INOVANCE

FORWARD, ALWAYS PROGRESSING

SV680-INT Series Servo Drive

Function Guide

Industrial Automation

Intelligent Elevator

New Energy Vehicle

Industrial Robot

Rail Transit

Data code PS00015554A03

Preface

Introduction

The SV680-INT series servo drive is a high-end servo drive designed based on global-leading standards and high-end application needs. It is featured with high speed, high precision, high performance, and tuning-free function. Compliant with CE, UL, KC, EAC, UKCA and TUV certification requirements and top international quality standards, it is specially suitable for high-end applications.

Its power ranges from 0.05 kW to 7.5 kW. It supports Modbus, CANopen and EtherCAT communication protocols and carries necessary communication interfaces to work with the host controller for implementing a networked operation of multiple servo drives. The servo drive supports adaptive stiffness level setting, inertia auto-tuning, and vibration suppression for easy use. The drive, together with an MS1 series high-response servo motor (with ultra-low, low or medium inertia) equipped with a 23- or 26-bit single-turn/multi-turn absolute encoder, any third party servo motor, linear motor or DDR motor, serves to deliver a quiet and stable operation and accurate process control through features like fully closed-loop, internal process segment and gantry synchronization.

The drive also comes with features like safe torque off, dynamic braking, and brake output (external relay not needed) as standard and supports extension of seven kinds of functional safety and bus functional safety FSoE (the PINT version further offers 24V backup power) for continuous safe production. The drive aims to achieve quick and accurate position control, speed control, and torque control through high-performance solutions for automation equipment in such industries as electronic manufacturing, lithium batteries, manipulators, packaging, and machine tools.

This manual introduces the functions and faults of the drive, including function overview, adjustment, basic servo functions and fault handling.

Note

The speed of a servo motor and DDR motor is in rpm and DDL motor is in mm/s. rpm is used throughout the manual. Unless otherwise specified, an rpm value is equivalent to the mm/s one.

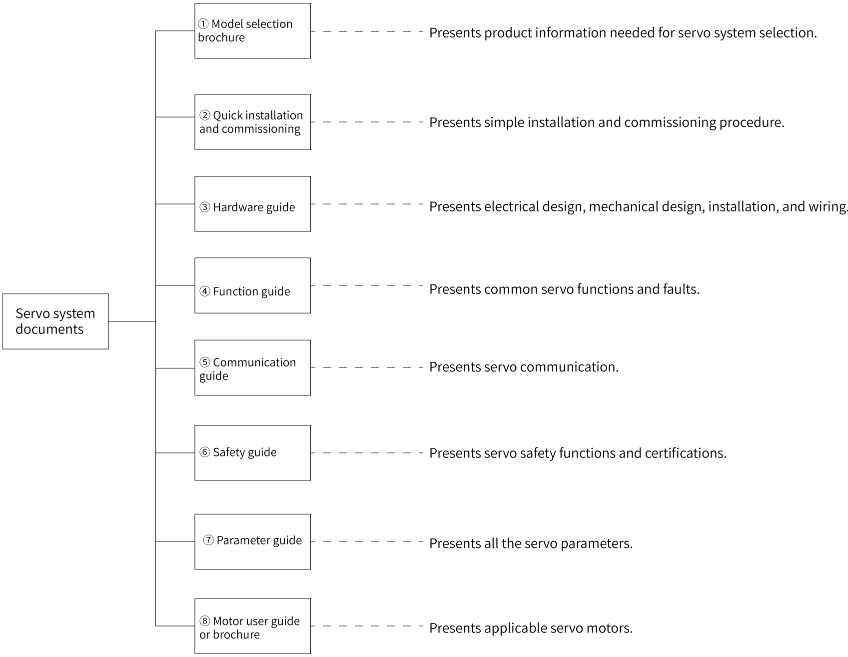
Product Name Abbreviation

The following abbreviations will be used herein to refer to the corresponding servo drives.

Abbreviation	Servo drive
[P]	SV680P*****-*INT
[N]	SV680N*****-*INT

More documents

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



No.	Name	Data Code	Description
①	SV680-INT series flagship servo drive	19120347	Provides instructions on product selection, including the list of supporting components, technical data on the drive, and the selection guide of cables.
②	SV680-INT Series Servo Drive Quick Installation and Commissioning	PS00015536	Describes the model number, installation, terminals and quick commissioning and operation of the drive.
③	SV680-INT Series Servo Drive Hardware Guide	PS00015494	Describes technical data, installation, terminals, required certificates and standards and solutions to common EMC problems of the drive.
④	SV680-INT Series Servo Drive Function Guide	PS00015554	Introduces the functions and faults of the drive, including function overview, adjustment, basic servo functions and fault handling.
⑤	SV680-INT Series Servo Drive Communication Guide	PS00015535	Introduces the communication of the drive, including configuration of Modbus, CANopen, and EtherCAT communication.
⑥	SV680P-INT Series Servo Drive Safety Guide	PS00009740	Describes the safety function and related certifications and standards, wiring, commissioning process, troubleshooting and parameters of the drive.
	SV680N-INT Series Servo Drive Safety Guide	PS00009768	

No.	Name	Data Code	Description
⑦	SV680-INT Series Servo Drive Parameter Guide	PS00015555	Introduces the parameters of the drive, including a parameter list and description of parameters.
⑧	MS1-R Series Servo Motor Selection Guide	PS00004605	Introduces the product information, general specifications, motor selection, cable selection, and required certificates and standards of the servo motor.
	MS1-R Series Servo Motor Installation Guide	PS00005407	Describes installation of the motor, including an installation flowchart, unpacking and transportation, mechanical installation, and electrical installation.
	Direct drive motor module platform and drive	19120011	Introduces the product information, general specifications, motor selection, cable selection, and required standards of the motor.

Revision History

Date	Version	Description
2024-08	A03	Made minor corrections. Updated content on parameters and faults.
2024-05	A02	Minor corrections.
2024-03	A01	Minor corrections.
2024-02	A00	First release.

Access to the Guide

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

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

Warranty

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

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

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

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

For details, see the Product Warranty Card.

Table of Contents

Safety Instructions

Disclaimer

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

Safety Levels and Definitions

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

Safety Instructions

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

Unpacking
WARNING
• Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking. • Do not install the equipment if you find water seepage or missing or damaged components upon unpacking. • Do not install the equipment if you find the packing list does not conform to the equipment you received.
CAUTION
• Check whether the package is intact and whether there is damage, water seepage, dampness, and deformation before unpacking. • Unpack the package by following the unpacking sequence. Do not strike the package violently. • Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking. • Check whether the package contents are consistent with the packing list before unpacking.
Storage and Transportation
WARNING
• Large-scale or heavy equipment must be transported by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage. • Before hoisting the equipment, ensure the equipment components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injuries or equipment damage. • Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment. • When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.

CAUTION

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

Installation

DANGER

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

WARNING

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

CAUTION

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. 6970After installation, remove the cloth or paper on the top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

DANGER

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

WARNING

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

CAUTION

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

Power-on

⚠ DANGER • Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted. • Check that the power supply meets equipment requirements before power-on to prevent equipment damage or a fire. • After power-on, do not open the cabinet door or protective cover of the equipment, touch any terminal, or disassemble any unit or component of the equipment. Failure to comply will result in an electric shock.
⚠ WARNING • Perform a trial run after wiring and parameter setting to ensure the equipment operates safely. Failure to comply may result in personal injuries or equipment damage. • Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire. • Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.
Operation
⚠ DANGER • The equipment must be operated only by professionals. Failure to comply will result in death or personal injuries. • Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply will result in an electric shock.
⚠ WARNING • Do not touch the equipment casing, fan, or resistor with bare hands to feel the temperature. Failure to comply may result in personal injuries. • Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.
Maintenance
⚠ DANGER • Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not maintain the equipment with power ON. Failure to comply will result in an electric shock. • Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label. • In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will result in an electric shock.

WARNING

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

Repair

DANGER

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

WARNING

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

Disposal

WARNING

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

Cautions for the dynamic brake

- Dynamic braking can only be used for emergency stop in case of failure and sudden power failure. Do not trigger failure or power failure frequently.
- Ensure that the dynamic braking function has an operation interval of more than 5 minutes at high speed, otherwise the internal dynamic braking circuit may be damaged.
- Dynamic braking is common in rotating mechanical structures. For example, when a motor has stopped running, it keeps rotating due to the inertia of its load. In this

case, this motor is in the regenerative state and short-circuit current passes through the dynamic brake. If this situation continues, the drive, and even the motor, may be burned.

Safety label

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

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

1 List of Parameters

Functions of the servo drive are listed below. See details in corresponding chapters.

Function		Description	Reference
Selection table		Servo motors, DDL motors, DDR motors, and third-party motors supported by the SV680-INT drive.	*SV680-INT series flagship servo drive*
Second encoder		ABZ incremental encoder, Inovance communication encoder, BiSS-C encoder, SSI encoder and EnDat 2.2 encoder.	-
High-resolution encoder		The servo drive supports a high-performance encoder with resolution up to 2^{26} (67108864) PPR.	-
AI, AO		Supports AI and AO.	-
Built-in brake		Used to monitor the brake status in real time.	*SV680-INT Series Servo Drive Hardware Guide*
External braking resistor		Used in case of insufficient braking capacity of the built-in braking resistor.	*SV680-INT Series Servo Drive Hardware Guide*
Electronic gear ratio		Decreasing or increasing the pulse input by: 0.001–4000 x encoder resolution/10000.	*SV680-INT Series Servo Drive Hardware Guide*
Status display		Used to display the drive status through the LED on the keypad.	*SV680-INT Series Servo Drive Quick Installation and Commissioning*
External I/O display		Used to display ON/OFF status of external I/O signals.	-
Inertia Auto-tuning	Offline	The servo drive calculates the load inertia ratio automatically through inertia auto-tuning.	*"2.3.1 Offline Inertia Auto-tuning" on page 27*
	Online	The host controller sends a command to make the motor rotate, and the servo drive calculates the load inertia ratio in real time.	*"2.3.2 Online Inertia Auto-tuning" on page 30*
Auto Gain Tuning	STune and ETune.	The servo drive generates a group of gain parameters based on the correct inertia ratio.	*" Auto Gain Tuning" on page 32*

Function		Description	Reference
Manual Gain Tuning	Basic gains	If the auto-tuned gain values fail to deliver desired performance, fine-tune the gains manually to improve the performance.	"2.5.1 Basic Parameters" on page 47
	Gain Switchover	Used to apply different gains to different status (operating or stop) of the motor. Gains can also be switched by external terminals during operation.	"2.5.2 Gain Switchover" on page 50
	Reference filter	Smoothens the position, speed, and torque references.	"2.5.3 Position Reference Filter" on page 56
	Feedforward gain	Improves the follow-up behavior.	"2.5.4 Feedforward gain" on page 56
	PDFF Control	Adjusts the speed loop control mode to improve the anti-interference capability at low frequency range.	"2.5.5 PDFF Control" on page 59
	Torque disturbance observer	Improves the resistance against torque disturbance.	"2.5.6 Torque disturbance observer" on page 61
	Speed Observer	The speed observer, which facilitates quick positioning, applies in applications with slight load characteristic change and constant inertia.	"2.5.7 Speed Observer" on page 62
	Model Tracking	The model tracking can be used to improve responsiveness and shorten the positioning time. It is only available in the position control mode.	"2.5.8 Model Tracking" on page 64
	Friction Compensation	Friction compensation is used to provide positive/negative compensation values according to the direction of operation. Friction compensation is valid only in the position control mode.	"2.5.9 Friction Compensation" on page 67
	Encoder Scale Ripple Suppression	It avoids the operation noise caused by the position for speed ripple in the control loop, and suppresses the output ripple caused by controlled speed ripple.	"2.5.10 Encoder Scale Ripple Suppression" on page 68
	Motor Cogging Torque Ripple Compensation	It ensures the stability margin of the system and reduce the speed fluctuation.	"2.5.11 Motor Cogging Torque Ripple Compensation" on page 71
Parameter Adjustment in Different Control Modes	Parameter adjustment in speed/torque/position mode	-	"2.5.2 Gain Switchover" on page 50
Vibration suppression	Mechanical Resonance Suppression	It enables the notch to suppress the mechanical resonance that may be generated when the response speed is excessively high.	"2.7.1 Mechanical Resonance Suppression" on page 77
	Low-Frequency Resonance Suppression at the Mechanical End	Activate the filter used to suppress low-frequency resonance.	"2.7.2 Low-Frequency Resonance Suppression at the Mechanical End" on page 83

<table>
<tr><th colspan="2">Function</th><th>Description</th><th>Reference</th></tr>
<tr><td colspan="2">Mechanical Characteristic Analysis</td><td>Used to analyze the resonance frequency and characteristics of the mechanical system through a PC installed with Inovance software tool.</td><td>"2.8 Mechanical Characteristic Analysis" on page 86</td></tr>
<tr><td colspan="2">High-performance Tuning</td><td>High performance tuning is an upgraded function of mechanical characteristic analysis, which can not only judge the mechanical resonance point and system bandwidth, but also simulate the influence of adding filters and adjusting parameters on loop control.</td><td>"2.9 High-performance Tuning" on page 87</td></tr>
<tr><td colspan="2">Profile Position Mode (PP)</td><td>The host controller sets parameters through the bus, and the servo drive generates position references and performs positioning control.</td><td>" Profile Position Mode (PP)" on page 122</td></tr>
<tr><td colspan="2">Profile Velocity Mode (PV)</td><td>The host controller sets parameters through the bus, and the servo drive generates speed references and performs speed control.</td><td>" Profile Velocity Mode (PV)" on page 132</td></tr>
<tr><td colspan="2">Profile Torque Mode (PT)</td><td>The host controller sets parameters through the bus, and the servo drive generates torque references and performs torque control.</td><td>" Profile Torque Mode (PT)" on page 137</td></tr>
<tr><td colspan="2">Homing Mode (HM)</td><td>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.</td><td>" Homing Mode (HM)" on page 145</td></tr>
<tr><td colspan="2">Process Segment Mode</td><td>It enables the servo drive to perform positioning control, constant speed control and parameter writing operations according to servo self-planning commands and process segment setting commands.</td><td>" Process Segment Mode" on page 101</td></tr>
<tr><td colspan="2">Position Control Mode</td><td>Used to make the servo drive operate in the position control mode.
Note: Model N only supports multi-position.</td><td>" Position Control Mode" on page 175</td></tr>
<tr><td colspan="2">Speed Control Mode</td><td>Used to make the servo drive operate in the speed control mode.</td><td>" Speed Control Mode" on page 240</td></tr>
<tr><td colspan="2">Torque Control Mode</td><td>Used to make the servo drive operate in the torque control mode.</td><td>" Torque Control Mode" on page 266</td></tr>
<tr><td rowspan="4">Mixed Control Mode [P]</td><td>Position/Speed Control Switchover Mode [P]</td><td>Used to switch between position control and speed control through external input signals.</td><td rowspan="4">"4.1 Mixed Control Mode" on page 294</td></tr>
<tr><td>Speed/Torque Control Switchover Mode [P]</td><td>Used to switch between speed control and torque control through external input signals.</td></tr>
<tr><td>Torque/Position Control Switchover Mode [P]</td><td>Used to switch between torque control and position control through external input signals.</td></tr>
<tr><td>Torque/Speed/ Position Control Switchover Mode [P]</td><td>Used to switch among torque control, speed control and position control through external input signals.</td></tr>
</table>

Function	Description	Reference
Interpolated Position (IP) Mode [P]	The interpolation mode can be used to achieve synchronous operations of multi-axis servo drives or single-axis servo drives.	*" Interpolation Mode (IP)" on page 295*
Cyclic Synchronous Position Mode (CSP) [N]	The host controller generates position references and sends the references cyclically through the bus. The servo drive performs positioning control.	*" Cyclic Synchronous Position Mode (CSP)" on page 323*
Cyclic Synchronous Velocity Mode (CSV) [N]	The host controller generates speed references and sends the references cyclically through the bus. The servo drive performs speed control.	*" Cyclic Synchronous Velocity Mode (CSV)" on page 327*
Cyclic Synchronous Torque Mode (CST) [N]	The host controller generates torque references and sends the references cyclically through the bus. The servo drive performs torque control.	*" Profile Position Mode (PP)" on page 122*
Position Reference Filter	Used to achieve smooth acceleration and deceleration.	*"3.9.4 Position reference filter" on page 206*
Interrupt positioning	Used to interrupt present position reference and execute the set displacement.	*"3.9.8 Interrupt Positioning" on page 219*
Frequency-Division Output	Used to output the position reference pulses or the position pulses fed back by the encoder in the form of phase A/phase B quadrature pulses.	*"3.9.6 Frequency-division Output" on page 208*
Homing	Used to search for the mechanical home automatically to locate the relative position between the mechanical home and mechanical zero	*"3.9.9 Homing" on page 222*
Zero Clamp	Used to keep the motor speed below a certain value in the speed control mode to lock the position.	*"3.10.4 Zero Clamp" on page 258*
DI signal assignment	Used to assign functions such as S-ON to corresponding pins.	-
Forced DO	Used to output signals not related to the drive status forcibly or used to check the wiring of output signals.	*"6.8 Communication-forced DO [P]" on page 359* and *"6.9 EtherCAT-forced DO [N]" on page 360*
Touch Probe	It is the same as the position latch function.	*"6.12 Touch Probe" on page 376*
Black box	The black box function is used to capture and save the data generated upon occurrence of faults or under designated conditions.	*"6.11 Black Box" on page 371*
SEMI F47 Voltage Drop	With combination of this function and H0A.84 (instantaneous power outage holding time), the drive can continue to run when the power supply voltage decreases.	*"6.13 SEMI F47 Voltage Drop" on page 381*
Accuracy Compensation	It compensates and corrects the physical accuracy of the motor. It is only available for DDL and DDR motors.	*"6.14.1 Function" on page 385*

Function	Description	Reference
Gantry synchronization	Used to achieve synchronization of two axes.	"6.15.1 Gantry Synchronization" on page 410
Position comparison output	Used to output a DO signal with designated pulse width after the drive reaches the preset target position.	"6.10 Position Comparison" on page 361
STO function	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start.	" STO" on page 431

2 Adjustment

2.1 Overview

The servo drive must drive the motor as quick and accurate as possible to follow the commands from the host controller or internal setting. Gain adjustment needs to be performed to meet such requirement.

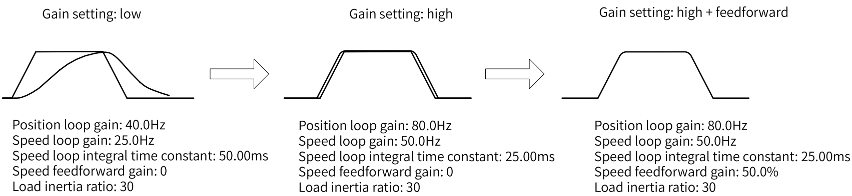


Figure 2-1 Example of gain tuning

The gain is defined by a combination of multiple parameters that affect each other. Such parameters include the position loop gain, speed loop gain, filter and load moment of inertia ratio. The values of these parameters must be balanced against each other during gain tuning.

Note

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

The following figure shows the general flowchart for gain tuning.

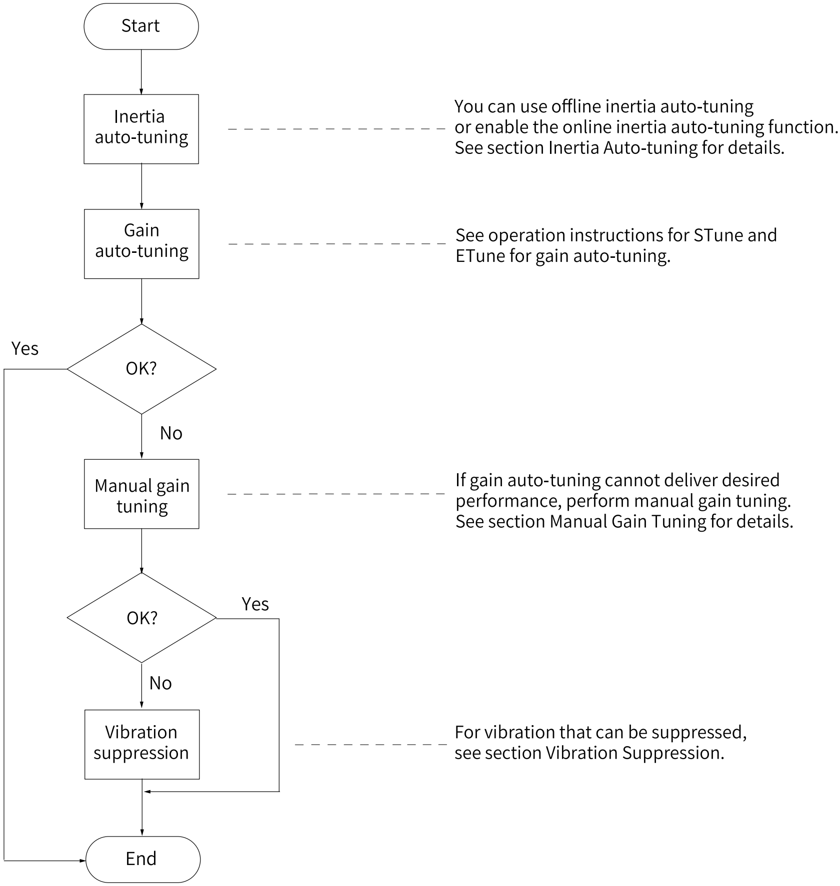


Figure 2-2 Steps

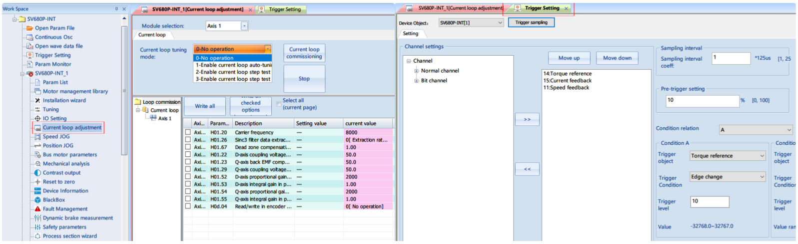
2.2 Current Loop Adjustment

Current loop parameter adjustment

As the innermost loop of the servo control system, the response and stability of the current loop play a vital role in the performance of the whole system.

