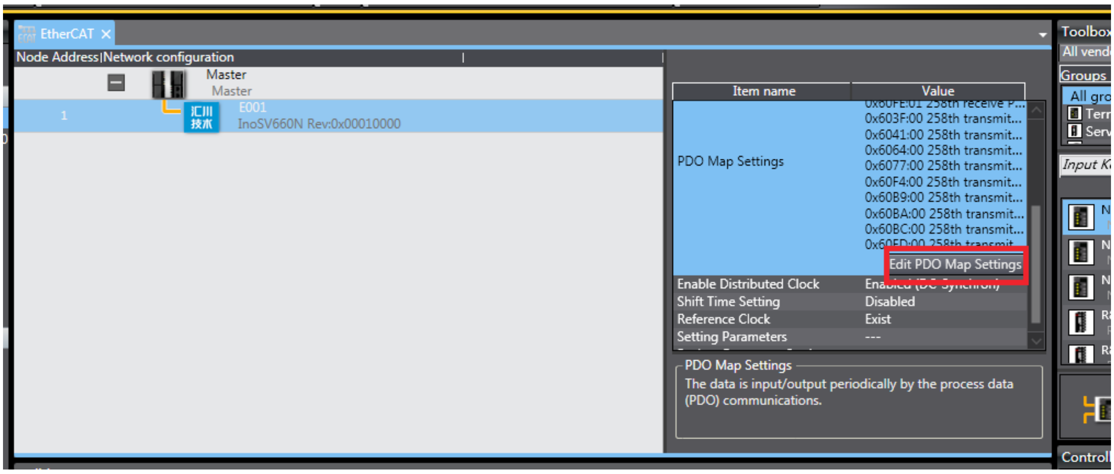




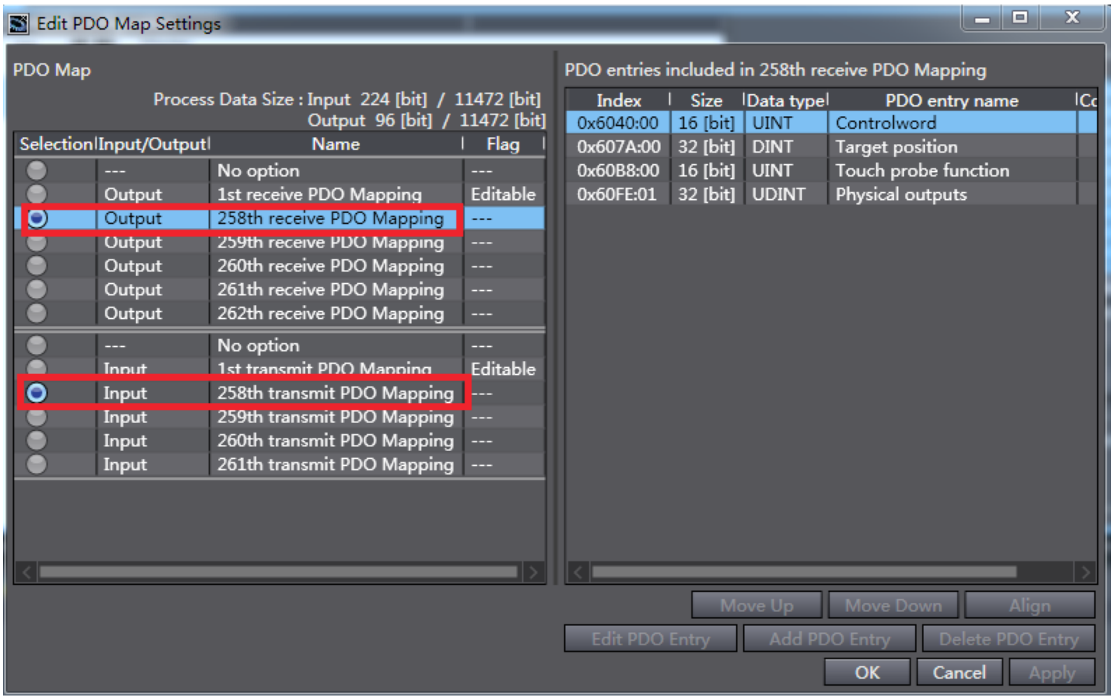
8) Setting parameters

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 **Add PDO Entry** and **Delete PDO Entry**. The frequently used mapping parameters are shown below.

RPDO

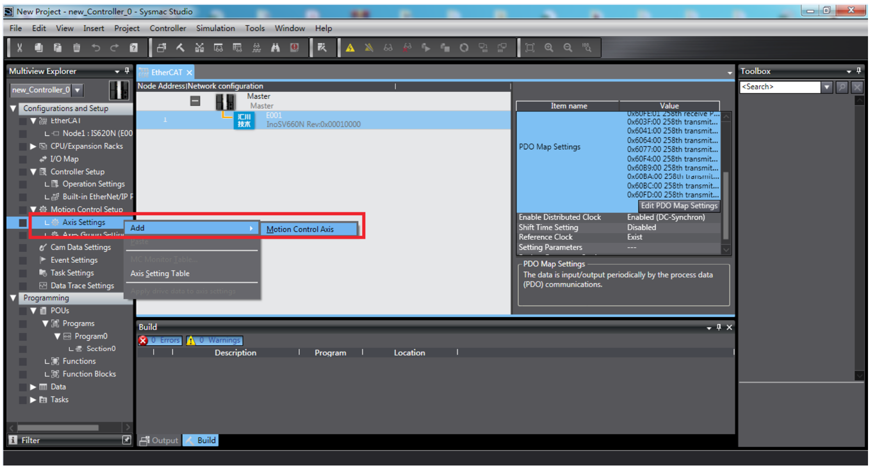
Index	Size	Data type	PDO entry name
0x6040:00	16 [bit]	UINT	Controlword
0x607A:00	32 [bit]	DINT	Target position
0x60B8:00	16 [bit]	UINT	Touch probe function
0x60FE:01	32 [bit]	UDINT	Physical outputs

TPDO

Index	Size	Data type	PDO entry name
0x603F:00	16 [bit]	UINT	Error code
0x6041:00	16 [bit]	UINT	Statusword
0x6064:00	32 [bit]	DINT	Position actual value
0x6077:00	16 [bit]	INT	Torque actual value
0x60F4:00	32 [bit]	DINT	Following error actual value
0x60B9:00	16 [bit]	UINT	Touch Probe Status

8-2) Setting axis parameters

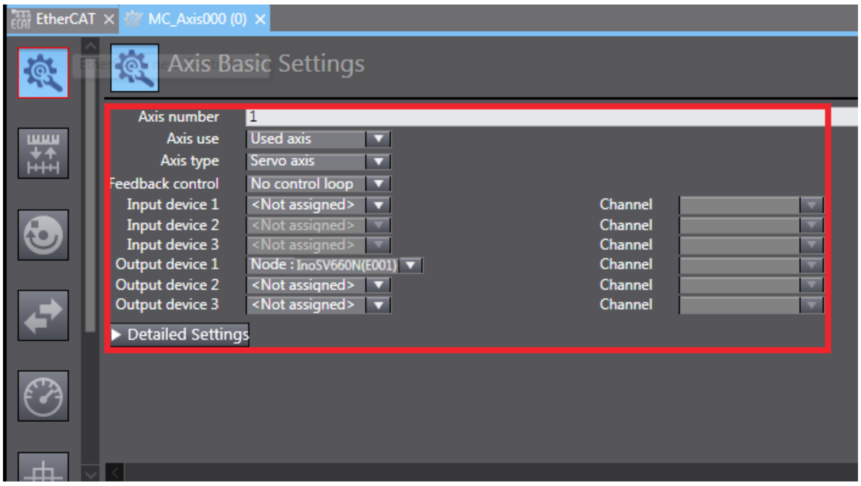
Right click **Motion Control Setup→Axis settings →Add→Motion Control Axis**, as shown below.



MC_Axis000 can be renamed through a simple click. For example, if it is named as Rewind axis, the axis variable 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 assignment



Axis number: Represents the Ethernet communication station No. of the servo drive, which is also the value of H0E-21.

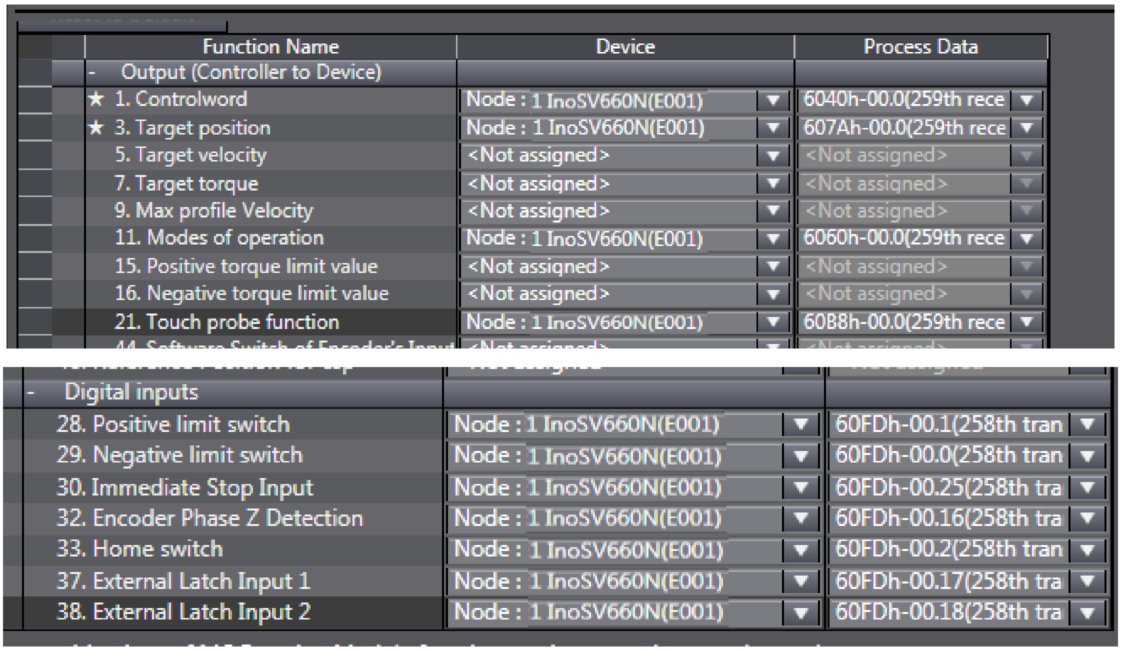
Axis use: Represents the axis in use.

Axis type: Represents the servo axis.

Output device 1: Select the SV660N servo drive.

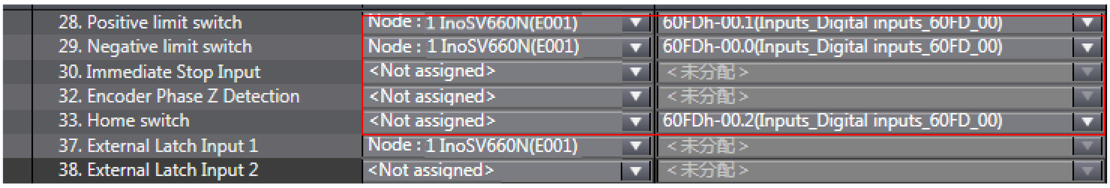
2) Detailed settings

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.



Function Name	Device	Process Data
- Output (Controller to Device)		
★ 1. Controlword	Node : 1 InoSV660N(E001)	6040h-00.0(259th rece
★ 3. Target position	Node : 1 InoSV660N(E001)	607Ah-00.0(259th rece
5. Target velocity	<Not assigned>	<Not assigned>
7. Target torque	<Not assigned>	<Not assigned>
9. Max profile Velocity	<Not assigned>	<Not assigned>
11. Modes of operation	Node : 1 InoSV660N(E001)	6060h-00.0(259th rece
15. Positive torque limit value	<Not assigned>	<Not assigned>
16. Negative torque limit value	<Not assigned>	<Not assigned>
21. Touch probe function	Node : 1 InoSV660N(E001)	60B8h-00.0(259th rece
- Digital inputs		
28. Positive limit switch	Node : 1 InoSV660N(E001)	60FDh-00.1(258th tran
29. Negative limit switch	Node : 1 InoSV660N(E001)	60FDh-00.0(258th tran
30. Immediate Stop Input	Node : 1 InoSV660N(E001)	60FDh-00.25(258th tra
32. Encoder Phase Z Detection	Node : 1 InoSV660N(E001)	60FDh-00.16(258th tra
33. Home switch	Node : 1 InoSV660N(E001)	60FDh-00.2(258th tran
37. External Latch Input 1	Node : 1 InoSV660N(E001)	60FDh-00.17(258th tra
38. External Latch Input 2	Node : 1 InoSV660N(E001)	60FDh-00.18(258th tra

60FDh must be mapped to objects by bit. The mapping must be consistent with that in the Omron controller. SV660N only supports the positive/negative limit, home function, and touch probe function.

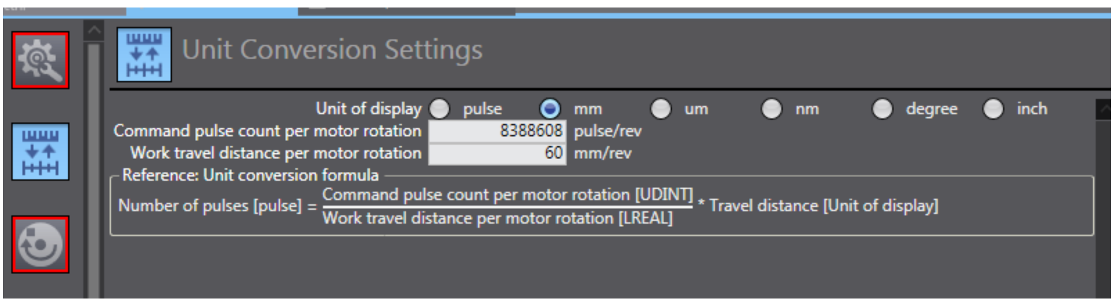


28. Positive limit switch	Node : 1 InoSV660N(E001)	60FDh-00.1(Inputs_Digital inputs_60FD_00)
29. Negative limit switch	Node : 1 InoSV660N(E001)	60FDh-00.0(Inputs_Digital inputs_60FD_00)
30. Immediate Stop Input	<Not assigned>	<未分配>
32. Encoder Phase Z Detection	<Not assigned>	<未分配>
33. Home switch	<Not assigned>	60FDh-00.2(Inputs_Digital inputs_60FD_00)
37. External Latch Input 1	Node : 1 InoSV660N(E001)	<未分配>
38. External Latch Input 2	<Not assigned>	<未分配>

CAUTION	
	The axis configuration of SV660N needs to be performed manually.

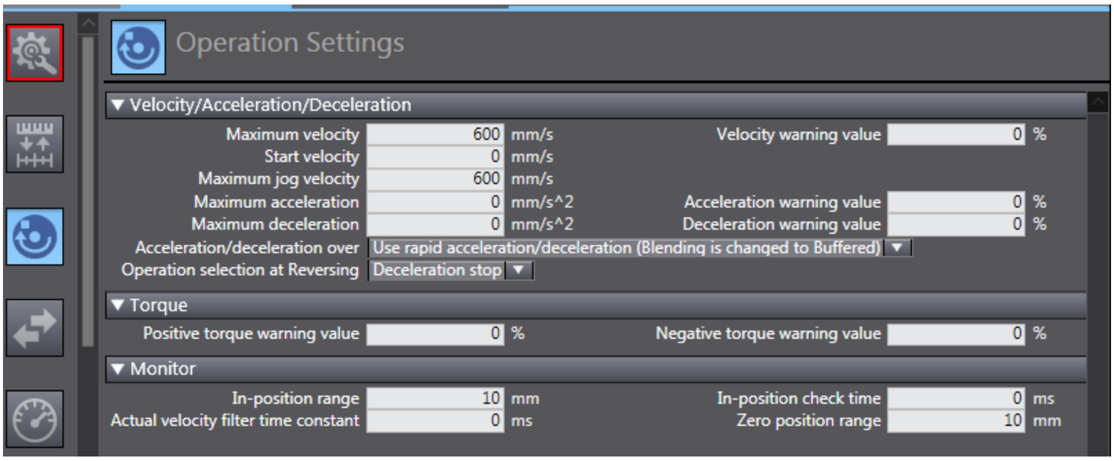
8-3) Unit conversion setting

Set **Command pulse count per motor rotation** based on the resolution of the motor in use (example: 8388608 pulses for 23-bit motor). In this example set to 60 mm per revolution, which results in that 1 mm/s equals 1 RPM of the motor.



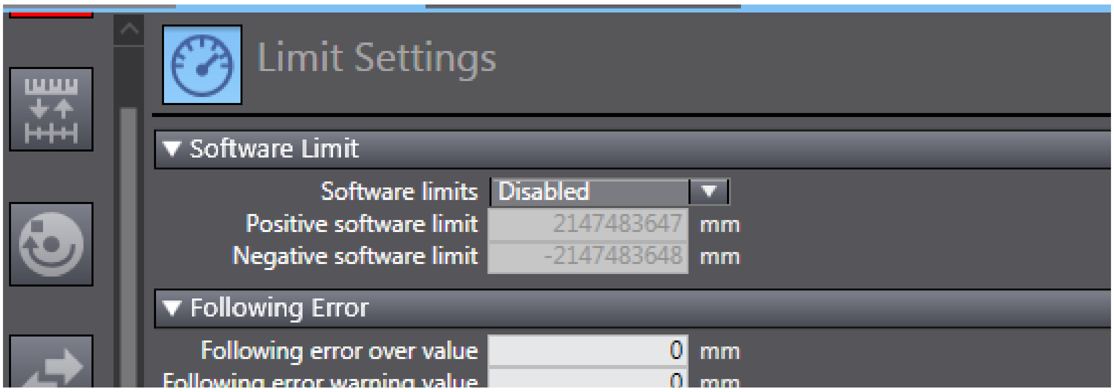
Select **Unit of display** based on the actual running unit when setting the gear ratio. All the position-type parameters in the host controller will be displayed in this unit.

8-4) Operation settings



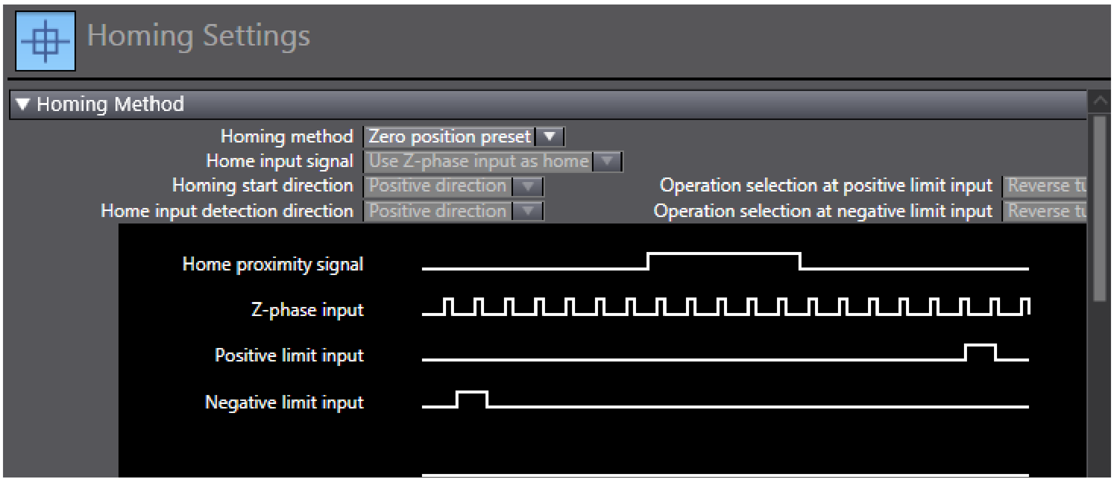
- **Velocity/Acceleration/Deceleration**: Set the maximum speed of the load according to actual conditions. If the motor speed converted from the set value exceeds 6000 RPM, a prompt will be displayed in the form of a red box.
  If the acceleration/deceleration rate is 0, the running curve will be generated based on the maximum acceleration/deceleration rate. If there is no special requirement, this parameter needs no setting.
- **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.
- **Monitor**: Set the **In-position range** and **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 limits



The set software limits 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

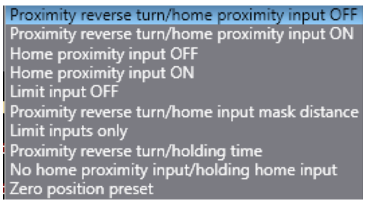
Select the homing mode of the host controller and set the homing speed, acceleration, and home offset based on actual mechanical conditions.

■ 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 types 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.

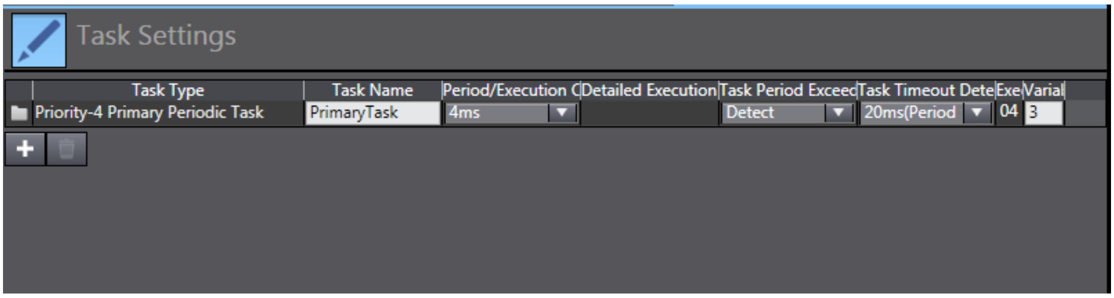
■ **Proximity reverse turn**: If the home proximity signal is ON when homing is enabled, the host controller reverses the running direction immediately after reaching the falling edge of the home proximity signal.

- **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**: 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 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 low speed in all the homing modes. If the motor runs at high speed, the home signal is masked when it decelerates from high speed to low speed.

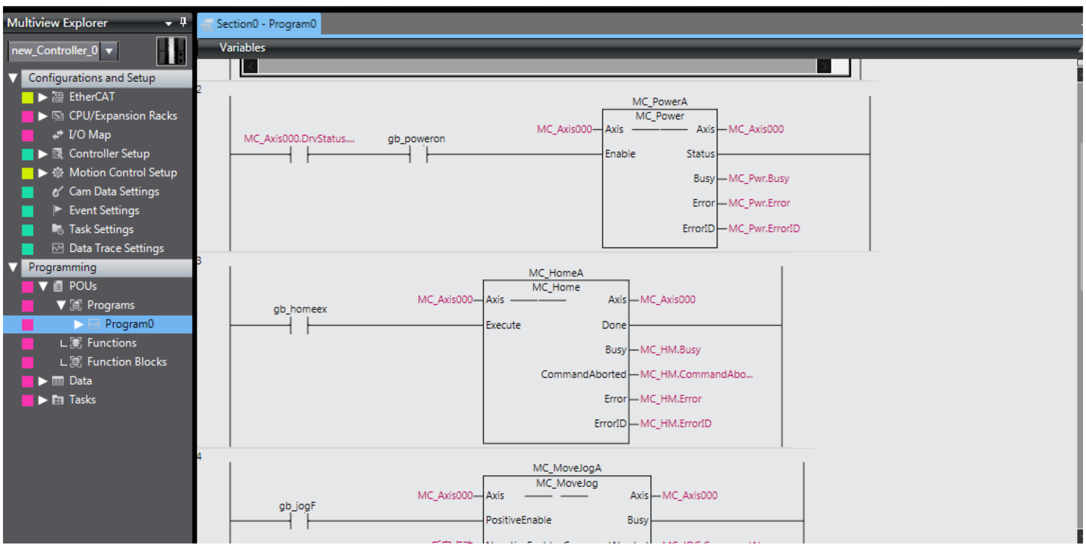
8-7) DC clock

The default clock is 1 ms. The synchronization clock (cycle of primary fixed-cycle tasks) named “PDO communication cycle” can be modified in **Task Settings**. 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.

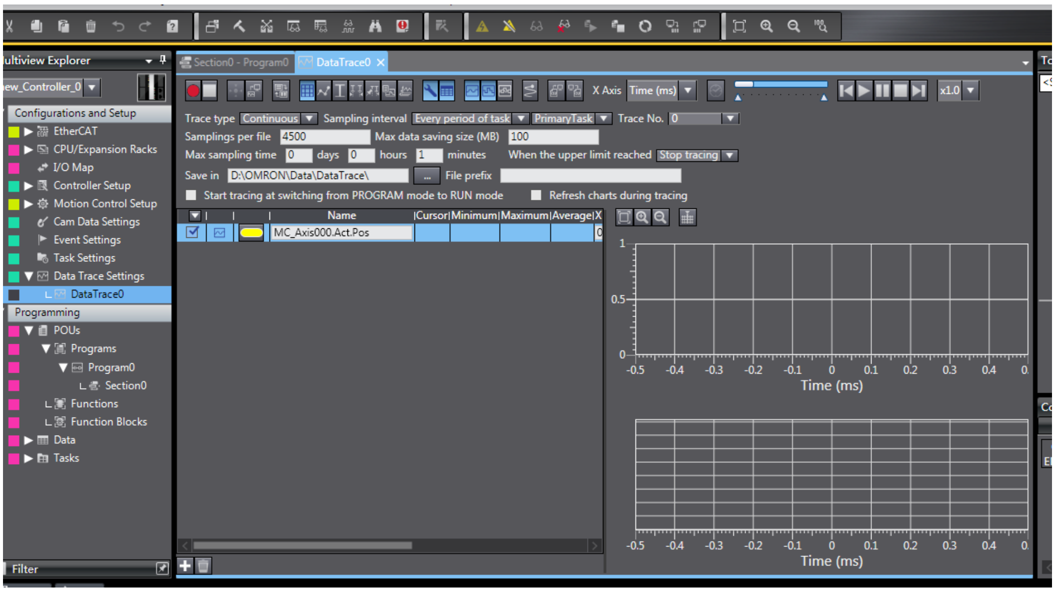


10) Online running

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 differences.

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

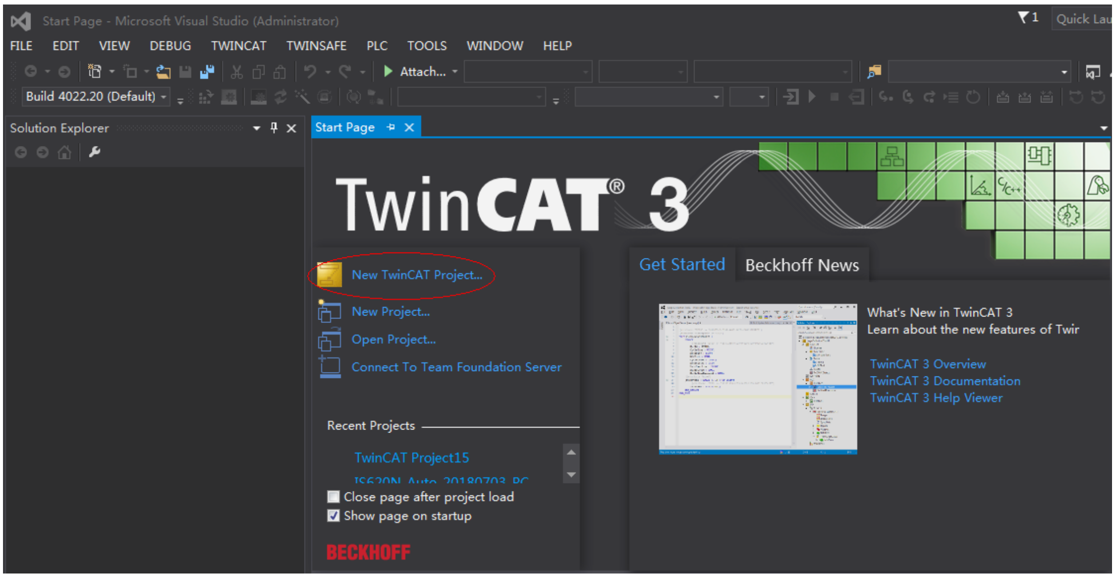
The TwinCAT3 software, which supports Win7 32-bit or 64-bit systems, can be downloaded from the official website of Beckhoff.

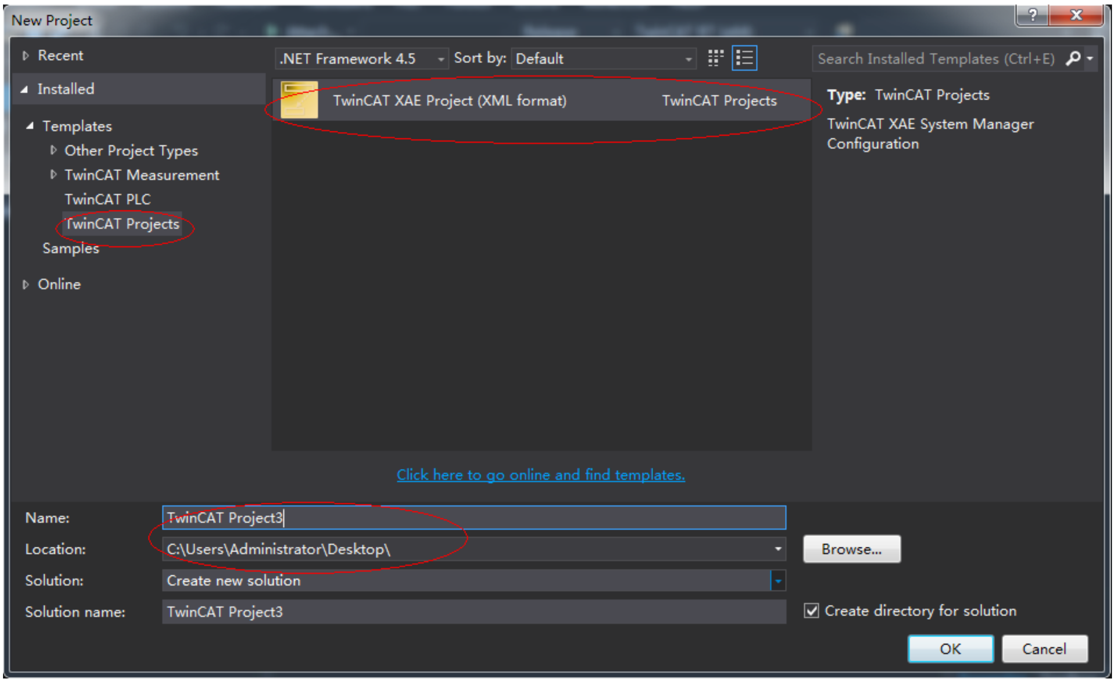
CAUTION

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.