To facilitate users to quickly commission the gain parameters of the current loop and ensure the high bandwidth and fast response of the current loop, the current loop adjustment control is provided in InoDriverShop.

This module integrates the **Current Loop Adjustment** window" and the **Trigger Setting Observation** window. The window functions are interrelated. After you select the commissioning mode and click Start, the drive completes the relevant test adjustment by itself, and the **Trigger Setting** window also collects the relevant waveforms synchronously.

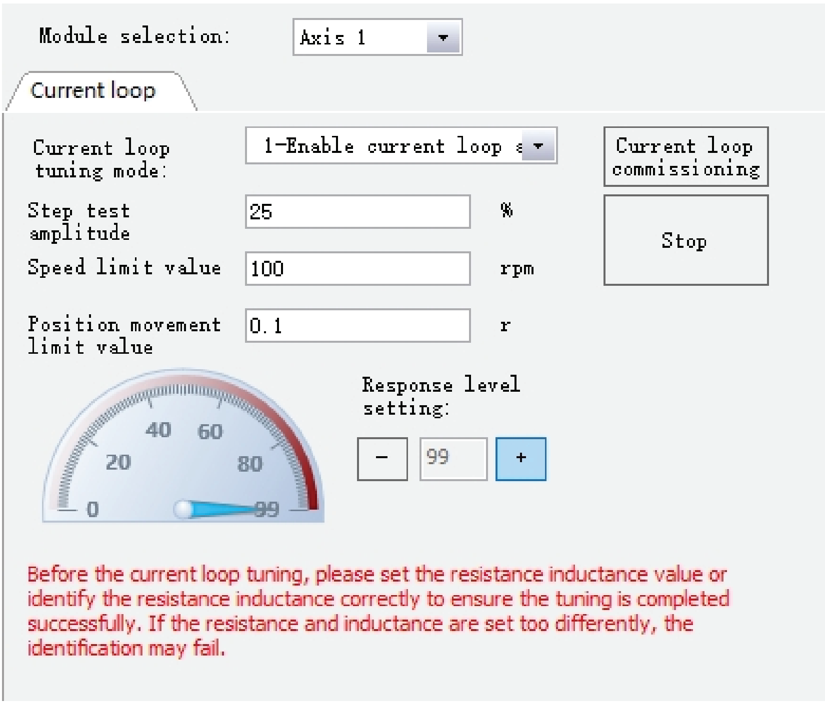


Current loop tuning provides three modes, which are described below.

1. **Current loop auto-tuning**

   This mode provides a static way to automatically tune the current loop. After starting, the drive can adjust the related gain parameters of the current loop by itself.

   You can set the response level. The larger the response level, the stronger the responsiveness and the higher the bandwidth of the final adjusted current loop.



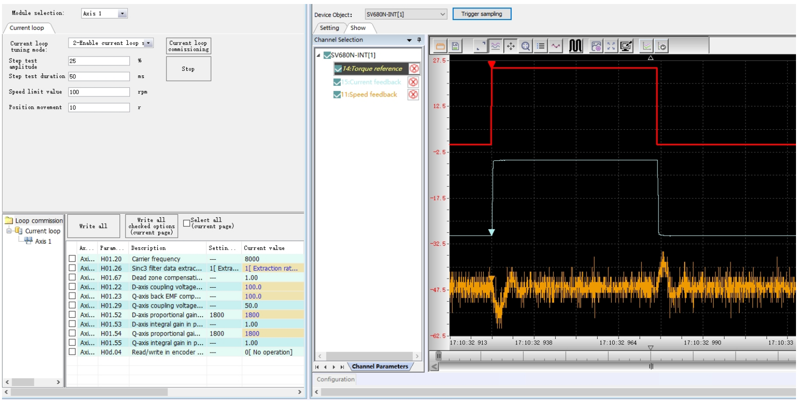
Note

Over-high current loop response may also excite current loop control noise. In actual use, you should set the response level as needed to obtain the balance between current loop responsiveness and noise.

Related parameters	Description
Auto-tuning step test amplitude	Auto-tuning excitation signal amplitude
Speed limit value	The maximum speed that can be achieved by stable current excitation
Position movement limit value	Maximum distance that can be achieved by stable current excitation
Response level setting	Expected current loop response level setting

2. **Static step test**

This mode provides a static current loop step response observation mode, which enables you to manually adjust the related current loop gain parameters and then observe and verify the current loop response.



Related parameters	Description
Static step test amplitude	Step excitation signal amplitude
Step test duration	Step excitation signal duration
Speed limit value	The maximum speed that can be achieved by stable current excitation
Position movement limit value	Maximum distance that can be achieved by stable current excitation

3. **Step test**

This mode provides a dynamic current loop step response observation mode, which is used in the same way as static step test. You can use this mode to manually adjust the relevant current loop gain parameters and then observe and verify the current loop response.

Note

In this mode, the motor will move a certain distance. You can restrict the movement by setting the speed limit value and the position movement limit value.

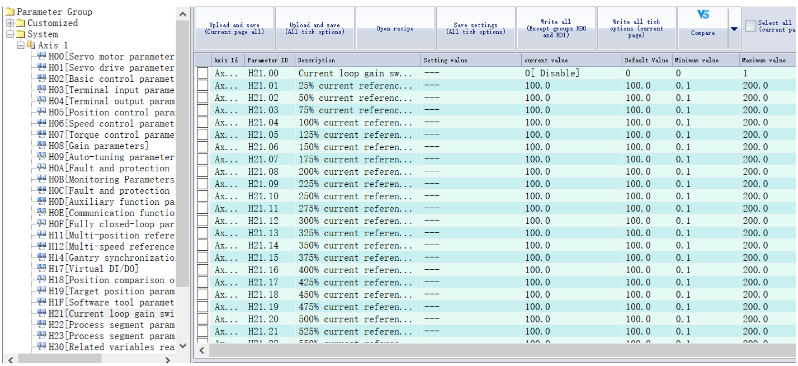
Current loop gain switching

Current loop gain switching is an advanced and supplementary mode of current loop commissioning. With this mode, you can cope with the current loop response deterioration or instability caused by the difference of inductance saturation characteristics of some motors.

When the controlled motor has inductance saturation characteristics in the normal working range, because the current loop gain is usually theoretically calculated and matched through inductance parameters, the large difference of inductance saturation may lead to poor or unstable current loop response under a single set of gains, and you can use the current loop gain switching to adjust it.

The SV680-INT provides 32 current loop gain switching coefficients which are not enabled by default. You can enable and use them as needed.

- Theoretically, the gain switching coefficients under different loads can be obtained directly from the inductance saturation characteristic curve provided by the motor manufacturer.
- In practical application, the gain coefficient can be adjusted manually according to the actual effect under different load rates.



2.3 Inertia Auto-tuning

The load inertia ratio (H08.15) is calculated through the following formula:

$$\text{Load inertia ratio} = \frac{\text{Total mechnical load moment of inertia}}{\text{Motor moment of inertia}}$$

The inertia ratio is an important parameter of the servo system, and quick commissioning can be implemented with the correct setting of this parameter.

You can set the load inertia ratio manually or get the inertia ratio through inertia auto-tuning.

The following two inertia auto-tuning modes are available:

- Offline Inertia Auto-tuning
  To enable offline inertia auto-tuning, use H0d.02 (Offline inertia auto-tuning) and make the motor rotate and execute inertia auto-tuning through the keypad. Offline inertia auto-tuning does not involve the host controller
- Online Inertia Auto-tuning
  Send a command to the servo drive through the host controller to make motor act accordingly to finish inertia auto-tuning. Online inertia auto-tuning involves the host controller.

Note

The following requirements must be met to ensure correct calculation of the inertia ratio:

- The actual maximum speed of the motor is higher than 150 rpm.
- The acceleration rate during acceleration/deceleration of the motor is higher than 3000 rpm/s.
- The load torque is stable without dramatic changes.
- The actual inertia ratio does not exceed 120.
- Inertia auto-tuning may fail in case of a large backlash of the transmission mechanism.

2.3.1 Offline Inertia Auto-tuning

Check the following before performing offline inertia auto-tuning:

The motor must meet the following requirements:

- A travel distance of more than one revolutions in the forward/reverse direction is available between the mechanical limit switches.

Danger

Ensure limit switches are installed to the machine and a travel distance as described above is reserved to prevent overtravel during inertia auto-tuning.

- The required number of revolutions (H09.09) is fulfilled.
  View the values 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 revolutions per inertia auto-tuning) to ensure the travel distance that starts from the stop position is larger than the value of H09.09. Otherwise, decrease the value of H09.06 or H09.07 until this requirement is met.

To preform offline inertia auto-tuning:

1. Switch off the S-ON signal.
2. In parameter display mode, switch to H0d.02 and press SET to enable offline inertia auto-tuning.
3. Press the UP/DOWN key to perform offline inertia auto-tuning.
4. To make the motor stop at zero speed, release the UP/DOWN key. Pressing the UP/DOWN key again starts a new inertia auto-tuning. The initial direction of operation is determined by the UP/DOWN key. For applications allowing unidirectional operations only, set H09.05 to 1.
5. Wait until the value displayed on the keypad is stabilized.
6. Hold the SET key down until the operating panel displays "SAVE".
7. Press the MODE key to exit.

For applications requiring large load inertia, set H08.15 (Load moment of inertia) to the approximate value, preventing intense system vibration caused by a low initial inertia.

The offline inertia auto-tuning flowchart is shown as follows.

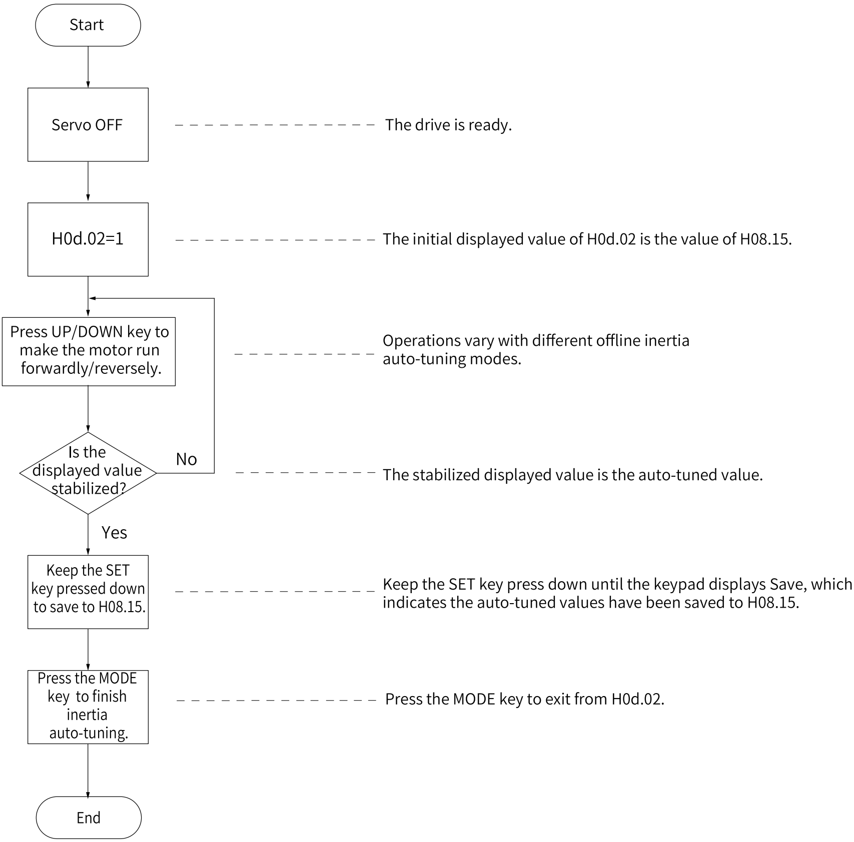


Figure 2-3 Offline inertia auto-tuning flowchart

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.05	2009-06h	Offline inertia auto-tuning mode	0: Bi-directional 1: Unidirectional	0	-	At stop
H09.06	2009-07h	Max. speed of inertia auto-tuning	100[mm/s]/[rpm]–1000[mm/s]/[rpm]	500	[mm/s]/[rpm]	At stop
H09.07	2009-08h	Time constant for accelerating to max. speed during inertia auto-tuning	10 ms–5000 ms	125	ms	At stop

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.08	2009-09h	Interval time after an individual inertia auto-tuning	50 ms–10000 ms	800	ms	At stop
H09.09	2009-0Ah	Motor rotating distance per inertia auto-tuning	0.00[mm]/[Rev]–100.00[mm]/[Rev]	1.00	[mm]/[Rev]	Real-time
H0d.02	200d-03h	Inertia auto-tuning enable	0–65	0	-	Real-time

2.3.2 Online Inertia Auto-tuning

The servo drive supports online inertia auto-tuning. The online inertia auto-tuning flowchart is shown as follows.

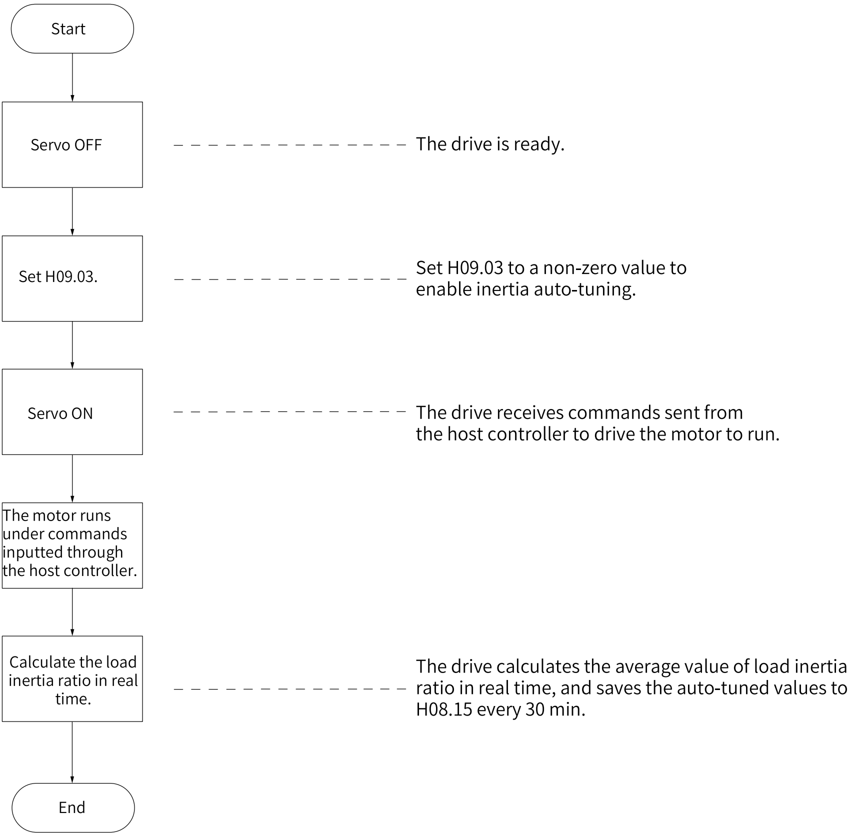


Figure 2-4 Online inertia auto-tuning flowchart

Note

H09.03 defines the real-time updating speed of the load inertia ratio (H08.15).

- H09.03 = 1: Applicable to cases where the actual load inertia ratio rarely changes, such as the machine tool and wood carving machine.
- H09.03 = 2: Applicable to cases where the load inertia ratio changes slowly.
- H09.03 = 3: Applicable to cases where the actual inertia ratio changes rapidly, such as handling manipulators.

☆Related parameter

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.03	2009-04h	Online inertia auto-tuning mode	0: Disabled 1: Enabled, changing slowly 2: Enabled, changing normally 3: Enabled, changing quickly	0	-	Real-time

2.4 Auto Gain Tuning

2.4.1 STune

Overview

STune performs gain auto-tuning based on the set stiffness level to fulfill the needs for rapidity and stability.

STune (mode 4) is turned on by default and will be turned off automatically after the drive operates as commanded for 5 min.

STune is intended to be used in applications featuring slight load inertia change. For applications featuring dramatic inertia change or where inertia auto-tuning is unavailable (due to low operating speed or low acceleration rate), turn off STune after initial power-on.

Note

In STune modes 3, 4, 5, 6 and 9, you need to perform load inertia auto-tuning through online inertia auto-tuning and ensure the following conditions are met:

- The load inertia changes quickly.
- The load torque changes quickly.
- Low-speed operation (less than 100 rpm for ROT, less than 20 rpm for DDR, and less than 20 mm/s for DDL).
- Acceleration/Deceleration is slow (lower than 1000 rpm per second).
- The acceleration/deceleration torque is lower than the unbalanced load/viscous friction torque.

If the conditions for online inertia auto-tuning cannot be fulfilled, set the correct inertia ratio manually.

Description of ITune operation

- **Operation flowchart**

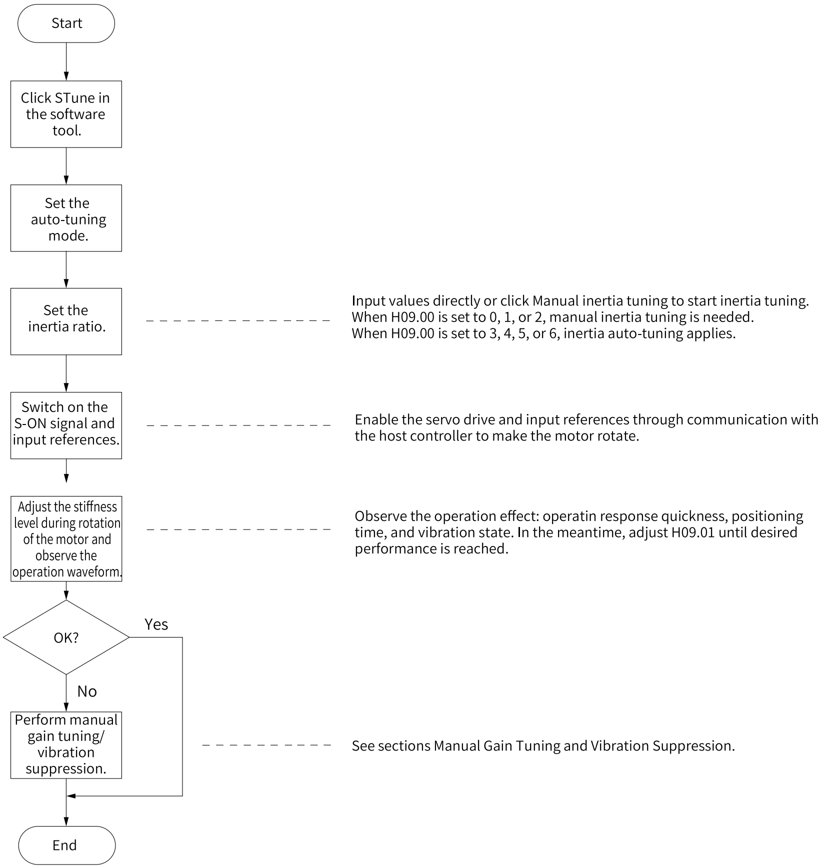


Figure 2-5 Operation flowchart

- **Description**

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

  1. Select the gain auto-tuning mode.

     - In modes 0, 1 and 2 shown in the following table, you need to set the inertia ratio before stiffness tuning. If the inertia is unknown, adjust the inertia manually. If vibration occurs on the machine, decrease the stiffness level before adjusting the inertia manually.
     - In modes 3, 4, 5, 6 and 9 shown in the following table, you can perform adjustment through the wizard-type interface directly, without the need for setting an inertia ratio.

Mode	Name	Function
0	Inactive	The gains need to be adjusted manually.
1	Standard stiffness level mode	Gains are set automatically based on the set stiffness level.
2	Positioning mode	Gains are set automatically based on the set stiffness level. This mode is applicable to occasions requiring quick positioning.
3	Interpolation mode + Inertia auto-tuning	Gains are set automatically based on the set stiffness level. In this mode, inertia is auto-tuned and vibration is suppressed automatically. This mode is applicable to multi-axis interpolation.
4	Normal mode + Inertia auto-tuning	Gains are set automatically based on the set stiffness level. The inertia is auto-tuned and vibration is suppressed automatically.
5	STune mode 5	Gains are set automatically based on the set stiffness level. Inertia is auto-tuned and vibration is suppressed automatically. This mode is applicable to linear motors.
6	Quick positioning mode + Inertia auto-tuning	Gains are set automatically based on the set stiffness level. Inertia is auto-tuned and vibration is suppressed automatically. This mode is applicable to occasions requiring quick positioning.
9	Model tracking B + Inertia auto-tuning + Friction compensation	Gains are set automatically based on the set stiffness level. Automatic Inertia auto-tuning, vibration suppression and friction compensation coefficient setting. This mode is applicable to occasions requiring quick positioning.

2. Adjust the stiffness level gradually during operation of the load. The present stiffness level value will be written to the drive automatically. Keep monitoring the operating waveform after increasing the stiffness level (increase by one level at a time) until desired performance is achieved.
3. In STune modes 3, 4, 5, 6 and 9, when the speed keeps higher than 100 r/min for more than 5 min, H09.00 returns to 0 automatically. In this case, the drive will exit from the STune mode.

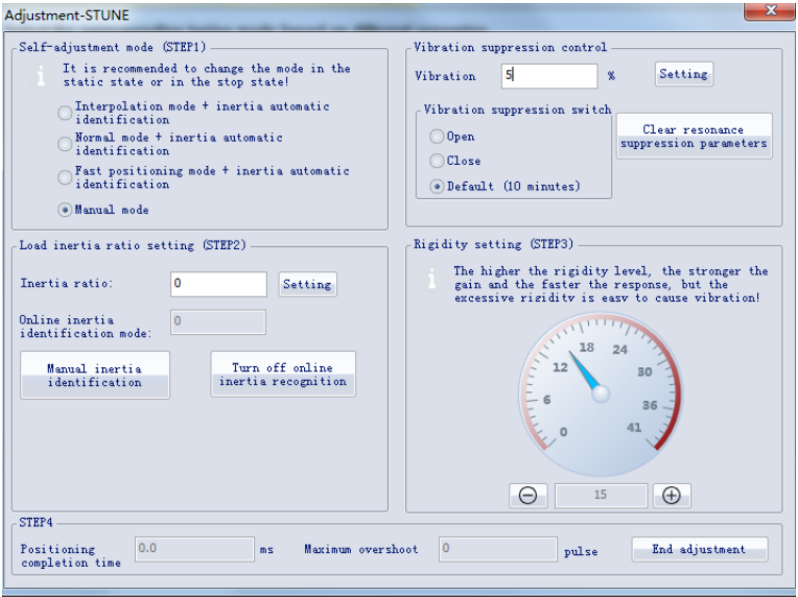
   After tuning, you can set H09.00 to 0 to exit the STune mode.

   To modify the STune time, set H09.37.
4. In STune modes 3, 4, 5, 6 and 9, resonance will be suppressed automatically. If the performance of automatic resonance suppression is inadequate, set H09.58 to 1 to clear resonance suppression parameters, reduce the stiffness level, and perform STune again.

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

   In STune modes 3, 4 and 5, determine the minimum value of H08.02 (Position loop gain). Then set H09.00 of each axis to 0 and set H08.02 of each axis to the same value.

   In STune modes 6 and 9, determine the minimum value of H08.43 (Model gain). Then set H09.00 of each axis to 0, and set H08.43 of each axis to the same value.



Note

To ensure a stable operation of STune modes 3, 4 and 5, gain parameters will be adjusted along with the inertia ratio when the inertia ratio is higher than 13. In multi-axis trajectories, responses may be inconsistent under the same stiffness level.

Remarks

Load inertia ratio range

- In scenarios requiring high response, the inertia ratio must be lower than 500% and should not exceed 1000%.

  - For belt pulley or gear rack requiring not high rigidity and accuracy, the inertia ratio should not exceed 1000%.
  - For lead screw or cardan shaft requiring high rigidity and accuracy, the inertia ratio should not exceed 500%.
  - In scenarios where high positioning accuracy or response is required, the inertia ratio should not exceed 200%.
- In scenarios requiring a certain accuracy and dynamic response, the inertia ratio should not exceed 3000%.
- When the inertia ratio exceeds 3000%, it is hard to adjust and the trajectory control cannot be performed. It is only applicable to mechanisms for point-to-point control and rotary motion but the acceleration/deceleration time should be large.

Rigidity meter setting

The setting range of H09.01 (Stiffness level selection) is 0–41. 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 for your reference.

Table 2–1 Reference of stiffness levels

Recommended Stiffness Level	Load Mechanisms
Level 8 to level 12	Large-scale machineries
Level 12 to level 18	Applications with low stiffness such as the conveyors
Above level 18	Applications with high stiffness such as the ball screws and direct-connected motors

The following 7 gain auto-tuning modes are available.

- Standard rigidity meter mode (H09.00 set to 1)
  The 1st gain parameters (H08.00 to H08.02 and H07.05) are automatically updated and saved based on the rigidity level set in H09.01.

Table 2–2 Parameters updated automatically in the standard mode

Parameter	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)
  Based on *"Table 2–2 " on page 36*, the 2nd gain parameters (H08.03 to H08.05 and H07.06) are also automatically updated and saved based on the rigidity level set in

H09.01. In addition, the position loop gain in the 2nd gain parameters has a higher rigidity level than that in the 1st gain parameters.

Table 2–3 Parameters updated automatically in the positioning mode

Parameter	Name	Description
H08.03	2nd speed loop gain	-
H08.04	2nd speed loop integral time constant	If H08.04 is set to remain at 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	2nd torque reference filter time constant	-

Values of speed feedforward parameters are fixed.

Table 2–4 Parameters with fixed values in the positioning mode

Parameter	Name
H08.19	Speed feedforward gain
H08.18	Speed feedforward filter time constant

Values of gain switchover parameters are fixed.

Gain switchover is activated automatically in the positioning mode.

Parameter	Name	Value	Description
H08.08	2nd gain mode setting	1	Switchover between the 1st gain set (H08.00...H08.02, H07.05) and 2nd gain set (H08.03...H08.05, H07.06) is active in the positioning mode. In other modes, the original setting is used.
H08.09	Gain switchover condition	10	In positioning mode, the gain switchover condition is that H08.09 is set to 10. In other modes, the original setting is used.
H08.10	Gain switchover delay	5.0ms	In positioning mode, the gain switchover delay is 5.0 ms. In other modes, the original setting is used.
H08.11	Gain switchover level	50	In the positioning mode, the gain switchover level is 50. In other modes, the original setting is used.
H08.12	Gain switchover hysteresis	30	In the positioning mode, the gain switchover dead time is 30. In other modes, the original setting is used.

Note

In the gain auto-tuning mode, parameters updated along with H09.01 and those with fixed setpoints cannot be modified manually. To modify these parameters, set H09.00 (Gain auto-tuning mode) to 0 first.

- In STune mode 3, 4, 5, 6, or 9
  resonance suppression will be performed automatically. When the load changes or the mechanical structure is re-installed, the system resonance frequency changes accordingly. Set H09.58 to 1 (Enable) and enable the STune mode again after clearing resonance suppression parameters.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.18	2009-13h	Frequency of the 3rd notch	50 Hz–8000 Hz	8000	Hz	Real-time
H09.19	2009-14h	Width level of the 3rd notch	0–20	2	-	Real-time
H09.20	2009-15h	Depth level of the 3rd notch	0–99	0	-	Real-time
H09.21	2009-16h	Frequency of the 4th notch	50 Hz–8000 Hz	8000	Hz	Real-time
H09.22	2009-17h	Width level of the 4th notch	0–20	2	-	Real-time
H09.23	2009-18h	Depth level of the 4th notch	0–99	0	-	Real-time
H09.58	2009-3Bh	STune resonance suppression reset selection	0: Disabled 1: Enabled	0	-	Real-time

Note

- If H09.00 is set to 3, 4, 5, 6 or 9, the servo drive will suppress the vibration and perform inertia auto-tuning automatically within 10 min (or other time defined by H09-37) after power-on or stiffness level setting, and then the servo drive exits from automatic adjustment. The time can be adjusted by the vibration suppression switch (H09.37). If the inertia auto-tuning function is deactivated automatically, switching to modes 3, 4, 5, 6 or 9 will not activate inertia auto-tuning.
- Do not set H09.00 to 3, 4, 5 or 6 in applications with slow acceleration/ deceleration, large vibration, and unstable mechanical couplings.
- 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).

Solutions to Common Faults

E661.0: STune failure

During STune operation, the gain drops to the lower limit. Position loop gain < 5; velocity loop gain < 5; model loop gain < 10.

- Set the notch manually when vibration cannot be suppressed automatically.
- Modify the electronic gear ratio to improve the command resolution, increase the command filter time constant in the parameter configuration interface.
- Increase the value of H09.11 as appropriate.
- Check whether the current of the machine fluctuates periodically.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.58	2009-3Bh	STune resonance suppression reset selection	0: Disabled 1: Enabled	0	-	Real-time

2.4.2 ETune

Overview

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

The ETune function is intended to be used in applications featuring slight load inertia change.

Description of ITune operation

- **Operation flowchart**

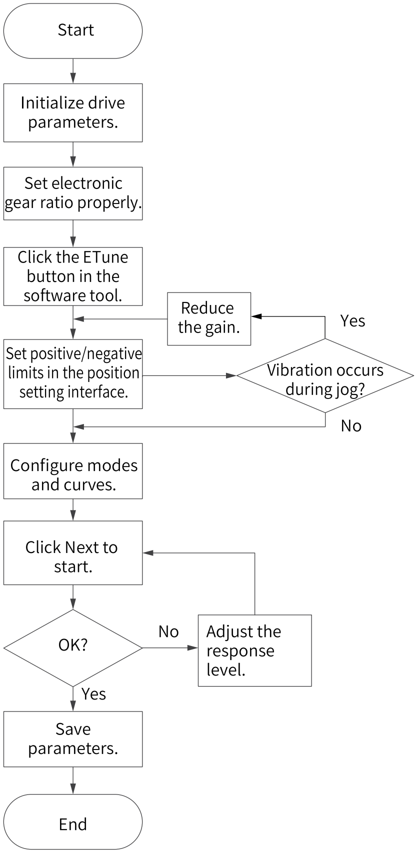
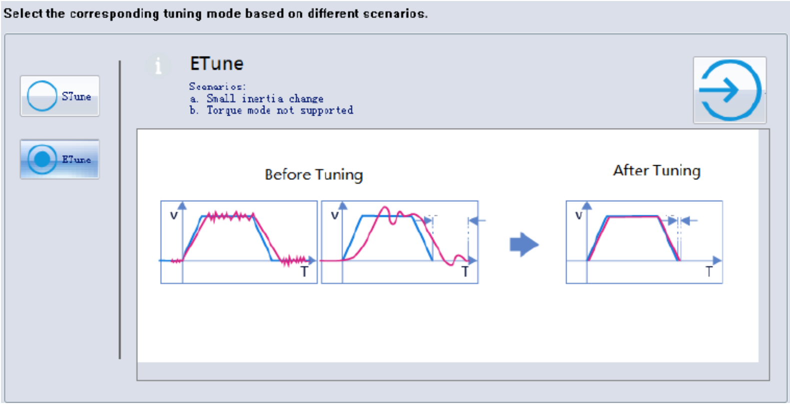


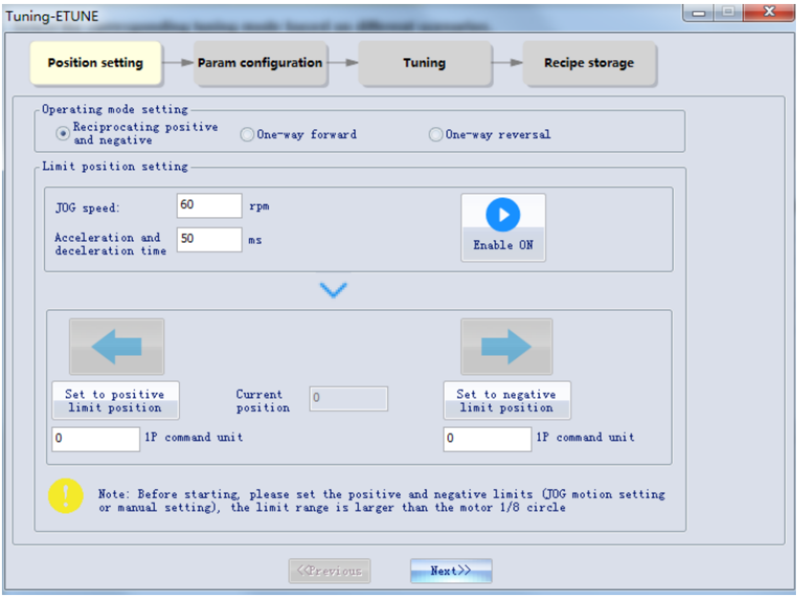
Figure 2-6 Operation flowchart

- **Description**

1. Click Usability adjustment in 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 between the positive and negative position limits as the maximum distance per action and keeps running in the forward direction.
   - In the One-way forward mode, the motor takes the difference between the positive and negative position limits as the maximum distance per action and keeps running in the reverse direction.



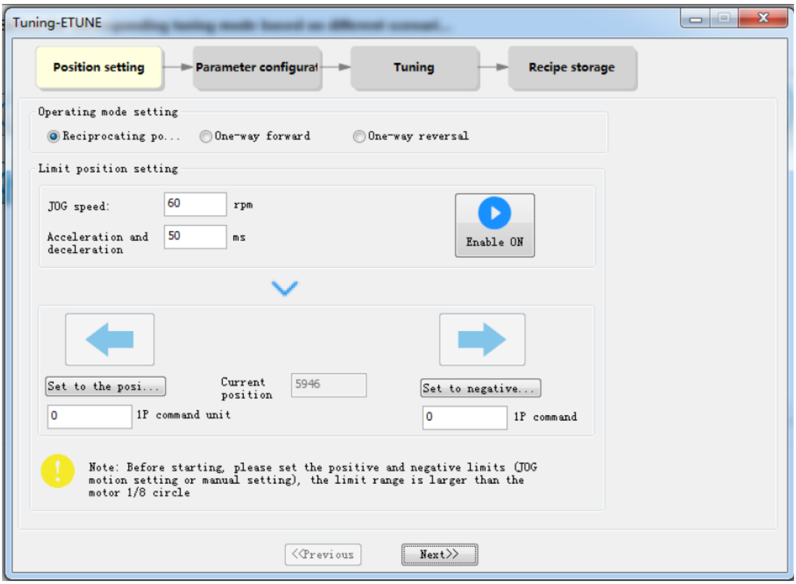
3. Designate the positive and negative limit positions allowed by the motor. The difference between the positive and negative limits defines the position reference pulses for the motor, which is also the value before multiplication/ division by the electronic gear ratio.

   You can set the positive and negative position limits through 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 positive limit position". 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 limits directly.

Note

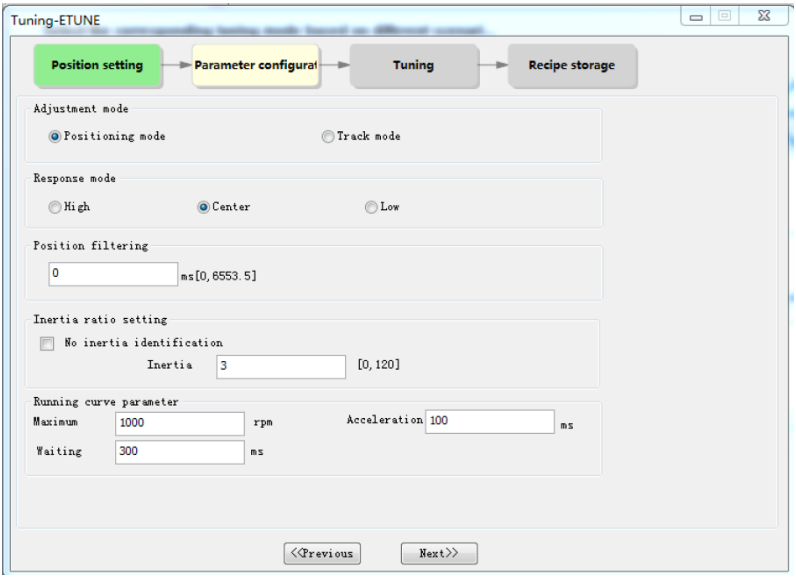
The difference between the positive and negative position limits must be larger than 1/8 of one revolution. The larger the value of the limit position, the better the adaptability of the auto-tuned parameters, but the longer will ETune adjustment take.



4. Click Next to switch to the mode parameter setting interface.

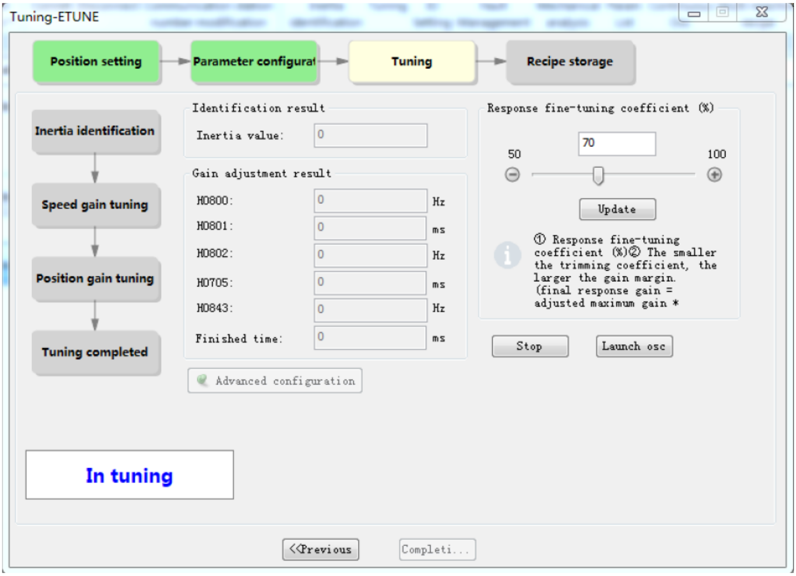
   The adjustment mode is divided into Positioning mode and Track mode.

   Auto-tuning of the inertia ratio is optional. If you choose not to perform inertia auto-tuning, set the correct inertia ratio (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 interval time for auto-tuning.

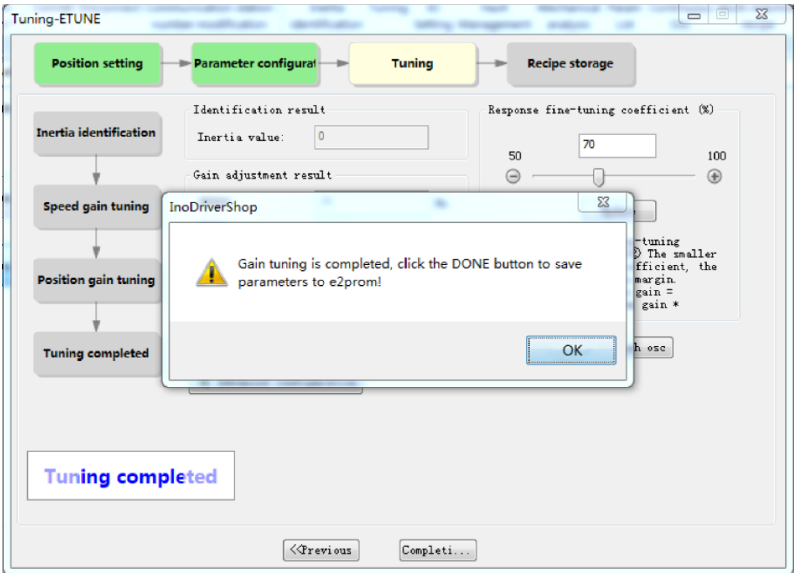


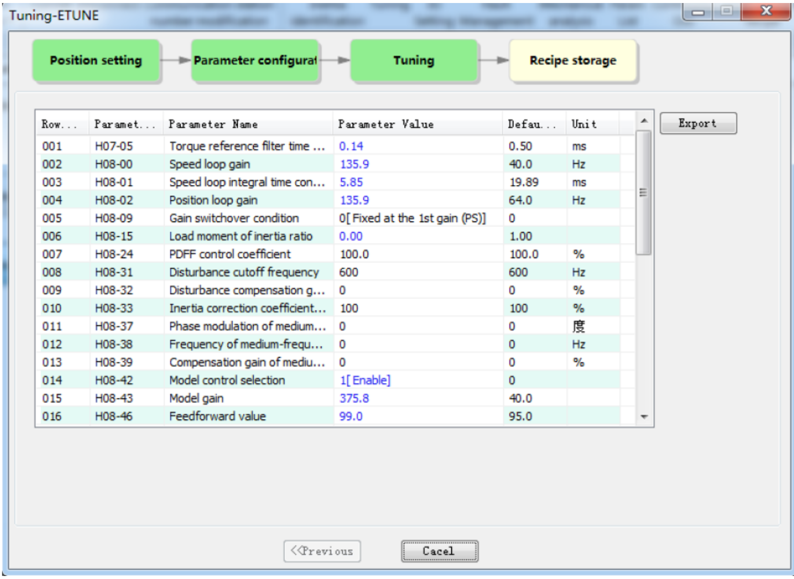
5. Click **"Next"** to start auto-tuning.

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



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





Row...	Paramet...	Parameter Name	Parameter Value	Defau...	Unit
001	H07-05	Torque reference filter time ...	0.14	0.50	ms
002	H08-00	Speed loop gain	135.9	40.0	Hz
003	H08-01	Speed loop integral time con...	5.85	19.89	ms
004	H08-02	Position loop gain	135.9	64.0	Hz
005	H08-09	Gain switchover condition	0[Fixed at the 1st gain (PS)]	0	
006	H08-15	Load moment of inertia ratio	0.00	1.00	
007	H08-24	PDFF control coefficient	100.0	100.0	%
008	H08-31	Disturbance cutoff frequency	600	600	Hz
009	H08-32	Disturbance compensation g...	0	0	%
010	H08-33	Inertia correction coefficient...	100	100	%
011	H08-37	Phase modulation of medium...	0	0	度
012	H08-38	Frequency of medium-frequ...	0	0	Hz
013	H08-39	Compensation gain of mediu...	0	0	%
014	H08-42	Model control selection	1[Enable]	0	
015	H08-43	Model gain	375.8	40.0	
016	H08-46	Feedforward value	99.0	95.0	

Precautions

- You can adjust the maximum speed and acceleration/deceleration time of the motion profile based on actual conditions. The acceleration/deceleration time can be increased properly because positioning will be quickened after auto-tuning.
- If the acceleration/deceleration time is too short, overload may occur. In this case, increase the acceleration/deceleration time properly.
- For vertical axes, take anti-drop measures beforehand and set the stop mode upon fault to "Stop at zero speed".
- For lead screw transmission, shorten the travel distance if the tuning duration is too long.

Solutions to Common Faults

Fault	Cause	Solution
E662.0: ETune failure	Check whether resonance that occurred during ETune operation cannot be suppressed.	• Set the notch manually when vibration cannot be suppressed automatically. • Modify the electronic gear ratio to improve the command resolution, increase the command filter time constant or in the parameter configuration interface. • Increase the value of H09.11 as appropriate. • Check whether the current of the machine fluctuates periodically. • Check whether the positioning threshold is too low. Increase the reference acceleration/deceleration time.
E600.0: Inertia auto-tuning failure	• Continuous vibration occurs during auto-tuning. • The auto-tuned values fluctuate dramatically. • Mechanical couplings of the load are loose or eccentric. • An alarm occurs during auto-tuning and causes interruption. • The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/deceleration time to ensure the motor current is unsaturated. • The position following-up is too poor. That is, the maximum speed of the motor is less than the speed setpoint of the inertia auto-tuning.	• Rectify the fault and perform inertia auto-tuning again. • For vibration that cannot be suppressed, enable vibration suppression. • Ensure mechanical couplings are connected securely. • Increase the maximum operating speed, reduce the acceleration/deceleration time, and shorten the stroke of the lead screw during ETune operation. • Ensure that the speed setpoint is less than the maximum speed of the motor.