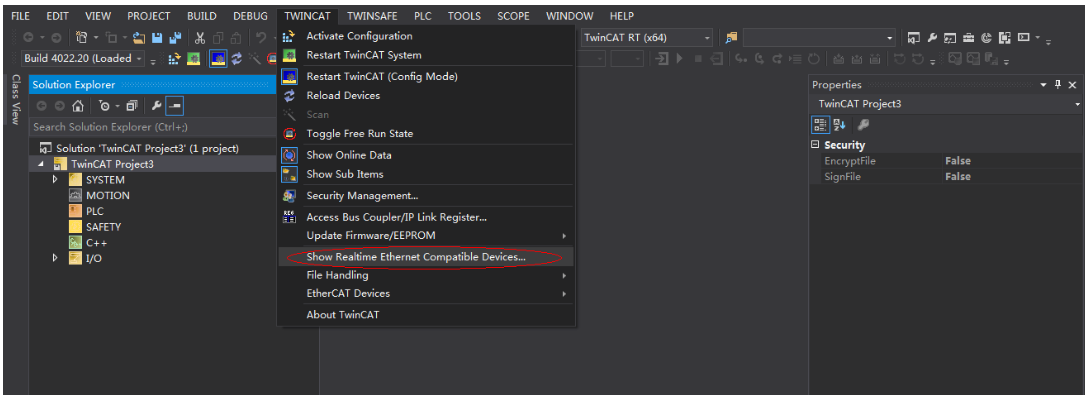
a) Copy the SV660N EtherCAT configuration file (SV660_1Axis_V0.04-0506) to the TwinCAT installation directory: TwinCAT\3.1\Config\Io\EtherCAT.

b) Open TwinCAT3 and create a **New Twincat3 Project**.

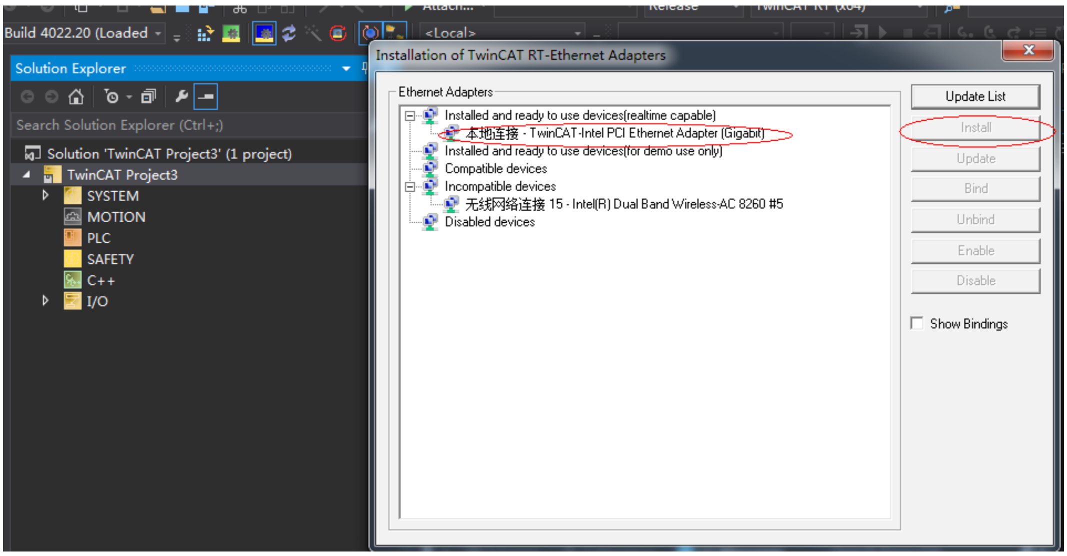




2) Installing the TwinCAT network adapter drive

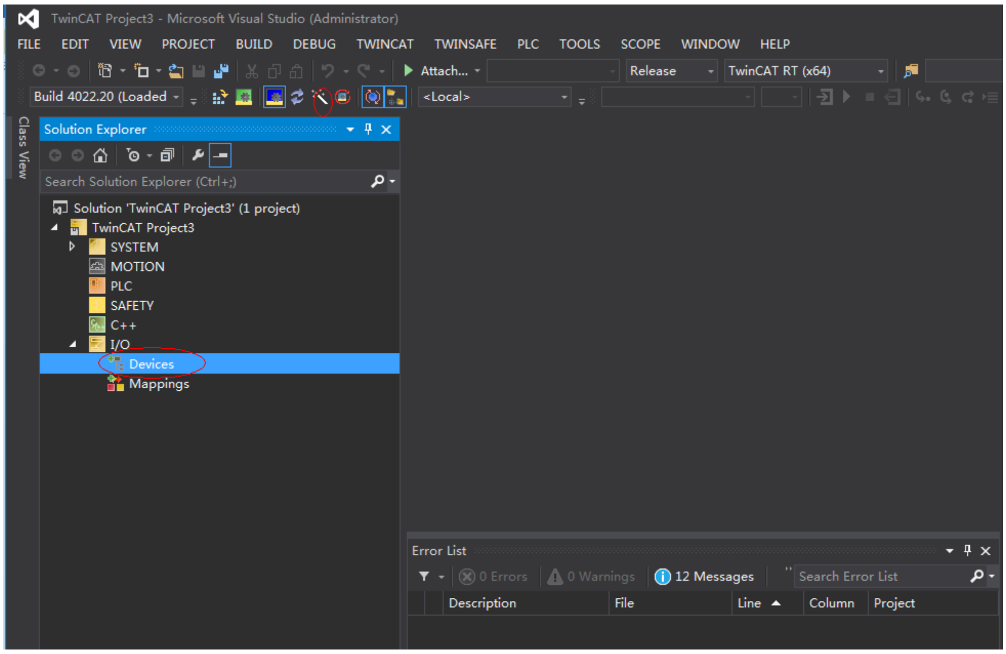


Open **Show Real Time Ethernet Compatible Devices…** in the menu shown in the preceding figure to display the following dialog box. Select local connection under **Incompatible devices**, and click **Install**. After installation is done, the network adapter installed will be displayed under **Installed and ready to use devices(realtime capable)**.

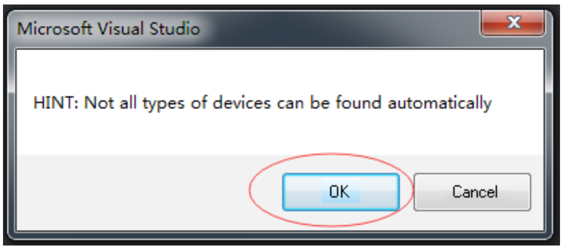


3) Searching for devices

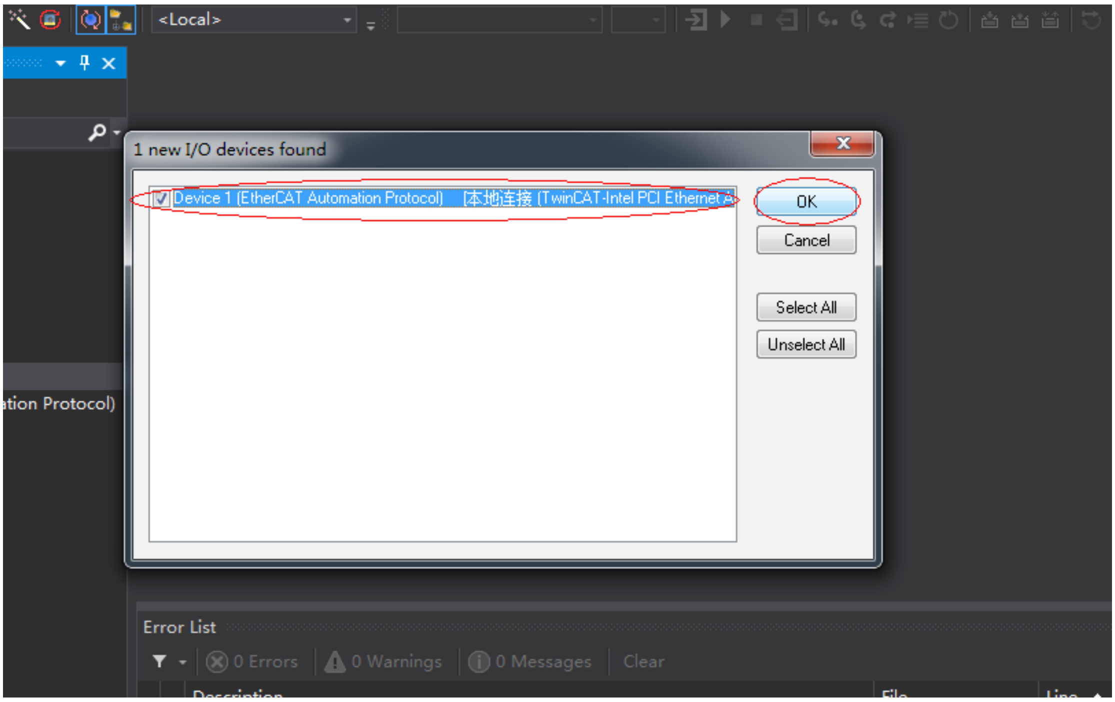
a) Create a project and start searching for devices. Select " Devices ", and click " " as shown below.



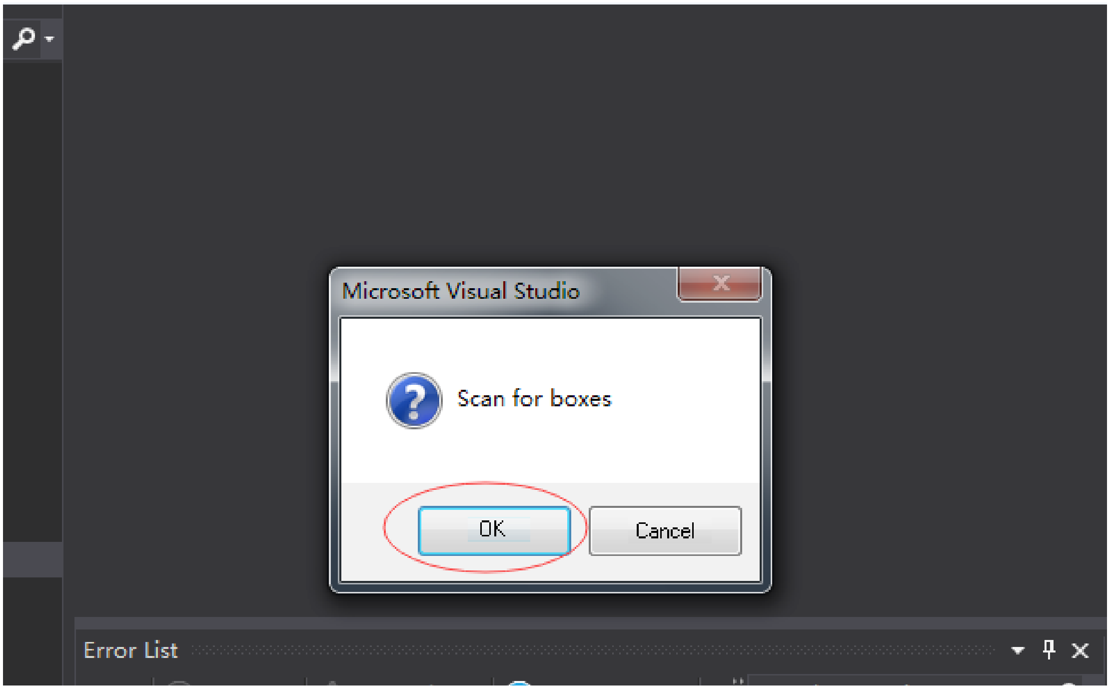
b) Click **OK**.



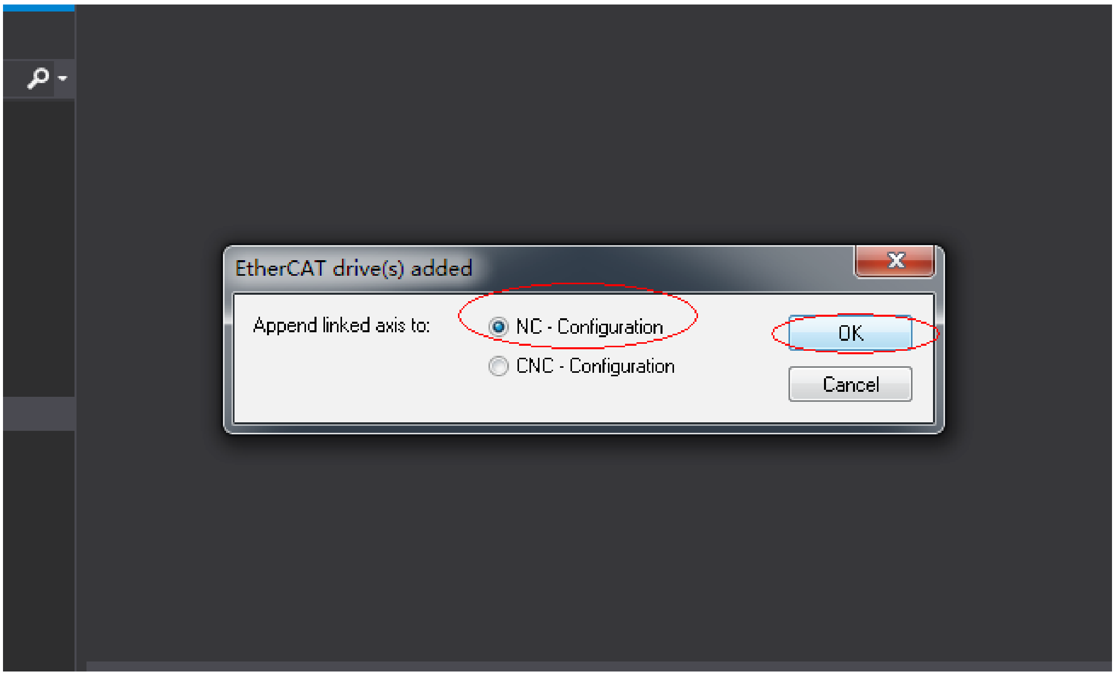
c) Click **OK**.



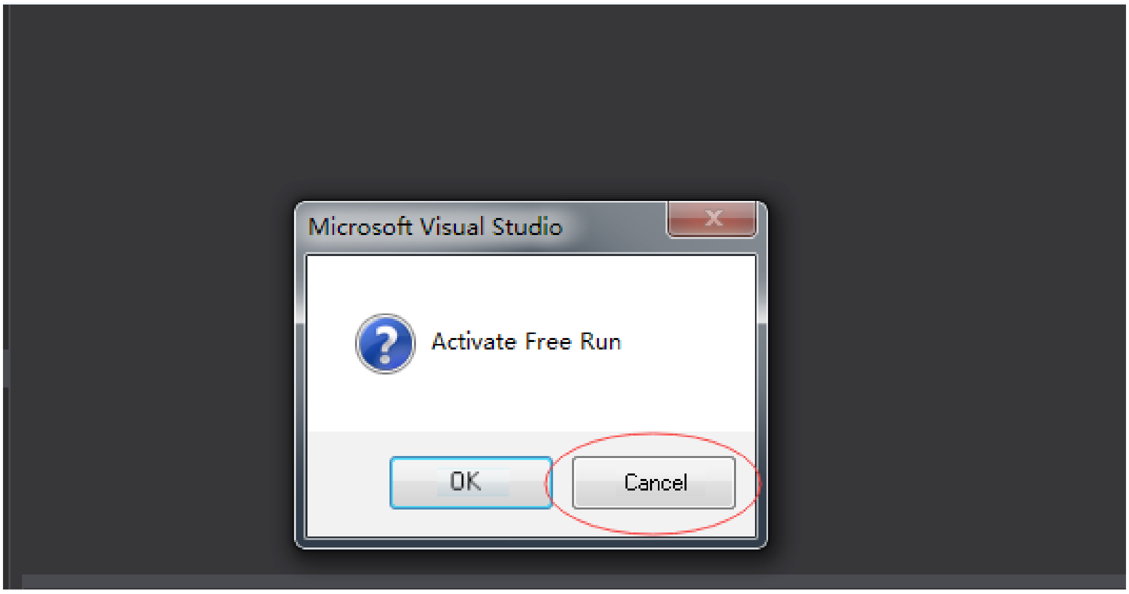
d) Click **Yes**.



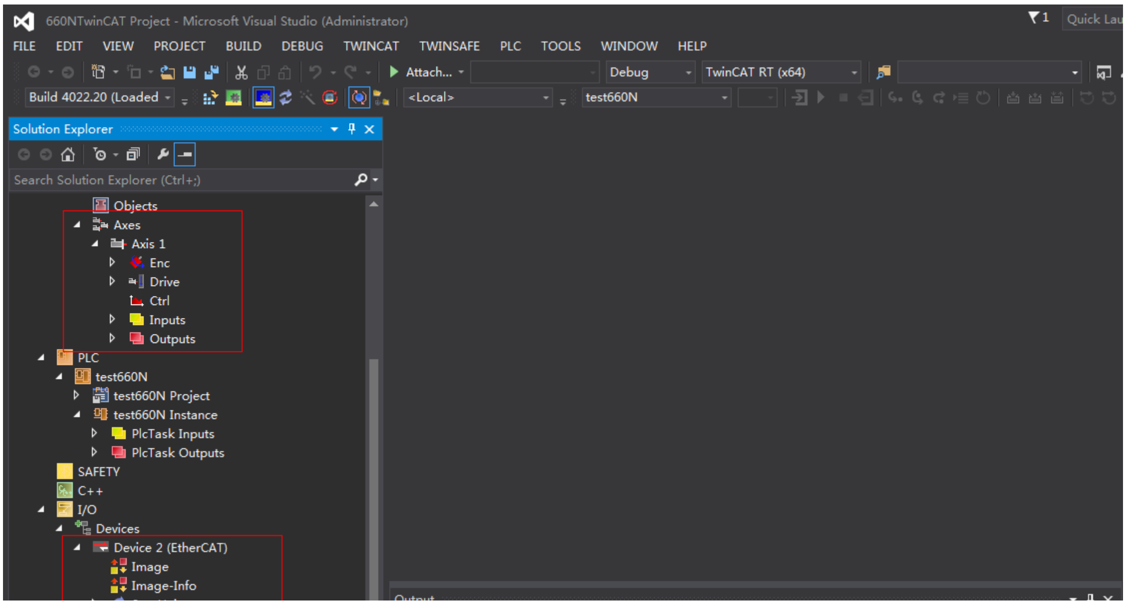
e) Click **OK**.



f) Click **No**.



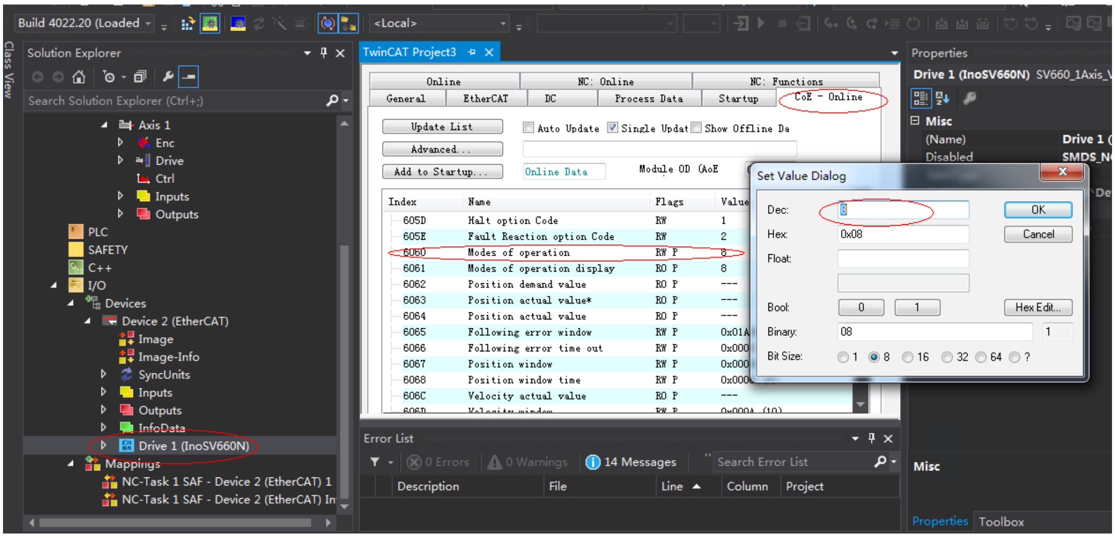
g) The device search is done, as shown below.



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.

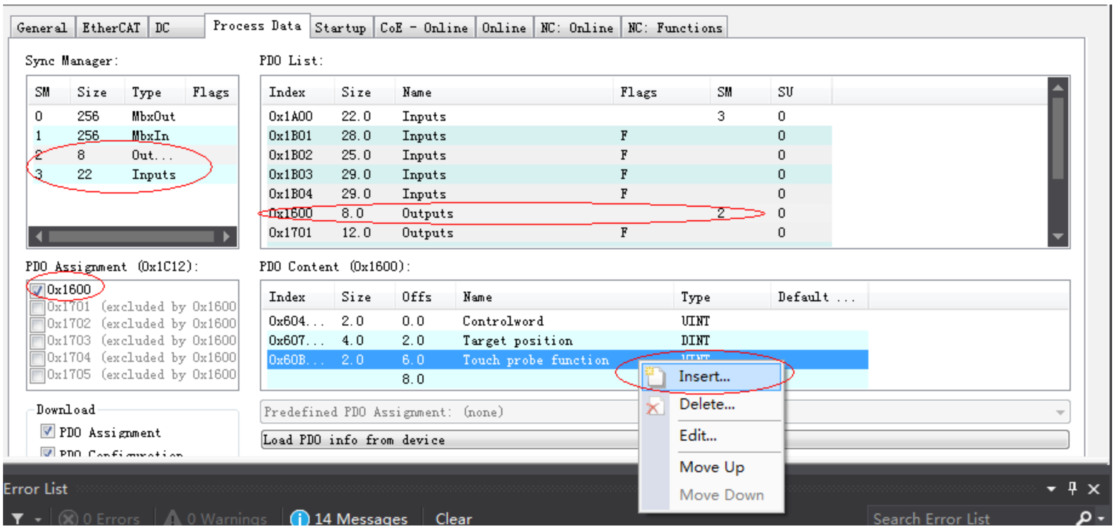
To modify 6060h to the CSP mode (8), follow the procedures shown in the following image.

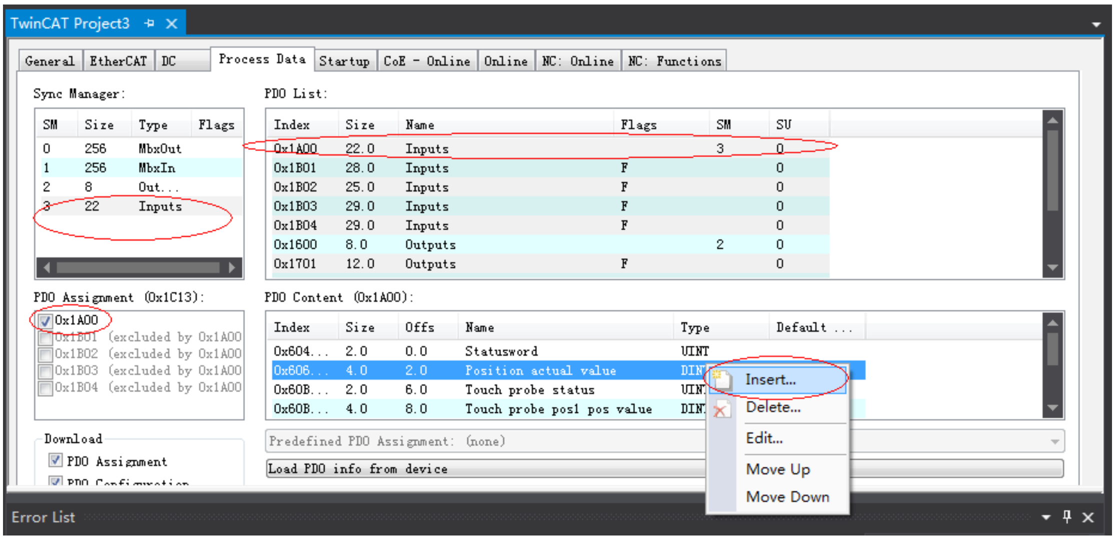


> **NOTE**
> This operation is available only when H02-00 (Control mode) is set to 9 (EtherCAT mode).

5) Configuring PDO

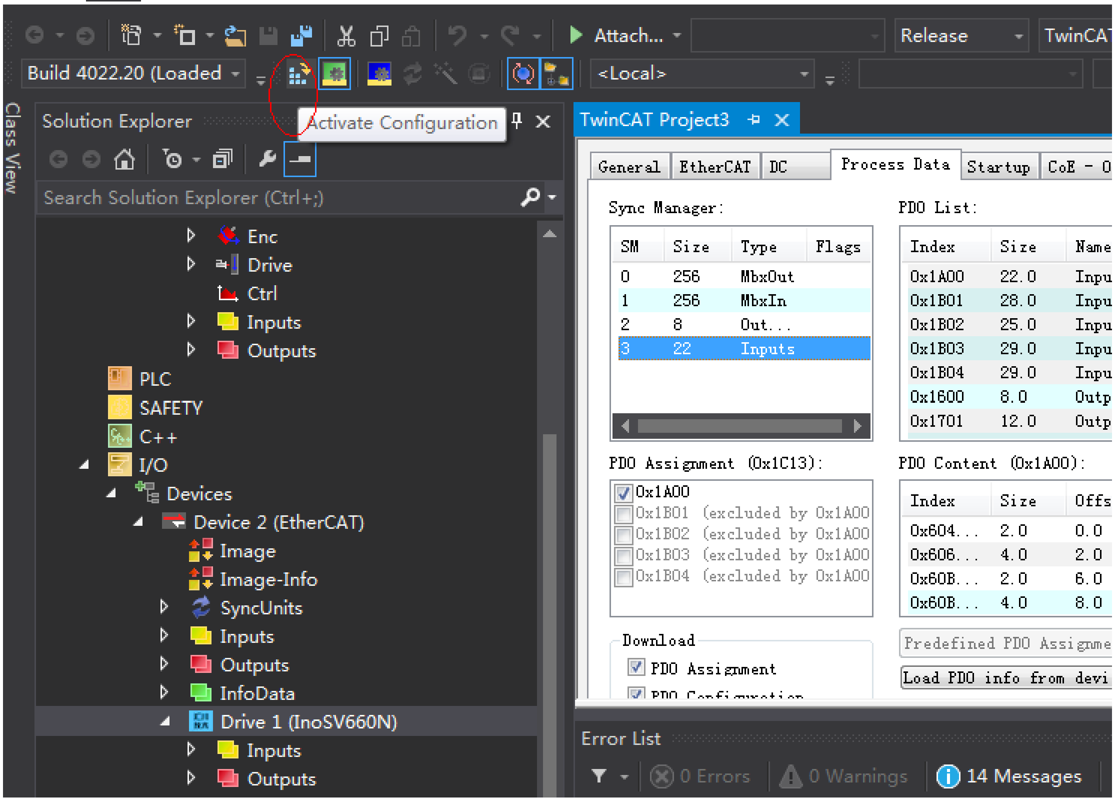
Select 0x1600 and 0x1A00 as shown in the following figure. Change the current PDO only if it does not fulfill your needs. To modify the PDO, right click the PDO Content window, click **Delete** to delete the redundant PDO or click **Insert** to add the PDO needed.