2.5 Manual Gain Tuning

2.5.1 Basic Parameters

When gain auto-tuning cannot fulfill the application needs, perform manual gain tuning. to achieve better result.

The servo system consists of 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.

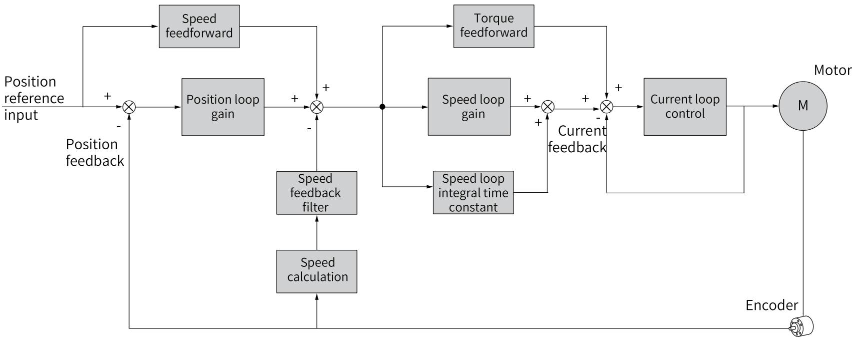


Figure 2-7 Basic control for manual gain tuning

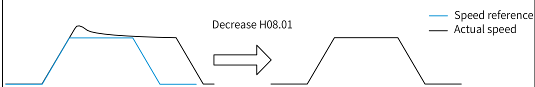
Caution

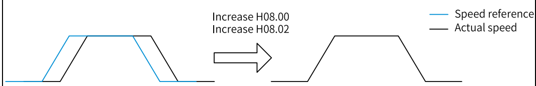
The response level of the inner loop must be higher than that of the outer loop. If it is not observed, the system may be unstable.

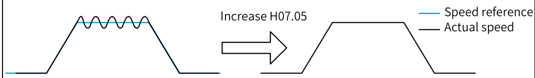
The current loop gain has been set with the highest level of responsiveness by default, avoiding the need for adjustment. you only need to adjust the position loop gain, speed loop gain and other auxiliary gains. When you choose a third party motor, the default current loop gain may not be suitable. You must perform auto-tuning for the current loop gain. For gain tuning in the position control mode, the position loop gain must be increased together with the speed loop gain, and the responsiveness of the former must be lower than the latter.

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

Table 2–5 Adjustment of gain parameters

Step	Parameter	Name	Description
1	H08.00	Speed loop gain	Function: Determines the maximum frequency of a variable speed reference that can be followed by the speed loop. When H08.15 (Load inertia ratio) is set correctly, the maximum frequency that can be followed by the speed loop is the setpoint of H08.00.  Note: • Increasing the setpoint without incurring extra noise or vibration shortens the positioning time, stabilizes the speed, and improves the follow-up behavior. • If noise occurs, decrease the setpoint. • If mechanical vibration occurs, enable mechanical resonance suppression. For details, see *" Vibration suppression" on page 76*.
2	H08.01	Speed loop integral time constant	Function: Eliminates the speed loop deviation.  Note: Set H08.01 according to the following formula: 500 ≤ H08.00 x H08.01 ≤ 1000 For example, if H08.00 is set to 40.0 Hz, the setpoint of H08.01 must meet the following requirement: 12.50 ms ≤ H08.01 ≤ 25.00 ms Decreasing the setpoint strengthens the integral action and shortens the positioning time, but an excessively low setpoint may easily lead to mechanical vibration. An excessively high setpoint prevents the speed loop deviation from being cleared. When H08.01 is set to 512.00 ms, the integral is invalid.

Step	Parameter	Name	Description
3	H08.02	Position loop gain	Function: It sets the position reference maximum frequency followed by the position loop. The maximum follow-up frequency of the position loop equals the value of H08.02.  Note: 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. $3 \leqslant \frac{2 \times \pi \times H08.00}{H08.02} \leqslant 5$ For example, when H08.00 is set to 40.0 Hz, H08.02 must meet the following requirement: 50.2 Hz ⩽ H08.02 ⩽ 83.7 Hz Adjust the setting based on the positioning time. Increasing the setpoint shortens the positioning time and improves the anti-interference capacity of a motor at standstill. An excessively high setpoint may easily lead to system instability and oscillation.

Step	Parameter	Name	Description
4	H07.05	Torque reference filter time constant	Function: Eliminates the high-frequency noise and suppresses mechanical resonance.  Note: 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, as shown in the following formula: $\frac{1000}{2 \times \pi \times H07.05} \geqslant (H08.00) \times 4$ For example, when H08.00 is set to 40.0 Hz, the setpoint of H07.05 must be lower than or equal to 1.00 ms. If vibration occurs after H08.00 is increased, adjust H07.05 to suppress the vibration. For details, see *"Vibration suppression" on page 76*. An excessively high setpoint weakens the responsiveness of the current loop. To suppress vibration upon stop, increase the setpoint of H08.00 and decrease the setpoint of H07.05. If strong vibration occurs upon stop, decrease the setpoint of H07.05.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.05	2007-06h	Torque reference filter time constant 1	0.00 ms–30.00 ms	0.50	ms	Real-time
H08.00	2008-01h	Speed loop gain	0.0 Hz–2000.0 Hz	40.0	Hz	Real-time
H08.01	2008-02h	Speed loop integral time constant	0.15 ms–512.00 ms	19.89	ms	Real-time
H08.02	2008-03h	Position loop gain	0.0 Hz–2000.0 Hz	64.0	Hz	Real-time

2.5.2 Gain Switchover

Gain switchover, which is active in the position control and speed control modes only, It is only effective in position and speed control modes. achieve the following purposes:

- 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 during operation of the motor to achieve better reference tracking performance
- Switching between different gain settings through an external signal to fit different conditions of the load devices

H08.08 = 0

When H08.08 is set to 0, the 1st gain (H08.00 to H08.02 and H07.05) is used, but you can switch between proportional control and proportional integral control through FunIN.3 (GAIN_SEL, gain switchover) for the speed loop.

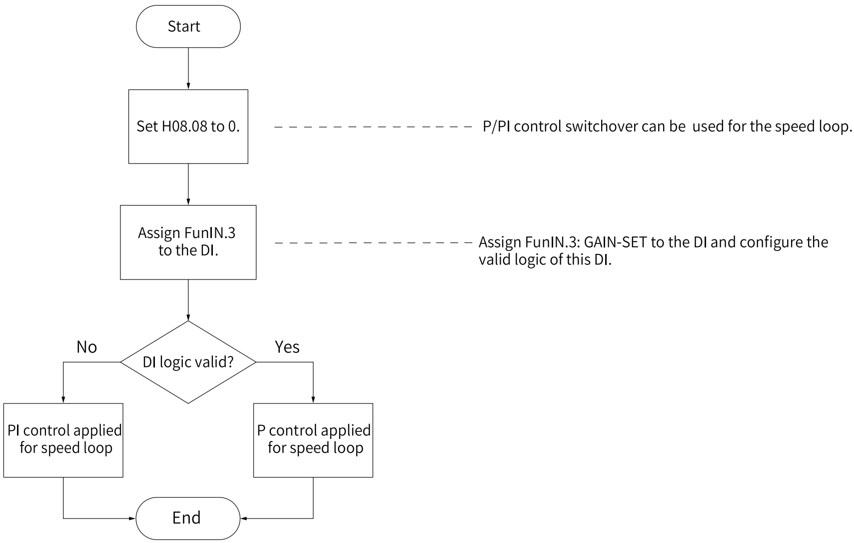


Figure 2-8 Gain switchover flowchart when H08.08 is set to 0

H08.08 = 1

You can switch between the 1st gain set (H08.00...H08.02, H07.05) and 2nd gain set (H08.03...H08.05, H07.06) based on the condition defined by H08.09.

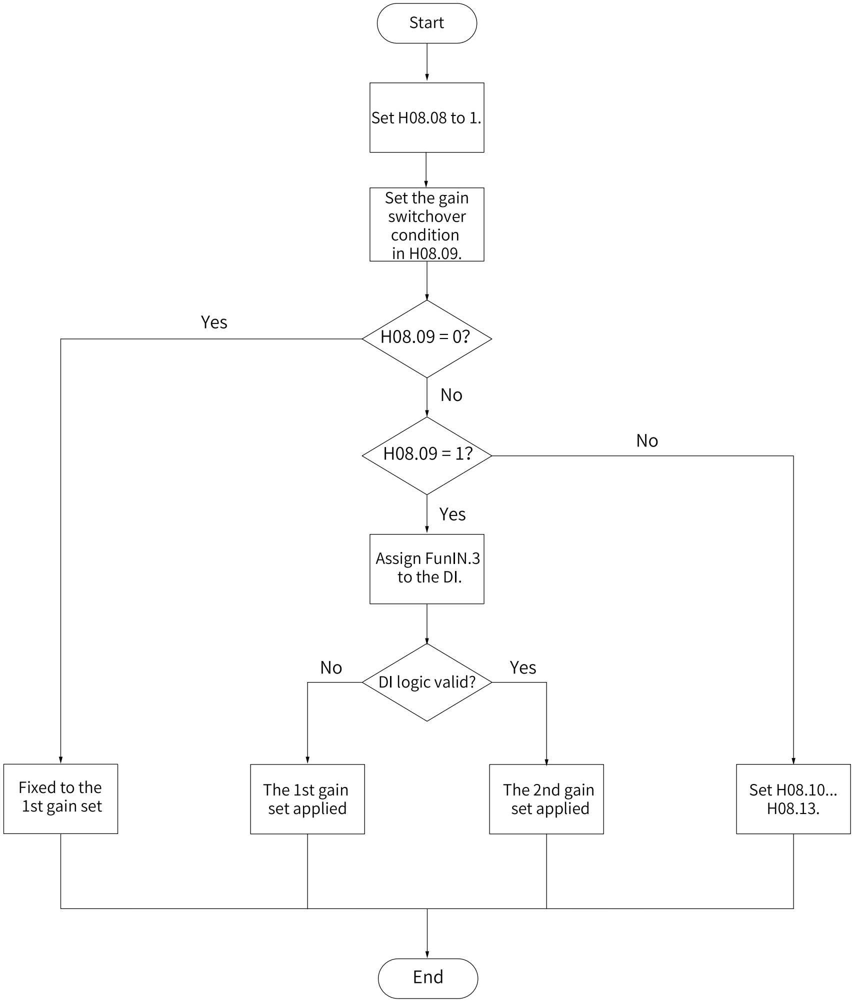
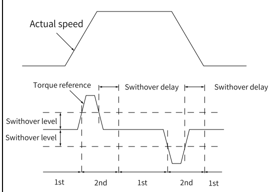
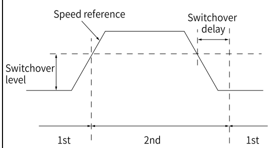
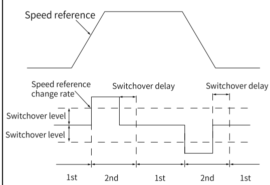
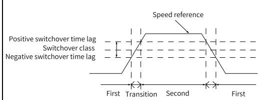
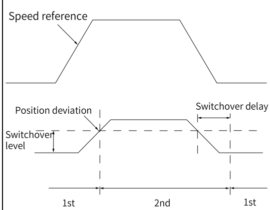
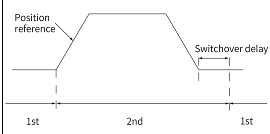
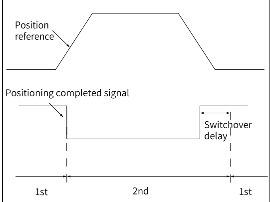
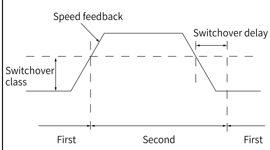


Figure 2-9 Gain switchover flowchart when H08.08 is set to 1

There are 10 2nd gain switchover modes. The following table describes the diagrams and related parameters of different conditions.

Table 2–6 Conditions for gain switchover

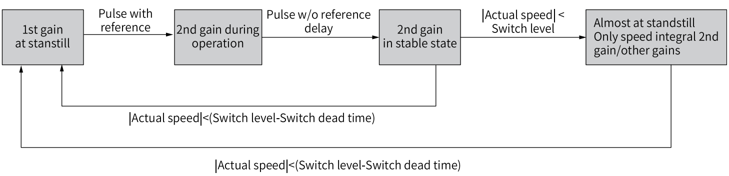
Gain Switchover Condition			Related parameters		
H08.09 Value	Condition	Diagram	Delay Time (H08.10)	Gain switchover level (H08.11)	Switchover Dead Time (H08.12)
0	Fixed to the 1st gain set	-	Inactive	Inactive	Inactive
2	Torque reference		Active	Active (%)	Active (%)
3	Speed reference		Active	Active	Active
4	Speed reference change rate		Active	Active (10 rpm/s)	Inactive (10 rpm/s)
5	Speed reference high/ low-speed threshold		Inactive	Active (rpm)	Active (rpm)
6	Position deviation		Active	Active (encoder unit)	Active (encoder unit)

Gain Switchover Condition			Related parameters		
H08.09 Value	Condition	Diagram	Delay Time (H08.10)	Gain switchover level (H08.11)	Switchover Dead Time (H08.12)
7	Position reference		Active	Inactive	Inactive
8	Positioning uncompleted		Active	Inactive	Inactive
9	Actual speed		Active	Active (rpm)	Active (rpm)
10	Position reference + Actual speed	See the following note for details.	Active	Active (rpm)	Active (rpm)

Caution

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

Note



☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H08.08	2008-09h	2nd gain mode setting	0: Fixed to the 1st gain, switched between P and PI as defined by bit26 of external 60FEh 1: Switched between the 1st and 2nd gain sets as defined by H08.09	1	-	Real-time
H08.09	2008-0Ah	Gain switchover condition	0: Fixed to the 1st gain set (PS) 1: Switched as defined by bit26 of 60FEh 2: Torque reference too large (PS) 3: Speed reference too large (PS) 4: Speed reference change rate too large (PS) 5: Speed reference low/high 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 + Actual speed (P)	0	-	Real-time
H08.10	2008-0Bh	Gain switchover delay	0.0 ms–1000.0 ms	5.0	ms	Real-time
H08.11	2008-0Ch	Gain switchover level	0–20000	50	-	Real-time
H08.12	2008-0Dh	Gain switchover hysteresis	0–20000	30	-	Real-time
H08.13	2008-0Eh	Position gain switchover time	0.0 ms–1000.0 ms	3.0	ms	Real-time

2.5.3 Position Reference Filter

Name	Function	Applicable Occasion	Impact of Excessive Filtering
Position reference filter	Filters the position references (encoder unit) divided or multiplied by the electronic gear ratio to smoothen the operation process of the motor and reduce shock to the machine.	• The acceleration/ deceleration process is not performed on the position references sent from the host controller. • The pulse reference frequency is low. • The electronic gear ratio is larger than 10.	The response delay is prolonged.

2.5.4 Feedforward gain

Speed feedforward can be applied to the position control mode. The speed feedforward function can be used to improve the speed reference responsiveness and reduce the position deviation at fixed speed.

Speed feedforward

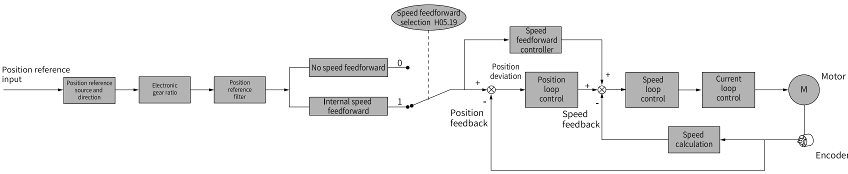


Figure 2-10 Operating procedure for speed feedforward control

Operating procedure for speed feedforward:

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

Parameter	Name	Value	Remarks
H05.19	Speed feedforward control	0: No speed feedforward	-
		1: Internal speed feedforward	Defines the speed corresponding to the position reference (encoder unit) as the speed feedforward signal source.
		2: 60B1h used as speed offset	-
		3: Zero phase control	-

2. Set speed feedforward parameters.

Set the speed feedforward gain (H08.19) and speed feedforward filter time constant (H08.18).

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H08.18	2008-13h	Time constant of speed feedforward filter	0.00 ms–64.00 ms	0.50	ms	Real-time
H08.19	2008-14h	Speed feedforward gain	0.0% to 100.0%	0.0	%	Real-time

Zero phase control

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

The loop calculation model is shown in the following figure.

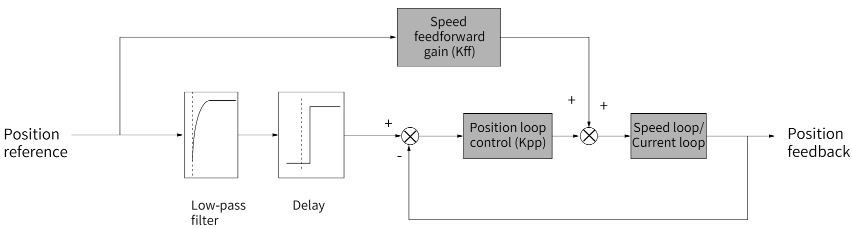


Figure 2-11 Zero phase control

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.04	2005-05h	First-order low-pass filter time constant	0.0 ms–6553.5 ms	0.0	ms	At stop
H05.19	2005-14h	Speed feedforward control	0: No speed feedforward 1: Internal speed feedforward 2: H05.72 3: Zero phase	1	-	At stop
H08.17	2008-12h	Zero phase delay	0.0 ms–4.0 ms	0.0	ms	Real-time

Torque feedforward

In the position control mode, torque feedforward can be used to improve torque reference responsiveness and reduce the position deviation during operation at constant acceleration/deceleration rate.

In the speed control mode, torque feedforward can be used to improve speed reference responsiveness and reduce the speed deviation during operation at constant speed.

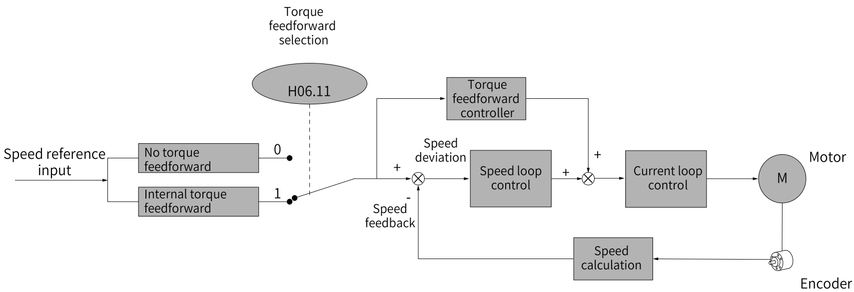


Figure 2-12 Operation diagram of torque feedforward control

The procedure for setting torque feedforward is as follows:

1. Set the torque feedforward signal source.

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

Parameter	Name	Value	Remarks
H06.11	Torque feedforward control	0: No torque feedforward	-
		1: Internal torque feedforward	Use the speed reference as the source of the torque feedforward signal. In the position control mode, the speed reference is outputted from the position controller.

2. Set torque feedforward parameters.

Parameter	Name	Description
H08.20	Torque feedforward filter time constant	Function: • Increasing the value of H08.21 improves the response but may cause overshoot during acceleration/deceleration. • Decreasing the value of H08.20 suppresses overshoot during acceleration/deceleration. Increasing the value of H08.20 suppresses the noise. Note: • Keep H08.20 to the default value, and then gradually increase the value of H08.21 from 0 to a certain value at which torque feedforward achieves the desired effect. • Adjust H08.20 and H08.21 repeatedly until a balanced performance is achieved.
H08.21	Torque feedforward gain	See this section for details.

2.5.5 PDFF Control

The pseudo derivative feedback and feedforward (PDFF) control can be used to adjust speed loop control in the non-torque control modes.

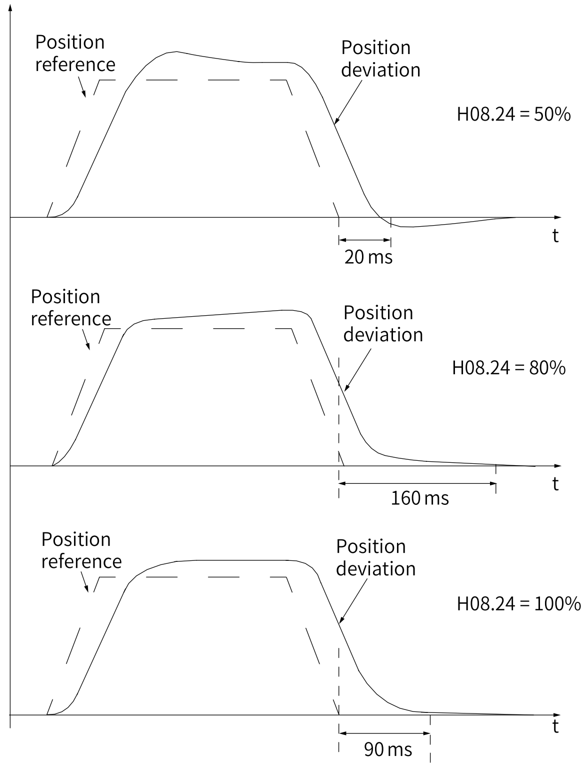


Figure 2-13 Example of PDFF control

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

Parameter	Name	Description
H08.24	PDFF control coefficient	Function: • Defines the control method of the speed loop in the non-torque control modes. Note: • Setting H08.24 to an excessively low value slows down the responsiveness of the speed loop. • When the speed feedback overshoots, gradually decrease the setpoint of H08.24 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.

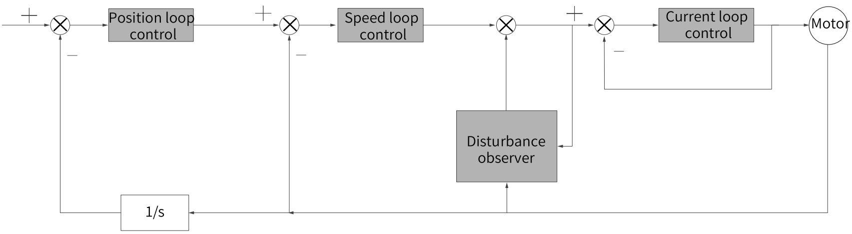
2.5.6 Torque disturbance observer

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

Disturbance observer

The disturbance observer is used to observe external disturbance. You can set different cutoff frequencies and compensation values to observe and suppress the disturbance within the frequency range.

The following figure depicts the control block diagram for disturbance observer 1.



Note

1/s: Integral element

Parameter	Name	Description
H08.31	Disturbance cutoff frequency	The higher the cutoff frequency, the more easily will vibration occur.
H08.32	Disturbance compensation gain	Defines the compensation percentage for the observer.
H08.33	Disturbance observer inertia correction coefficient	H08.33 needs to be changed only when the inertia ratio does not reflect the actual condition. The acting inertia is the product of the set inertia and H08.33. It is recommended to use the default value of H08.33.

☆ Related parameters:

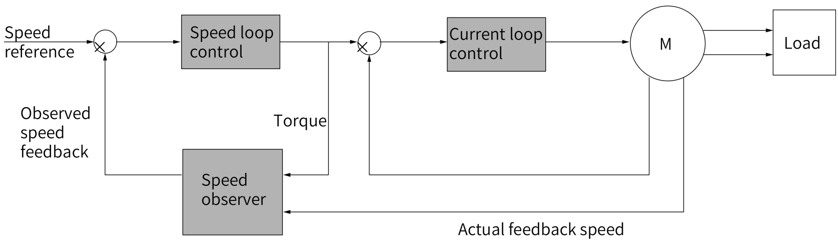
Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H08.31	2008-20h	Disturbance cutoff frequency	1 Hz–4000 Hz	600	Hz	Real-time
H08.32	2008-21h	Disturbance compensation gain	0% to 100%	0	%	Real-time
H08.33	2008-22h	Disturbance observer inertia correction coefficient	1% to 1600%	100	%	Real-time

2.5.7 Speed Observer

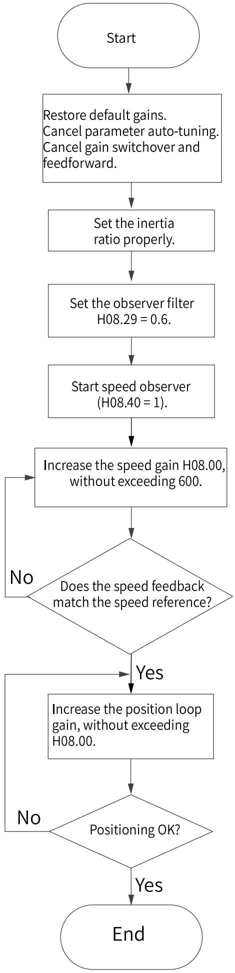
The speed observer, which facilitates quick positioning, applies in applications with slight load characteristic change and constant inertia.

It improves the responsiveness and filters high frequencies automatically, improving the gains and shortening the positioning time without incurring high-frequency vibration.

The block diagram for the speed observer is as follows.



Commissioning Steps



Note

- Before using the speed observer, set H08.15 (Load inertia ratio) to a proper value or perform inertia auto-tuning. A wrong inertia ratio can cause vibration.
- Setting H08.27, H08.28, or H08.29 to excessively low or high values can result in motor vibration.

Related parameters

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H08.00	2008-01h	Speed loop gain	0.0 Hz–2000.0 Hz	40.0	Hz	Real-time
H08.27	2008-1Ch	Speed observer cutoff frequency	50 Hz–600 Hz	170	Hz	Real-time
H08.28	2008-1Dh	Speed observer inertia correction coefficient	1% to 1600%	100	%	Real-time
H08.29	2008-1Eh	Speed observer filter time	0.00 ms–10.00 ms	0.80	ms	Real-time
H08.40	2008-29h	Speed observer selection	0: Disabled 1: Enabled	0	-	Real-time

2.5.8 Model Tracking

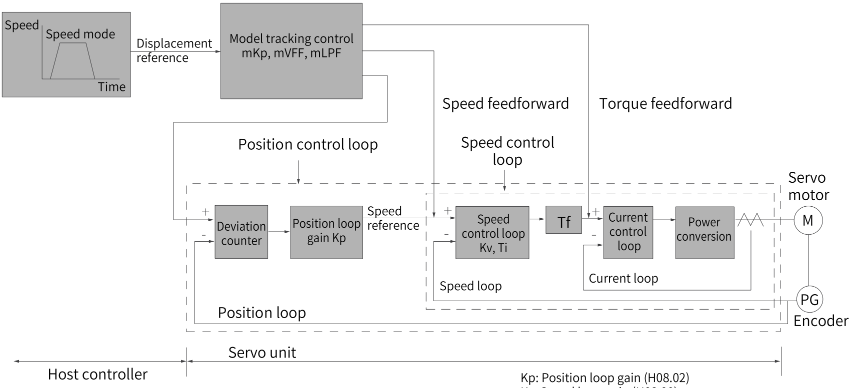
The model tracking control, which is only available in the position control mode, can be used to improve responsiveness and shorten the positioning time. It is only available in the position control mode.

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:

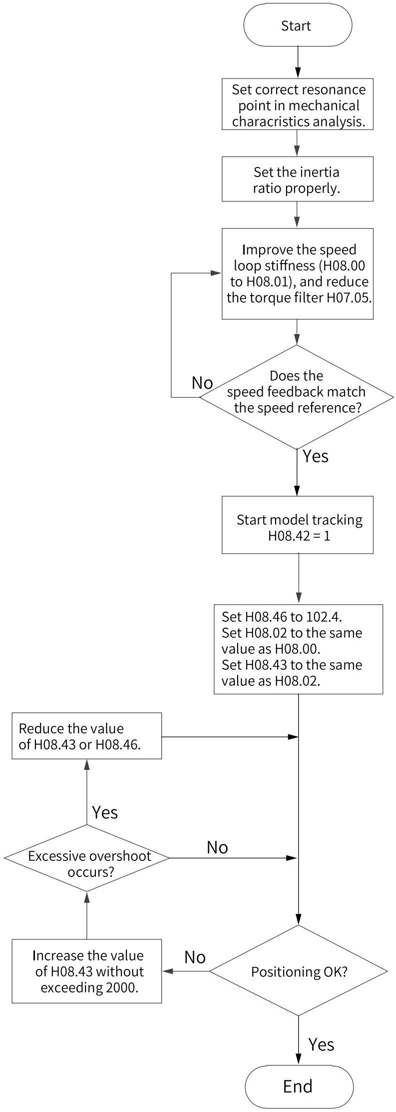
- The auto-tuned values cannot deliver desired performance.
- Improving the responsiveness takes priority over the auto-tuned or customized values.
- User-defined gain parameters or model tracking control parameters are needed.

The block diagram for model tracking control is as follows.



Kp: Position loop gain (H08.02)
Kv: Speed loop gain (H08.00)
Ti: Speed loop integral time constant (H08.01)
Tf: Torque reference filter time constant (H07.05)
mKp: Model tracking control gain (H08.43)
mVFF: Model tracking control speed feedforward compensation (H08.46)
mLPF: Model filter time

Commissioning Steps



Note

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

Related parameters

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.05	2007-06h	Torque reference filter time constant 1	0.00 ms–30.00 ms	0.50	ms	Real-time
H08.00	2008-01h	Speed loop gain	0.0 Hz–2000.0 Hz	40.0	Hz	Real-time
H08.01	2008-02h	Speed loop integral time constant	0.15 ms–512.00 ms	19.89	ms	Real-time
H08.02	2008-03h	Position loop gain	0.0 Hz–2000.0 Hz	64.0	Hz	Real-time
H08.42	2008-2Bh	Model control selection	0: Disabled 1: Enabled 2: Reserved	0	-	Real-time
H08.43	2008-2Ch	Model gain	0.1–2000.0	40.0	-	Real-time
H08.46	2008-2Fh	Feedforward value	0.0–102.4	95.0	-	Real-time

2.5.9 Friction Compensation

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

Note

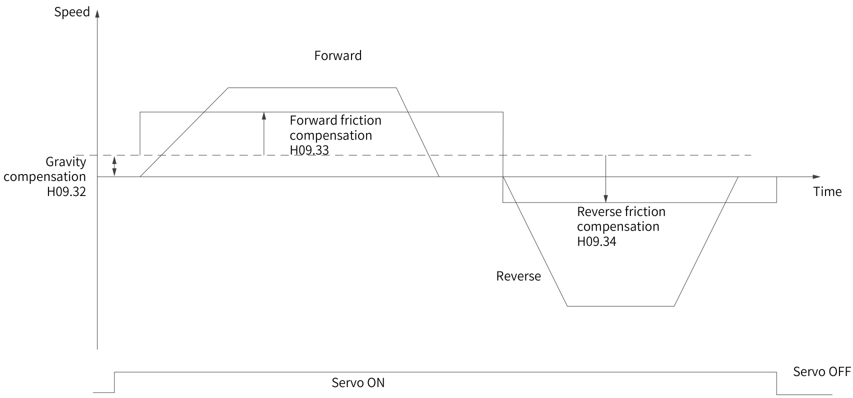
Friction compensation is effective only in the position mode.

☆Related parameters

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.32	2009-21h	Gravity compensation value	-100.0% to 100.0%	0.0	%	Real-time
H09.33	2009-22h	Positive friction compensation value	0.0% to 100.0%	0.0	%	Real-time
H09.34	2009-23h	Negative friction compensation value	-100.0% to 0.0%	0.0	%	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.35	2009-24h	Friction compensation speed	0.0–20.0	2.0	-	Real-time
H09.36	2009-25h	Friction compensation speed	0: Slow mode+Speed reference 1: Slow mode+Model speed 2: Slow mode+Speed feedback 3: Slow mode+Observe speed 16: Quick mode +Speed reference 17: Quick mode +Model speed 18: Quick mode +Speed feedback 19: Quick mode+Observe speed	0	-	Real-time

The diagram for friction compensation is as follows.



Note

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 detemined by the direction of the actual position reference. Forward direction requires positive compensation value. Reverse direction requires negative compensation value.

2.5.10Encoder Scale Ripple Suppression

Usually, we think that in the ideal encoder feedback, the fed back position information corresponds to the position of the motor mover (rotor) linearly. However, due to the physical characteristics of the encoder scale, position information of the ripple will be introduced. See the following figure for details.

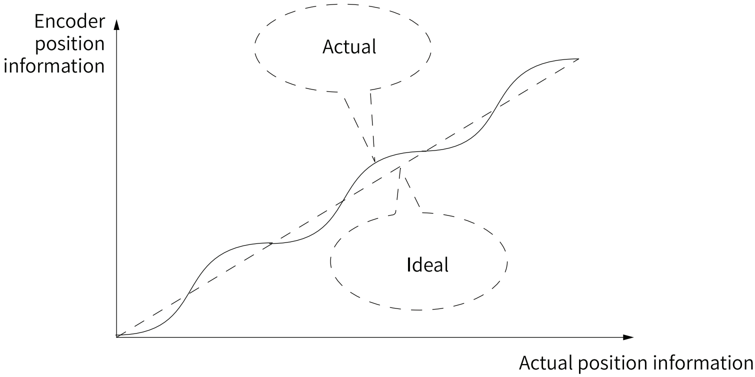


Figure 2-14 Encoder feedback

Therefore, the actual position information can be equivalent to the superposition of linear transmission Gliner and ripple transmission Gwave. The ripple transmission part is usually associated with the encoder scale spacing. The ripple frequency is linearly and positively correlated with the running speed.

This ripple position information will be converted into position feedback and speed feedback and introduced into the control loop, which will lead to ripple in the output of the whole control system. When the gain of the control loop is strong, this ripple will be amplified and cause additional vibration noise.

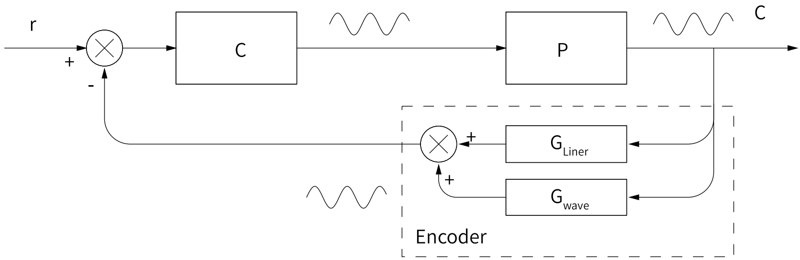


Figure 2-15 Control system loop with ripple

Therefore, the SV680-INT provides a scale ripple suppressor, which "isolates" the scale ripple introduced by encoder feedback, avoids the operation noise caused by the position for speed ripple in the control loop, and suppresses the output ripple caused by controlled speed ripple. The principle is as follows.

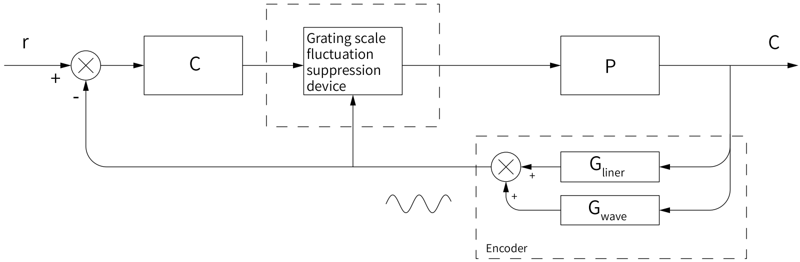


Figure 2-16 Principle block diagram of SV680-INT scale ripple suppressor

To use the suppressor:

1. Check the scale spacing and set H00.45 and H00.46. Usually, you can obtain the scale spacing by inquiring the scale information. If it is uncertain, you can determine it according to the speed ripple frequency and average speed during uniform speed operation.
2. Turn on ripple suppression. You can turn on the number of suppressors and corresponding mode as needed. Among them, the adaptive mode is used for reciprocating operation with unequal speed or unidirectional operation with variable speed. The hysteretic mode is used for reciprocating operation with constant speed.

Parameter	Name	Default	Value Range	Description
H00.45	Encoder pitch 1	2 mm	0.00–655.35	Unit: [mm]/[deg]
H00.46	Encoder pitch 2	0.5 mm	0.00–655.35	Unit: [mm]/[deg]
H08.90	Encoder scale spacing ripple suppressor enable	0	0–4	Encoder scale spacing ripple suppressor enable 0: Disabled 1: Enable the first one, adaptive mode 2: Enable the first one, hysteretic mode 3: Enable two, adaptive mode 4: Enable two, hysteretic mode

Note

- This feature is more effective for applications with slow acceleration and deceleration in a long travel (especially those where DDL works with a magnetic grid encoder at a constant speed in a long travel, such as applications in the digital jet printing industry). It can significantly reduce speed fluctuation and noise caused by magnetic grid spacing.
- Other situations, such as small magnetic grid spacing or large amount of scale graduations, are usually less susceptible to magnetic grid spacing fluctuation and therefore do not benefit much from this feature. You can enable it as needed.

2.5.11 Motor Cogging Torque Ripple Compensation

Motor cogging torque ripple compensation is used to compensate the torque ripple caused by the motor cogging torque, so as to suppress the speed ripple caused by the cogging torque ripple under the low control loop gain without compromising the stability margin of the system.

The SV680-INT provides two types of application modes for rotary motors (general-purpose ROT/DDR)[1]):

Note

[1]: General-purpose ROT is servo motor; DDR is a direct drive torque motor.

- **ROT/DDR application mode with Inovance absolute encoder**
  In this mode, the motor has already obtained the compensation data before delivery. You only need to enable or disable the feature through H06.28.

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.28	2006-1Dh	Cogging torque ripple compensation	0–1	1	-	At stop

- **ROT/DDR application mode with incremental encoder (incremental encoder with Inovance communication T5 interpolator, quadrature pulse encoder with QEP counting)**
  When this mode is applied, it is necessary to carry out auto-tuning of motor cogging torque ripple and obtain the compensation list before enabling compensation. Auto-tuning and the compensation can only take effect after angle auto-tuning and homing are completed. The process is as follows:

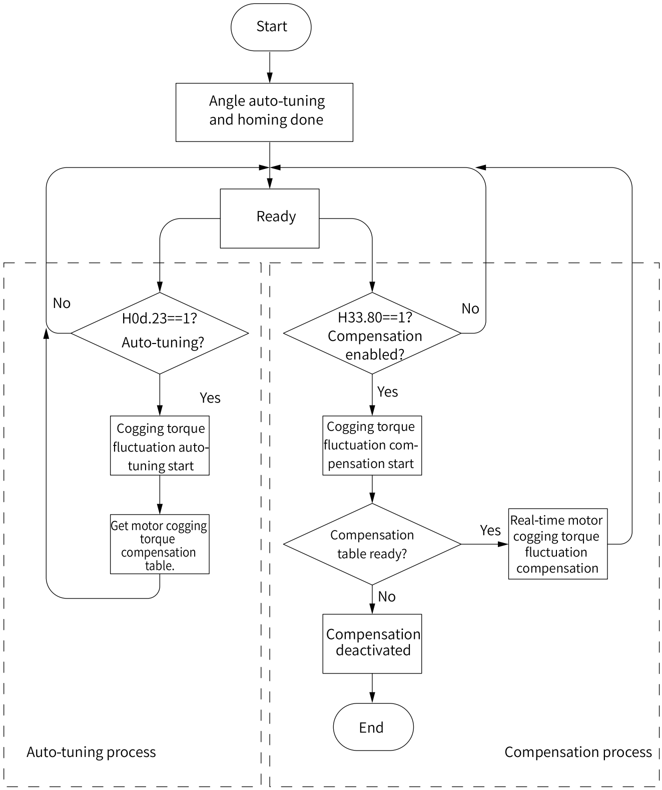


Figure 2-17 Flow chart of ROT/DDR application mode with incremental encoder

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H33.80	2033-51h	Medium to save motor cogging Torque ripple compensation data	0: Encoder 1: Flash	0	-	At stop
H0d.23	200d-18h	Motor cogging torque ripple auto-tuning enable	0: Disabled 1: Enabled	0	-	At stop

When motor cogging torque ripple auto-tuning is enabled (H0d.23=1), the SV680-INT will control the motor to rotate for several revolutions to obtain the cogging torque ripple compensation list.

Note

During this process, you need to ensure that the motor has enough operating range to avoid collision. It is recommended to perform auto-tuning when the motor is unloaded, to avoid external disturbance.

After auto-tuning is completed, compensation is enabled automatically (H06.28= 1). The drive is powered off and restarted to perform angle auto-tuning and homing. You can disable this feature manually when you do not need it (H06.28= 0).

2.6 Parameter Adjustment in Different Control Modes

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

2.6.1 Parameter Adjustment in the Speed Control Mode

Parameter adjustment in the speed control mode is the same as that in the position control mode, except for the position loop gain (H08.02 and H08.05). For details, see *"2.6.2 Parameter Adjustment in the Position Control Mode" on page 73*.

2.6.2 Parameter Adjustment in the Position Control Mode

Obtain the value of H08.15 (Load inertia ratio) through inertia auto-tuning.

2) Perform gain adjustment.

- 1st gain set:

Parameter	Name	Function	Default
H07.05	Torque reference filter time constant 1	Defines the torque reference filter time constant.	0.50ms
H08.00	Speed loop gain	Defines the speed loop proportional gain.	40.0 Hz
H08.01	Speed loop integral time constant	Defines the integral time constant of the speed loop.	19.89ms
H08.02	Position loop gain	Defines the position loop proportional gain.	64.0 Hz

- 2nd gain set:

Parameter	Name	Function	Default
H07.06	Torque reference filter time constant 2	Defines the torque reference filter time constant.	0.27ms
H08.03	2nd speed loop gain	Defines the speed loop proportional gain.	75.0 Hz
H08.04	2nd speed loop integral time constant	Defines the integral time constant of the speed loop.	10.61ms
H08.05	2nd position loop gain	Defines the position loop proportional gain.	120.0ms
H08.08	2nd gain mode setting	Defines the mode of the 2nd gain set.	1
H08.09	Gain switchover condition	Used to set the condition for gain switchover.	0
H08.10	Gain switchover delay	Defines the gain switchover delay.	5.0ms
H08.11	Gain switchover level	Defines the gain switchover level.	50
H08.12	Gain switchover hysteresis	Defines the dead time of gain switchover.	30
H08.13	Position gain switchover time	Defines the position loop gain switchover time.	3.0ms

- Common gain set

Parameter	Name	Function	Default
H08.18	Time constant of speed feedforward filter	Defines the filter time constant of the speed feedforward signal.	0.50ms
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.	0.50ms
H08.21	Torque feedforward gain	Defines the torque feedforward gain.	0.0%
H08.22	Speed feedback filtering option	Defines the speed feedback filtering 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%

Parameter	Name	Function	Default
H09.30	Torque disturbance compensation gain	Defines the torque disturbance compensation gain.	0.0%
H09.31	Filter time constant of torque disturbance observer	Defines the filter time constant of the disturbance observer.	0.5ms
H09.04	Low-frequency resonance suppression mode	Defines the low-frequency resonance suppression mode.	0
H09.38	Frequency of low-frequency resonance suppression 1 at the mechanical end	Defines the frequency of the low-frequency resonance suppression filter.	100.0 Hz
H09.39	Low-frequency resonance suppression 1 at the mechanical end	Defines the setting of low-frequency resonance suppression filter.	2

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

Fine-tune the following gains manually.