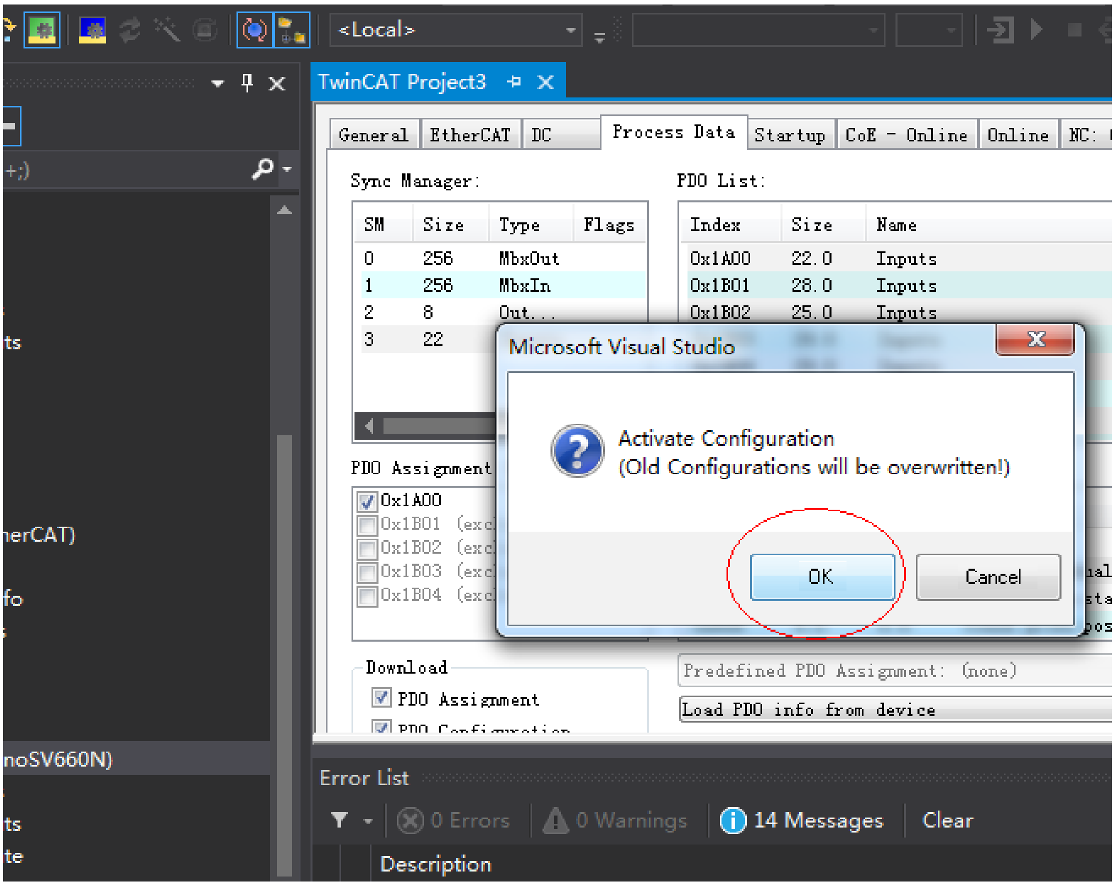


6) Activating the configuration and switching to the running mode

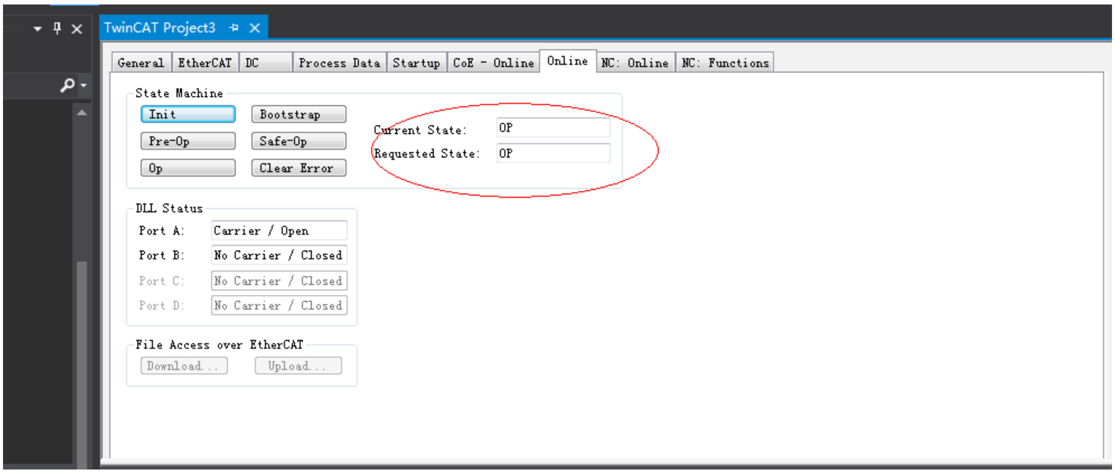
a) Click  .



b) Click **OK**.



c) After clicking **OK**, the device enters OP status as shown in the **Online** interface. The 3rd LED on the keypad displays the value 8, and the keypad displays _88RY.

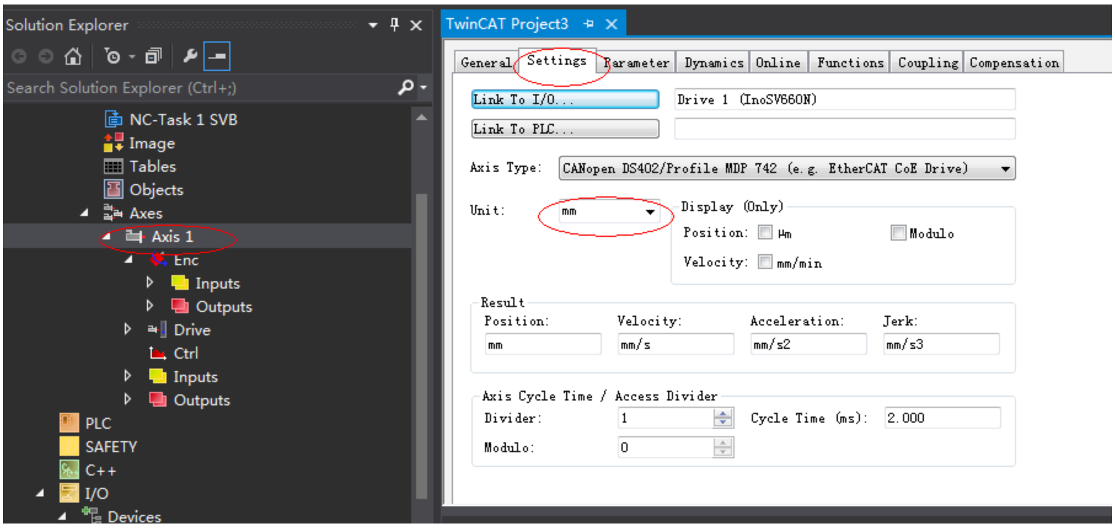


7) Controlling the servo drive through NC controller or PLC program

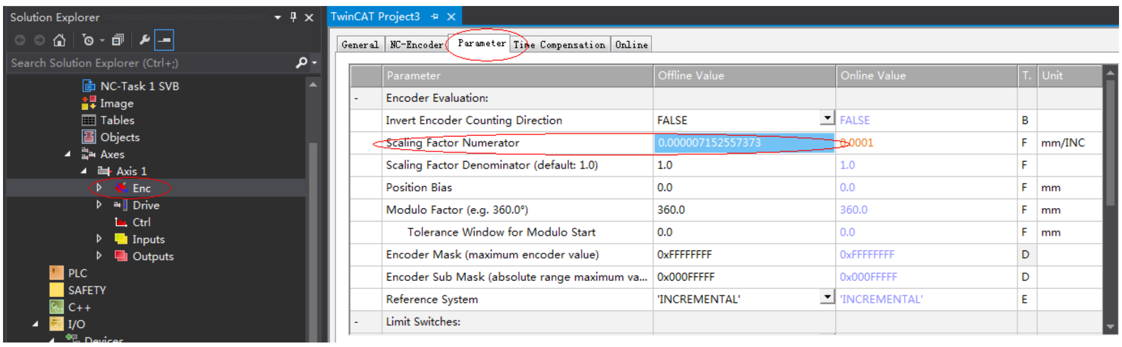
7-1) Servo drive running in the CSP mode

a) Set the unit.

The unit is “mm” during testing.



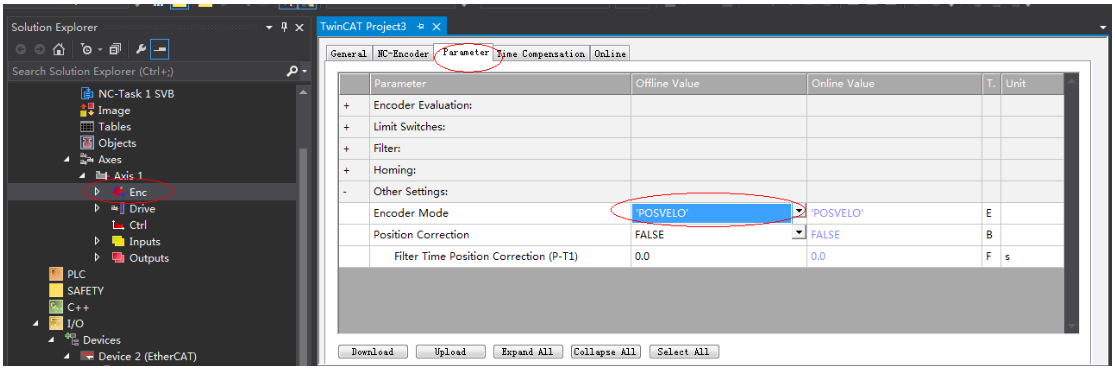
b) Set the scaling factor.



- **Scaling factor Numerator**: Indicates the 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**.

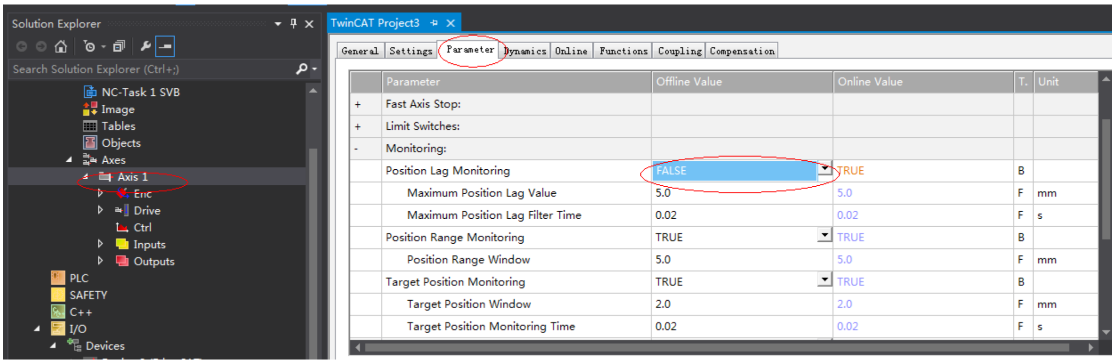


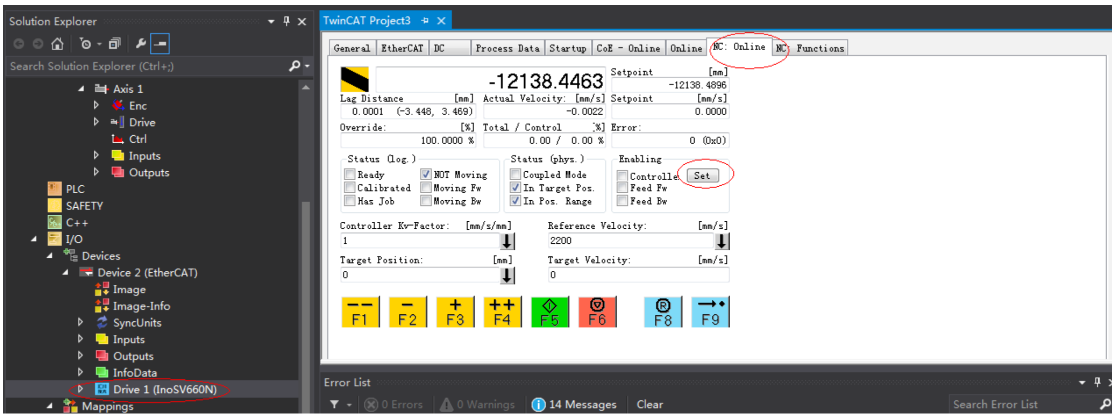
Descriptions for “Other Settings”:

- **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.

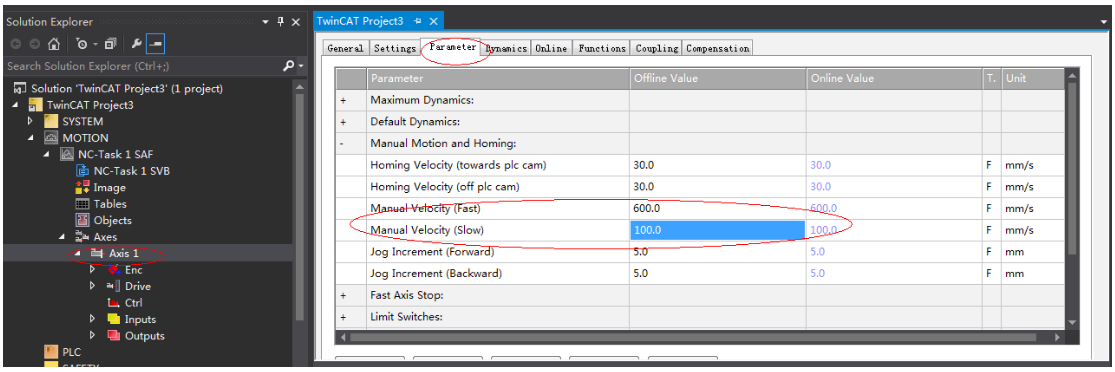
d) Jogging test

Hide the system deviation temporarily.



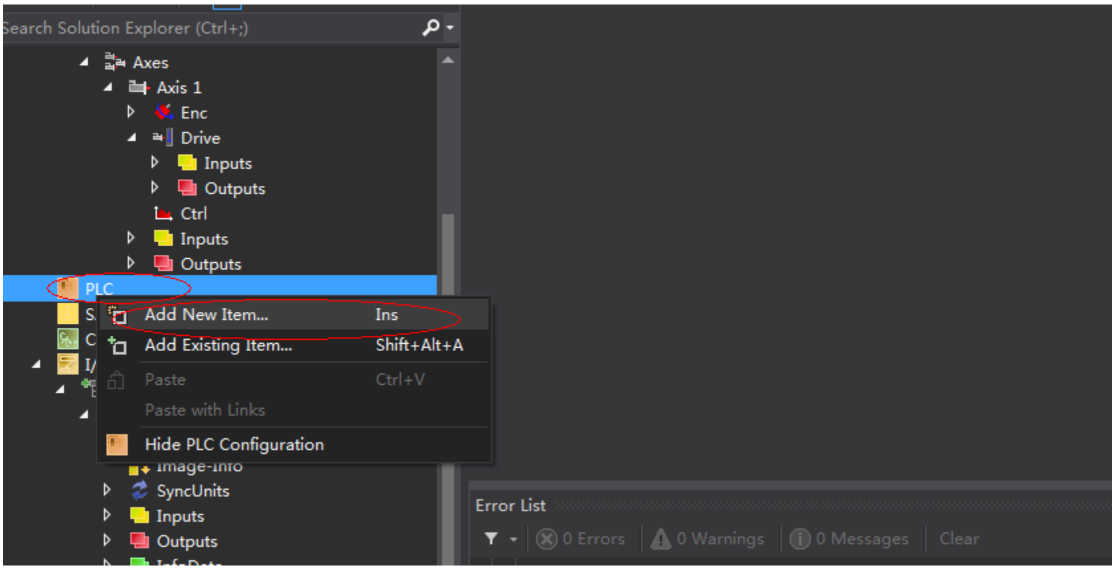


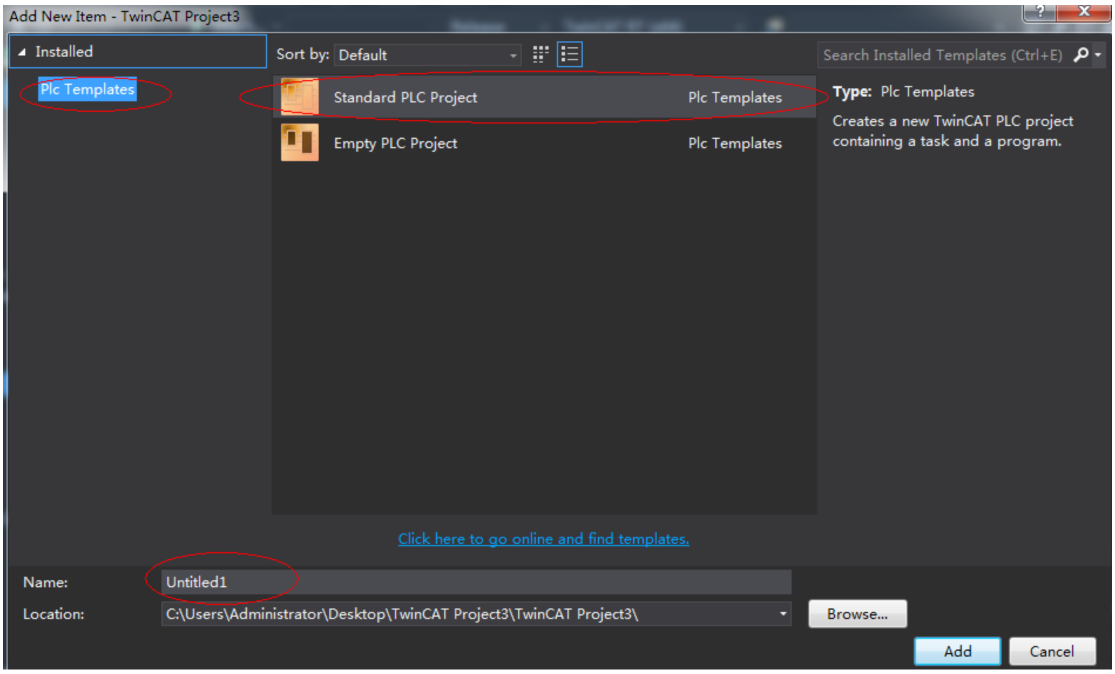
Click **Set** to display a dialog box and then click **All** to enable the servo drive. Perform jogging through F1 to F4. The jog speed is set as follows.



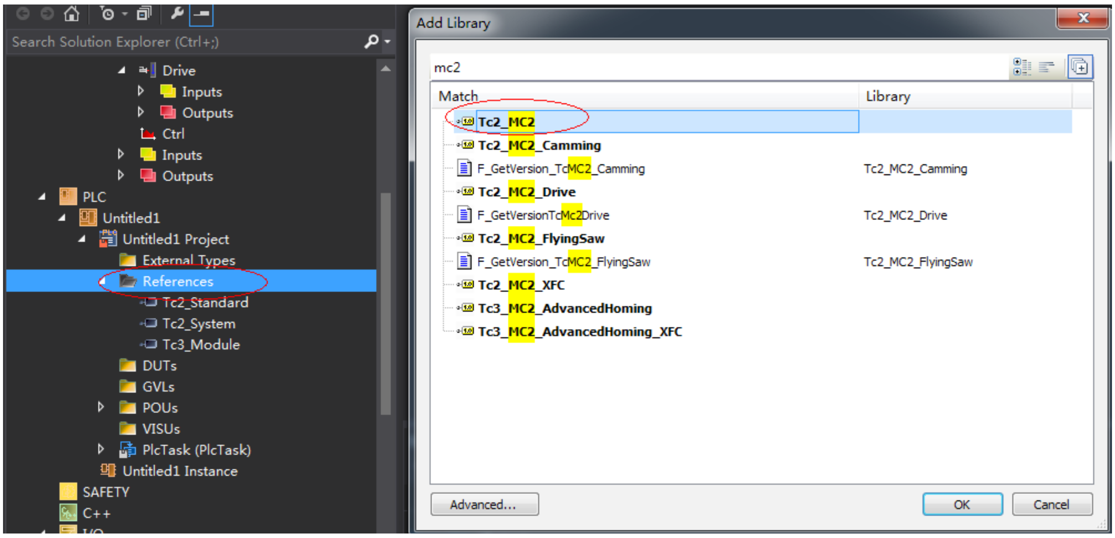
7-2) Controlling the servo operations through the PLC

a) Create a PLC program.

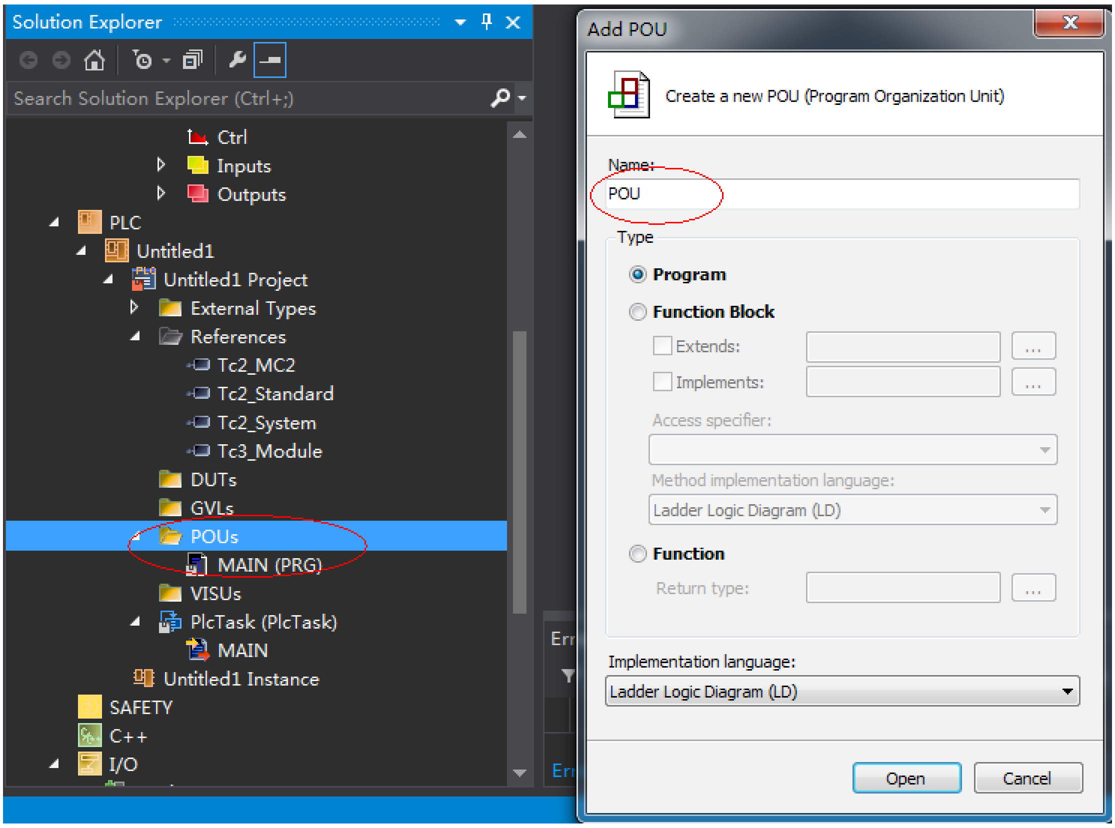




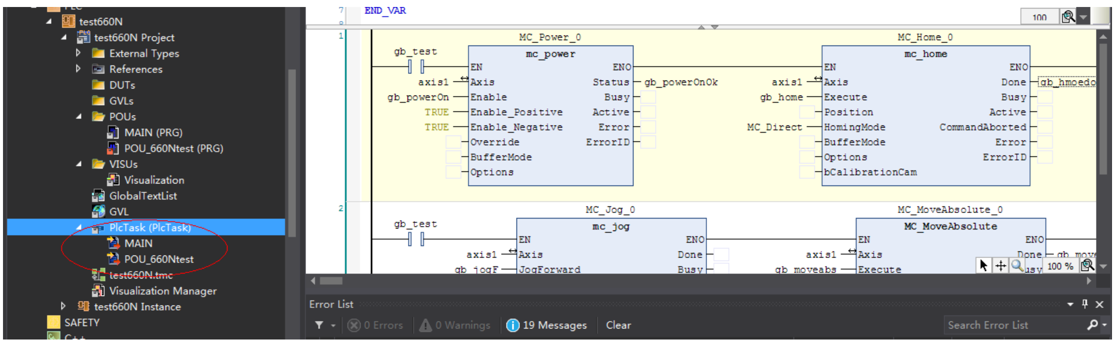
b) Add a motion control library for the convenience of calling the motion control function blocks.



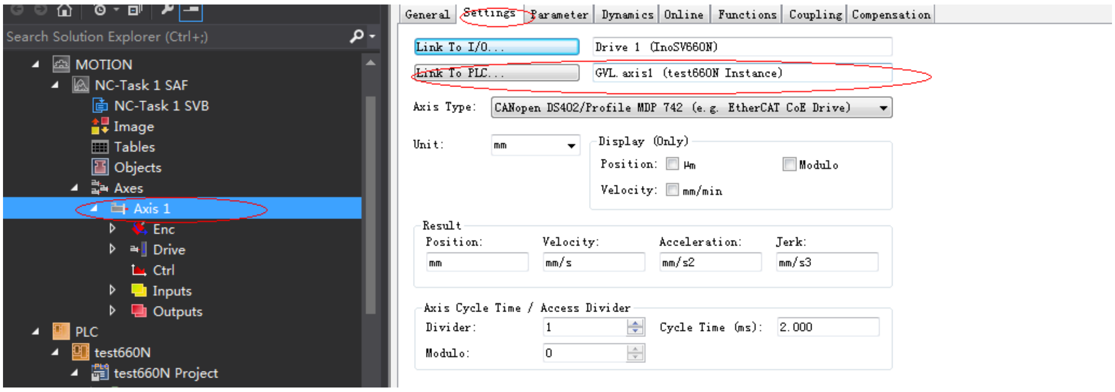
c) Create a POU program.



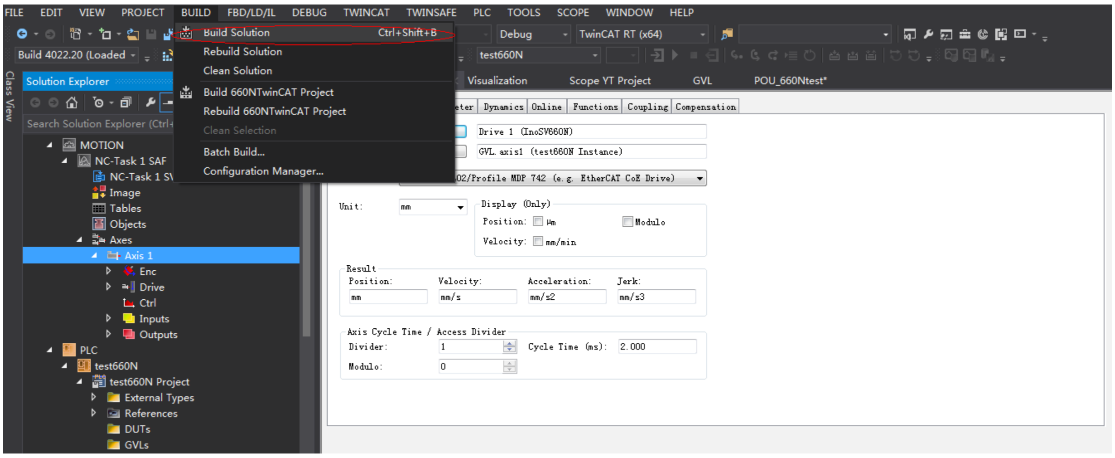
d) Call the motion module to implement some simple actions of the servo drive and input the final program to **PlcTask (PlcTask)**.

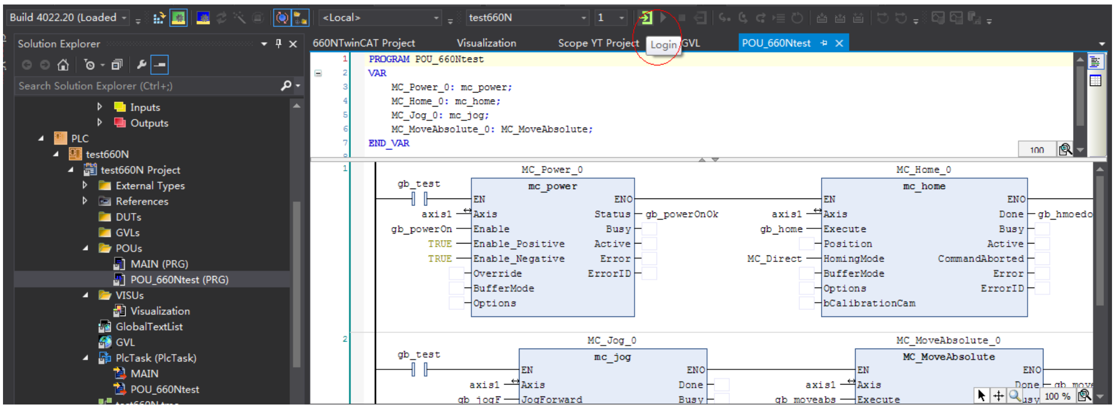


e) Link the axis to the variables defined in the PLC.

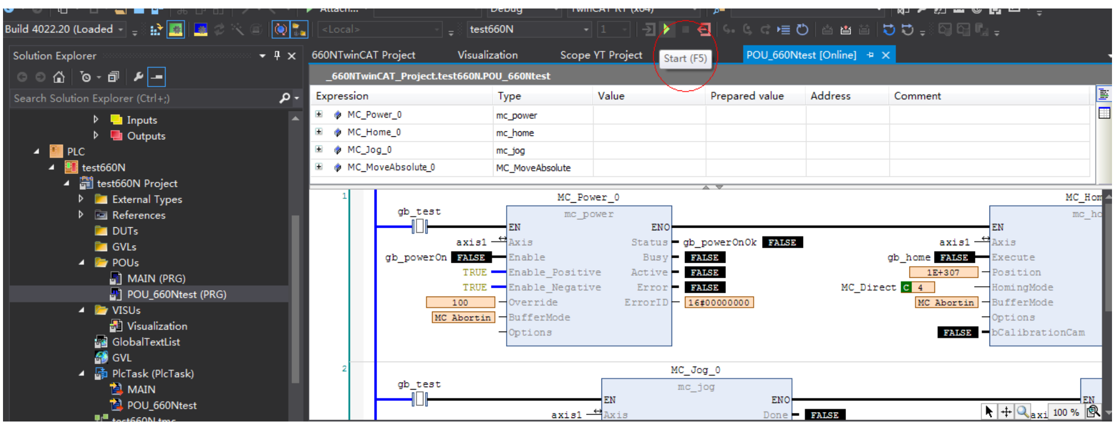


f) Compile the program. If there is not fault, activate the configuration and log onto the PLC.

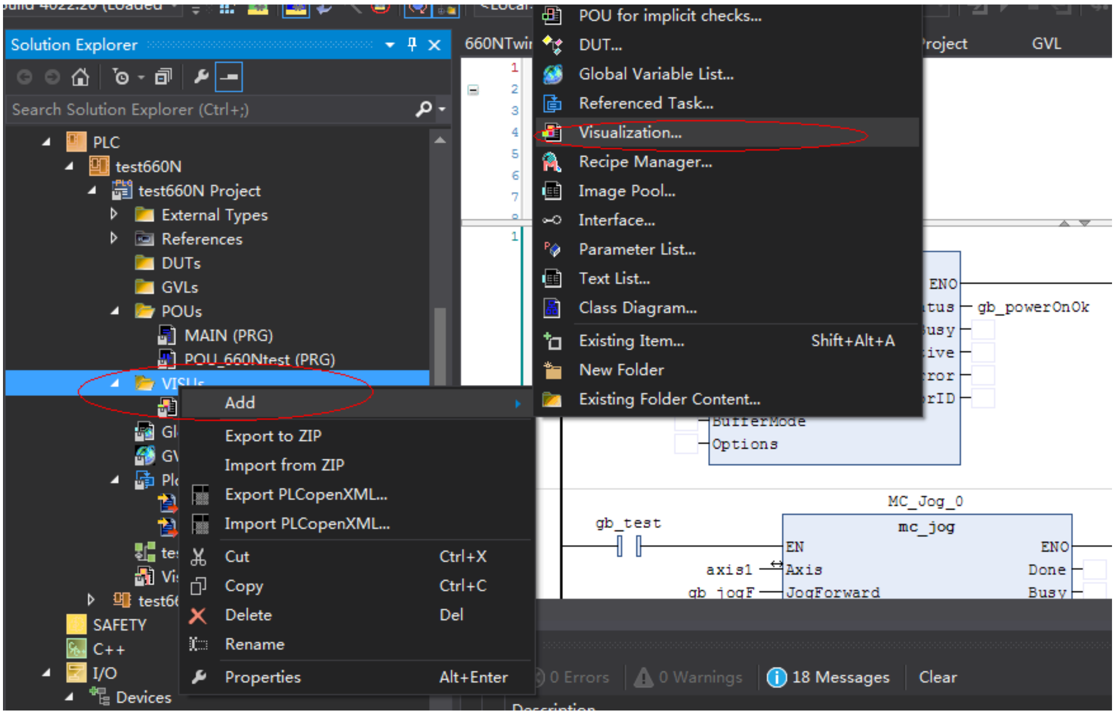


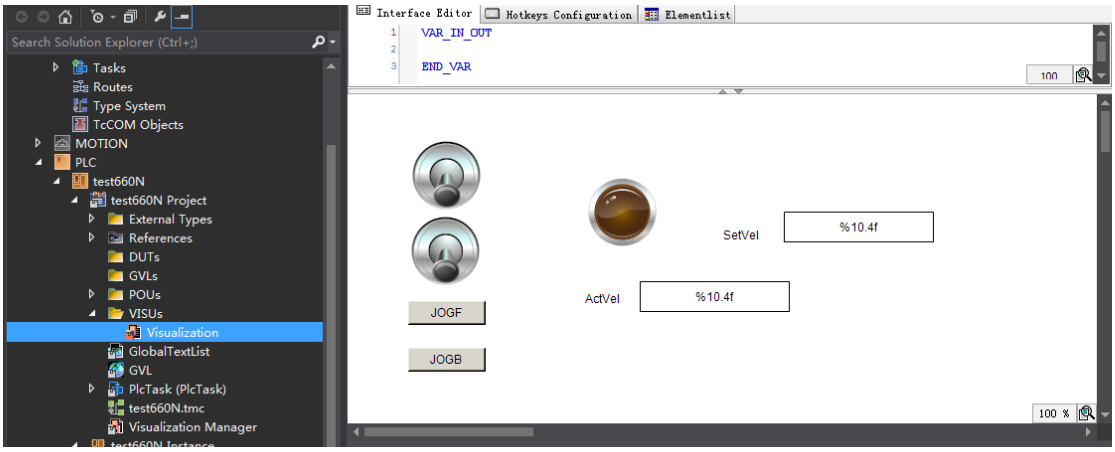


g) Click the Start icon to make the servo drive run.



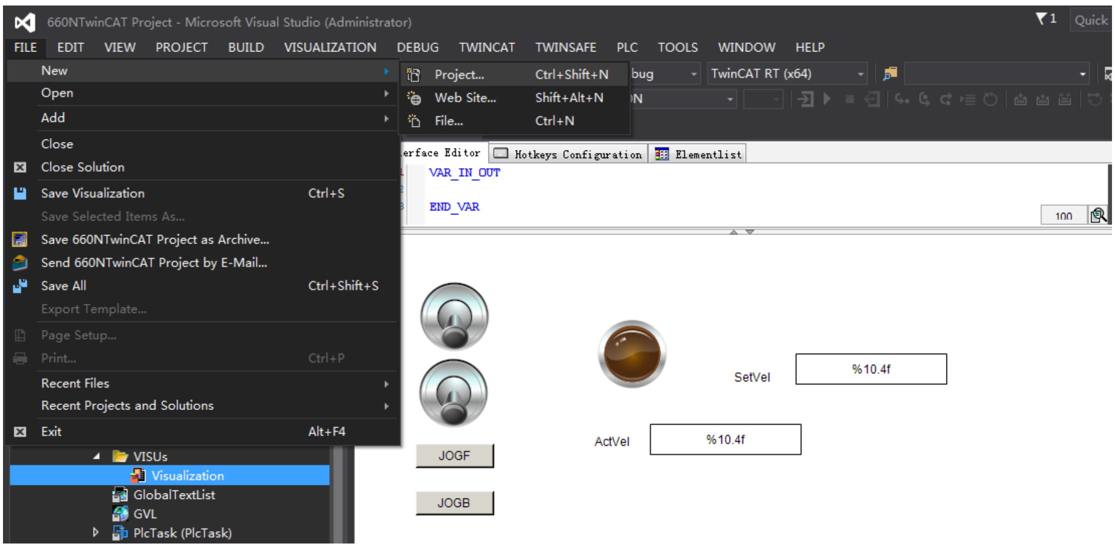
8) Adding the HMI interface to control the servo drive through the HMI interface

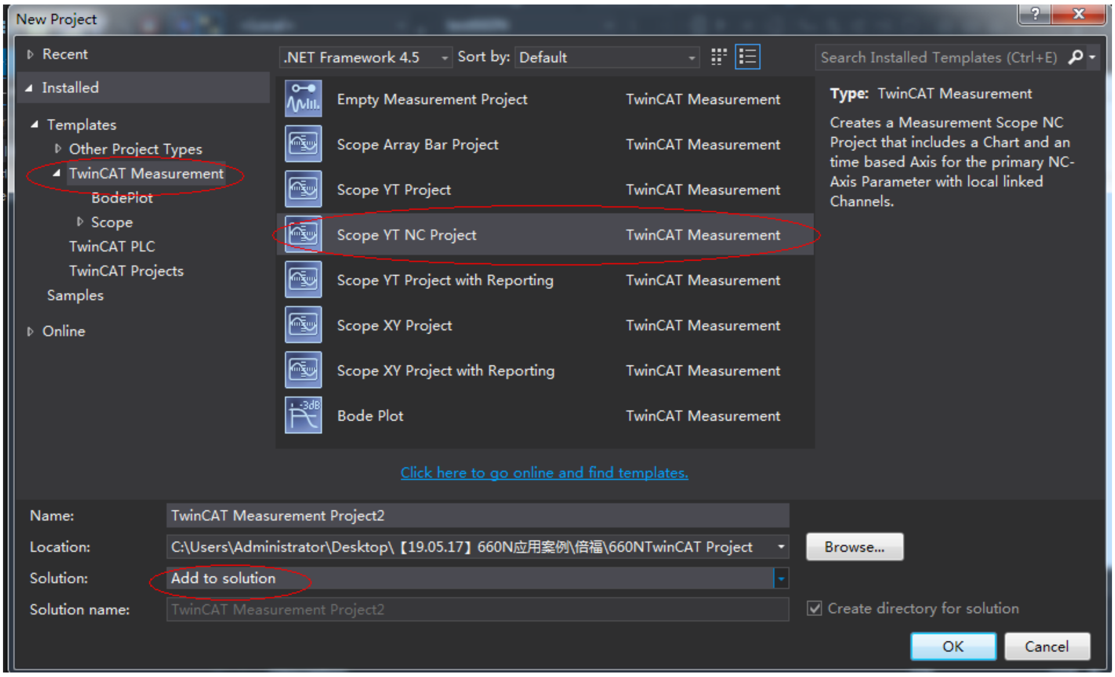




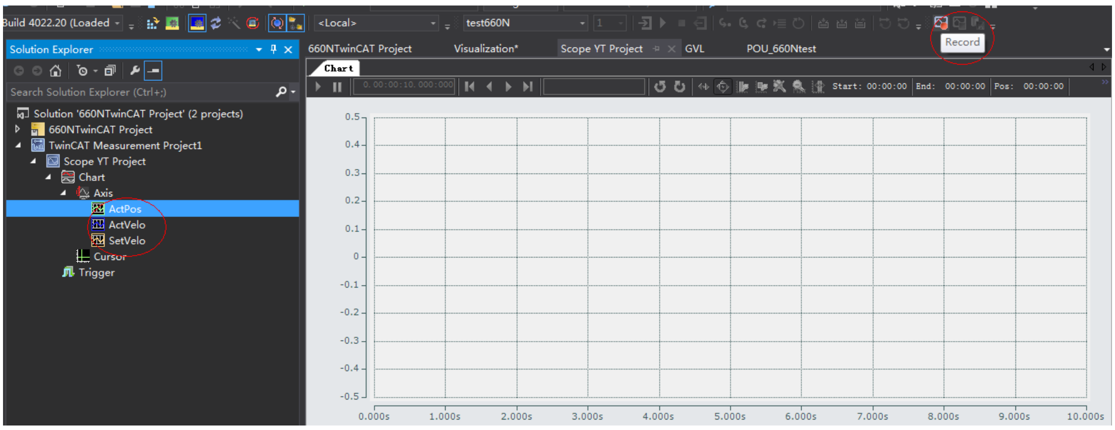
9) Using the scope view function of Beckhoff.

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.



Case 4 KEYENCE KV7500 Controller as the Host Controller

1 Configuring the servo drive

- Servo drive version

It is recommended to use the device description file of "SV660N-Ecat_v0.09.xml" or above for trial run of SV660N series servo drives.

It is recommended to use MCU software version of 901.4 or above for SV660N series servo drives.

- Description of related parameters

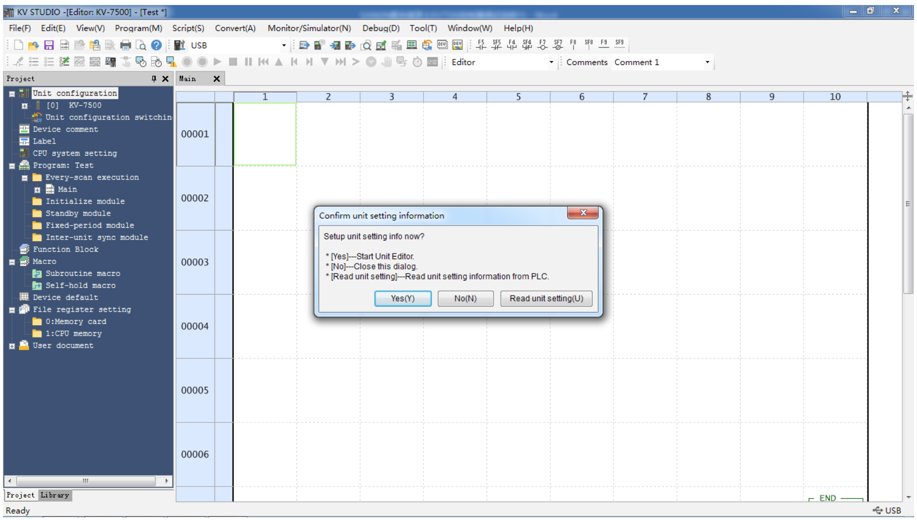
Definitions of 60FD in the object dictionary of SV660N are as follows:
bit0: negative limit
bit1: positive limit
bit2: home switch
bit16 to bit20 correspond to DI1 to DI5.

2 Configuring the software tool of KV7500 controller

Use the KEYENCE software tool of KV STUDIO 9.45 or above. Versions lower than KV STUDIO 9.45 do not support extension of the EtherCAT module "KV-XH16EC".

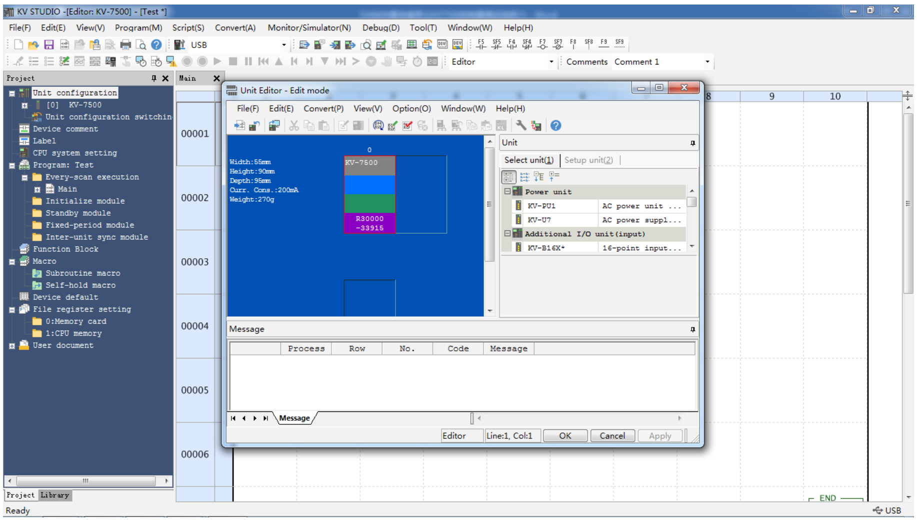
- Unit configuration setting

Creat a project and click **OK** to display the following window. Click **Yes**, **No**, or **Read unit setting** as needed.

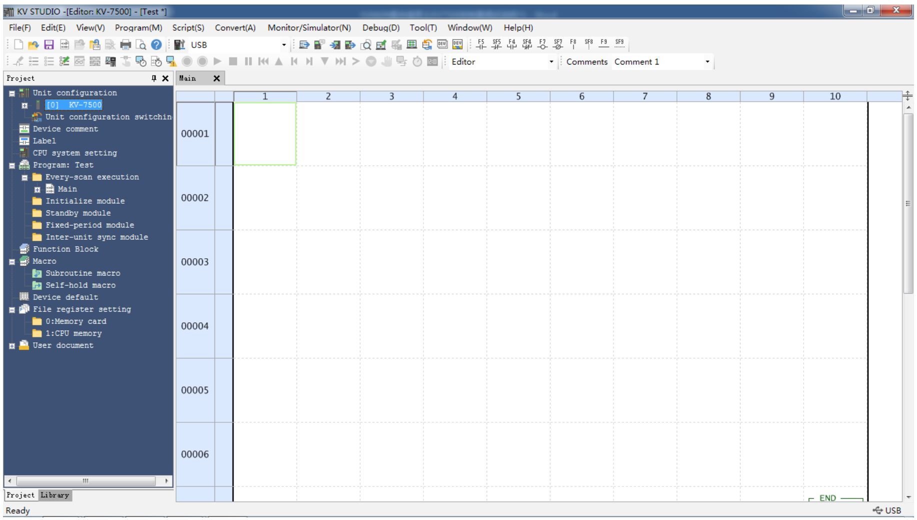


Click **Read unit setting** when the physical PLC unit is connected properly and able to communicate with the software tool. The software tool obtains unit settings automatically according to the physical connection.

If you click **Yes**, the Unit editor window is displayed, allowing you to select units for configuration through dragging or double-clicking.

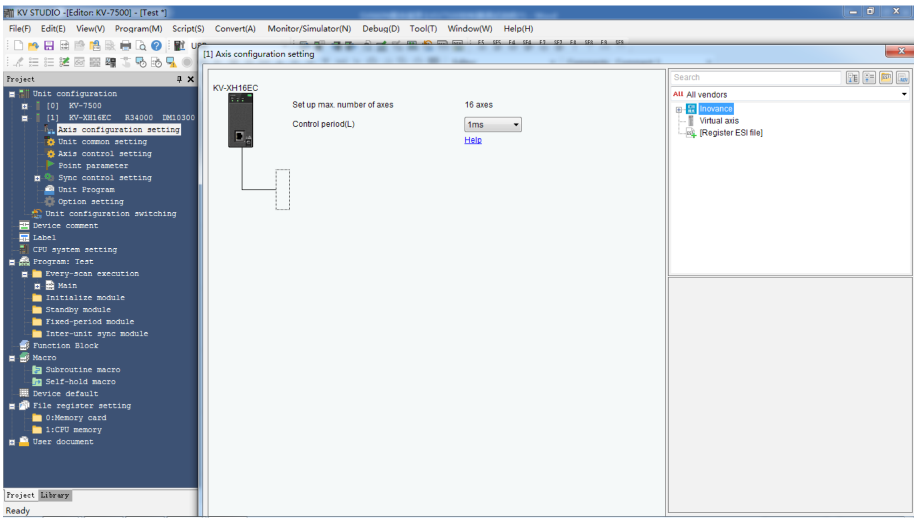


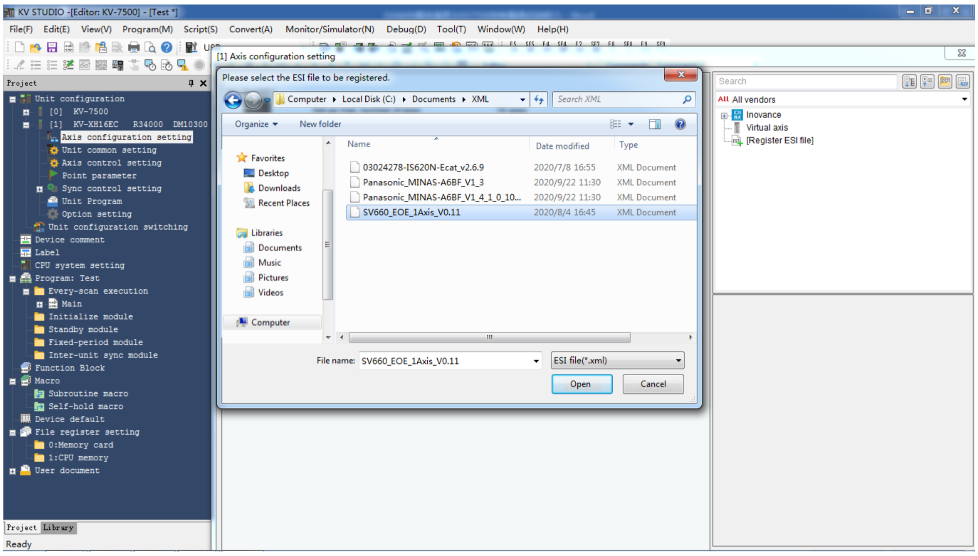
If you click **No**, you can instead click **Tool** > **Unit editor** or double-click **[0] KV7500** under **Unit configuration**.



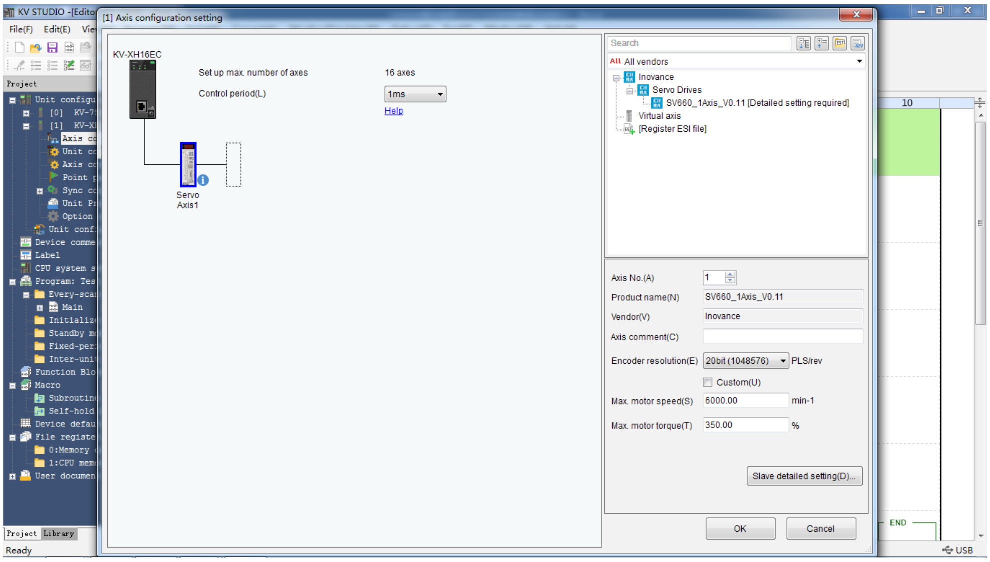
■ Axis configuration setting

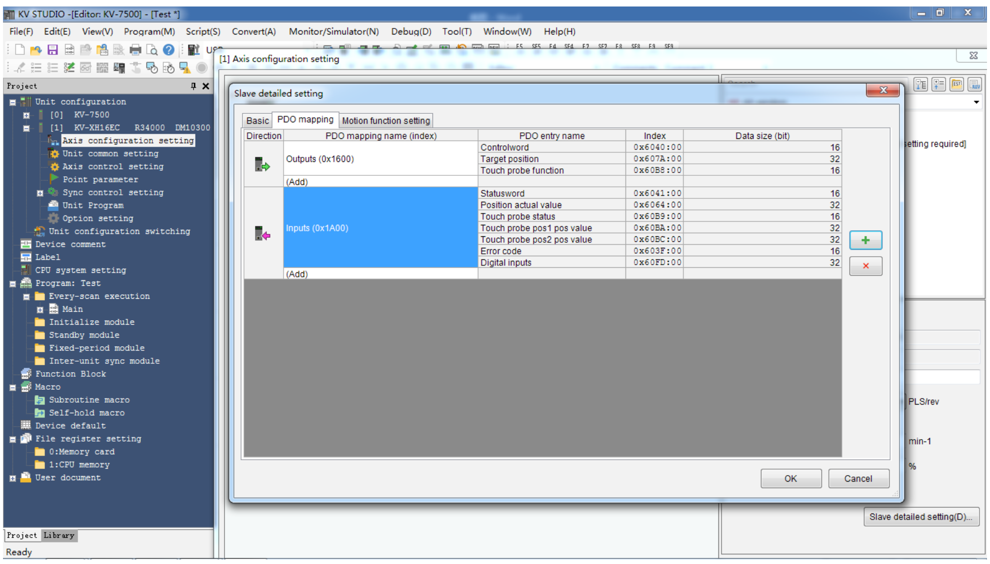
Select **Axis configuration setting** and double-click **Register ESI file**. Find the storage directory of the device description file ".xml" and open it to import the ".xml" file. After the device description file is imported, you can start to add axes and set the control cycle in **Axis configuration setting**. The default control cycle is 1 ms and the minimum control cycle is 250 us.



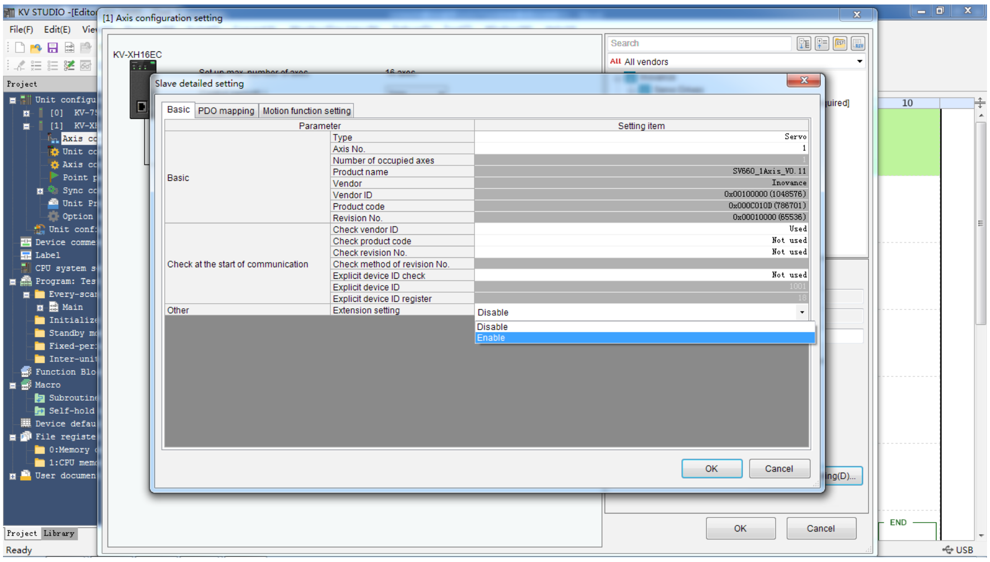


You can add the axes needed through dragging or double-clicking. Select the corresponding axis, and set critical information such a **Encoder resolutuion**, **Max. motor speed**, and **Max. motor torque** for this axis. You can add PDO setting in detailed setting of the slave.

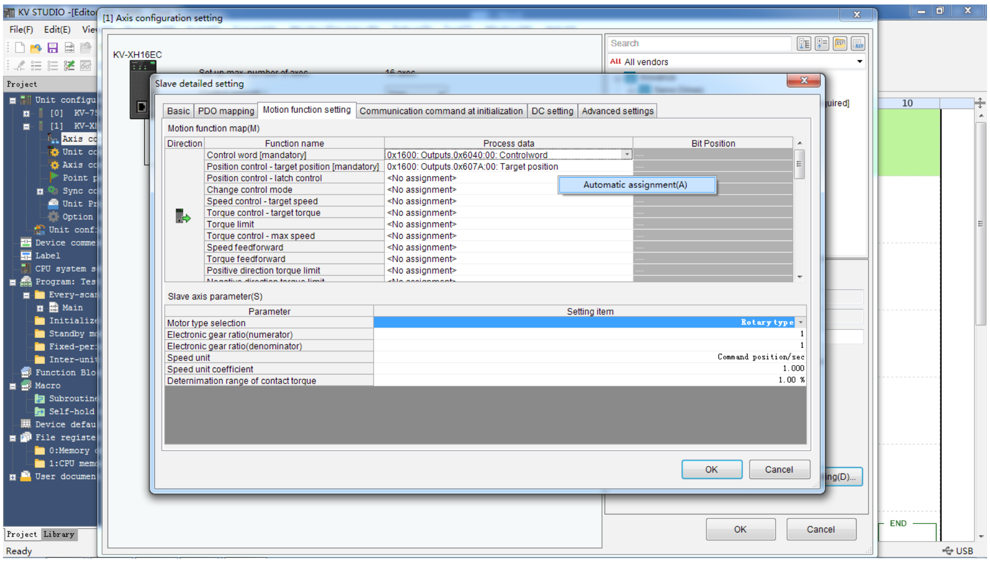




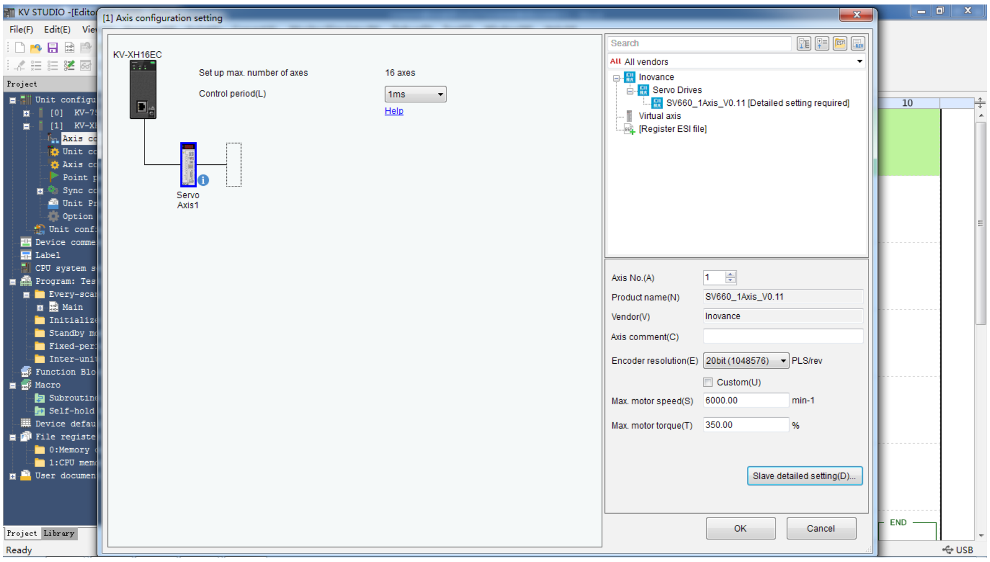
If extension setting is needed, set **Extension setting** to **Enable**.