Parameter	Name	Function	Default
H07.05	Torque reference filter time constant 1	Defines the torque reference filter time constant.	0.50ms
H08.00	Speed loop gain	Defines the speed loop proportional gain.	40.0 Hz
H08.01	Speed loop integral time constant	Defines the integral time constant of the speed loop.	19.89ms
H08.02	Position loop gain	Defines the position loop proportional gain.	64.0 Hz
H08.19	Speed feedforward gain	Defines the speed feedforward gain.	0.0%

2.6.3 Parameter Adjustment in the Torque Control Mode

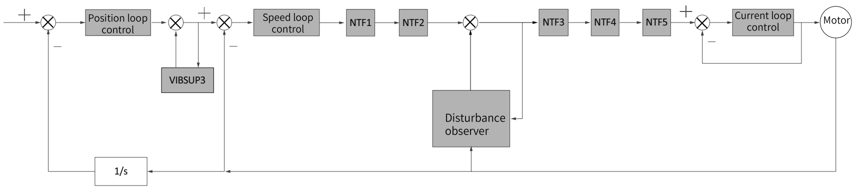
Parameter adjustment in the torque control mode are differentiated based on the following conditions:

- If the actual speed reaches the speed limit, the adjustment method is the same as that described in *"2.6.1 Parameter Adjustment in the Speed Control Mode" on page 73*.

- If the actual speed does not reach the speed limit, the adjustment method is the same as that described in *"2.6.1 Parameter Adjustment in the Speed Control Mode" on page 73*, except the position/speed loop gain and speed loop integral time constant.

2.7 Vibration suppression

The block diagram for vibration suppression is as follows.



Where:

- NTF1–5: 1st notch to 5th notch
- VIBSUP3: Suppression of medium- and low-frequency vibration reduction applied at a carrier frequency lower than 8 k under 300 Hz
- 1/s: Integral element

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H08.53	2008-36h	Medium- and low-frequency jitter suppression frequency 3	0.0 Hz–300.0 Hz	0.0	Hz	Real-time
H08.54	2008-37h	Medium- and low-frequency jitter suppression compensation 3	0% to 200%	0	%	Real-time
H08.56	2008-39h	Medium- and low-frequency jitter suppression phase modulation 3	0% to 600%	100	%	Real-time

Note

- jitter suppression phase modulation coefficient: synchronous phase adjustment of the compensation value and vibration. It is recommended to use the default value. Adjustment is needed when the compensation value phase differs greatly from the vibration phase.
- Jitter suppression frequency: Defines the jitter frequency that needs to be suppressed.
- Jitter suppression compensation coefficient: Defines the compensation coefficient for jitter suppression.

2.7.1 Mechanical Resonance Suppression

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

Mechanical resonance can be suppressed in the following two methods:

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/[2π x H07.059 (ms) x 0.001]

Notch

The notch reduces the gain at certain frequencies to suppress 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.

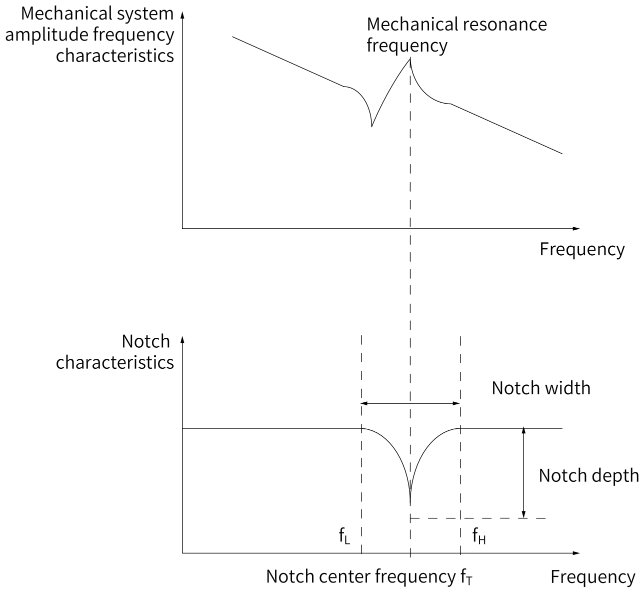


Figure 2-18 Operating principle of the notch

A total of 5 notches can be used, and each notch is defined by three parameters: frequency, width level, and depth level. The 1st, 2nd and fifth notches are manual notches whose parameters needs to be set by the user. Parameters of the 3rd and 4th notches can be either set by the user or set automatically after being configured as an adaptive notch (H09.02 =1 or 2).

Table 2–7 Description of notch parameters

Item	Manual Notch			Manual/Adaptive Notch	
	1st Notch	2nd Notch	5th Notch	3rd Notch	4th Notch
Frequency	H09.12	H09.15	H09.41	H09.18	H09.21
Width level	H09.13	H09.16	H09.42	H09.19	H09.22
Depth level	H09.14	H09.17	H09.43	H09.20	H09.23

Note

- When the frequency is 8000 Hz (default), the notch is inactive.
- The adaptive notch is preferred for resonance suppression. The manual notch can be used in cases where the adaptive notch cannot deliver desired performance.

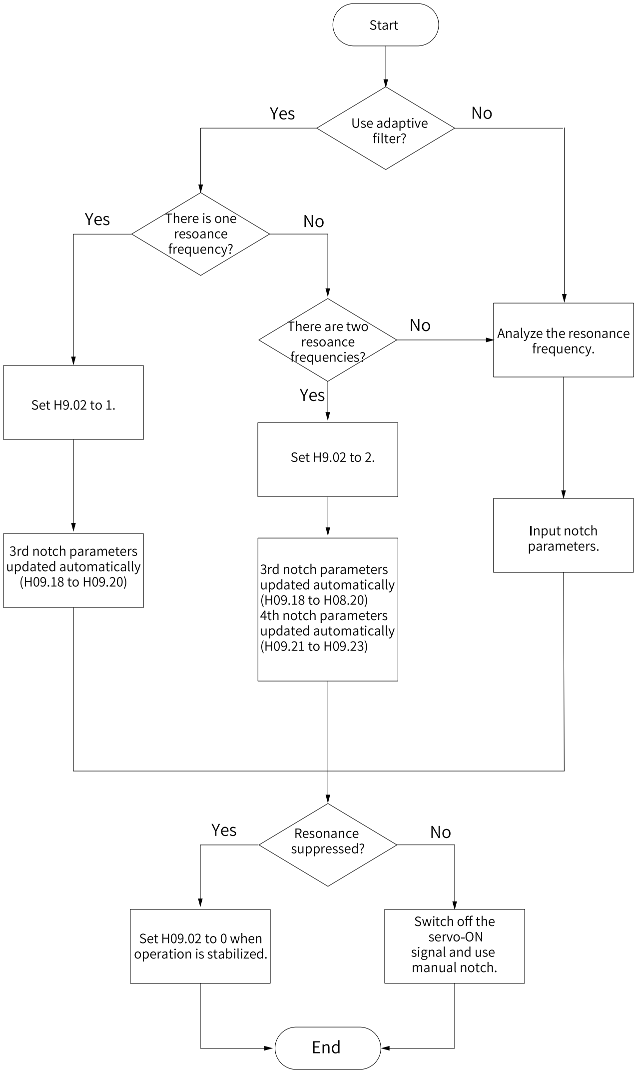


Figure 2-19 Using the notch

- Procedure for setting the adaptive notch:

1. Set H09.02 (Adaptive notch mode selection) to 1 or 2 based on the number of resonance frequencies.
2. When resonance occurs, set H09.02 to 1 first to enable one adaptive notch. If new resonance occurs after gain adjustment, set H09.02 to 2 to enable two adaptive notches.

3. Parameters of the 3rd, 4th and 5th notches are updated automatically during operation, and parameter values are saved automatically to the corresponding parameters in group H09 every 30 min.
4. If resonance is suppressed, the adaptive notch works. After the servo drive runs stably for a period of time, set H09.02 to 0 and the parameters of the adaptive notch are fixed to the last updated values.

   This is to prevent notch parameters from being updated to wrong values due to misoperation. Wrong values will intensity resonance.
5. If resonance persists after the notch is working for a period of time, switch off the S-ON signal.
6. If there are more than two resonance frequencies, the problem cannot be solved by only using the adaptive notches. In this case, add a manual notch, Additionally use the manual notch, or use all the 5 notches as manual ones (H09.02 = 0).

Note

- When adaptive notch is applied, if the S-OFF signal is activated within 30 min, the notch parameters will not be saved to the corresponding parameter
- When the resonance frequency is below 300 Hz, the suppression effect of the adaptive notch may be degraded.

- Procedure for setting the manual notch:

1. Analyze the resonance frequency.
2. When using the manual notch, set the notch frequency to same value as the actual resonance frequency obtained in the following ways: The resonance frequency can be obtained by using the following methods:
   - Use the "Mechanical characteristic analysis" function in Inovance software tool.
   - Calculate the resonance frequency based on the motor phase current displayed on the oscilloscope interface of the software tool.
   - Set H09.02 (Adaptive notch mode) to 3. The drive detects the resonance frequency and saves the detected value to H09.24 automatically during operation.
3. Input the resonance frequency obtained in step 1 to the parameter of the selected notch, and input the width level and depth level of this notch.
4. If resonance has been suppressed, it indicates the notch functions well and you can continue adjusting the gain. If resonance occurs again, repeat steps 1 and 2.
5. If resonance persists after the notch is working for a period of time, switch off the S-ON signal.

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

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

Figure 2-20

Where:

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

$f_H - f_L$ is the notch width, that is, the frequency bandwidth with an amplitude attenuation rate of –3 dB relative to the notch central frequency.

The following figure shows the correspondence. Use the default value 2 in normal cases.

- 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 99, the input can be fully passed at the center frequency. Therefore, the lower the depth level is, the higher the notch depth is, and the stronger the suppression effect will be. Note that an excessively low depth level may lead to system oscillation.

Note

If the amplitude frequency characteristic curve obtained through the mechanical analysis function does not have obvious peak, it indicates that vibration occurs actually. Such vibration may not be mechanical resonance, and cannot be suppressed by the notch. It occurs because the gain reaches the limit, and can be suppressed only by reducing the gain or the filter time of torque reference.

The following figure shows the frequency characteristics of the notch.

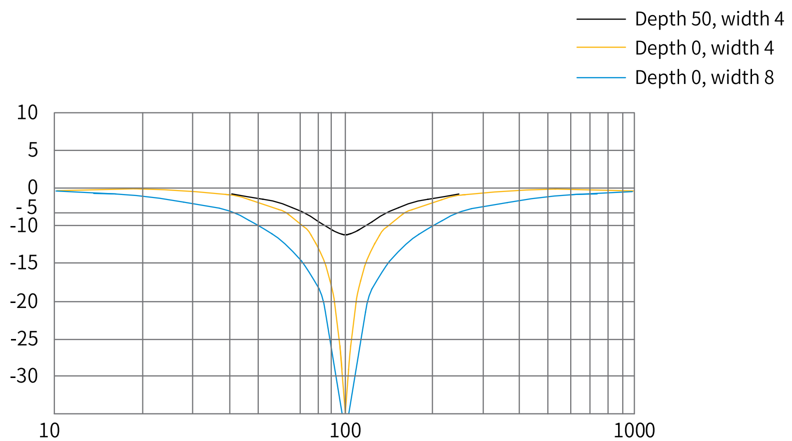


Figure 2-21 Notch frequency characteristics

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.02	2009-03h	Mode selection of adaptive notch	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 3rd and 4th notches restored to default	0	-	Real-time
H09.12	2009-0Dh	Frequency of the 1st notch	50 Hz–8000 Hz	8000	Hz	Real-time
H09.13	2009-0Eh	Width level of the 1st notch	0–20	2	-	Real-time
H09.14	2009-0Fh	Depth level of the 1st notch	0–99	0	-	Real-time
H09.15	2009-10h	Frequency of the 2nd notch	50 Hz–8000 Hz	8000	Hz	Real-time
H09.16	2009-11h	Width level of the 2nd notch	0–20	2	-	Real-time
H09.17	2009-12h	Depth level of the 2nd notch	0–99	0	-	Real-time
H09.18	2009-13h	Frequency of the 3rd notch	50 Hz–8000 Hz	8000	Hz	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.19	2009-14h	Width level of the 3rd notch	0–20	2	-	Real-time
H09.20	2009-15h	Depth level of the 3rd notch	0–99	0	-	Real-time
H09.21	2009-16h	Frequency of the 4th notch	50 Hz–8000 Hz	8000	Hz	Real-time
H09.22	2009-17h	Width level of the 4th notch	0–20	2	-	Real-time
H09.23	2009-18h	Depth level of the 4th notch	0–99	0	-	Real-time
H09.24	2009-19h	Auto-tuned resonance frequency	0 Hz–5000 Hz	0	Hz	Unchangeable
H09.41	2009-2Ah	Frequency of the 5th notch	50 Hz–8000 Hz	8000	Hz	Real-time
H09.42	2009-2Bh	Width level of the 5th notch	0–20	2	-	Real-time
H09.43	2009-2Ch	Depth level of the 5th notch	0–99	0	-	Real-time

2.7.2 Low-Frequency Resonance Suppression at the Mechanical End

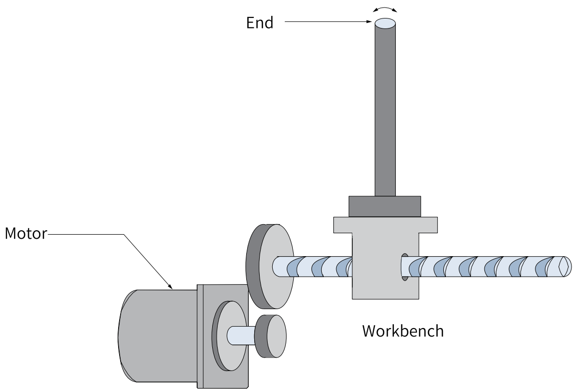


Figure 2-22 Low-frequency vibration at the mechanical end

If the mechanical load end is long and heavy, vibration may easily occur in 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 lower than the mechanical resonance frequency mentioned in *"2.7.1 Mechanical Resonance Suppression" on page 77*. Use the low-frequency resonance suppression function to reduce such vibration.

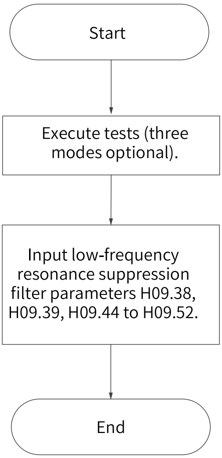


Figure 2-23 Procedure for setting low-frequency resonance suppression filter

First, use the oscilloscope function in the software tool to collect the position deviation waveform of the motor in the positioning state. Then calculate the position deviation fluctuation frequency, which is the low-frequency resonance frequency. Finally, input the value of H09.38 manually and use the default value of H09.39. Observe the resonance suppression effect after using the low-frequency resonance suppression filter.

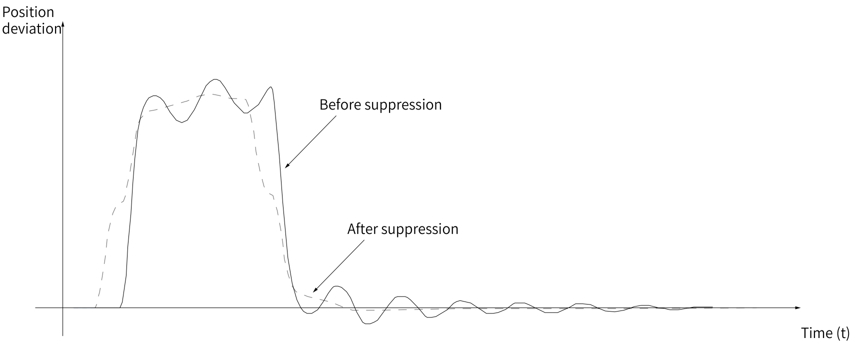


Figure 2-24 Low-frequency resonance suppression effect

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H09.38	2009-27h	Frequency of low-frequency resonance suppression 1 at the mechanical end	1.0 Hz–100.0 Hz	100.0	Hz	At stop
H09.39	2009-28h	Low-frequency resonance suppression 1 at the mechanical end	0–3	2	-	At stop
H09.44	2009-2Dh	Frequency of low-frequency resonance suppression 2 at mechanical load end	0.0–200.0	0.0	-	At stop
H09.45	2009-2Eh	Responsiveness of low-frequency resonance suppression 2 at mechanical load end	0.01–10.00	1.00	-	At stop
H09.47	2009-30h	Width of low-frequency resonance suppression 2 at mechanical load end	0.00–2.00	1.00	-	At stop
H09.49	2009-32h	Frequency of low-frequency resonance suppression 3 at mechanical load end	0.0–200.0	0.0	-	At stop
H09.50	2009-33h	Responsiveness of low-frequency resonance suppression 3 at mechanical load end	0.01–10.00	1.00	-	At stop
H09.52	2009-35h	Width of low-frequency resonance suppression 3 at mechanical load end	0.00–2.00	1.00	-	At stop

2.8 Mechanical Characteristic Analysis

Overview

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

Steps

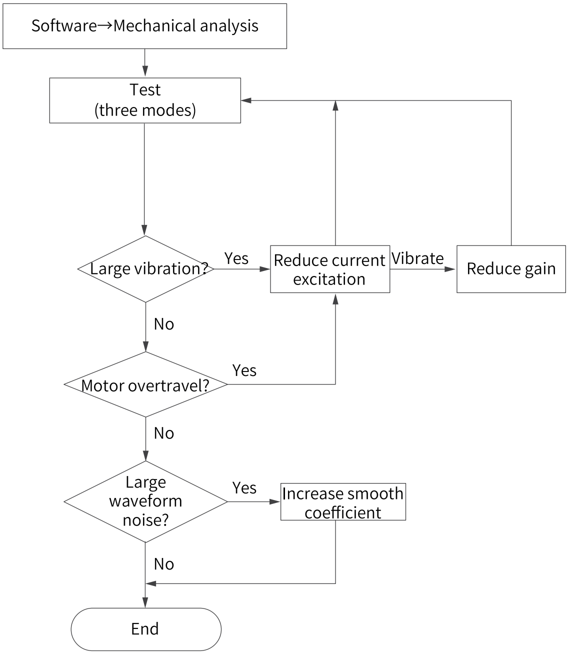


Figure 2-25 Operating procedure for mechanical characteristic analysis

Note

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

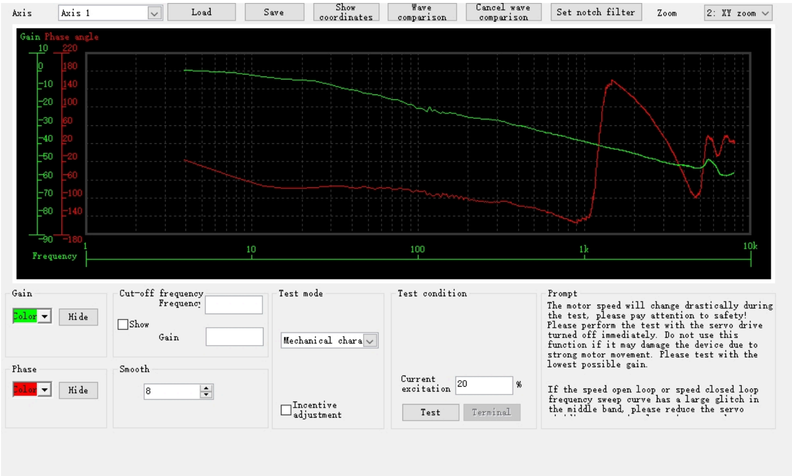


Figure 2-26 Example of the waveform obtained

An example of the waveform obtained with the mechanical characteristic analysis is shown in *"Figure 2–25 Example of the waveform obtained" on page 87*.

2.9 High-performance Tuning

Overview

High performance tuning is an upgraded function of mechanical characteristic analysis, which can not only judge the mechanical resonance point and system bandwidth, but also simulate the influence of adding filters and adjusting parameters on loop control. It supports response characteristic analysis up to 8 kHz and enables you to measure and simulate mechanical characteristics, current loop, speed and position open/closed loop frequency domain characteristics.

Note

- Before frequency domain measurement, you need to set H02.00 to the corresponding speed mode or position mode. Other modes may trigger an abnormal servo state alarm.
- During the measurement, do not disconnect the drive from the software, otherwise the measurement process will be interrupted.

Steps

1. **Generation of measured image**

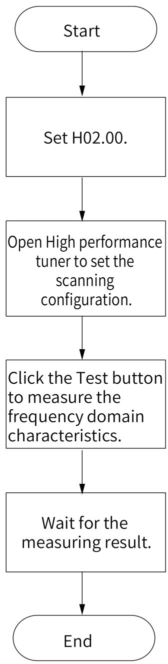


Figure 2-27 Flow chart of measured image generation

a. Select **High Performance Tuner** in **Workspace** and click **Sweep Frequency Config**.

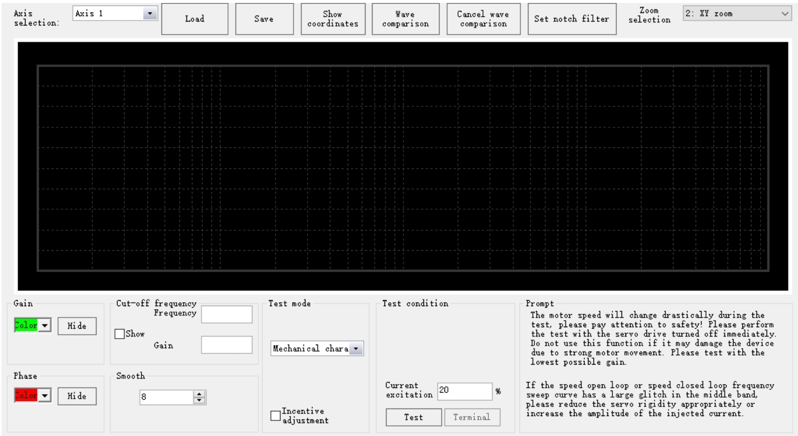


Figure 2-28 Sweep frequency configuration

☆ Related parameters:

Parameter	Name	Unit
H09.71	Low frequency starting frequency	Hz
H09.72	End frequency	Hz
H09.73	Low frequency interpolated points	-
H09.74	Excitation amplitude	%
H09.75	High frequency starting frequency	Hz
H09.76	High frequency interpolated points	-

b. After that, the measured frequency domain characteristics of the system are obtained. In the following figure, red and orange are measured and green and brown are simulated:

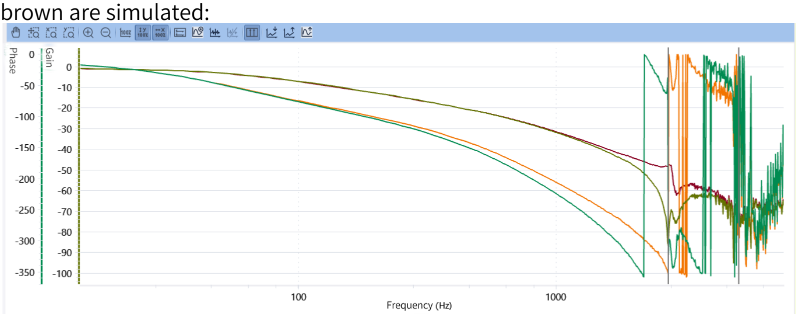


Figure 2-29 Frequency domain curve

Note

- To avoid large vibration during the test, set the current excitation to 10% during initial execution.
- The analysis waveform may be distorted if the current excitation is too low.
- If vibration is present during the test, and cannot be eliminated by reducing current excitation, possible causes and measures are:
  - 1) The gain is too high. Reduce the speed gain or set the notch based on the auto-tuned resonance point.
  - 2) The set inertia ratio is too high. Rectify the setting.