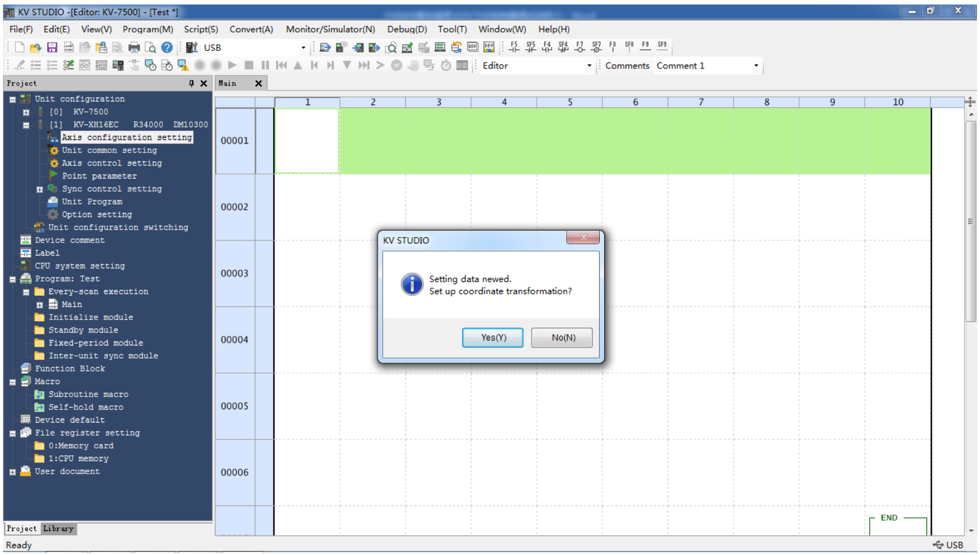
For motion function settings, you can double-click or click the ComboBox (small triangle icon) to select the PDO configuration needed fron the dropdown list, or you can right click and select **Automatic assignment**, and then click **Yes**, in this way the assigned contents will correspond to preceding PDO contents automatically. During manual assignment, do not neglect any contents in the PDO mapping. Otherwise, a pop-up window will be displayed to remind you of the missing contents when you click **OK**. For **Communication command at initialization**, **DC setting**, and **Advanced settings**, use the default values. After settings are done, click **OK**.



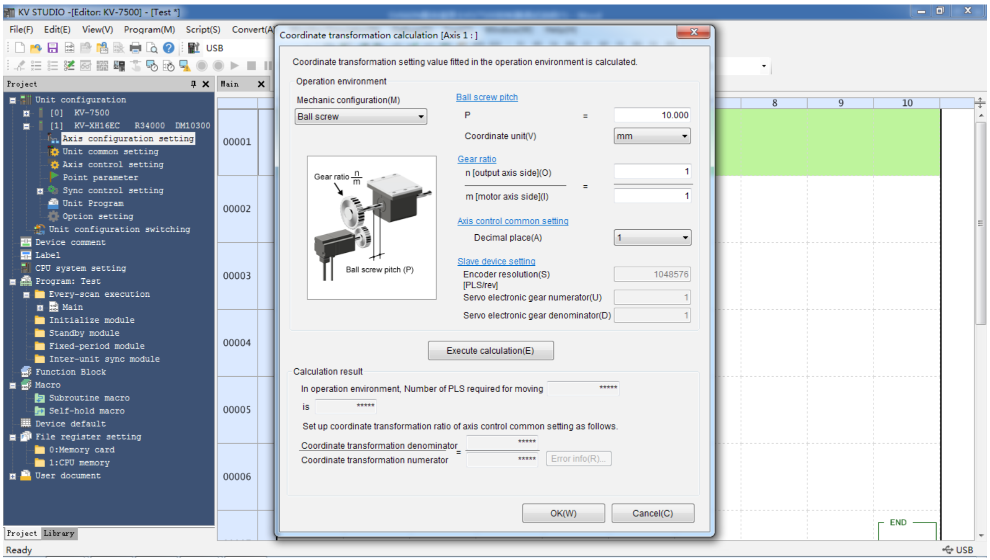
After **Slave detailed setting** is done, the exclamation symbol disappears.



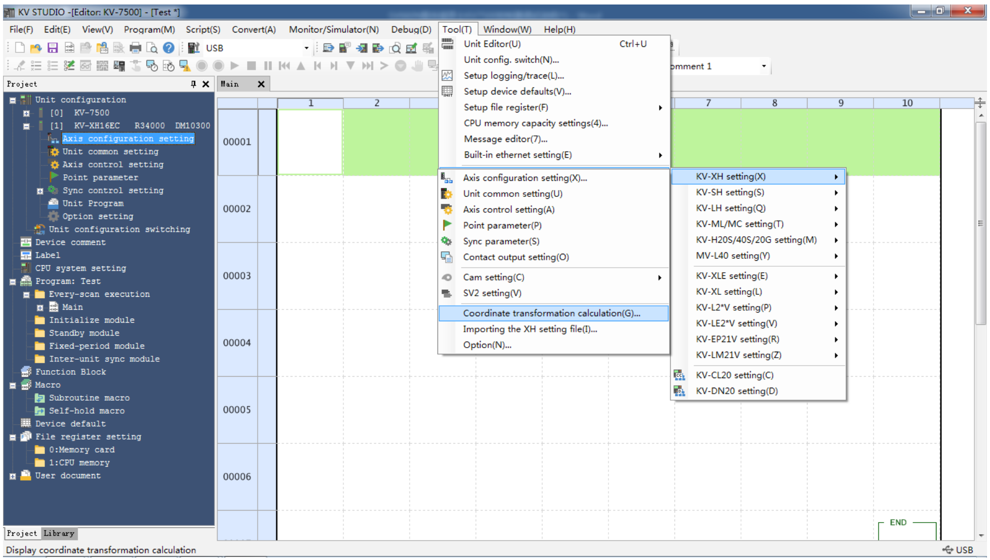
After adding the axes, click **OK**. The following dialogue box opens, asking you whether to set up coordinate transformation.



Click **Yes** and the coordinate transformation dialog box opens. Set mechanical parameters and the coordinate unit based on actual conditions and click **Execute calculation**. The software calculates the denominator and numerator for coordinate transformation automatically and writes parameters to **Axis control setting** automatically.



If you click **No**, you can instead click **Tool** > **Coordinate transformation calculation** > **HV-XH setting** > **Coordinate transformation calculation**.



■ Axis control setting

To open axis control setting, click **Tool** > **Axis configuration setting** > **KV-XH setting** > **Axis control setting**, or click **Axis control setting** under **Project**. In axis control setting, you can set items including **Unit coordinate transformation**, **Software limit coord**, **Axis error**, **Axis control function**, **Common in position control**, **Operation speed**, and **JOG**.

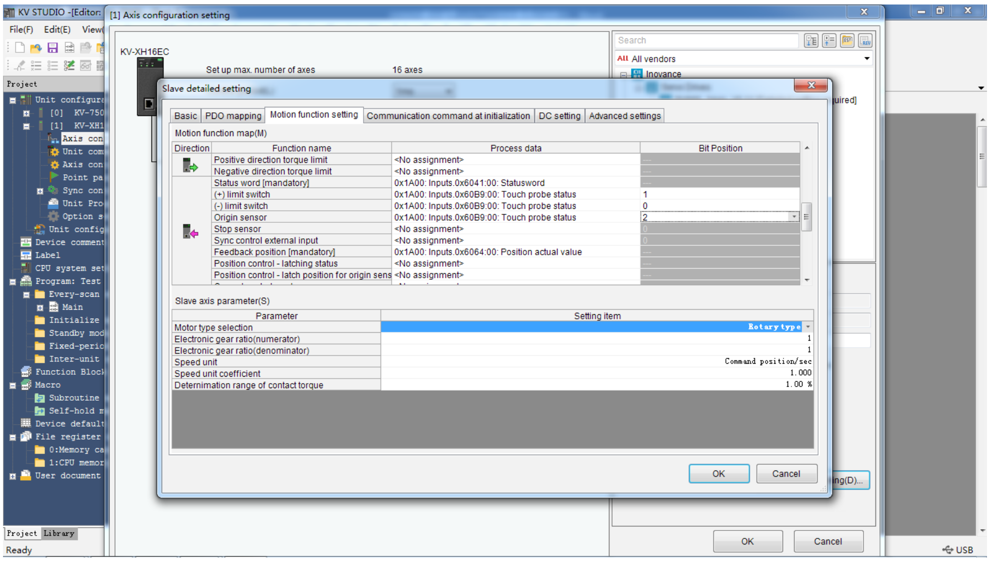
3 Operation settings

■ Homing

Before performing homing, assign **(+) limit switch**, **(-) limit switch**, and **Orgin sensor** in Motion function setting under **Axis configuration setting** to each bit of 60FD. 60FD is defined as follows by Inovance:

bit0: negative limit
bit1: positive limit
bit2: home switch
bit16 to bit 20 corresponding to DI1 to DI5 respectively.

In automatic assignment, you need to assign (+) limit switch, (-) limit switch, and origin sensor manually, you can assign them to corresponding bits of 60FD based on the relation shown in the following figure or to bit16...bit20, in this case, you also need to assign them to corresponding DIs of the servo drive.



Set the restriction parameters for homing in **Axis control setting** > **Origin return**. The following homing methods are available. For detailed trajectories, see KEYENCE instruction manual for positioning/motion control unit KV-XH16EC.

Default	DOG type (with phase Z)	
Setting Range	DOG type (with phase Z)	Decelerates upon DOG signal input and executes homing through phase Z signal.
	DOG type (without phase Z)	Decelerates upon DOG signal input and executes homing in the falling edge of DOG signal.
	DOG-type jogging (with phase Z)	Pauses after moving based on Dog ON upon DOG signal input, then moves to the homign direction through position speed control and executes homing with phase Z signal.
	DOG-type jogging (without phase Z)	Moves based on Dog ON upon DOG signal input before executing homing.
	DOG type (contact)	Executes homing when the ON duration of the torque limit signal keeps longer than the compression torque time upon DOG signal input.
	Origin sensor and phase Z	Executes homing in the initial phase Z position after the origin sensor is ON.
	Rising edge of origin sensor	Executes homing using the rising edge of the origin sensor.
	Middle point of origin sensor (without phase Z)	Takes the middle point of the ON range of origin sensor as the origin and compares it with that in the homing method "Rising edge of origin sensor". Even if the light-receptive performance of the origin sensor is deteriorated, the homing position can hardly change with the time.
	Rising edge of limit switch	Executes homing with negative limit switch as the origin sensor.
	Immediate homing of phase Z	Executes homing using phase Z signal.
	Data setting type	Takes current coordinate as the origin coordinate.

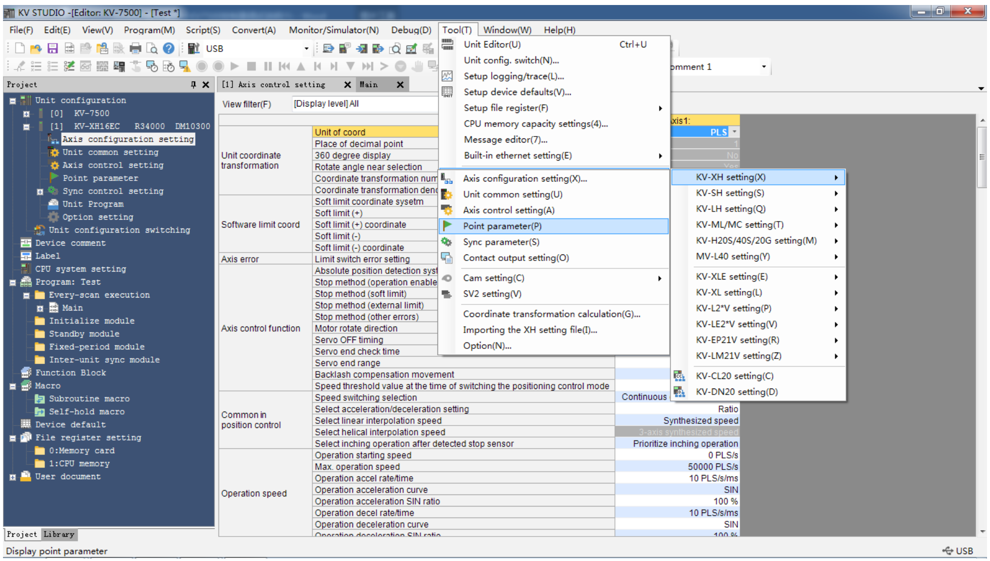
The following homing methods are available in IS620N and SV660N series servo drive.

No.	Homing Method	IS620N	SV660N
1	DOG type (with phase Z)	OK	OK
2	DOG type (without phase Z)	OK	OK
3	DOG-type jogging (with phase Z)	No	No
4	DOG-type jogging (without phase Z)	No	No
5	DOG type (contact)	OK	Homing is available and the home (origin) can be determined after homing, but the reference coordinate is not 0. Updating to the xml coordinate of IS620N zeroes out the reference coordinate.
6	Origin sensor and phase Z	OK	OK
7	Rising edge of origin sensor	OK	OK
8	Middle point of origin sensor	No	No
9	Rising edge of limit switch	Homing is available, but the reference coordinate after homing is not 0.	Homing is available, but the reference coordinate after homing is not 0.
10	Immediate homing of phase Z	OK	OK

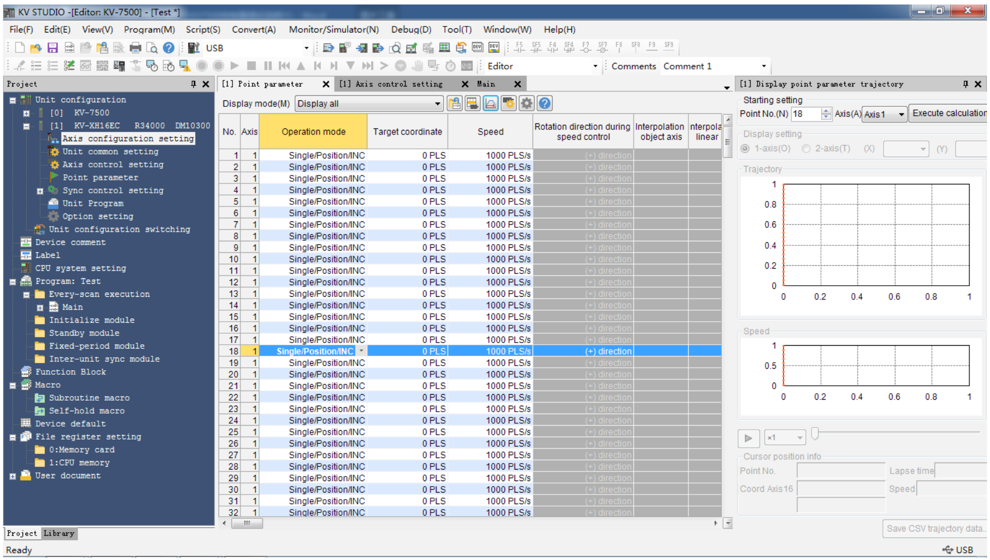
■ Positioning operation

Set the correct unit coordinate transformation before positioning operation. The unit coordinate transformation is PLS by default, which allows no modification on the numerator or denominator. Suppose N revolutions is required by the servo drive, in this case, the number of commands that need to be sent by the host controller is N x pulses per revolution. If coordinate transformation calculation has been confirmed, the unit coordinate transformation parameters will correspond to the unit transformation results automatically.

Set the motion profile of the servo drive in **Point parameter**. You can set the target coordinate and speed per positioning segment as needed. After setting, you can call the corresponding point No. through the program to start operation.

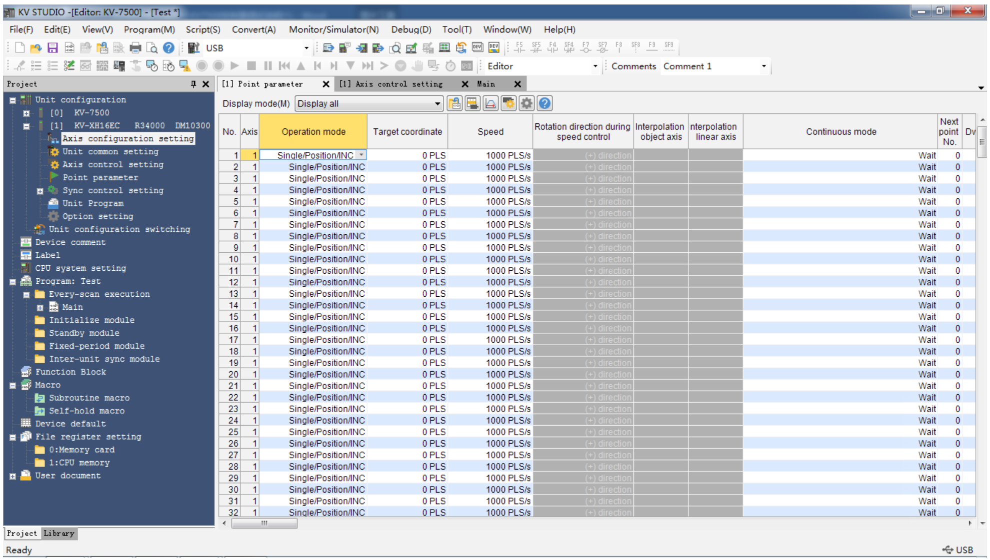


You can preview the parameter trajectory through the following short-cut.

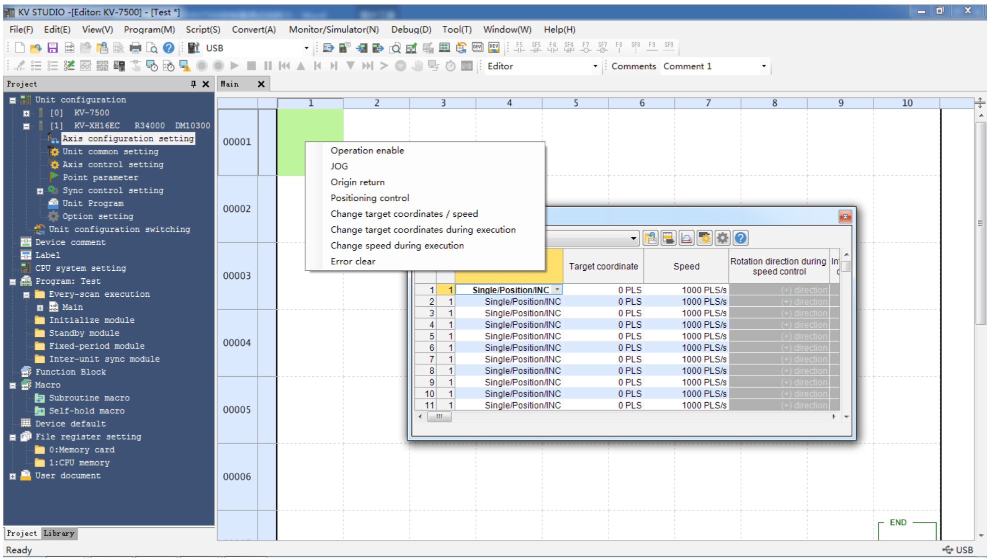


Ladder diagrams can be written using regular methods or the following time-saving method provided by KEYENCE.

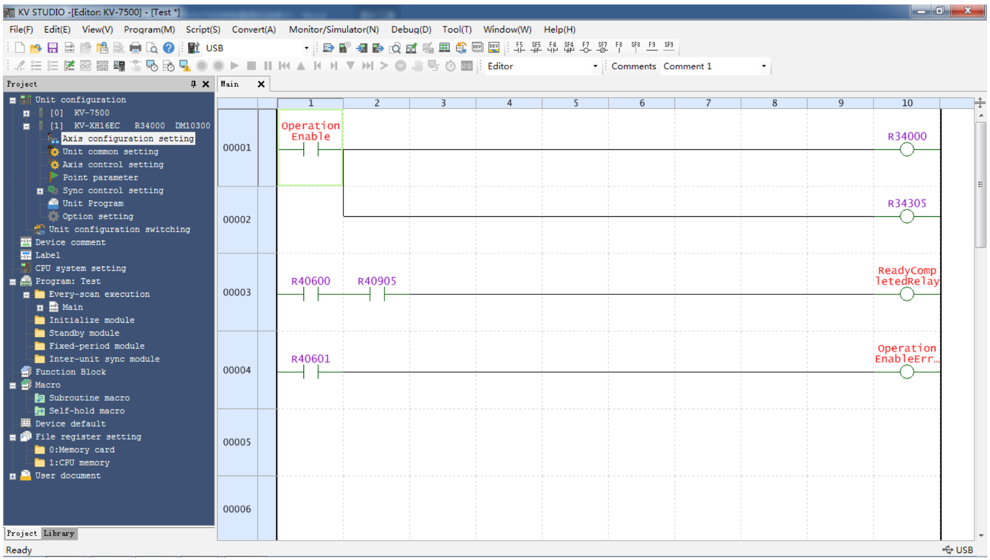
1. Drag down the **Point parameter** window with left mouse button, and zoom out the window to put it in a proper place.



2. Move the mouse to the point parameter, such as No.1-Axis1, and wait until the mouse icon to change from an arrow to a small hand. Then drag towards the program edit interface with mouse right button, and the following shortcut pops out.



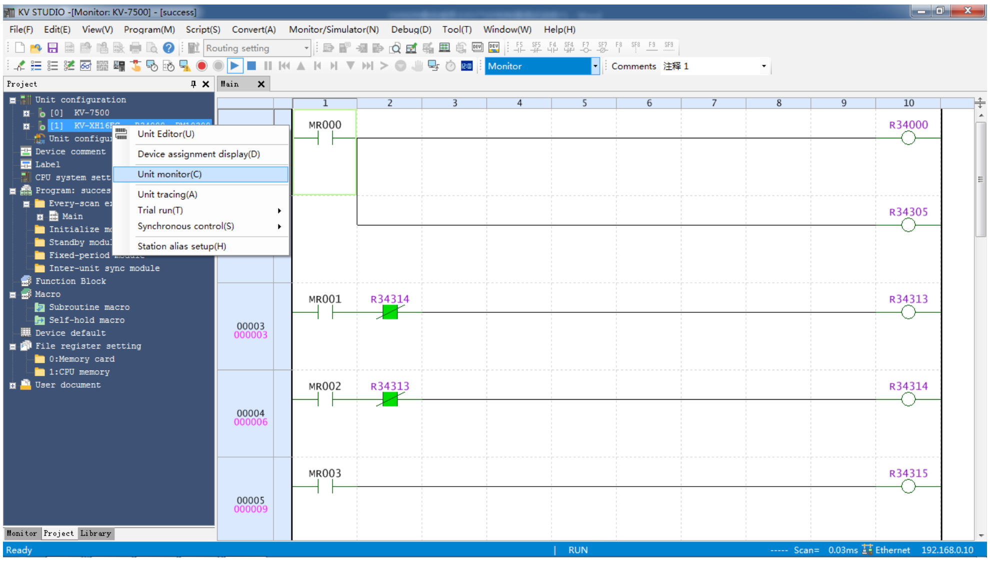
Select the function needed, such as **Operation enable**, click it to generate a DEMO program automatically. Then designate the part in red as the relay needed. After these actions are done, this function is done compiling.

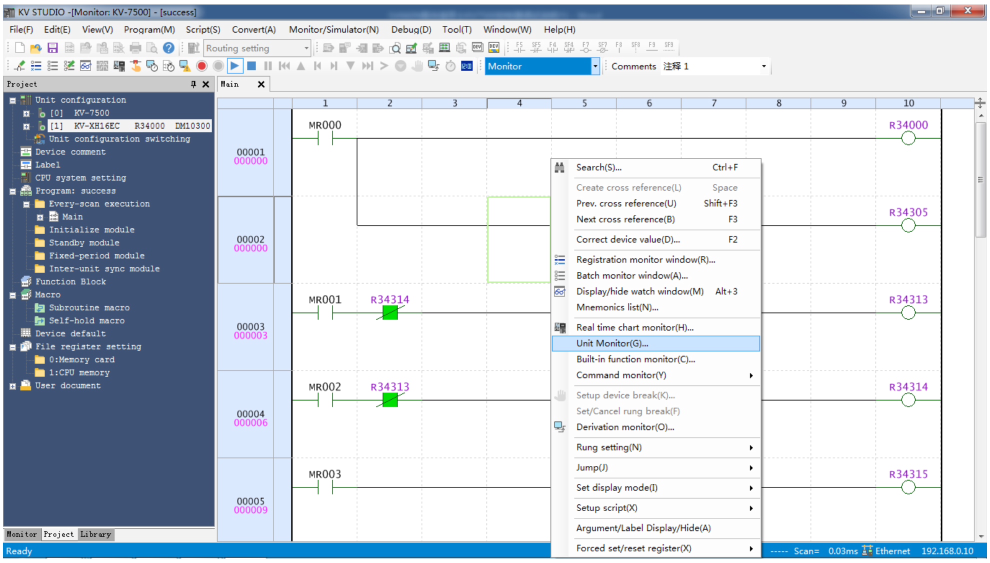


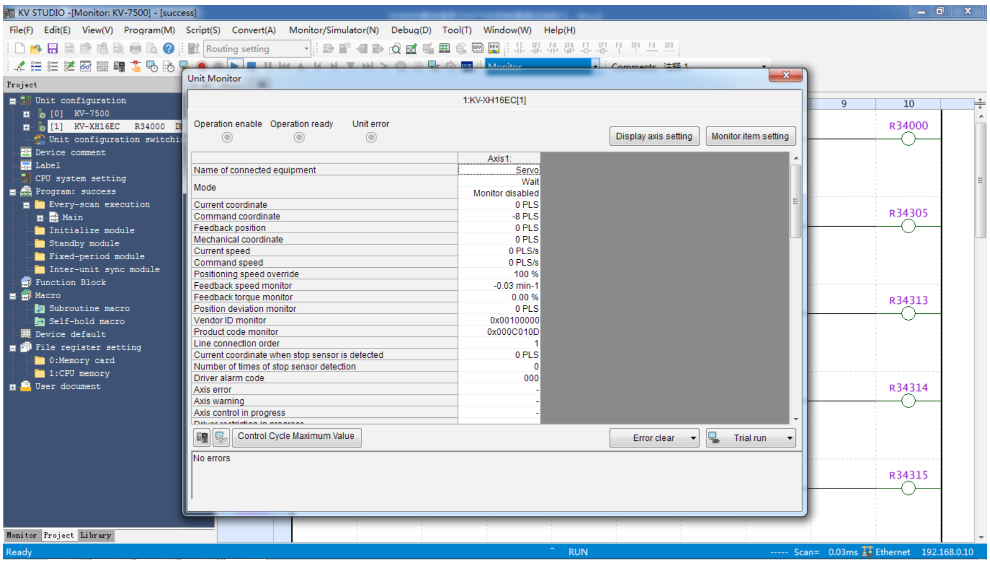
4 Unit monitor

The unit monitor supports monitoring on the operating state of KV-XH16EC or the internal data.

Select the unit to be monitored and right-click to select **Unit monitor** in the shorcut menu, or double-click with left mouse button to open the **Unit monitor**, or right-click the blank part in the **main** program to select **Unit monitor** in the pop-up menu.





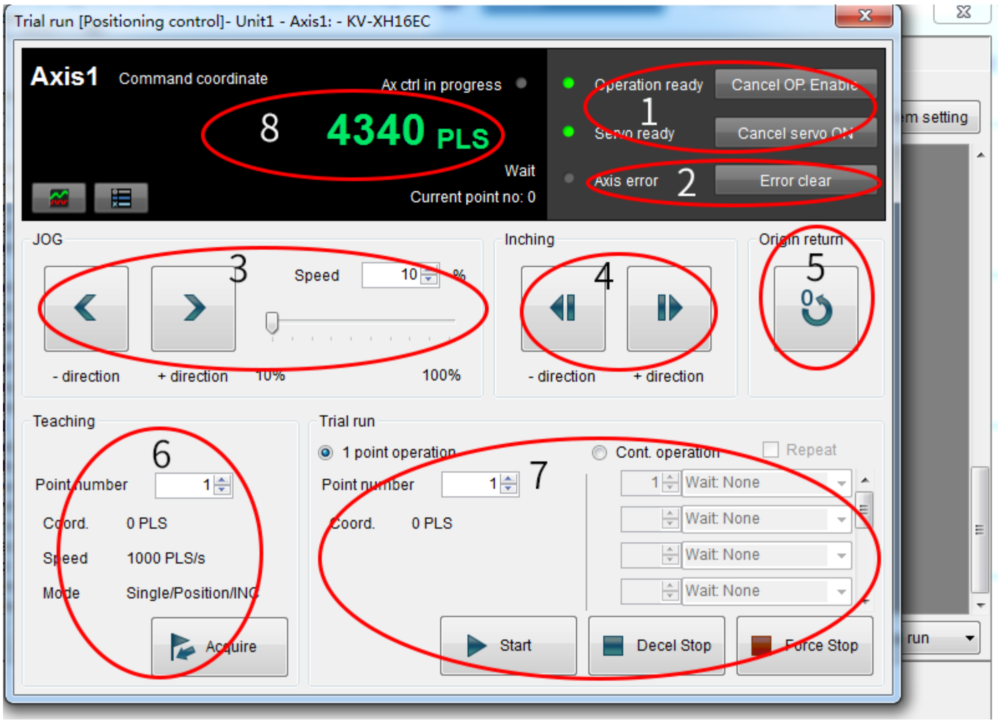


The unit monitor displays the operating state of each axis. To change the operating state of the monitor item, click **Monitor item setting** on the top right corner. To check whether I/O signals such as limit switch signals and origin sensor signals are normal, open **Unit monitor** and find the corresponding monitoring position. If corresponding message is received, a small black circle will be displayed.