2. **Loop control adjustment**

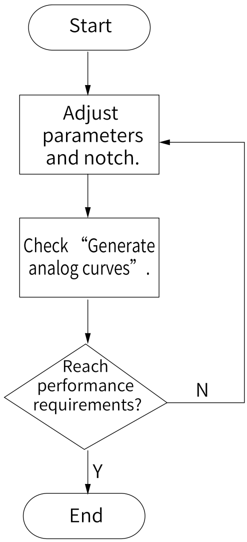


Figure 2-30 Flow chart of loop control adjustment

After adjusting parameter configuration and four notch filters, the simulation curve is generated again. You can see the influence of changing parameters on the system.

☆ Related parameters:

Parameter	Name	Parameter Type
H08.00	Speed loop gain	Gain
H08.01	Speed loop integral time	Gain
H08.02	Position loop gain	Gain
H08.05	Inertia ratio	Gain

Parameter	Name	Parameter Type
H07.05	Torque Reference Filter	Filter
H09.77 to H09.81	Biquad filter	Filter
H09.12 to H09.23	Notch	Filter

Note

Notch filter 1 becomes a notch only when it is not enabled. It can be configured as first-order low-pass, second-order low-pass, lead-lag, or custom biquad filter.

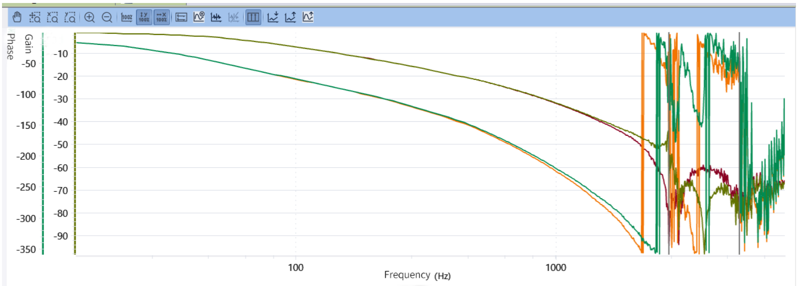


Figure 2-31 Comparison between simulated curve and measured curve

3 Control mode

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

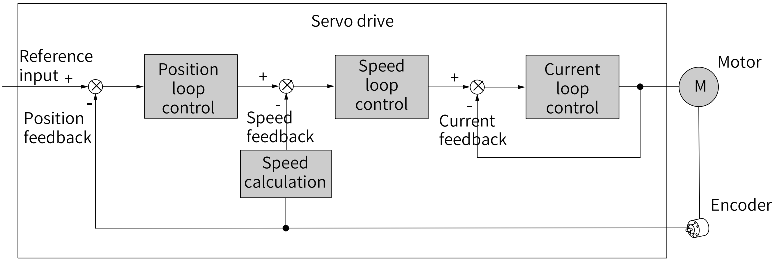


Figure 3-1 Structure of a basic servo system

As the control core of the servo system, the servo drive performs accurate position, speed, torque, or hybrid control on the servo motor by processing the input signals and feedback signals. Position control is the most important mode of a servo system.

Descriptions of the control modes are as follows:

- Position control In the position control mode, the target position of a motor is determined by the sum of position references, and the motor speed is determined by the position reference frequency. The servo drive performs quick and accurate position and speed control through the encoder installed on the motor or an external encoder (full closed-loop control). The position control mode mainly applies to applications requiring positioning control, such as manipulators, SMT machines, engraving and milling machines, and CNC machine tools.
- Speed control In the speed control mode, the servo drive performs quick and accurate speed control through the speed reference sent through communication. The speed control mode mainly applies to application requiring speed control or where a host controller is used for position control or the commands sent from the host controller are used as the speed references for the servo drive, such as the engraving and milling machine.
- In the torque control mode, the motor current is in linear relation with the torque. Therefore, torque control is implemented through current control. The servo drive controls the motor output torque based on torque references. The torque reference can be set through communication. This control mode is mainly applicable to the winding and unwinding devices with strict tension requirements. In these scenarios, the torque always changes with the winding radius so that the tension will not change along with the change of the winding radius.

3.1 Setting and Display of the Operation Modes

Introduction to the operation modes

The pre-operational mode of the servo drive is set in 6060h. The current operation mode of the servo drive can be viewed in 6061h.

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable

Communication cycle supported by each mode

The SV680P-INT supports 1ms or an integer multiple of 1 ms. The maximum synchronization period is 20 ms.

For the SV680N-INT, the min. sync period is 250 μs and the max. sync period is 20 ms.

3.2 Conversion Factor

Gear ratio refers to the motor displacement (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 (reference unit) and the motor displacement (encoder unit), as shown below.

Motor displacement = Load shaft displacement x Gear ratio

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

The calculation formula is as follows.

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

☆Related parameters

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6091.01h	6091-01h	Motor resolution	1–4294967295	1	-	At stop
6091.02h	6091-02h	Shaft resolution	1–4294967295	1	-	At stop

Calculation of servo motor position factor

Take the load ball screw as an example.

Minimum reference unit f_C = 1 mm

Lead P_B = 10 mm/r

Reduction ratio n = 5:1

Resolution of Inovance motor equipped with 26-bit serial-type encoder (P) = 67108864 PPR

The position factor is therefore calculated as follows:

Position factor:

$$\text{Position factor} = \frac{\text{Motor resolution P x n}}{P_B} = \frac{67108864 \times 5}{10} = \frac{335544320}{10} = 33554432$$

Therefore, 6091.01h = 33554432; 6091.02h = 1. That means when the load shaft displacement is 1 mm, the motor displacement is 33554432.

Reduce the values of 6091.01h and 6091.02h to a point where there is no common divisor, and take the final value.

Calculation of direct drive motor position factor

Take the Inovance DDR communication encoder (H00.00 = 14201) directly connected without a reducer as an example:

Minimum reference unit f_c = 1°

Travel of one revolution P_B = 360°

Motor resolution P = 8388608 PPR

The position factor is therefore calculated as follows:

Position factor:

$$\text{Position factor} = \frac{\text{Motor resolution P}}{P_B} = \frac{8388608}{360}$$

Therefore, 6091.01h = 8388608; 6091.02h = 360. That means when the load shaft displacement is 360°, the motor displacement is 8388608.

Take the Inovance DDL communication encoder (H00.00 = 14202) directly connected without a reducer as an example:

Minimum reference unit f_c = 1 mm

Pole distance of motor (N-N) × P_B = 32mm x (2 x H00.48)

Motor resolution P = 8388608 PPR

The position factor is therefore calculated as follows:

Position factor:

$$\text{Position factor} = \frac{\text{Motor resolution P}}{P_B} = \frac{8388608}{32}$$

Therefore, 6091.01h = 8388608; 6091.02h = 32. That means when the load shaft displacement is 32 mm, the motor displacement is 8388608.

Reduce the values of 6091.01h and 6091.02h to a point where there is no common divisor, and take the final value.

Setting electronic gear ratio of the linear motor

Minimum reference unit 1 mm

Encoder resolution 0.5μm/pulse

Because the linear motor moves linearly, the reduction ratio is 1:1.

The position factor is therefore calculated as follows:

Position factor = 1 mm ÷ (0.5 um/pulse) = 2000

The load displacement is 1mm. The motor mover moves 1mm, and the encoder feeds back 2000 pulses.

3.3 Servo State

Abide by the process stipulated in the CiA402 protocol when operating the SV680-INT servo drive. Otherwise, the servo drive cannot run in the designated status.

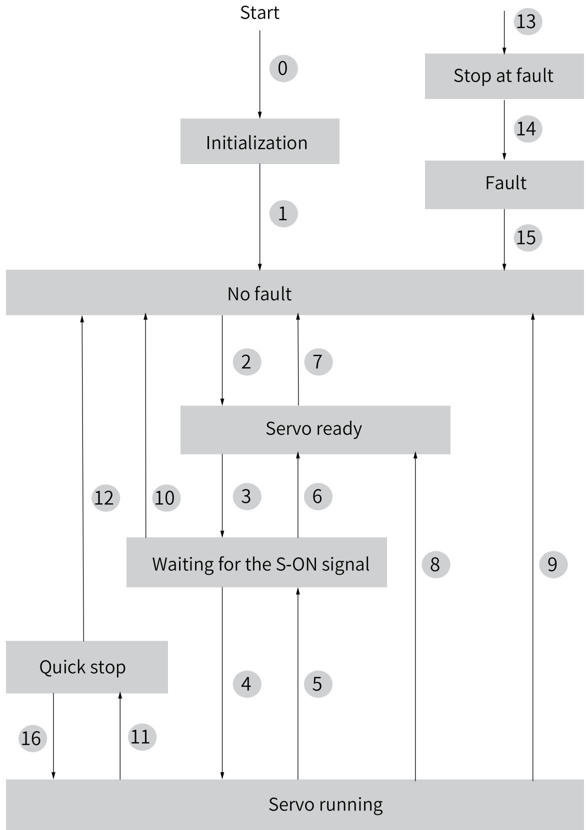


Figure 3-2 Switchover of CiA402 state machine

See the following table for descriptions of different status.

Initialization	Initialization of the servo drive and internal self-inspection are done. Parameters cannot be set. Drive functions cannot be executed.
No fault	No fault exists in the servo drive or the fault has been cleared. Parameters can be set.
Ready to switch on	The servo drive is ready to run. Parameters can be set.
Wait for the S-ON signal	The servo drive is waiting for the S-ON signal. Parameters can be set.
Enable operation	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 value inputted is not 0. Only parameters whose "Setting Condition" is "During running" can be set.
Quick stop	Quick stop is activated and the servo drive is in the process of quick stop. Only parameters whose "Setting Condition" is "During running" can be set.
Fault reaction	A fault occurs and the servo drive is in the process of stop. Only parameters whose "Setting Condition" is "During running" can be set.
Fault	The stop process is done and all the drive functions are disabled. Parameters can be modified for troubleshooting purpose.

The following table describes the control commands and status switchover.

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
1	Initialization → No fault	Natural transition, control command not required If an error occurs during initialization, the servo drive directly enters status 13.	0x0250/0x270
2	No fault → Servo ready	0x0006	0x0231
3	Servo ready→Waiting for the S-ON signal	0x0007	0x0233
4	Waiting for the S-ON signal→Servo running	0x000F	0x0237

CiA402 Status Switchover		Control Word 6040h	bit0 to bit9[1] of status word 6041h
5	Servo running→Waiting for the S-ON signal	0x0007	0x0233
6	Waiting for the S-ON signal→Servo ready	0x0006	0x0231
7	Servo ready → No fault	0x0000	0x0250
8	Servo running → Servo ready	0x0006	0x0231
9	Servo running → No fault	0x0000	0x0250
10	Waiting for the S-ON signal → No fault	0x0000	0x0250
11	Servo running → Quick stop	0x0002	0x0217
12	Quick stop → No fault	Quick stop mode 605Ah can be set to 0 to 3. The process is performed automatically and no control command is required.	0x0250
13	→ Stop at fault	If a fault occurs in any status other than "fault", the servo drive automatically switches to the stop-at-fault state, without the need for a control command.	0x021F
14	Stop at fault→Fault	Natural transition applies after stop and no control command is required.	0x0218
15	Fault→No fault	0x80 Bit7 is rising edge-triggered. bit7 is maintained at 1, and other control commands are ineffective.	0x0250
16	Quick stop → Servo running	Set 605A to a value between 5 and 7. 0x0F will be sent after stop.	0x0237

Note

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

3.3.1 Control Word 6040h

6040h **Control word**

Address:	6040h		
Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Real-time
Access:	RW	Mapping:	RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	S-ON	Switch on	1: Enabled, 0: Disabled
1	Enable voltage	Enable voltage	1: Enabled, 0: Disabled
2	Quick stop	Quick stop	0: Enabled, 1: Disabled
3	Operation enabled	Enable operation	1: Enabled, 0: Disabled
4–6	Operation mode specific	Operation mode specific	Related to the operation mode of the servo drive.
7	Fault reset	Fault reset	0: Disabled 0→1: Fault reset is available only for faults and alarms that can be reset. 1: Other control commands are invalid. 1→0: Inactive
8	Halt	Halt	1: Enabled, 0: Disabled
9	Operation mode specific	Operation mode specific	Related to the servo drive operation mode.
10	Reserved	Reverse	Undefined
11–15	Manufacturer-specific	Manufacturer-specific	Manufacturer-specific

Note

- All bits in the control word constitute a control command.
- The meanings of bit0...bit3 and bit7 are the same in each 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–bit6 are related to each mode (see the control commands in different modes for details).
- bit9 is not defined.

3.3.2 Status Word 6041h

6041h **Status word**

Address: 6041h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Unchangeable
Access:	RO	Mapping:	TPDO

Value Range:

0x0 to 0xFFFF

Description:

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 reach；rm=remote；w=warning；sod=switch on disabled；qs=quick stop；ve=voltage enabled；f=fault；oe=operation enabled；so=switch on；rtso=ready to switch on

Table 3–1 Description of each bit of 6041h

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Enabled, 0: Disabled
1	Switch on	Switch on	1: Enabled, 0: Disabled
2	Operation enabled	Operation enabled	1: Enabled, 0: Disabled
3	Fault	Fault	1: Enabled, 0: Disabled
4	Voltage enabled	Voltage enabled	1: Enabled, 0: Disabled
5	Quick stop	Quick stop	0: Enabled, 1: Disabled
6	Switch on disabled	Switch on disabled	1: Enabled, 0: Disabled
7	Alarm	Alarm	1: Enabled, 0: Disabled

bit	Name		Description
8	Manufacturer-specific	Manufacturer-specific	Undefined
9	Remote	Remote	1: Enabled, control word activated 0: Disabled
10	Target reach	Target reach	1: Enabled, 0: Disabled
11	Internal limit active	Internal limit active	1: Enabled, 0: Disabled
12–13	Operation mode specific	Operation mode specific	Related to the servo drive operation mode.
14	Manufacturer-specific	Manufacturer-specific	Undefined
15	Home find	Home find	0: Home not found 1: Home found

Table 3–2 Descriptions of setpoints of 6041h

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 servo mode. These three bits indicate the servo status after a certain servo mode is executed.

3.4 Process Segment Mode

Set H02.00 (Control mode) to 7 (Position control mode) through the keypad or Inovance software tool to make the drive operate in the process segment mode. The process segment mode is a multi-function position mode integrated with homing, constant speed control, and positioning control.

16 process segments are available, in which process segment 0 is the homing mode and process segments 1 to 15 are defined by users. The interval time and linkage mode among process segments can also be selected as needed. The setting flowchart is as follows.

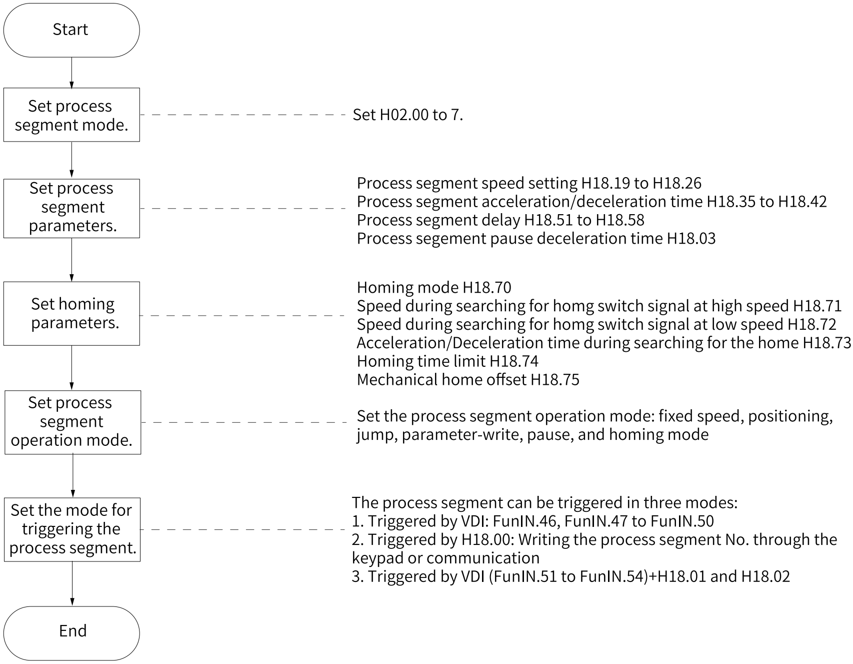


Figure 3-3 Flowchart for setting process segment mode

3.4.1 Mode Triggering

The following table shows how to trigger the process segment mode.

Triggered By	Triggered From	Description
DI triggering	DI: FunIN.46 (PrEnable) + FunIN.47–50 (PrCMD1–4)	Combine FunIN.47–FunIN.50 to form the process segment number to be triggered. Trigger the process segment through the rising edge of FunIN.46.
Parameter	H22.00	Write the process segment number to H22.00 through the keypad or communication to trigger the process segment.

Triggered By	Triggered From	Description
DI + parameter triggering	DI: FunIN.51–54 (PrEvent1~4) + H22.01/H22.02	Set the process segment number to be triggered through H22.01 and H22.02. H22.01: DI: Triggered by the rising edge of FunIN.51...FunIN.54 H22.02: DI: Triggered by the falling edge of FunIN.51...FunIN.54
Homing	DI: FunIN.32 (HomingStart)	Trigger the process segment through the rising edge of FunIN.32.
	H22.00 = 0	Parameter H22.00 = 0.
	FunIN.46 + FunIN.47...FunIN.50 (combined segment number being 0)	When the process segment is triggered by the rising edge of FunIN.46, the motor executes homing based on the set homing mode and home speed.
Halt	DI: FunIN.55 (PrSuspend)	Trigger the process segment through the rising edge of FunIN.55.
	H22.00 = 1000	When H22.00 is set to 1000, the process segment in progress is stopped immediately and the motor ramps to stop based on the deceleration time defined by H22.03. The motor remains enabled after stop.

When a DI is used to trigger the process segment, assign the DI of the servo drive with corresponding function and set the active logic of this DI.

Note

- PrEnable, PrSuspend, PrEvent1–4 signals are edge-triggered. When DI is used, the effective signal width of the DI must be at least 0.125 ms.
- In the process segment mode, FunIN.32 (HomingStart) is used to trigger the process segment homing mode.
- In the position mode, FunIN.32 (HomingStart) is used to trigger the local homing mode.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H22.00	2022-01h	Process segment command trigger	0–1000	0	-	Real-time
H22.01	2022-02h	Process segment triggered by the event rising edge	0–65535	0	-	Real-time

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
H22.02	2022-03h	Process segment triggered by the event falling edge	0–65535	0	-	Real-time
H22.03	2022-04h	Acceleration/ Deceleration time upon technology segment pause	0: Acceleration/Deceleration time 1: Acceleration/Deceleration time 1 2: Acceleration/Deceleration time 2 3: Acceleration/Deceleration time 3 4: Acceleration/Deceleration time 4 5: Acceleration/Deceleration time 5 6: Acceleration/Deceleration time 6 7: Acceleration/Deceleration time 7	0	-	Real-time

Table 3–3 Description of function No.

<table>
<tr><th>Code</th><th>Name</th><th>Function Name</th><th>Function</th></tr>
<tr><td>FunIN.32</td><td>HomingStart</td><td>Homing enable</td><td>Active: Homing enabled (The HomingStart signal cannot be triggered repeatedly during homing.)
Inactive: Homing inhibited</td></tr>
<tr><td>FunIN.46</td><td>PrEnable</td><td>Technology segment enable</td><td>The process segment can be enabled only when the rising edge of the PrEnable signal is active. Otherwise, the process segment function is ineffective.</td></tr>
<tr><td>FunIN.47</td><td>PrCMD1</td><td>Technology segment command switchover 1</td><td rowspan="4">The segment number is a 4-bit binary. The relationship between the segment number and PrCMD1–PrCMD4 is shown in "Table 3–4 " on page 105.
The DI logic is level-triggered. The PrCMD value is 1 upon active level input or 0 upon inactive level input.</td></tr>
<tr><td>FunIN.48</td><td>PrCMD2</td><td>Technology segment command switchover 2</td></tr>
<tr><td>FunIN.49</td><td>PrCMD3</td><td>Technology segment command switchover 3</td></tr>
<tr><td>FunIN.50</td><td>PrCMD4</td><td>Technology segment command switchover 4</td></tr>
<tr><td>FunIN.51</td><td>PrEvent1</td><td>Event trigger technology segment 1</td><td rowspan="4">The DI assigned with event trigger process segment is used together with H22.01 and H22.02.</td></tr>
<tr><td>FunIN.52</td><td>PrEvent2</td><td>Event trigger technology segment 2</td></tr>
<tr><td>FunIN.53</td><td>PrEvent3</td><td>Event trigger technology segment 3</td></tr>
<tr><td>FunIN.54</td><td>PrEvent4</td><td>Event trigger technology segment 4</td></tr>
</table>

Code	Name	Function Name	Function
FunIN.55	PrSuspend	Process segment suspend	When the rising edge of the PrSuspend signal is active, the process segment in progress stops immediately and the motor ramps to stop based on the deceleration time defined by H22.03. The motor remains enabled after stop.