The error state of the unit can also be displayed in the **Unit monitor**. The axis error can be cleared using the **Error clear** button in the bottom right.

5 Trial run

In trial run, actions can be acknowledged directly, without programming ladder diagrams. You can find the **Trial run** button at the bottom right of the unit monitor interface. Select the control mode from positioning control, speed control, and torque control, and then select the object axis for trial run. If trial run is executed in the speed control mode or torque control mode, a warning will be reported. To execute trial run, set the control mode to position control mode. The following introduces trial run > positioning control.



1) **OP enable/Servo ON**: Unrelated to the status of the ladder diagram program. **OP enable** and **Servo ON** can be executed through **Commissioning**. After operations are done, the **Operation ready** and **Servo ready** indicators are green. To ensure safety, set the CPU unit to PROG mode and execute operations again after stopping ladder diagram program.

Confirm the following items when the **Servo ready** indicator is not in green.

- No error occurs on the axis.
- No warning occurs on the servo drive.
- The main circuit power supply of the servo drive is switched on.
- The Ethernet cable is connected.

2) **Axis error/Error clear**: Check the axis error occurred and clear the error. After rectify the error cause, click **Error clear** button to clear the error.

3) **JOG**: Click < or > to execut forward or reverse JOG, which operates with the speed multiplied by a certain ratio between 10% to 100%, settable based on an increment of 1%.

4) **Inching**: Click < or > to execute forward or reverse inching based on **Axis control setting** > **JOG starting speed** and the movement value defined in **Axis control setting** > **Inching movement**.

5) **Origin return**: Click the Origin return button to execut homing.

6) **Teaching**: Click the **Acquire** button to save current command coordinate value to the buffer memory of the target coordinate of the designated poing number. The teaching function is available only in the online edit mode. The teaching value will also be reflected to the buffer memory and the point parameter.

7) **Trial run**: Designate a point number and click the **Start** button to execute point positioning. To stop operation, click the **Decel Stop** or **Force Stop** button to stop smoothly with speed reduced to zero gradully or stop immediately with shock being incurred. Clicking the **1 point operation** button makes the servo drive execute positioning of one point. Clicking the **Cont. operation** button makes the servo drive execute positioning of ten points at most. Clicking the **Repeat** button makes the servo drive return to the point in the first row and execute positioning repeatedly after positioning of the point in the last row is done. The time interval between points can be set to a value within 0.1s to 20.0s.

8) **Changing current coordinate**: Click **Command coordinate** and the **Changing current coordinate** dialog box opens. Enter the coordinate needing to be changed and click the **Change** button to change the current coordinate of an axis in trial run, and then close the **Changing current coordinate** dialog box. If you click the **Close** button after changing current coordinate, the **Changing current coordinate** dialog box will be closed with current coordinate unchanged.

12 Appendix

12.1 Standards Compliance

12.1.1 CE Certification

■ CE Mark

Figure 12-1 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.

12.1.2 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 12-1 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
Size C	SV660NS7R6I	5.1	FWP-20B
Size D	SV660NS012I	8	FWP-35B
Three-phase 220 V			
Size C	SV660NS7R6I	5.1	FWP-20B
Size D	SV660NS012I	8	FWP-35B
Three-phase 380 V			
Size C	SV660NT3R5I	2.4	FWP-15B
	SV660NT5R4I	3.6	FWP-20B
Size D	SV660NT8R4I	5.6	FWP-20B
	SV660NT012I	8	FWP-35B
Size E	SV660NT017I	12	FWP-50B
	SV660NT021I	16	FWP-70B
	SV660NT026I	21	FWP-125B

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 intrusion of unwanted 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.

12.1.3 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 "12.1.5 Selection of EMC Filters" for selection of the EMC filter.

2) Install the recommended AC reactor on the input end. See section 12.1.5 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.

12.1.4 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

12.1.5 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

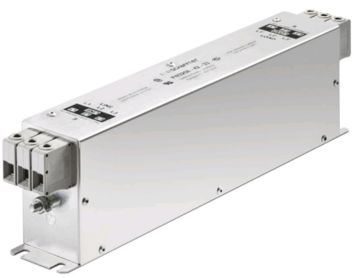


Figure 12-2 Schaffner FN3258 series filter

Figure 12-3 Schaffner FN2080 series filter

■ Recommended Model Selection

The recommended Schaffner models are listed in the following table.

Table 12-2 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
Size C	SV660NS7R6I	5.1	FN 3258-7-44
Size D	SV660NS012I	8	FN 3258-16-44
Three-phase 220 V			
Size C	SV660NS7R6I	5.1	FN 3258-7-44
Size D	SV660NS012I	8	FN 3258-16-44
Three-phase 380 V			
Size C	SV660NT3R5I	2.4	FN 3258-7-44
	SV660NT5R4I	3.6	FN 3258-7-44
Size D	SV660NT8R4I	5.6	FN 3258-7-44
	SV660NT012I	8	FN 3258-16-44
Size E	SV660NT017I	12	FN 3258-16-44
	SV660NT021I	16	FN 3258-16-44
	SV660NT026I	21	FN 3258-30-33

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 current consumption of the connected devices must be equal to or less than the rated current allowed by the EMI filter.

■ Dimensions of Schaffner FN2080 series filters (1-16 A)

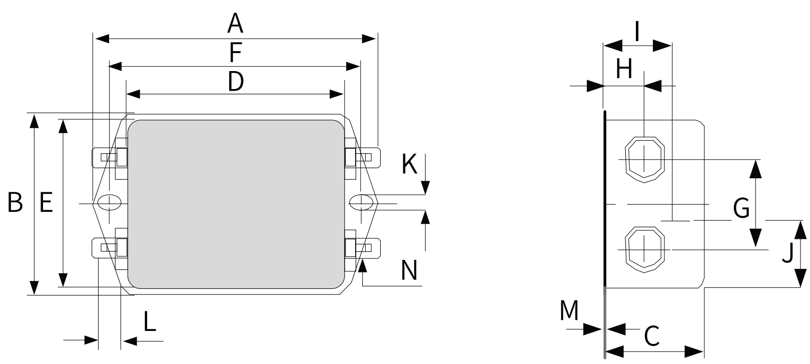


Figure 12-4 Dimensions of FN2080 series filters (1–16 A) (unit: mm)

Table 12-3 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)

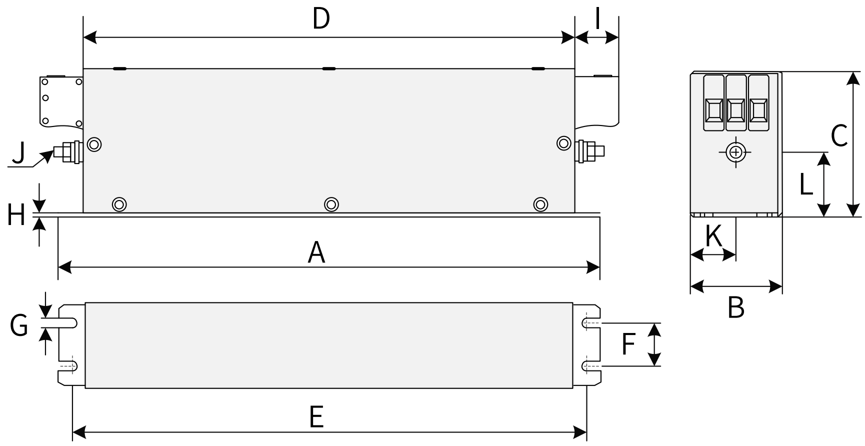


Figure 12-5 Dimensions of FN3258 series filters (7–180 A) (unit: mm)

Table 12-4 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 magnetic ring

To filter out part of the interference generated during running, connect a safety capacitance box and wind a magnetic ring 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).

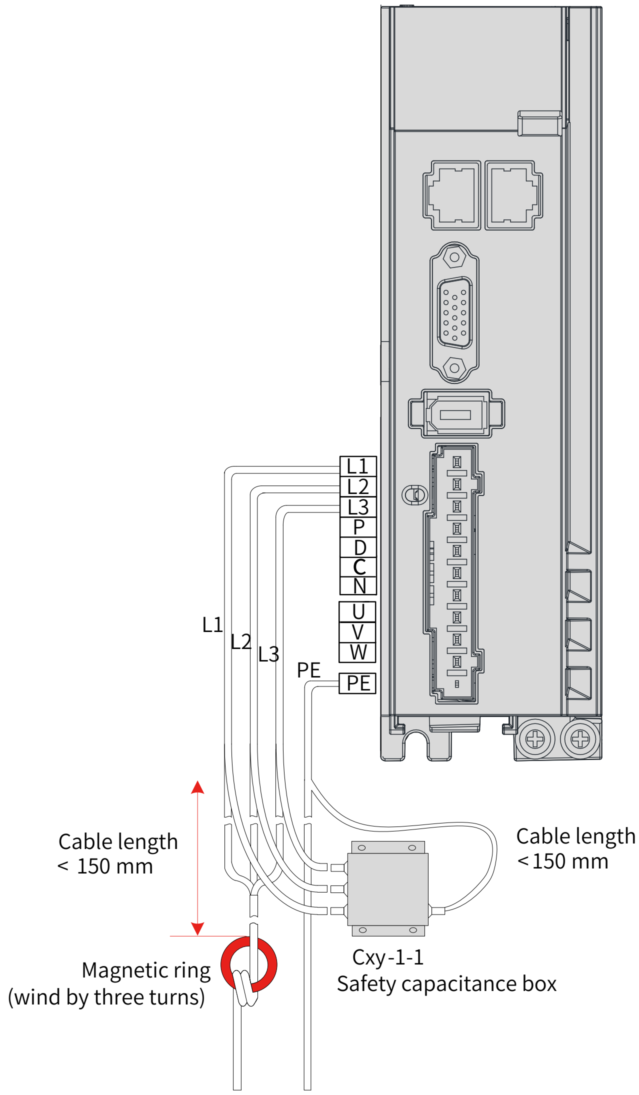


Figure 12-6 Installation of the capacitance box and the magnetic ring

■ Dimension drawing of the safety capacitance box

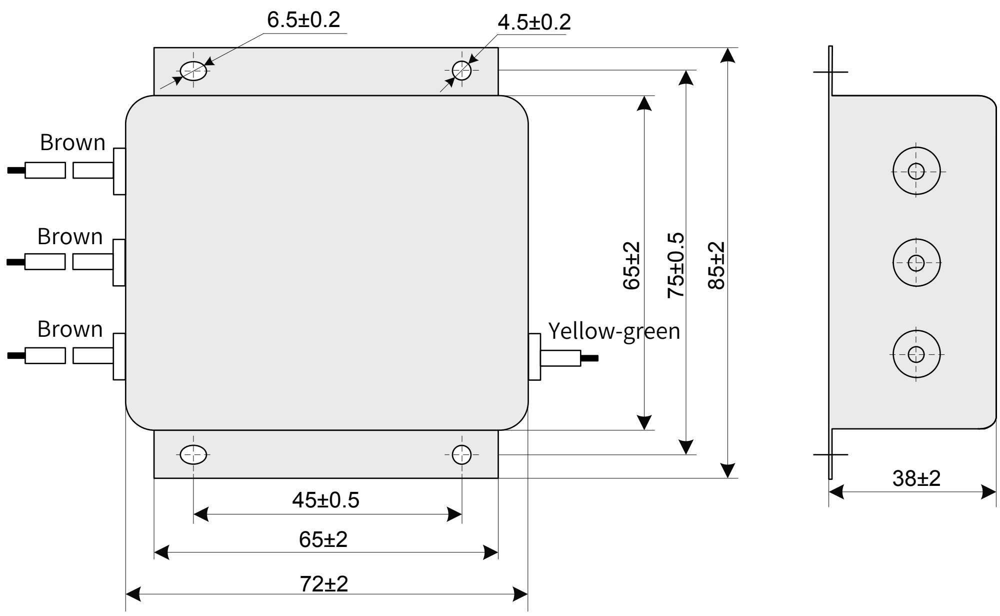


Figure 12-7 Dimensions of the safety capacitance box

Table 12-5 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 magnetic ring

To reduce the noise current and the interference to neighboring devices, install the output magnetic ring around the U/V/W power cables (PE excluded) near the servo drive side.

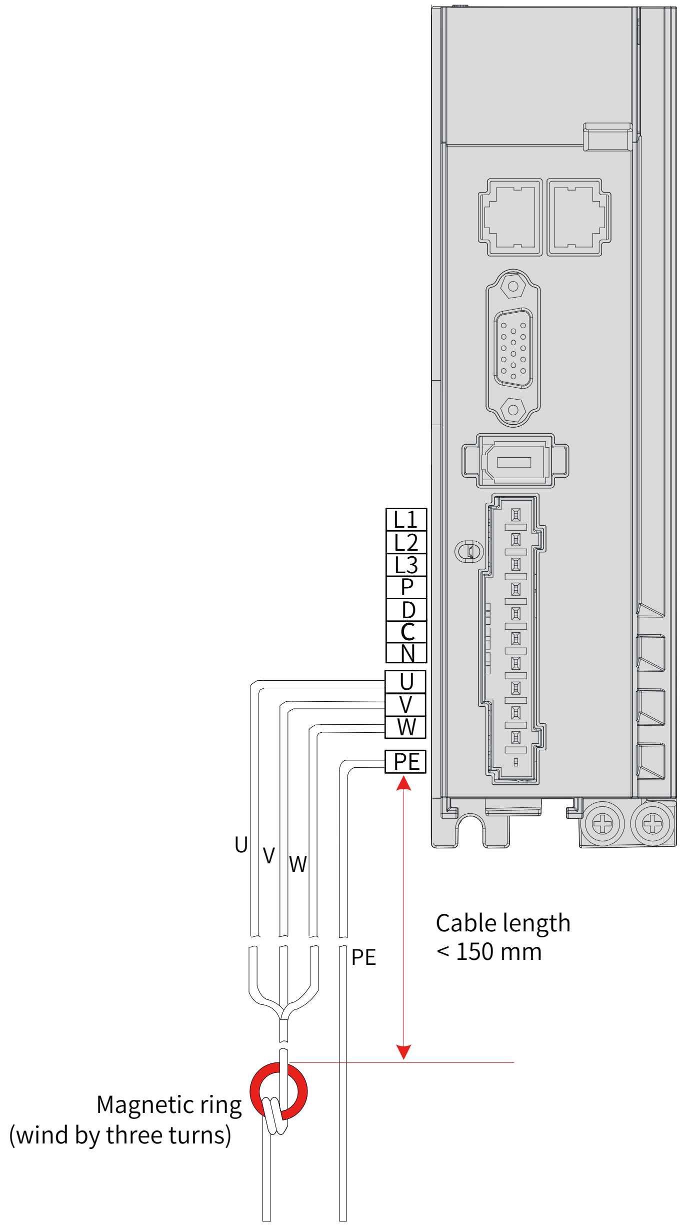


Figure 12-8 Installation of the output magnetic ring (external)

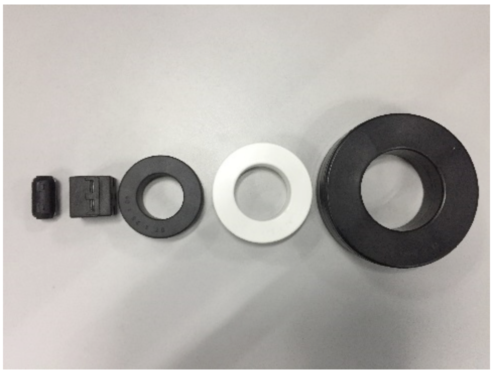


Figure 12-9 Appearance of the output magnetic rings (external)

Table 12-6 Model selection of the output magnetic rings (external)

Magnetic Ring Model	Code	Dimensions (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

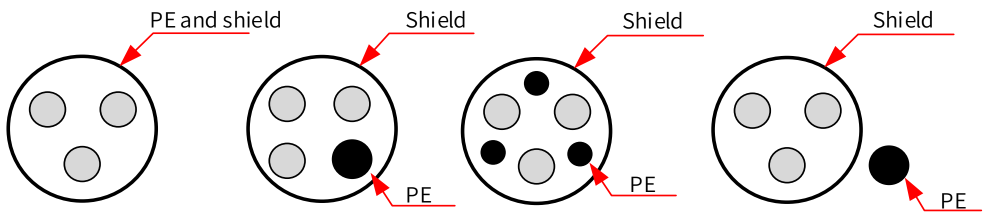
The AC input reactor is an option used to suppress the harmonics in the input current. In applications where strong suppression of harmonics is required, install an external AC input reactor.

12.1.6 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 for the control signals.

3) It is recommended to adopt shielded cables for the motor brake.

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.

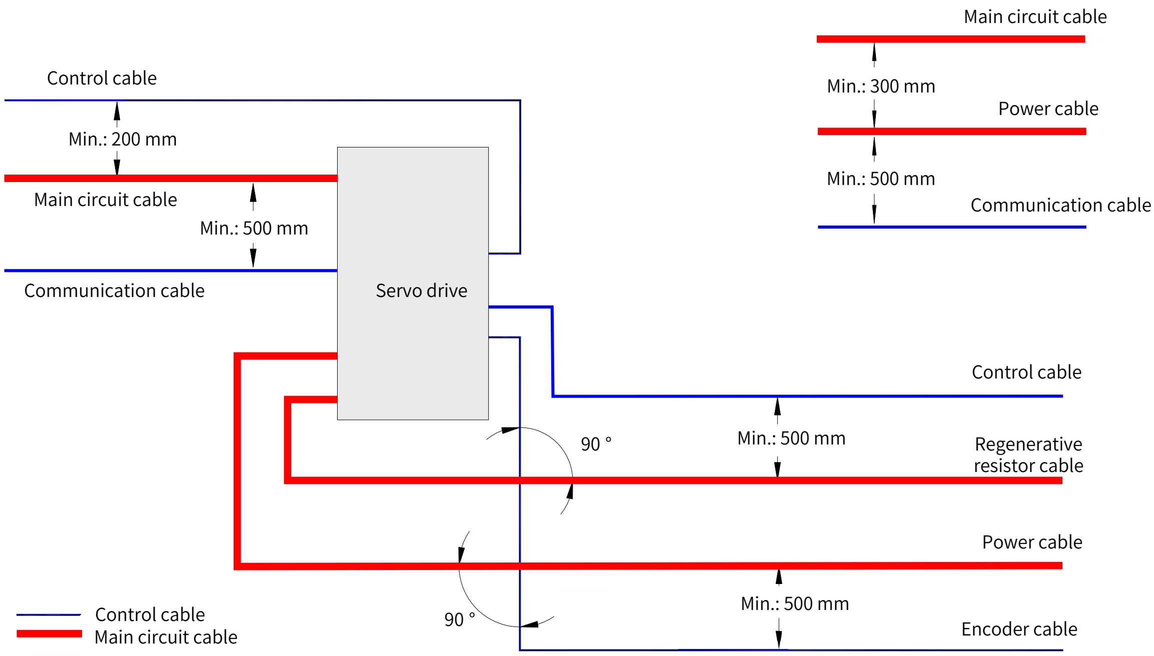
7) Power input and output cables and signal cables (such as control cables) of the servo drive should, if possible, be laid upright rather than in parallel.

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 using cables with a cross sectional area of more than 16 mm^2.

10) The filter, the servo drive and the motor must be properly connected to the electrical system, with the conductive metal kept in full contact.

■ The recommended wiring diagram is shown below.



12.1.7 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 tripping current not lower than 100 mA. If multiple servo drives share the same RCD, the tripping current of this RCD must be not lower 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 causes the RCD to trip, take the following measures:

- Increase the rated tripping current of the RCD.
- Replace the original RCD with a time-delay type-B RCD.
- Reduce the carrier frequency.
- Shorten the length of the drive output cables.
- Wind the magnetic ring around the power cables (PE cable excluded). Recommended RCD brands are Chint and Schneider.

12.1.8 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 12-7 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/or wind a magnetic ring).
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.

12.1.9 UL Certification

C UL US
LISTED
E467465
IND.CONT.EQ.

Figure 12-10 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 certified.

This series of servo drives have been tested in accordance with UL standard 61800-5-1 and CSA C22.2 No. 274-17 and comply with UL/cUL standards. Abide by the following requirements to enable machines and devices integrated with this servo drive to comply with UL/cUL 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 *"10 Troubleshooting"* for fuse selection.

See the specifications and model selection of the servo drive for the input and output current of the servo drive.

See *"10 Troubleshooting"* 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 main circuit of 480 V (400 V class) and below, with short-circuit current less than 100,000 A.

12.2 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	Profile 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 hardware version
100A	00	Manufacturer software version	RO	NO	-	-	-	Determined by the software 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 mapping objects in group 1600	RW	NO	Uint8	-	0–0x0A	0x03
	01	1st mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60400010
	02	2nd mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60600008
	03	3rd mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60B80010
	04	4th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	05	5th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	06	6th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	07	7th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	08	8th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	09	9th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	0A	10th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
1701	RPDO mapping objects in group 1701							
	00	Number of mapping objects in group 1701	RO	NO	Uint8	-	-	0x04
	01	1st mapping object	RO	NO	Uint32	-	-	0x60400010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x607A0020
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60B80010
	04	4th mapping object	RO	NO	Uint32	-	-	0x60FE0120
1702	RPDO mapping objects in group 1702							
	00	Number of mapping objects in group 1702	RO	NO	Uint8	-	-	0x07
	01	1st mapping object	RO	NO	Uint32	-	-	0x60400010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x607A0020
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60FF0020
	04	4th mapping object	RO	NO	Uint32	-	-	0x60710010
	05	5th mapping object	RO	NO	Uint32	-	-	0x60600008
	06	6th mapping object	RO	NO	Uint32	-	-	0x60B80010
	07	7th mapping object	RO	NO	Uint32	-	-	0x607F0020
1703	RPDO mapping objects in group 1703							
	00	Number of mapping objects in group 1703	RO	NO	Uint8	-		0x07
	01	1st mapping object	RO	NO	Uint32	-		0x60400010
	02	2nd mapping object	RO	NO	Uint32	-		0x607A0020
	03	3rd mapping object	RO	NO	Uint32	-		0x60FF0020
	04	4th mapping object	RO	NO	Uint32	-		0x60600008
	05	5th mapping object	RO	NO	Uint32	-		0x60B80010
	06	6th mapping object	RO	NO	Uint32	-		0x60E00010
	07	7th mapping 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 mapping objects in group 1704	RO	NO	Uint8	-	-	0x09
	01	1st mapping object	RO	NO	Uint32	-	-	0x60400010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x607A0020
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60FF0020
	04	4th mapping object	RO	NO	Uint32	-	-	0x60710010
	05	5th mapping object	RO	NO	Uint32	-	-	0x60600008
	06	6th mapping object	RO	NO	Uint32	-	-	0x60B80010
	07	7th mapping object	RO	NO	Uint32	-	-	0x607F0020
	08	8th mapping object	RO	NO	Uint32	-	-	0x60E00010
	09	9th mapping object	RO	NO	Uint32	-	-	0x60E10010
1705	RPDO mapping objects in group 1705							
	00	Number of mapping objects in group 1705	RW	NO	Uint8	-	-	0x08
	01	1st mapping object	RW	NO	Uint32	-	-	0x60400010
	02	2nd mapping object	RW	NO	Uint32	-	-	0x607A0020
	03	3rd mapping object	RW	NO	Uint32	-	-	0x60FF0020
	04	4th mapping object	RW	NO	Uint32	-	-	0x60600008
	05	5th mapping object	RW	NO	Uint32	-	-	0x60B80010
	06	6th mapping object	RW	NO	Uint32	-	-	0x60E00010
	07	7th mapping object	RW	NO	Uint32	-	-	0x60E10010
	08	8th mapping object	RW	NO	Uint32	-	-	0x60B20010
1A00	Mapping objects in group 1A00							
	00	Number of mapping objects in group 1A00	RW	NO	Uint8	-	0–0x0A	0x07
	01	1st mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60410010
	02	2nd mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60640020
	03	3rd mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60B90010
	04	4th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60BA0020
	05	5th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60BC0020
	06	6th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x603F0010
	07	7th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	0x60FD0010
	08	8th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	09	9th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
	0A	10th mapping object	RW	NO	Uint32	-	0–0xFFFFFFFF	-
1B01	Mapping objects in group 1B01							
	00	Number of mapping objects in group 1B01	RO	NO	Uint8	-	-	0x09
	01	1st mapping object	RO	NO	Uint32	-	-	0x603F0010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x60410010
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60640020
	04	4th mapping object	RO	NO	Uint32	-	-	0x60770010
	05	5th mapping object	RO	NO	Uint32	-	-	0x60F40020
	06	6th mapping object	RO	NO	Uint32	-	-	0x60B90010
	07	7th mapping object	RO	NO	Uint32	-	-	0x60BA0020
	08	8th mapping object	RO	NO	Uint32	-	-	0x60BC0020
	09	9th mapping object	RO	NO	Uint32	-	-	0x60FD0010

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1B02	Mapping objects in group 1B02							
	00	Number of mapping objects in group 1B02	RO	NO	Uint8	-	-	0x09
	01	1st mapping object	RO	NO	Uint32	-	-	0x603F0010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x60410010
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60640020
	04	4th mapping object	RO	NO	Uint32	-	-	0x60770010
	05	5th mapping object	RO	NO	Uint32	-	-	0x60610008
	06	6th mapping object	RO	NO	Uint32	-	-	0x60B90010
	07	7th mapping object	RO	NO	Uint32	-	-	0x60BA0020
	08	8th mapping object	RO	NO	Uint32	-	-	0x60BC0020
	09	9th mapping object	RO	NO	Uint32	-	-	0x60FD0010
1B03	Mapping objects in group 1B03							
	00	Number of mapping objects in group 1B03	RO	NO	Uint8	-	-	0x0A
	01	1st mapping object	RO	NO	Uint32	-	-	0x603F0010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x60410010
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60640020
	04	4th mapping object	RO	NO	Uint32	-	-	0x60770010
	05	5th mapping object	RO	NO	Uint32	-	-	0x60F40020
	06	6th mapping object	RO	NO	Uint32	-	-	0x60610008
	07	7th mapping object	RO	NO	Uint32	-	-	0x60B90010
	08	8th mapping object	RO	NO	Uint32	-	-	0x60BA0020
	09	9th mapping object	RO	NO	Uint32	-	-	0x60BC0020
	0A	10th mapping object	RO	NO	Uint32	-	-	0x60FD0010
1B04	Mapping objects in group 1B04							
	00	Number of mapping objects in group 1B04	RO	NO	Uint8	-	-	0x0A
	01	1st mapping object	RO	NO	Uint32	-	-	0x603F0010
	02	2nd mapping object	RO	NO	Uint32	-	-	0x60410010
	03	3rd mapping object	RO	NO	Uint32	-	-	0x60640020
	04	4th mapping object	RO	NO	Uint32	-	-	0x60770010
	05	5th mapping object	RO	NO	Uint32	-	-	0x60610008
	06	6th mapping object	RO	NO	Uint32	-	-	0x60F40020
	07	7th mapping object	RO	NO	Uint32	-	-	0x60B90010
	08	8th mapping object	RO	NO	Uint32	-	-	0x60BA0020
	09	9th mapping object	RO	NO	Uint32	-	-	0x60BC0020
	0A	10th mapping 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

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
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	-	-	-
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			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
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-type 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 software version	-	0–6553.5	0	1	16 bits	-	-
	02h	H01-01	FPGA software version	-	0–6553.5	0	1	16 bits	-	-
	0Bh	H01-10	Servo drive series number	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	-	0–10737418.24	0.4	1 kW	32 bits	-	-
	0Fh	H01-14	Max. output power of the servo drive	-	0–10737418.24	0.4	1 kW	32 bits	-	-
	11h	H01-16	Rated output current of the servo drive	-	0–10737418.24	2.8	1 A	32 bits	-	-
	13h	H01-18	Max. output current of the servo drive	-	0–10737418.24	10.1	1 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 control mode 1: Position control mode 2: Torque control mode 9: EtherCAT mode	0–9	9	1	16 bits	At stop	Immed-iately

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
2002	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
2002	06h	H02-05	Stop mode at S-ON OFF	-3: Stop at zero speed, keeping DB state -2: Ramp to stop as defined by 6084h/609Ah, keeping DB state -1: DB stop, keeping DB state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/609Ah, keeping de-energized state	-3 to +1	0	1	16 bits	At stop	Immed-iately
2002	07h	H02-06	Stop mode at No. 2 fault	-5: Stop at zero speed, keeping DB state -4: Stop at emergency torque, keeping DB state -3: Ramp to stop as defined by 6084h, keeping DB state -2: Ramp to stop as defined by 6084h/609Ah, keeping DB state -1: DB stop, keeping DB state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/609Ah, keeping de-energized state 2: Ramp to stop as defined by 6084h, keeping de-energized state 3: Stop at emergency torque, keeping de-energized state	-5 to +3	2	1	16 bits	At stop	Immed-iately

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2002	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 6084h/609Ah, keeping de-energized state 4: Ramp to stop as defined by 6084h/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	Immed-iately
	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	Immed-iately
	0Ah	H02-09	Delay from brake output ON to command received	-	0–500	250	1 ms	16 bits	During running	Immed-iately
	0Bh	H02-10	Delay from brake output OFF to motor de-energized	-	50–1000	150	1 ms	16 bits	During running	Immed-iately
	0Ch	H02-11	Motor speed threshold at brake output OFF in the rotation status	-	20–3000	30	1 RPM	16 bits	During running	Immed-iately

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	Immed-iately
	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	Immed-iately
	15h	H02-20	DB relay coil ON delay	-	30–30000	30	1 ms	16 bits	During running	Immed-iately
	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	Immed-iately
	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	Immed-iately
	1Bh	H02-26	Power of external regenerative resistor	-	1–65535	40	1 kW	16 bits	During running	Immed-iately
	1Ch	H02-27	Resistance of external regenerative resistor	-	15–1000	50	1 Ω	16 bits	During running	Immed-iately
	1Fh	H02-30	User password	-	0–65535	0	1	16 bits	During running	Immed-iately
	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	Immed-iately
	21h	H02-32	Group H0B parameter selection	-	0–99	50	1	16 bits	During running	Immed-iately
	24h	H02-35	Keypad data refresh rate	-	0–20	0	1 Hz	16 bits	During running	Immed-iately
	2Ah	H02-41	Factory password	-	0–65535	0	1	16 bits	During running	Immed-iately
2003h/H03 Terminal input parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
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	0–40	14	1	16 bits	During running	Immed-iately
	04h	H03-03	DI1 logic selection	0: Normally open 1: Normally closed	0–1	0	1	16 bits	During running	Immed-iately
	05h	H03-04	DI2 function selection	0–39 See the description of H03-02 for details.	0–40	15	1	16 bits	During running	Immed-iately
	06h	H03-05	DI2 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immed-iately
	07h	H03-06	DI3 function selection	0–39 See the description of H03-02 for details.	0–40	31	1	16 bits	During running	Immed-iately
	08h	H03-07	DI3 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immed-iately
	09h	H03-08	DI4 function selection	0–39 See the description of H03-02 for details.	0–40	39	1	16 bits	During running	Immed-iately
	0Ah	H03-09	DI4 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immed-iately
	0Bh	H03-10	DI5 function selection	0–39 See the description of H03-02 for details.	0–40	38	1	16 bits	During running	Immed-iately
	0Ch	H03-11	DI5 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immed-iately
	3Dh	H03-60	DI1 filter time	-	0–500	0.5	1 ms	16 bits	During running	Immed-iately
	3Eh	H03-61	DI2 filter time	-	0–500	0.5	1 ms	16 bits	During running	Immed-iately
	3Fh	H03-62	DI3 filter time	-	0–500	0.5	1 ms	16 bits	During running	Immed-iately
	40h	H03-63	DI4 filter time	-	0–500	0.5	1 ms	16 bits	During running	Immed-iately
	41h	H03-64	DI5 filter time	-	0–500	0.5	1 ms	16 bits	During running	Immed-iately
2004h/H04 Terminal Output Parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
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	Immed-iately
	02h	H04-01	DO1 logic selection	0: Normally open 1: Normally closed	0–1	0	1	16 bits	During running	Immed-iately
	03h	H04-02	DO2 function selection	0–32 See the description of H04-00 for details.	0–32	11	1	16 bits	During running	Immed-iately
	04h	H04-03	DO2 logic selection	0–1 See the description of H04-01 for details.	0–1	0	1	16 bits	During running	Immed-iately
	05h	H04-04	DO3 function selection	0–32 See the description of H04-00 for details.	0–32	9	1	16 bits	During running	Immed-iately
	06h	H04-05	DO3 logic selection	0–1 See the description of H04-01 for details.	0–1	0	1	16 bits	During running	Immed-iately
	18h	H04-23	EtherCAT forced DO offline output logic	0: Status of DO1 to DO3 unchanged in the non-OP status 1: No output in DO1 and status of others unchanged in the non-OP status 2: No output in DO2 and status of others unchanged in the non-OP status 3: No output in DO1 or DO2 and status of others unchanged in the non-OP status 4: No output in DO3, status of others unchanged in the non-OP status 5: No output in DO1 or DO3, status of others unchanged in the non-OP status 6: No output in DO2 or DO3 and status of others unchanged in the non-OP status 7: No output in DO1, DO2, or DO3.	0–7	0	1	16 bits	During running	Immed-iately
2005h/H05 Position control parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2005	05h	H05-04	First-order low-pass filter time constant	-	0–6553.5	0	1 ms	16 bits	At stop	Immed-iately
	06h	H05-05	Average filter time constant 1	-	0–1000	0	1 ms	16 bits	At stop	Immed-iately
	07h	H05-06	Average filter time constant 2	-	0–128	0	1 ms	16 bits	At stop	Immed-iately
	08h	H05-07	Numerator of electronic gear ratio	-	0–4294967295	1	1	32 bits	During running	Immed-iately
	0Ah	H05-09	Denominator of electronic gear ratio	-	0–4294967295	1	1	32 bits	During running	Immed-iately
	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	Immed-iately
	15h	H05-20	Condition for outputting positioning completed signal	0: Position deviation = Filtered position reference - Position feedback	0–3	0	1	16 bits	At stop	Immed-iately
	24h	H05-35	Duration limit of homing	-	0–6553.5	5000	1s	16 bits	During running	Immed-iately
	2Fh	H05-46	Position offset in absolute position linear mode (low 32 bits)	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	31h	H05-48	Position offset in absolute position linear mode (high 32 bits)	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	33h	H05-50	Numerator of the mechanical gear ratio in absolute position rotation mode	-	1–65535	1	1	16 bits	At stop	Immed-iately
	34h	H05-51	Denominator of mechanical gear ratio in absolute position rotation mode	-	1–65535	1	1	16 bits	At stop	Immed-iately
	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	Immed-iately
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	Immed-iately
2006h/H06 Speed control parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2006	04h	H06-03	Speed reference	-	-6000 to +6000	200	1 RPM	16 bits	During running	Immed-iately
	06h	H06-05	Acceleration ramp time of speed reference	-	0–65535	0	1 RPM	16 bits	During running	Immed-iately
	07h	H06-06	Deceleration ramp time of speed reference	-	0–65535	0	1 RPM	16 bits	During running	Immed-iately
	09h	H06-08	Forward speed limit	-	0–6000	6000	1 RPM	16 bits	During running	Immed-iately
	0Ah	H06-09	Reverse speed limit	-	0–6000	6000	1 RPM	16 bits	During running	Immed-iately
	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	Immed-iately
	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	Immed-iately
	0Dh	H06-12	Jog speed acceleration ramp time	-	0–65535	10	1 ms	16 bits	During running	Immed-iately
	0Eh	H06-13	Speed feedforward smoothing filter	-	0–2000	0	1	16 bits	During running	Immed-iately
	11h	H06-16	Motor speed threshold	-	0–1000	20	1 RPM	16 bits	During running	Immed-iately
	17h	H06-22	Enable	0: No 1: Yes	0–1	1	1	16 bits	During running	Immed-iately
	17h	H06-22	Study	0: No 1: Yes	0–1	1	1	16 bits	During running	Immed-iately
	1Dh	H06-28	Spline torque compensation selection	0: Disable 1: Enable	0–1	1	1	16 bits	During running	Immed-iately
2007h/H07 Torque control parameters										
2007	04h	H07-03	Torque reference value set through keypad	-	-400 to +400	0	1%	16 bits	During running	Immed-iately
	06h	H07-05	Torque reference filter time constant 1	-	0–30	0.2	1 ms	16 bits	During running	Immed-iately
	07h	H07-06	Torque reference filter time constant 2	-	0–30	0.27	1 ms	16 bits	During running	Immed-iately
	0Ah	H07-09	Forward internal torque limit	-	0–400	350	1%	16 bits	During running	Immed-iately
	0Bh	H07-10	Reverse internal torque limit	-	0–400	350	1%	16 bits	During running	Immed-iately
	10h	H07-15	Emergency stop torque	-	0–400	100	1%	16 bits	During running	Immed-iately

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	Immed-iately
	15h	H07-20	Reverse internal speed limit in torque control	-	0–6000	3000	1 RPM	16 bits	During running	Immed-iately
	16h	H07-21	Base value for torque reach	-	0–400	0	1%	16 bits	During running	Immed-iately
	17h	H07-22	Torque output value when torque reached DO signal turned on	-	0–400	20	1%	16 bits	During running	Immed-iately
	18h	H07-23	Torque output value when torque reached DO signal turned off	-	0–400	10	1%	16 bits	During running	Immed-iately
	19h	H07-24	Flux-weakening depth	-	60–115	115	100%	16 bits	During running	Immed-iately
	1Ah	H07-25	Maximum allowable demagnetizing current	-	1–100	100	100%	16 bits	During running	Immed-iately
	1Bh	H07-26	Flux-weakening enable	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immed-iately
	1Ch	H07-27	Flux-weakening gain	-	1–1000	30	1 Hz	16 bits	During running	Immed-iately
	25h	H07-36	Time constant of low-pass filter 2	-	0–10	0	1 ms	16 bits	During running	Immed-iately
	26h	H07-37	Torque reference filter selection	0: First-order filter 1: Biquad filter	0–1	0	1	16 bits	During running	Immed-iately
	27h	H07-38	Attenuation ratio of biquad filter	-	0–50	16	1	16 bits	At stop	Immed-iately
2008h/H08 Gain parameters										
2008	01h	H08-00	Speed loop gain	-	0.1–2000	39	1	16 bits	During running	Immed-iately
	02h	H08-01	Speed loop integral time constant	-	0.15–512	20.51	1 ms	16 bits	During running	Immed-iately
	03h	H08-02	Position loop gain	-	0.1–2000	55.7	1 Hz	16 bits	During running	Immed-iately
	04h	H08-03	2nd speed loop gain	-	0.1–2000	75	1 Hz	16 bits	During running	Immed-iately
	05h	H08-04	2nd speed loop integral time constant	-	0.15–512	10.61	1 ms	16 bits	During running	Immed-iately
	06h	H08-05	2nd position loop gain	-	0.1–2000	120	1 Hz	16 bits	During running	Immed-iately
	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	Immed-iately

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	Immed-iately
	0Bh	H08-10	Gain switchover delay	-	0–1000	5	1 ms	16 bits	During running	Immed-iately
	0Ch	H08-11	Gain switchover level	-	0–20000	50	1	16 bits	During running	Immed-iately
	0Dh	H08-12	Gain switchover hysteresis	-	0–20000	30	1	16 bits	During running	Immed-iately
	0Eh	H08-13	Position gain switchover time	-	0–1000	3	1 ms	16 bits	During running	Immed-iately
	10h	H08-15	Load inertia ratio	-	0–120	3	1	16 bits	During running	Immed-iately
	12h	H08-17	Zero phase delay	-	0–4	0	1 ms	16 bits	During running	Immed-iately
	13h	H08-18	Speed feedforward filter time constant	-	0–64	0.5	1 ms	16 bits	During running	Immed-iately
	14h	H08-19	Speed feedforward gain	-	0–100	0	1%	16 bits	During running	Immed-iately
	15h	H08-20	Torque feedforward filter time constant	-	0–64	0.5	1 ms	16 bits	During running	Immed-iately
	16h	H08-21	Torque feedforward gain	-	0–300	0	1%	16 bits	During running	Immed-iately
	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	Immed-iately
	18h	H08-23	Cutoff frequency of low-pass filter of speed feedback		100–8000	8000	Hz	16 bits	During running	Immed-iately
	19h	H08-24	PDFF control coefficient		0–200	100	%	16 bits	During running	Immed-iately

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	-	50–600	170	Hz	16 bits	During running	Immed-iately
	1Dh	H08-28	Speed observer inertia correction coefficient	-	1–1600	100	%	16 bits	During running	Immed-iately
	1Eh	H08-29	Speed observer filter time	-	0–10	0.8	ms	16 bits	During running	Immed-iately
	1Fh	H08-30	Disturbance compensation time	-	0–100	0.2	ms	16 bits	During running	Immed-iately
	20h	H08-31	Disturbance observation cutoff frequency	-	10–4000	600	Hz	16 bits	During running	Immed-iately
	21h	H08-32	Disturbance compensation gain	-	0–100	0	%	16 bits	During running	Immed-iately
	22h	H08-33	Disturbance observer inertia correction coefficient	-	1–1600	100	%	16 bits	During running	Immed-iately
	26h	H08-37	Phase modulation of medium-frequency suppression 2	-	-90 to +90	0	°	16 bits	During running	Immed-iately
	27h	H08-38	Frequency of medium-frequency suppression 2	-	0–1000	0	Hz	16 bits	During running	Immed-iately
	28h	H08-39	Compensation gain of medium-frequency suppression 2	-	1–300	0	%	16 bits	During running	Immed-iately
	29h	H08-40	Speed observer selection	0: Disabled 1: Enabled	0–1	0	1	16 bits	During running	Immed-iately
	2Bh	H08-42	Model control selection	0: Disabled 1: Enabled	0–1	0	1	16 bits	During running	Immed-iately
	2Ch	H08-43	Model gain	-	0.1–2000	40	1	16 bits	During running	Immed-iately
	2Fh	H08-46	Feedforward value	-	0–102.4	95	1	16 bits	During running	Immed-iately
	36h	H08-53	Medium and low frequency jitter suppression frequency 3	-	0–300	0	Hz	16 bits	During running	Immed-iately
	37h	H08-54	Medium- and low-frequency jitter suppression compensation 3	-	0–200	0	1%	16 bits	During running	Immed-iately
	39h	H08-56	Medium- and low- frequency jitter suppression phase modulation 3	-	0–600	100	1%	16 bits	During running	Immed-iately
	3Ch	H08-59	Medium- and low-frequency jitter suppression frequency 4	-	0–300	0	Hz	16 bits	During running	Immed-iately

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2008	3Dh	H08-60	Medium- and low-frequency jitter suppression compensate 4	-	0–200	0	1%	16 bits	During running	Immed-iately
	3Eh	H08-61	Medium- and low- frequency jitter suppression phase modulation 4	-	0–600	100	1%	16 bits	During running	Immed-iately
	3Fh	H08-62	Position loop integral time constant	-	0.15–512	512	1	16 bits	During running	Immed-iately
	40h	H08-63	2nd position loop integral time constant	-	0.15–512	512	1	16 bits	During running	Immed-iately
	41h	H08-64	Speed observation feedback source	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immed-iately
	49h	H08-72	Viscous friction of zero deviation control	-	0–100	0	1	16 bits	During running	Immed-iately
	4Ah	H08-73	Forward coulomb friction of zero deviation control	-	0–100	0	1	16 bits	During running	Immed-iately
	4Bh	H08-74	Reverse coulomb friction of zero deviation control	-	-100–0	0	1	16 bits	During running	Immed-iately
	4Ch	H08-75	Friction compensation selection of zero deviation control	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immed-iately
	4Dh	H08-76	Acceleration compensation factor of zero deviation control	-	0–900	0	1	16 bits	During running	Immed-iately
	4Eh	H08-77	Static friction of zero deviation control	-	0–100	0	1	16 bits	During running	Immed-iately
	4Fh	H08-78	Speed of transition between coulomb friction and viscous friction of zero deviation control	-	0–100	0	1	16 bits	During running	Immed-iately
	50h	H08-79	Initial torque shock of zero deviation control	-	0–100	0	1	16 bits	During running	Immed-iately
	51h	H08-80	Friction compensation delay of zero deviation control	-	0–1000	20	1	16 bits	During running	Immed-iately
2009h/H09 Gain auto-tuning parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
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	4	1	16 bits	During running	Immed-iately
	02h	H09-01	Stiffness level selection	-	0–41	15	1	16 bits	During running	Immed-iately
	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	3	1	16 bits	During running	Immed-iately
	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	2	1	16 bits	During running	Immed-iately
	06h	H09-05	Offline inertia auto-tuning mode	0: Bidirectional 1: Unidirectional	0–1	1	1	16 bits	At stop	Immed-iately
	07h	H09-06	Maximum speed of inertia auto-tuning	-	100–1000	500	1 RPM	16 bits	At stop	Immed-iately
	08h	H09-07	Time constant for accelerating to the maximum speed during inertia auto-tuning	-	20–800	125	1 ms	16 bits	At stop	Immed-iately
	09h	H09-08	Inertia auto-tuning interval	-	50–10000	800	1 ms	16 bits	At stop	Immed-iately
	0Ah	H09-09	Number of motor revolutions per inertia auto-tuning	-	0–100	1	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.								
2009	0Ch	H09-11	Vibration threshold		0–100	5	1%	16 bits	During running	Immed-iately
	0Dh	H09-12	1st notch frequency	-	50–8000	8000	1 Hz	16 bits	During running	Immed-iately
	0Eh	H09-13	Width level of the 1st notch	-	0–20	2	1	16 bits	During running	Immed-iately
	0Fh	H09-14	Depth level of the 1st notch	-	0–99	0	1	16 bits	During running	Immed-iately
	10h	H09-15	2nd notch frequency	-	50–8000	8000	1 Hz	16 bits	During running	Immed-iately
	11h	H09-16	Width level of the 2nd notch	-	0–20	2	1	16 bits	During running	Immed-iately
	12h	H09-17	Depth level of the 2nd notch	-	0–99	0	1	16 bits	During running	Immed-iately
	13h	H09-18	3rd notch frequency	-	50–8000	8000	1 Hz	16 bits	During running	Immed-iately
	14h	H09-19	Width level of the 3rd notch	-	0–20	2	1	16 bits	During running	Immed-iately
	15h	H09-20	Depth level of the 3rd notch	-	0–99	0	1	16 bits	During running	Immed-iately
	16h	H09-21	4th notch frequency	-	50–8000	8000	1 Hz	16 bits	During running	Immed-iately
	17h	H09-22	Width level of the 4th notch	-	0–20	2	1	16 bits	During running	Immed-iately
	18h	H09-23	Depth level of the 4th notch	-	0–99	0	1	16 bits	During running	Immed-iately
	19h	H09-24	Auto-tuned resonance frequency	-	0–5000	0	1 Hz	16 bits	-	-
	1Fh	H09-30	Tension fluctuation compensation gain	-	-100 to +100	0	1	16 bits	During running	Immed-iately
	20h	H09-31	Tension fluctuation compensation filter time	-	0–25	0.5	1	16 bits	During running	Immed-iately
	21h	H09-32	Gravity compensation	-	0 to 100	0	1%	16 bits	During running	Immed-iately
	22h	H09-33	Forward friction compensation	-	0 to 100	0	1%	16 bits	During running	Immed-iately
	23h	H09-34	Reverse friction compensation	-	-100 to 0	0	1%	16 bits	During running	Immed-iately
	24h	H09-35	Friction compensation speed	-	0–20	2	1	16 bits	During running	Immed-iately
	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	Immed-iately

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	Immed-iately
	27h	H09-38	Low-frequency resonance suppression frequency 1 at the mechanical end	-	1–100	100	1 Hz	16 bits	During running	Immed-iately
	28h	H09-39	Low-frequency resonance suppression 1 at the mechanical end	-	0–3	2	1	16 bits	At stop	Immed-iately
	2Ah	H09-41	5th notch frequency	-	50–8000	8000	1 Hz	16 bits	During running	Immed-iately
	2Bh	H09-42	Width level of the 5th notch	-	0–20	2	1	16 bits	At stop	Immed-iately
	2Ch	H09-43	Depth level of the 5th notch	-	0–99	0	1	16 bits	At stop	Immed-iately
	2Dh	H09-44	Low-frequency resonance suppression frequency 2 at the mechanical end	-	0–200	0	1	16 bits	During running	Immed-iately
	2Eh	H09-45	Low-frequency resonance suppression response 2 at the mechanical end	-	0.01–10	1	1	16 bits	During running	Immed-iately
	30h	H09-47	Low-frequency resonance suppression width 2 at the mechanical end	-	0–2	1	1	16 bits	During running	Immed-iately
	32h	H09-49	Low-frequency resonance suppression frequency 3 at the mechanical end	-	0–200	0	1	16 bits	During running	Immed-iately
	33h	H09-50	Low-frequency resonance suppression response 3 at the mechanical end	-	0.01–10	1	1	16 bits	During running	Immed-iately
	35h	H09-52	Low-frequency resonance suppression width 3 at the mechanical end	-	0–2	1	1	16 bits	During running	Immed-iately
	39h	H09-56	STune mode setting	-	0–4	4	1	16 bits	During running	Immed-iately
	3Ah	H09-57	STune resonance suppression switching frequency	-	0–1500	850	1 Hz	16 bits	During running	Immed-iately
	3Bh	H09-58	STune resonance suppression reset selection	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immed-iately
200Ah/H0A Fault and Protection Parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
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.	0–3	0	1	16 bits	During running	Immed-iately
	02h	H0A-01	Absolute position limit selection	0: Disable 1: Enable 2: Enabled after homing	0–2	0	1	16 bits	At stop	Immed-iately
	05h	H0A-04	Motor overload protection gain	-	50–300	100	1	16 bits	At stop	Immed-iately
	09h	H0A-08	Overspeed threshold	-	0–20000	0	1 RPM	16 bits	During running	Immed-iately
	0Dh	H0A-12	Runaway protection	0: Disable 1: Enable	0–1	1	1	16 bits	During running	Immed-iately
	13h	H0A-18	IGBT over-temperature threshold	-	120–175	135	1°C	16 bits	During running	Immed-iately
	14h	H0A-19	Probe 1 filter time constant	-	0–6.3	2	1 μs	16 bits	During running	Immed-iately
	15h	H0A-20	Probe 2 filter time constant	-	0–6.3	2	1 μs	16 bits	During running	Immed-iately
	16h	H0A-21	STO function display selection	0: Displaying STO status 1: Displaying STO fault	0–1	0	1	16 bits	During running	Immed-iately
	18h	H0A-23	TZ signal filter time	-	0–31	15	125 ns	16 bits	At stop	Next power-on
	1Ah	H0A-25	Filter time constant of speed feedback display value	-	0–5000	50	1 ms	16 bits	At stop	Immed-iately
	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	Immed-iately
	1Ch	H0A-27	Speed DO filter time constant	-	0–5000	50	1 ms	16 bits	During running	Immed-iately
	21h	H0A-32	Time threshold for locked rotor over-temperature protection	-	10–65535	200	1 ms	16 bits	During running	Immed-iately
	22h	H0A-33	Locked rotor over-temperature protection	0: Hide 1: Enable	0–1	1	1	16 bits	During running	Immed-iately
	25h	H0A-36	Encoder multi-turn overflow fault	0: Not hide 1: Hide	0–1	0	1	16 bits	During running	Immed-iately
	29h	H0A-40	Overtravel compensation switch	0: Compensation activated 1: Compensation inhibited	0–1	0	1	16 bits	At stop	Immed-iately

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	32h	H0A-49	Regenerative resistor over-temperature threshold	-	100–175	115	1°C	16 bits	During running	Immed-iately
	33h	H0A-50	Encoder communication fault tolerance threshold	-	0–31	3	1	16 bits	During running	Immed-iately
	34h	H0A-51	Phase loss detection filter times	-	3–36	20	55 ms	16 bits	During running	Immed-iately
	35h	H0A-52	Encoder temperature protection threshold	-	0–150	0	1°C	16 bits	During running	Immed-iately
	38h	H0A-55	Runaway current threshold	-	100–400	200	1%	16 bits	During running	Immed-iately
	39h	H0A-56	Reset delay	-	0–60000	10000	1 ms	16 bits	During running	Immed-iately
	3Ah	H0A-57	Runaway speed threshold	-	1–1000	50	1 RPM	16 bits	During running	Immed-iately
	3Bh	H0A-58	Runaway speed filter time	-	0.1–100	2	1 ms	16 bits	During running	Next power-on
	3Ch	H0A-59	Runaway protection detection time	-	10–1000	30	1 ms	16 bits	During running	Immed-iately
	3Ch	H0A-70	Overspeed threshold	-	0–20000	0	1	16 bits	During running	Immed-iately
	3Ch	H0A-71	MS1 motor overload curve switchover	0: New overload curve 1: Old overload curve 2: Discharge upon power-off shielded 3: Old overload curve & Discharge upon power-off shielded	0–3	0	1	16 bits	During running	Immed-iately
	49h	H0A-72	Maximum time of ramp-to-stop	-	0–65535	10000	1 ms	16 bits	At stop	Immed-iately
	4Ah	H0A-73	STO 24 V disconnection filter time	-	0–5	5	1 ms	16 bits	At stop	Immed-iately
	4Bh	H0A-74	STO fault tolerance filter time	-	0–10	10	1 ms	16 bits	At stop	Immed-iately
	4Ch	H0A-75	OFF delay after STO triggered	-	0–25	20	1 ms	16 bits	At stop	Immed-iately
200Bh/H0B Monitoring parameters										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
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	-	-500 to +500	0	0.1%	16 bits	-	-
	04h	H0B-03	Monitored DI status	-	0–65535	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	-	0–800	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	-	0–6553.5	0	1 A	32 bits	-	-
	1Bh	H0B-26	Bus voltage	-	0–6553.5	0	1 V	16 bits	-	-
	1Ch	H0B-27	Power module temperature	-	-20 to +200	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	Immed-iately
	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	-	-32767 to +32767	0	1 RPM	16 bits	-	-
	27h	H0B-38	Motor phase U current upon occurrence of the selected fault	-	-3276.7 to +3276.7	0	1 A	16 bits	-	-
	28h	H0B-39	Motor phase V current upon occurrence of the selected fault	-	-3276.7 to +3276.7	0	1 A	16 bits	-	-
	29h	H0B-40	Bus voltage upon occurrence of the selected fault	-	0–6553.5	0	V	16 bits	-	-
	2Ah	H0B-41	Input terminal state upon occurrence of the selected fault	-	0–65535	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	-	-6000 to +6000	0	1 RPM	32 bits	-	-
	3Ah	H0B-57	Bus voltage of control circuit	-	0–6553.5	0	1 V	16 bits	-	-
	3Bh	H0B-58	Mechanical absolute position (low 32 bits)	-	-2147483648 to +2147483647	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: Control circuit power error 2: Phase loss detection error 3: Main circuit power detection error (including short-to-ground fault) 4: Other servo faults 5: Short-to-ground detection not done	0–5	0	1	16 bits	-	-
	43h	H0B-66	Encoder temperature	-	-100 to +200	0	1°C	16 bits	-	-
	44h	H0B-67	Regenerative resistor load ratio	-	0–200	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)	-	-2147483648 to +2147483647	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										

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200D	01h	H0D-00	Software reset	0: No operation 1: Enable	0–1	0	1	16 bits	At stop	Immed-iately
	02h	H0D-01	Fault reset	0: No operation 1: Enable	0–1	0	1	16 bits	At stop	Immed-iately
	04h	H0D-03	Encoder initial angle auto-tuning	0: No operation 1: Enable	0–1	0	1	16 bits	At stop	Immed-iately
	05h	H0D-04	Encoder ROM read/write	0: No operation 1: Write ROM 2: Read ROM	0–2	0	1	16 bits	At stop	Immed-iately
	06h	H0D-05	Emergency stop	0: No operation 1: Emergency stop	0–1	0	1	16 bits	During running	Immed-iately
	0Ch	H0D-12	UV phase current balance correction	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immed-iately
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	Immed-iately
	13h	H0D-18	Forced DI setting value	-	0x00–0x1F	0	1	16 bits	During running	Immed-iately
	14h	H0D-19	Forced DO setting value	-	0x00–0x07	0	1	16 bits	During running	Immed-iately
	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	Immed-iately
200Eh/H0E Auxiliary function parameters										
200E	01h	H0E-00	Node address	-	0–127	1	1	16 bits	During running	Immed-iately
	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 dictionaries written through communication to EEPROM 3: Save parameters and object dictionaries written through communication to EEPROM	0–3	3	1	16 bits	During running	Immed-iately
	15h	H0E-20	EtherCAT slave name	-	0–65535	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	16h	H0E-21	EtherCAT slave alias	-	0–65535	0	1	16 bits	At stop	Immed-iately
	17h	H0E-22	Number of synchronization interrupts allowed by EtherCAT	-	1–20	9	1	16 bits	During running	Immed-iately
	18h	H0E-23	EtherCAT station alias from EEPROM	-	1–65535	0	1	16 bits	During running	Immed-iately
	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	-	-
	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	Immed-iately
	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	Immed-iately
	24h	H0E-35	AL fault code	-	0–65535	0	1	16 bits	-	-
	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

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200E	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	Immed-iately
	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	Immed-iately
	53h	H0E-82	Modbus response delay	-	0–20	0	1 ms	16 bits	During running	Immed-iately
	54h	H0E-83	Modbus communication timeout	-	0–600	0	1 ms	16 bits	During running	Immed-iately
	5Bh	H0E-90	Modbus version number	-	0–655.35	0	1	16 bits	-	-
	5Eh	H0E-93	EtherCAT CoE version No.	-	0–655.35	0	1	16 bits	-	-
	61h	H0E-96	XML version No.	-	0–655.35	0	1	16 bits	-	-
2018h/H18 Position comparison output										
2018	01h	H18-00	Position comparison output selection	0: Disable 1: Enable (rising edge-triggered)	0–1	0	1	16 bits	During running	Immed-iately
	03h	H18-02	Position comparison value resolution	0: 24-bit 1: 23-bit 2: 22-bit 3: 21-bit 4: 20-bit 5: 19-bit 6: 18-bit 7: 17-bit	0–7	1	1	16 bits	During running	Immed-iately
	04h	H18-03	Position comparison mode selection	0: Individual comparison mode 1: Cyclic comparison mode	0–1	0	1	16 bits	During running	Immed-iately
	05h	H18-04	Current position as zero point	0: Disable 1: Enable (rising edge-triggered)	0–1	0	1	16 bits	During running	Immed-iately
	06h	H18-05	Position comparison output width	-	0–204.7	0	0.1 ms	16 bits	During running	Immed-iately
	08h	H18-07	Position comparison starting point	-	0–8	0	1	16 bits	During running	Immed-iately

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2018	09h	H18-08	Position comparison end point	-	0–8	0	1	16 bits	During running	Immed-iately
	0Ah	H18-09	Current state of position comparison	-	0–8	0	1	16 bits	During running	Immed-iately
	0Bh	H18-10	Real-time position of position comparison	-	-2147483648 to +2147483647	0	1	32 bits	-	-
	0Dh	H18-12	Zero offset of position comparison	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
2019h/H19 Target position parameters										
2019	01h	H19-00	Target value of position comparison 1	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	03h	H19-02	Attribute value of position comparison 1	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	0–3	0	1	16 bits	During running	Immed-iately
	04h	H19-03	Target value of position comparison 2	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	06h	H19-05	Attribute value of position comparison 2	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	0–3	0	1	16 bits	During running	Immed-iately
	07h	H19-06	Target value of position comparison 3	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2019	09h	H19-08	Attribute value of position comparison 3	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	0–3	0	1	16 bits	During running	Immed-iately
	0Ah	H19-09	Target value of position comparison 4	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	0Ch	H19-11	Attribute value of position comparison 4	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	0–3	0	1	16 bits	During running	Immed-iately
	0Dh	H19-12	Target value of position comparison 5	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	0Fh	H19-14	Attribute value of position comparison 5	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	0–3	0	1	16 bits	During running	Immed-iately
	10h	H19-15	Target value of position comparison 6	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately

Parameter Group			Name	Option Description	Value Range	Default	Min. Unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2019	12h	H19-17	Attribute value of position comparison 6	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	0–3	0	1	16 bits	During running	Immed-iately
	13h	H19-18	Target value of position comparison 7	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	15h	H19-20	Attribute value of position comparison 7	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	0–3	0	1	16 bits	During running	Immed-iately
	16h	H19-21	Target value of position comparison 8	-	-2147483648 to +2147483647	0	1	32 bits	During running	Immed-iately
	18h	H19-23	Attribute value of position comparison 8	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	0–3	0	1	16 bits	During running	Immed-iately

Object Group 6000h

The object group 6000h contains objects supported and related to DSP 402 profile.

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	Immed-iately
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	Immed-iately
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	Immed-iately
6066	00	Following error time out	RW	RPDO	Uint32	ms	0–0xFFFF	0	During running	Immed-iately
6067	00	Position window	RW	RPDO	Uint32	Reference unit	0–0xFFFFFFFF	0x000002DE	During running	Immed-iately
6068	00	Position window time	RW	RPDO	Uint16	ms	0–0xFFFF	0	During running	Immed-iately
606C	00	Velocity actual value	RO	TPDO	Int32	Reference unit/s	-	-	-	-
606D	00	Velocity window	RW	RPDO	Uint16	RPM	0–0xFFFF	0x0A	During running	Immed-iately
606E	00	Velocity window time	RW	RPDO	Uint16	ms	0–0xFFFF	0	During running	Immed-iately
606F	00	Velocity threshold	RW	RPDO	Uint16	RPM	0–0xFFFF	0x0A	During running	Immed-iately
6070	00	Velocity threshold time	RW	RPDO	Uint16	ms	0–0xFFFF	0	During running	Immed-iately
6071	00	Target torque	RW	RPDO	Int16	0.1%	0xF448–0x0BB8	0	During running	Immed-iately
6072	00	Max torque	RW	RPDO	Uint16	0.1%	0–0x0BB8	0x0BB8	During running	Immed-iately
6074	00	Torque demand value	RO	TPDO	Int16	0.1%	-	0	-	-
6077	00	Torque actual value	RO	TPDO	Int16	0.1%	-	0	-	-

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
607A	00	Target position	RW	RPDO	Int32	Reference unit	0x80000000–0x7FFFFFFF	0	During running	Immed-iately
607C	00	Home offset	RW	RPDO	Int32	Reference unit	0x80000000–0x7FFFFFFF	0	During running	Immed-iately
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	Immed-iately
	02	Max position limit	RW	RPDO	Int32	Reference unit	0x80000000–0x7FFFFFFF	0x7FFFFFFF	During running	Immed-iately
607E	00	Polarity	RW	RPDO	Uint8	-	0–0xFF	0	During running	Immed-iately
607F	00	Max profile velocity	RW	RPDO	Uint32	Reference unit/s	0–0xFFFFFFFF	0x06400000	During running	Immed-iately
6081	00	Profile velocity	RW	RPDO	Uint32	User speed unit	0–0xFFFFFFFF	0x001AAAAB	During running	Immed-iately
6083	00	Profile acceleration	RW	RPDO	Uint32	Reference unit/s^2	0–0xFFFFFFFF	0x0A6AAAAA	During running	Immed-iately
6084	00	Profile deceleration	RW	RPDO	Uint32	Reference unit/s^2	0–0xFFFFFFFF	0x0A6AAAAA	During running	Immed-iately
6085	00	Quick stop deceleration	RW	RPDO	Uint32	User acceleration unit	0–0xFFFFFFFF	0x7FFFFFFF	During running	Immed-iately
6086	00	Motion profile type	RW	RPDO	Int16	-	0x8000–0x7FFF	0	During running	Immed-iately
6087	00	Torque slope	RW	RPDO	Uint32	0.1%/s	0–0xFFFFFFFF	0xFFFFFFFF	During running	Immed-iately
6091		Gear ratio								
	00	Highest sub-index supported	RO	NO	Uint8	Uint8	-	0x02	-	-
	01	Motor revolutions	RW	RPDO	Uint32	-	0–0xFFFFFFFF	1	During running	Immed-iately
	02	Shaft revolutions	RW	RPDO	Uint32	-	1–0xFFFFFFFF	1	During running	Immed-iately
6098	00	Homing method	RW	RPDO	Int8	-	-2 to 35	0x01	During running	Immed-iately
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	Immed-iately
	02	Speed during search for zero	RW	RPDO	Uint32	Reference unit/s	0–0xFFFFFFFF	0x0002AAAB	During running	Immed-iately
609A	00	Homing acceleration	RW	RPDO	Uint32	Reference unit/s^2	0–0xFFFFFFFF	0x0A6AAAAA	During running	Immed-iately
60B0h	00	Position offset	RW	RPDO	Int32	Reference unit	0x80000000–0x7FFFFFFF	0	During running	Immed-iately
60B1h	00	Velocity offset	RW	RPDO	Int32	Reference unit/s	0x80000000–0x7FFFFFFF	0	During running	Immed-iately

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
60B2h	00	Torque offset	RW	RPDO	Int16	0.1%	0xF448–0x0BB8	0	During running	Immed-iately
60B8h	00	Touch probe function	RW	RPDO	Uint16	-	0–0xFFFF	0	During running	Immed-iately
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	Immed-iately
60C6h	0	Max deceleration	RW	RPDO	Uint32	User acceleration unit	0–0xFFFFFFFF	0xFFFFFFFF	During running	Immed-iately
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	-	Immed-iately
60E1h	00	Negative torque limit value	RW	RPDO	Uint16	0.1%	0–0x0BB8	0x0BB8	-	Immed-iately

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	Immed-iately
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	Immed-iately
	02	Bit mask	RW	NO	Uint32	-	0–0xFFFFFFFF	0	During running	Immed-iately
60FFh	00	Target velocity	RW	RPDO	Int32	Reference unit/s	0x80000000–0x7FFFFFFF	0	During running	Immed-iately
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	Indicates an attempt to read a write-only object.
0601 0002	Indicates an 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.

12.3 Safe Torque Off (STO) Function

12.3.1 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.

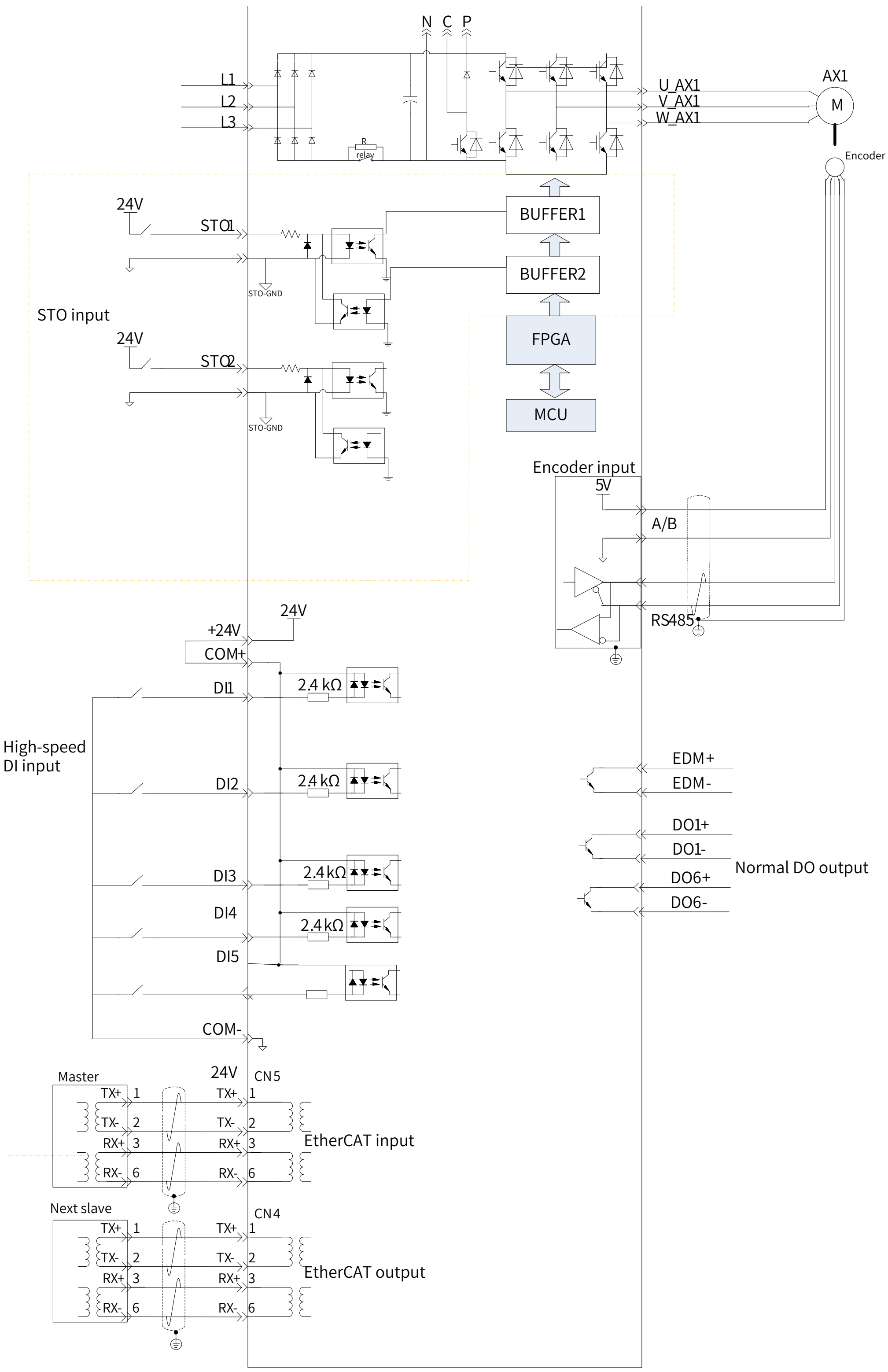


Figure 12-11 Overview of the safety drive

12.3.2 Standards Compliance

- North American Standards (UL)

UL 61800-5-1

CSA C22.2 No. 274

- European Directives and Standards

Low Voltage Directive 2014/35/EU; Standards EN 61800-5-1 and IEC 61800-5-1

Electromagnetic Compatibility Directive 2014/30/EU; Standards EN 61800-3, IEC 61800-3, and IEC 61800-5-2

Machinery Directive 2006/42/EC (functional safety); Standard IEC 61800-5-2

- 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 ≤ 0.1×10^{-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

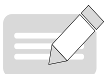
12.3.3 General Safety Information

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.

12.3.4 Specifications

- Electrical safety complies with IEC 61800-5-1:2016, over voltage category II.
- The environment test requirement complies with IEC 61800 -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/s² (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 EN/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
Location	Integrated in the control board of the servo drive
Safety function - Inputs	2 channels: STO1/STO2

The STO subsystem elements must always operate within the range of temperature, humidity, corrosion, dust, vibration, and other items specified above.

12.3.5 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.

12.3.6 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 terminals".

12.3.7 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 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 circuit breaker.	
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 circuit breaker 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. Activate 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. Activate 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. Activate 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. Activate 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.

12.3.8 Safety Function: STO

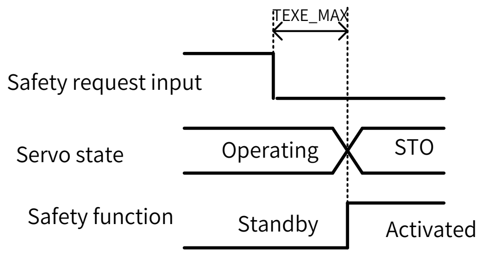
1 Description of safety function

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.



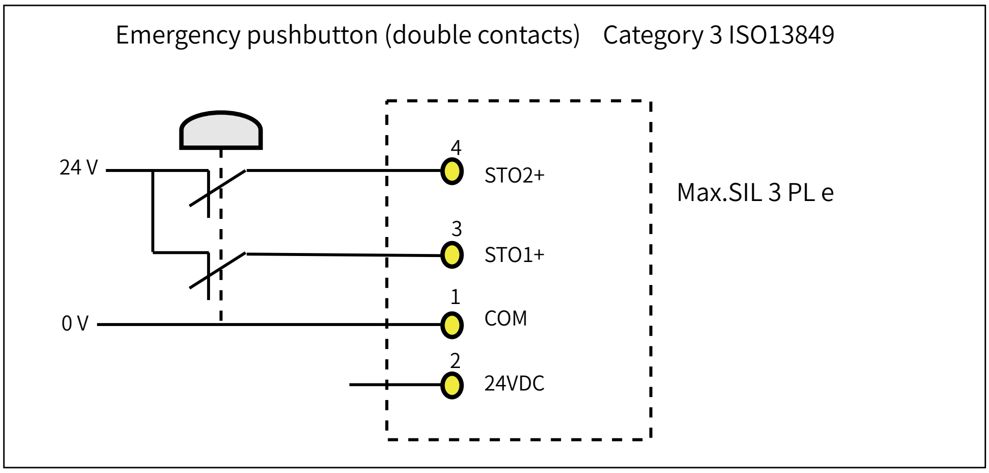
■ The STO function table is as follows.

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 gate signals 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



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 internal diagnosis	OV/UV of 5 V power supply detected
E150.3	STO activated by internal diagnosis	Input circuits of STO working abnormally
E150.4	STO activated by internal 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.

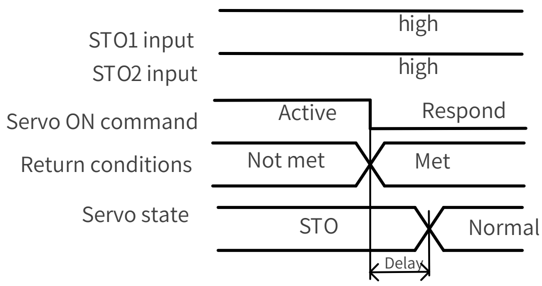


Figure 12-12 Return condition of S-ON/RUN command

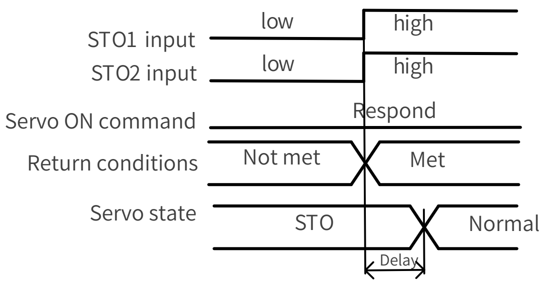


Figure 12-13 Return condition of external STO request state

12.3.9 Troubleshooting

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. Contact Inovance for technical support.
E150.2	OV/UV of 5 V power supply detected	Restore the 5 V power supply to normal state. Contact Inovance for technical support.
E150.3	Input circuit of STO working abnormally	Fix the input circuit fault. Contact Inovance for technical support.
E150.4	Buffer circuit of STO working abnormally	Fix the buffer circuit fault. Contact Inovance for technical support.

12.3.10 Product Information

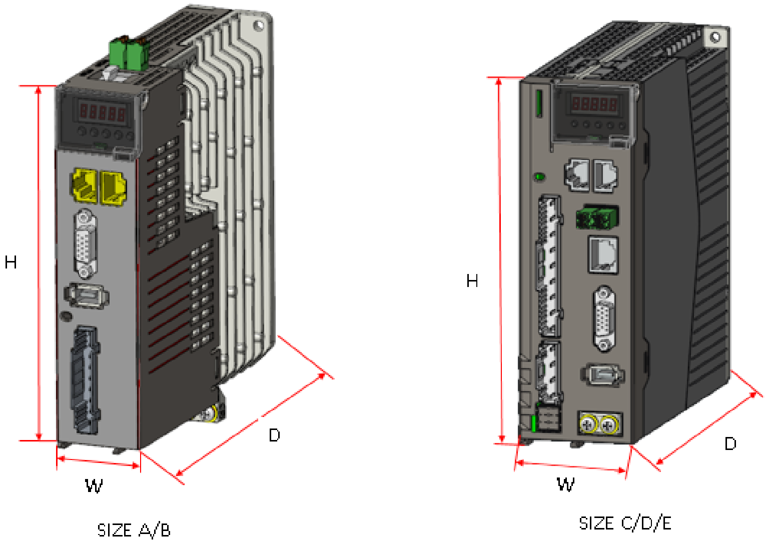
1 Nameplate and model number

See "1.1.1 Nameplate and Model Number" for details.

2 Applicable servo drive

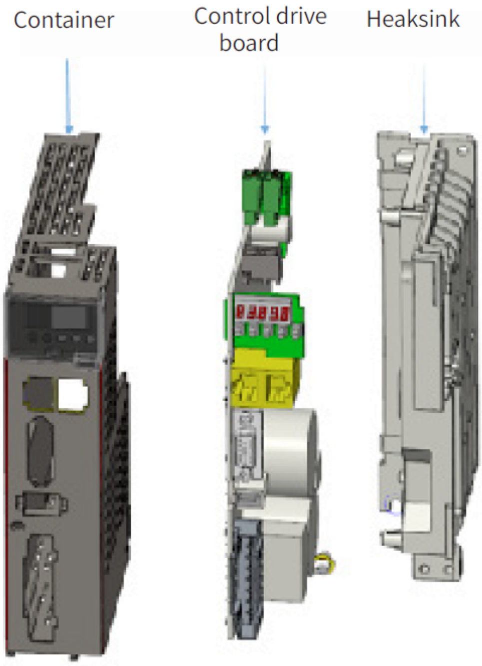
STO applies to the servo drives in the following two kinds of physical structures.

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



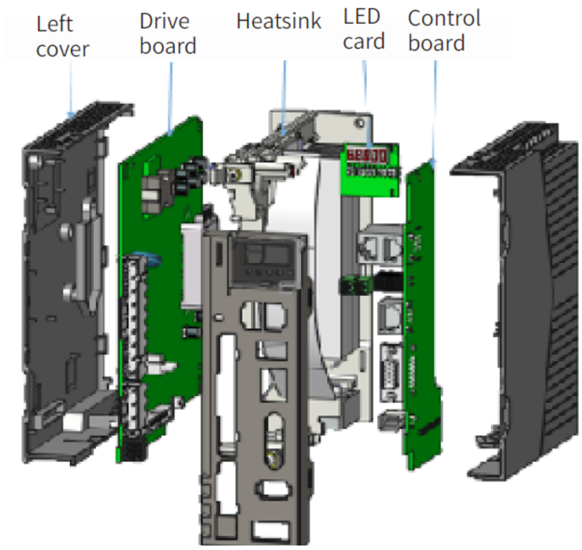
NOTE

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.



12.3.11 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), depending on the number of motor pole pairs

Direct drive motor: 1/20 rotation max. (rotation angle at motor shaft conversion), depending on the number of motor pole pairs

Linear servo motor: 30 mm max., depending on the number of motor pole pairs

12.4 Multi-Machine Recipe Management

In EtherCAT multi-axis applications, parameters of each axis are ususally written or read separately, which is time-consuming and error-prone. Therefore, a PC software capable of writing/reading parameters of all the servo axes is needed in EtherCAT networking, so that parameters of Inovance servo axis parameters can be written/read through an individual operation, with the full device receipe being saved.

1 Function

- Identification and scanning of axis drives: The PC software identifies Inovance EtherCAT devices (available in IS620N series servo drives only) based on the configuration of network card.
- Upload and download of all the cascaded axis drive parameters
- Storage and download of drive recipes
- Comparison and copy of axis drive parameters
- Comparison of device parameters and recipe parameters

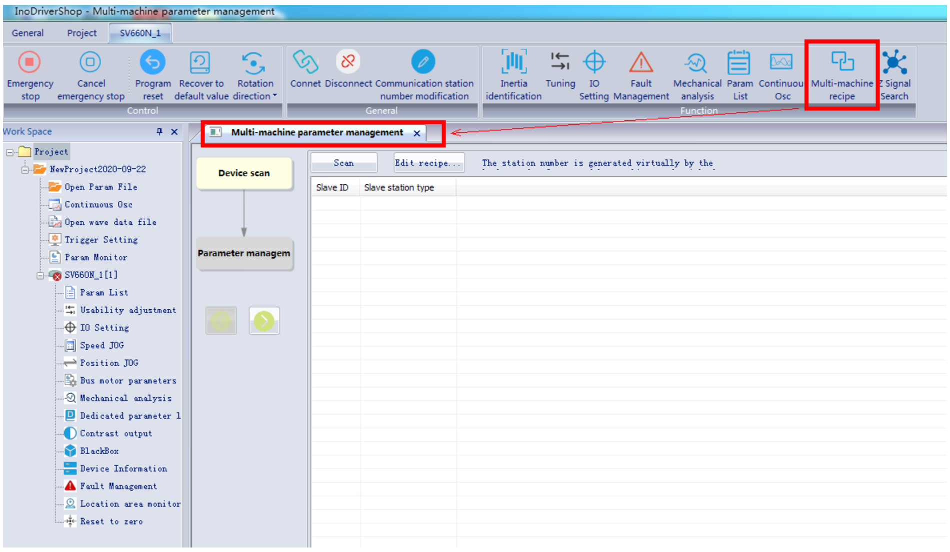
2 Operating environment

- Hardware: PC
- Software supported:

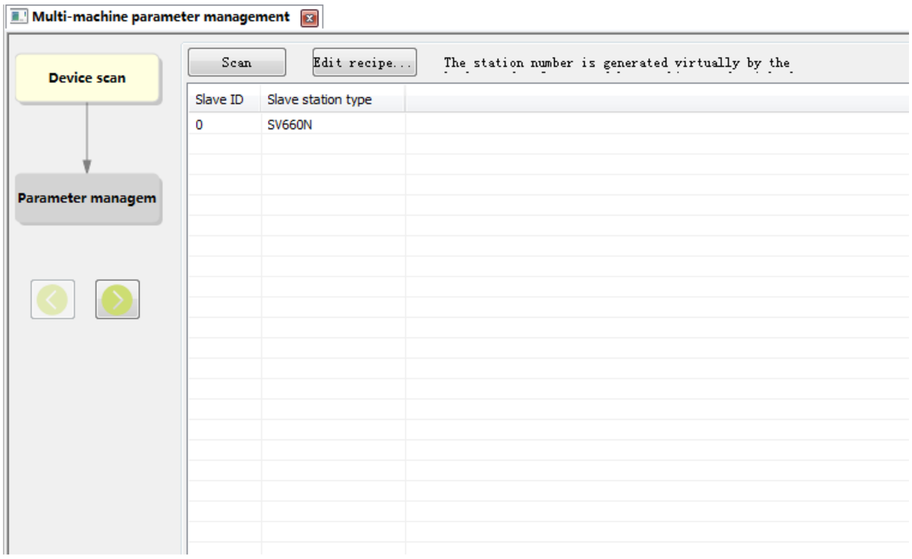
Operating system: WIN7 32/64-bit systems and WIN 10 32/64-bit systems

3 Instructions for use

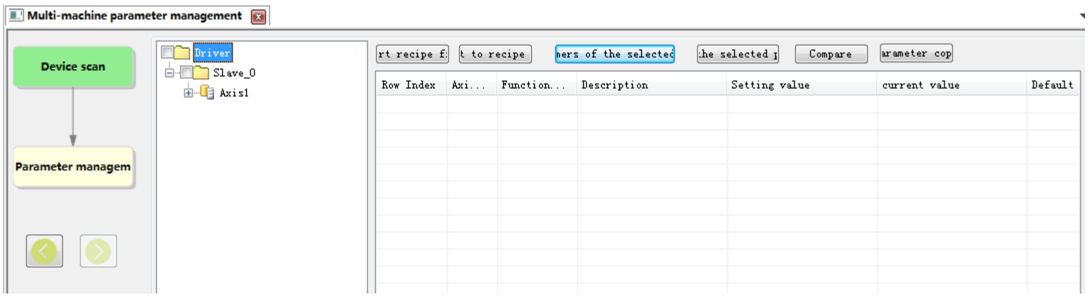
1) Click the **Multi-machine recipe** button under **SV660N** to start the multi-machine recipe function, as shown below.



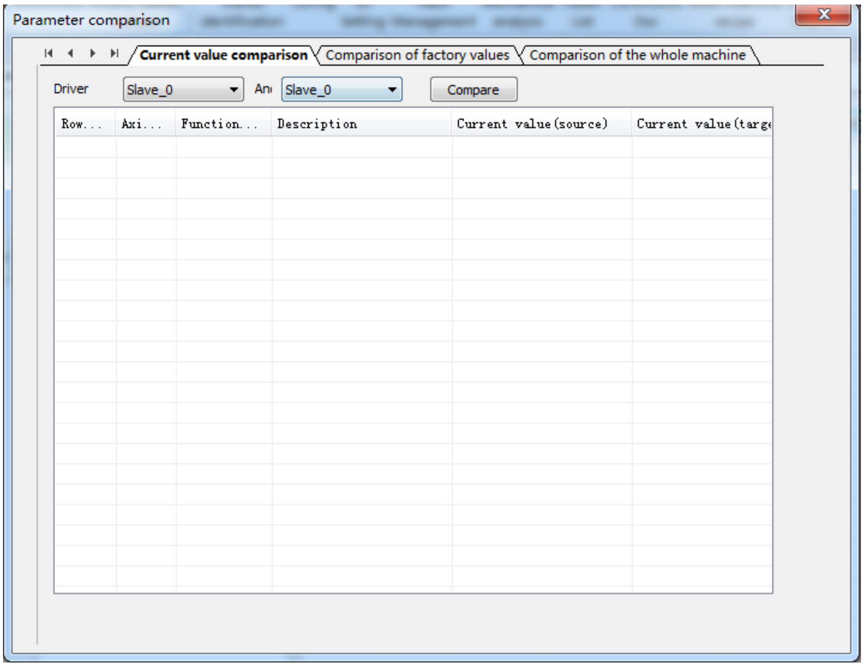
2) Scanning: Click the **Scan** button, and all the EtherCAT slaves cascaded will be scanned and displayed. The scanning time is directly proportional to the number of cascaded slaves, so you may wait a few minutes in case of large numebers of cascaded slaves. (Non-Inovance slaves are displayed as "Non-Inovance device".)



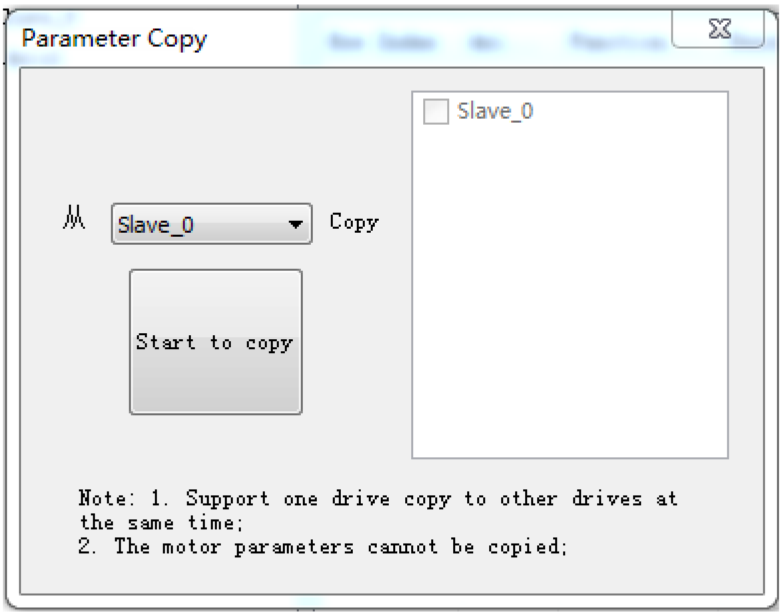
3) Click  to enter parameter management interface.



- **Import recipe files**: Import the machine recipe saved in the local to current device.
- **Export to recipe files**: Upload parameters of all slaves and save them as a recipe file (the recipe file does not contain parameters in groups H00 or H01).
- **Upload the paramers of the selected slave stations**: You can choose to upload parameter of all slaves, partial slaves or a single slave.
- **Compare**: You can compare current parameter values between slaves, default values of slaves, and machine recipes.



- **Parameter copy**: You can copy parameters from slave to slave.



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