Table 3–4 Relationship between the segment number and CMD1 to CMD4

PrCMD4	PrCMD3	PrCMD2	PrCMD1	Segment No.
0	0	0	0	0
0	0	0	1	1
…				
1	1	1	1	15

3.4.2 Related Parameters

The speed setpoint (SpdSet) and acceleration/deceleration time (AccTime/DecTime) for each segment in the process segment, and the interval time (DelayTime) upon completion of each process segment are set by three groups of parameters respectively, with each parameter group containing eight parameters.

During operation, you can select one parameters from these three parameter groups respectively to generate the process segment.

1. Speed setpoint (SpdSet) (0.1 rpm to 6000.0 rpm)
   Corresponding to H22.19 to H22.26 (unit: 0.1 rpm).

2. Acceleration/Deceleration time (AccTime/DecTime) (0 ms to 65535 ms)
   Corresponding to H22.35 to H22.42.

   The acceleration/deceleration time indicates the time for a motor to change from 0 rpm to 1000 rpm. The actual acceleration/deceleration time is therefore as follows:

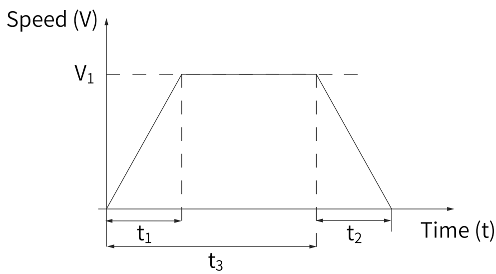


Figure 3-4 Example of the curve in fixed speed mode

As shown in the preceding figure, the speed reference is V_1 and the actual acceleration time t_1 is as follows:

$$t_1 = \frac{V_1}{1000} \times \text{Acceleration time set for this speed}$$

The actual deceleration time t_2 is:

$$t_2 = \frac{V_1}{1000} \times \text{Deceleration time set for this speed}$$

3. Interval time after completion of process segment (DelayTime) (0 ms to 65535 ms) Corresponding to H22.51 to H22.58.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H22.19	2022-14h	Target speed	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	50.0	[mm/s]/[rpm]	Real-time
H22.20	2022-15h	Target speed 1	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	200.0	[mm/s]/[rpm]	Real-time
H22.21	2022-16h	Target speed 2	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	500.0	[mm/s]/[rpm]	Real-time
H22.22	2022-17h	Target speed 3	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	1000.0	[mm/s]/[rpm]	Real-time
H22.23	2022-18h	Target speed 4	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	1500.0	[mm/s]/[rpm]	Real-time
H22.24	2022-19h	Target speed 5	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	2000.0	[mm/s]/[rpm]	Real-time
H22.25	2022-1Ah	Target speed 6	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	2500.0	[mm/s]/[rpm]	Real-time
H22.26	2022-1Bh	Target speed 7	0.1[mm/s]/[rpm]–6000.0[mm/s]/[rpm]	3000.0	[mm/s]/[rpm]	Real-time
H22.35	2022-24h	Accel/Decel time	0 ms–65535 ms	50	ms	Real-time
H22.36	2022-25h	Acceleration/Deceleration time 1	0 ms–65535 ms	200	ms	Real-time
H22.37	2022-26h	Acceleration/Deceleration time 2	0 ms–65535 ms	500	ms	Real-time
H22.38	2022-27h	Acceleration/Deceleration time 3	0 ms–65535 ms	1000	ms	Real-time
H22.39	2022-28h	Acceleration/Deceleration time 4	0 ms–65535 ms	1500	ms	Real-time

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
H22.40	2022-29h	Acceleration/ Deceleration time 5	0 ms–65535 ms	2000	ms	Real-time
H22.41	2022-2Ah	Acceleration/ Deceleration time 6	0 ms–65535 ms	2500	ms	Real-time
H22.42	2022-2Bh	Acceleration/ Deceleration time 7	0 ms–65535 ms	3000	ms	Real-time
H22.51	2022-34h	Delay after completion of the process segment	0 ms–65535 ms	0	ms	Real-time
H22.52	2022-35h	Delay time 1 after completion of the process segment	0 ms–65535 ms	50	ms	Real-time
H22.53	2022-36h	Delay time 2 after completion of the process segment	0 ms–65535 ms	200	ms	Real-time
H22.54	2022-37h	Delay time 3 after completion of the process segment	0 ms–65535 ms	500	ms	Real-time
H22.55	2022-38h	Delay time 4 after completion of the process segment	0 ms–65535 ms	1000	ms	Real-time
H22.56	2022-39h	Delay time 5 after completion of the process segment	0 ms–65535 ms	1500	ms	Real-time
H22.57	2022-3Ah	Delay time 6 after completion of the process segment	0 ms–65535 ms	2000	ms	Real-time
H22.58	2022-3Bh	Delay time 7 after completion of the process segment	0 ms–65535 ms	3000	ms	Real-time

3.4.3 Operation Mode

The process segment mode supports the homing mode, constant speed mode, and positioning mode. Six operation modes are available, which are homing mode, constant speed mode, positioning mode, jump mode, parameter-write mode, and halt mode.

The homing mode is set in process segment 0 and the halt mode is set in process segment 1000. Other modes are set in process segments 1 to 15.

Each group of process segments is comprised of two parts, process segment definition and process segment data. The process segment parameters are H23.00–H23.62 (16 groups in total), with each parameter group containing two 32-bit parameters.

<table>
<tr><th colspan="3">Definition of process segment</th></tr>
<tr><th>bit</th><th>Description</th><th>Value</th></tr>
<tr><td>3–0</td><td>Mode</td><td>
<table>
<tr><th>bit3 to bit0</th><th>Process segment mode</th><th>Description of Process Segment</th></tr>
<tr><td>0001</td><td>Constant speed mode</td><td>-</td></tr>
<tr><td>0010</td><td>Positioning mode</td><td>Stopped after positioning is done</td></tr>
<tr><td>0011</td><td>Positioning mode</td><td>Executing the next segment after positioning is done</td></tr>
<tr><td>0111</td><td>Jump mode</td><td>Jumping to the designated process segment</td></tr>
<tr><td>1000</td><td>Parameter-write mode</td><td>Writing specific parameters</td></tr>
</table>
</td></tr>
<tr><td>7–4</td><td>-</td><td>-</td></tr>
<tr><td>11–8</td><td>-</td><td>-</td></tr>
<tr><td>15–12</td><td>-</td><td>-</td></tr>
<tr><td>19–16</td><td>-</td><td>-</td></tr>
<tr><td>23–20</td><td>-</td><td>-</td></tr>
<tr><td>27–24</td><td>-</td><td>-</td></tr>
<tr><td>31–28</td><td>-</td><td>-</td></tr>
</table>

Process segment data	
bit	Value
31–0	-

Note

If segment 15 is the program block loaded automatically to the last, the first segment applies after segment 15 is done executing.

Homing mode

When process segment 0 is triggered, the homing function is triggered.

In the process segment mode, the software homing function cannot be enabled.

See the following table for definitions of the homing mode.

Definition of process segment		
bit	Description	Value
3–0	-	-
7–4	PathNum	0: The motor stops after homing is done
		1 to 15: After homing is done, the PathNum segment is executed automatically after the DelayTime elapses
11–8	-	-
15–12	-	-
19–16	-	-
23–20	DelayTime	0 to 8: Time interval index after process segment is done executing H22.51 to H22.58 For details, see *SV670-INT Series Servo Drive Parameter Guide*.
27–24	-	-
31–28	-	-

Process segment data	
bit	Value
31–0	Process segment data (32-bit) (unused)

Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H22.70	2022-47h	Homing mode	-32768–32767	-2	-	Real-time
H22.71	2022-48h	Speed of high-speed search for home switch signal	0[mm/s]/[rpm]–3000[mm/s]/[rpm]	100	[mm/s]/[rpm]	Real-time
H22.72	2022-49h	Speed of low-speed search for home switch signal	0[mm/s]/[rpm]–1000[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time
H22.73	2022-4Ah	Acceleration/ Deceleration time during homing	0 ms–1000 ms	1000	ms	Real-time
H22.74	2022-4Bh	Home search time limit	0 ms–65535 ms	10000	ms	Real-time
H22.75	2022-4Ch	Mechanical home offset	-2147483648 to 2147483647	0	Reference unit	Real-time
H22.79	2022-50h	Relative/Absolute homing	0–65535	0	-	Real-time

☆ Related parameters:

Code	Name	Function Name	Function
FunOut.16	HomeAttain	Homing is completed.	Active: Homing completed in the process segment mode Inactive: Homing not completed

Constant speed mode

Mode 1 is the constant speed mode. When the constant speed mode is in progress, the motor operates to the set speed based on the set acceleration/deceleration time, and then keeps operating at the set speed.

<table>
<tr><th colspan="3">Definition of process segment</th></tr>
<tr><th>bit</th><th>Description</th><th>Value</th></tr>
<tr><td>3–0</td><td>Mode</td><td>1</td></tr>
<tr><td>7–4</td><td>Func</td><td>
<table>
<tr><th>bit</th><th>Description</th><th>Description</th></tr>
<tr><td>4</td><td>Updated immediately (ImmedUpd)</td><td>The present segment overrides the previous segment, which means the previous segment will be interrupted so as to execute present segment. See " Special mode" on page 118Special Modes for details.</td></tr>
<tr><td>5</td><td>Loading next segment (Auto)</td><td>The next process segment applies after the constant speed is reached and the DelayTime elapses.</td></tr>
<tr><td>6</td><td>Unit</td><td>0: 0.1 rpm
1: PPS (pulses/s) (reference unit)</td></tr>
<tr><td>7</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>11–8</td><td>AccTime</td><td rowspan="2">Index of the acceleration/deceleration time
Index H22.35 to H22.42.</td></tr>
<tr><td>15–12</td><td>DecTime</td></tr>
<tr><td>19–16</td><td>…</td><td>-</td></tr>
<tr><td>23–20</td><td>DelayTime</td><td>Index of the interval time after the process segment is done executing
Index H22.51 to H22.58.</td></tr>
<tr><td>27–24</td><td>-</td><td>-</td></tr>
<tr><td>31–28</td><td>-</td><td>-</td></tr>
</table>

<table>
<tr><th colspan="2">Process segment data</th></tr>
<tr><th>bit</th><th>Value</th></tr>
<tr><td>31–0</td><td>Target speed (accurate to 0.1 RPM)</td></tr>
</table>

Where:

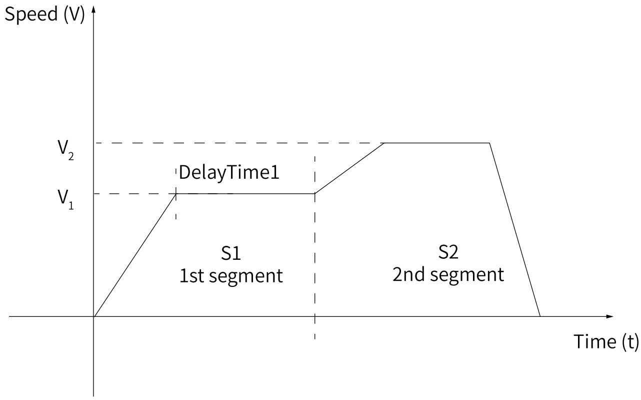


Figure 3-5 Time-Speed curve

Segment 1: Constant speed mode; DelayTime1: Time interval set for the constant speed mode; V_1: Speed set for the constant speed mode

Segment 2: Positioning mode; V_2: Speed set for the positioning mode

S1 represents displacement 1 and S2 represents displacement 2.

Positioning mode

Modes 2 and 3 indicate positioning mode. In mode 2, the servo drive stops after positioning is done. In mode 3, the next segment will be executed after positioning is done.

When positioning mode is in progress, the motor accelerates or decelerates at present speed to the set speed based on the set acceleration/deceleration time. After operating at constant speed for a period of time, the motor decelerates to 0 rpm based on the set deceleration time. Finally, the motor stops at the position set by the positioning mode.

<table>
<tr><th colspan="3">Definition of process segment</th></tr>
<tr><th>bit</th><th>Description</th><th>Value</th></tr>
<tr><td>3–0</td><td>Mode</td><td>Positioning mode 2: Stopped after positioning is done
Position mode 3: Executing the next segment after positioning is done</td></tr>
<tr><td>7–4</td><td>Func</td><td><table>
<tr><th>bit</th><th>Description</th><th>Description</th></tr>
<tr><td>4</td><td>Updated immediately (ImmedUpd)</td><td>The present segment overrides the previous segment, which means the previous segment will be interrupted so as to execute present segment. See " Special mode" on page 118Special Modes for details.</td></tr>
<tr><td>5</td><td>Overlap (OverLap)</td><td>The present segment can overlap with the next segment. During overlapping, the interval time of present segment is set to 0 forcibly. See " Special mode" on page 118Special Modes for details.</td></tr>
<tr><td>6</td><td rowspan="2">Position reference type (CmdType)</td><td rowspan="2">Bit6 and bit7 set to 00: Absolute positioning command (Final position = Target position)
Bit6 and bit7 set to 10: Incremental positioning command (Final position = Previous final position + Target position)</td></tr>
<tr><td>7</td></tr>
</table></td></tr>
<tr><td>11–8</td><td>AccTime</td><td rowspan="2">Index of the acceleration/deceleration time
Index H22.35 to H22.42.</td></tr>
<tr><td>15–12</td><td>DecTime</td></tr>
<tr><td>19–16</td><td>SpdSet</td><td>Index of the speed setpoint
Index H22.19 to H22.26.</td></tr>
<tr><td>23–20</td><td>DelayTime</td><td>Index of the interval time after the process segment is done executing
Index H22.51 to H22.58.</td></tr>
<tr><td>27–24</td><td>-</td><td>-</td></tr>
<tr><td>31–28</td><td>-</td><td>-</td></tr>
</table>

<table>
<tr><th colspan="2">Process segment data</th></tr>
<tr><th>bit</th><th>Value</th></tr>
<tr><td>31–0</td><td>Target position (32-bit) (reference unit)</td></tr>
</table>

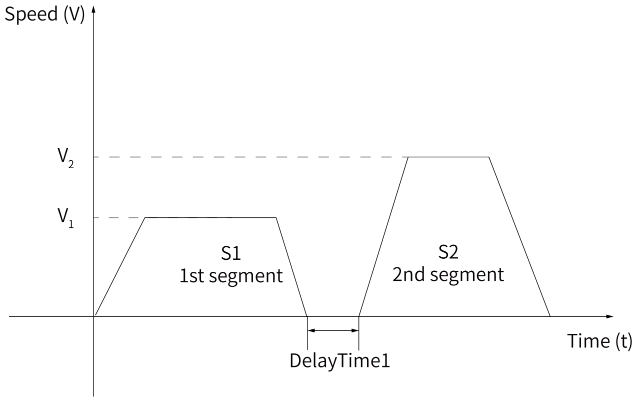


Figure 3-6 Time-Speed curve

Segment 1: positioning mode; Mode = 3; OverLap = 0; Delaytime1: interval time set for the positioning mode; V_1: speed set for the positioning mode.

Segment 2: positioning mode; Mode = 2; ImmedUpd = 0; V_2: speed set for the positioning mode.

S1 represents displacement 1 and S2 represents displacement 2.

Jump mode

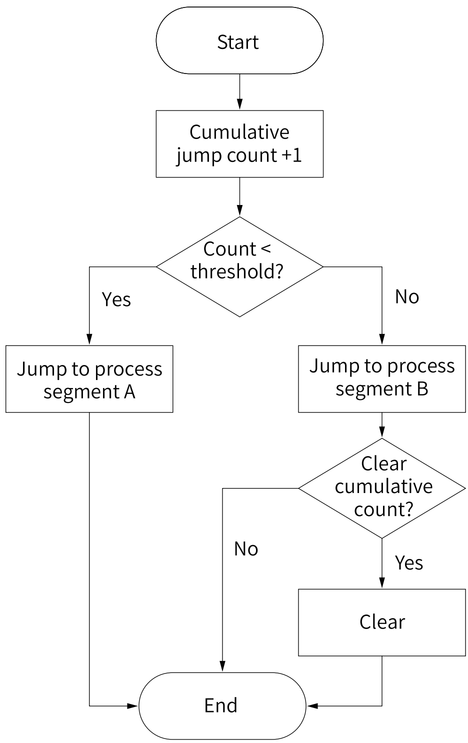
Mode 7 represents the jump mode. When the jump mode is in progress, the servo drive can jump to any process segment. When the target process segment exceeds the process segment range, E126.0 occurs.

Definition of process segment		
bit	Description	Value
3–0	Mode	7
4	Updated immediately (ImmedUpd)	The present segment overrides the previous segment, which means the previous segment will be interrupted so as to execute present segment. See *" Special mode" on page 118Special Modes* for details.
8–5	Jump evaluation threshold	Jump evaluation threshold index. Index H22.83 to H22.90.
9	Clear the cumulative count flag when jumping to process segment B	1: Clear the cumulative jump count when jumping to process segment B
19–10	-	-

Definition of process segment		
bit	Description	Value
23–20	DelayTime	Index of the interval time after the process segment is done executing Index H22.51 to H22.58.
31–24	-	-

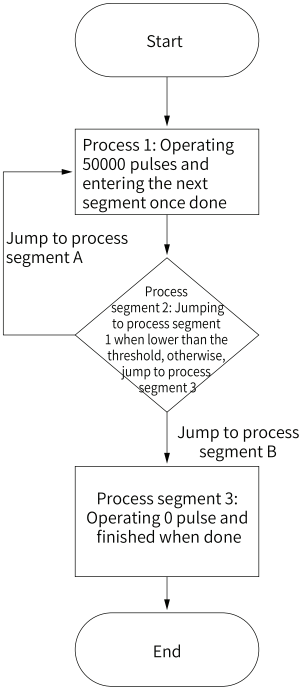
Process segment data	
bit	Value
7–0	Process segment B number
15–8	Process segment A number
31–0	Cumulative number of jumps

There is an evaluation condition for process segment jump. Each jump is counted to the cumulative number of jumps. When the counted number of jumps is smaller than this value, it will jump to process segment A, otherwise it will jump to process segment B. When jumping to process segment B, if bit9=1, this value will be cleared. The execution flow chart is as follows:

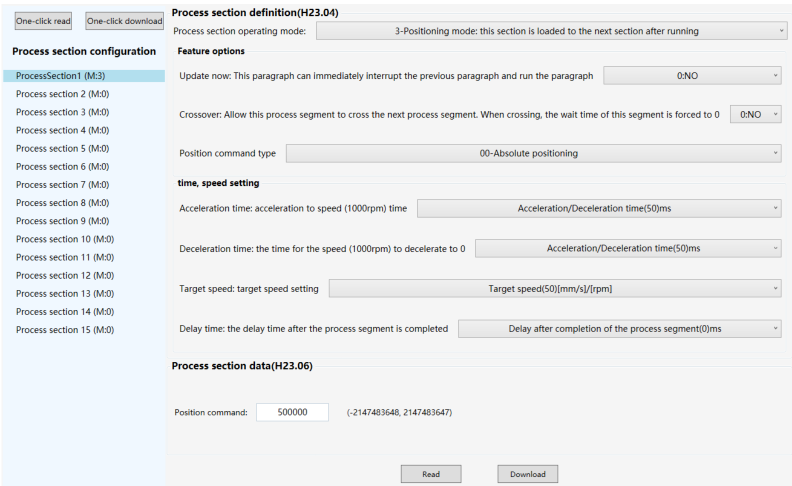


Application case

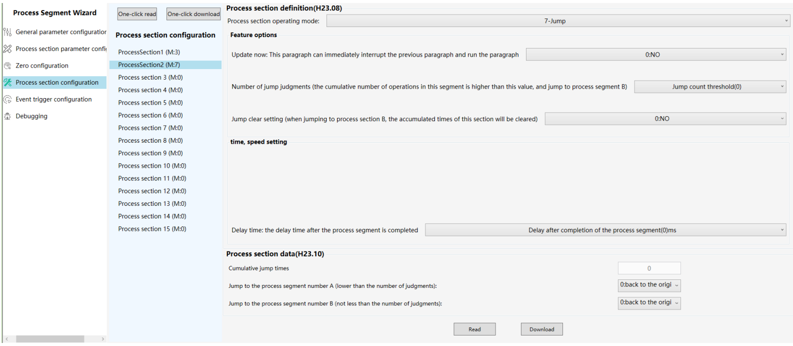
Achieving limited repetitive multi-position with process segment jump:



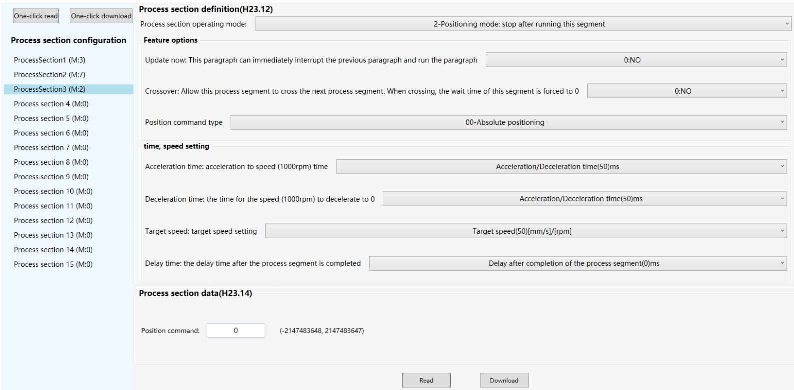
1. Configure process segment 1 to position mode, and run 50000pulse forward.



2. Configure process segment 2 to use jump.



3. Configure process segment 3 to positioning mode, and finish operation.



Parameter-write mode

Mode 8 represents the parameter-write mode. When parameter-write mode is in progress, you can re-write new parameters to the designated parameters and the new parameter can be saved to EEPROM as needed.

<table>
<tr><th colspan="3">Definition of process segment</th></tr>
<tr><th>bit</th><th>Description</th><th>Value</th></tr>
<tr><td>3–0</td><td>Mode</td><td>8</td></tr>
<tr><td>7–4</td><td>Func</td><td>
<table>
<tr><th>bit</th><th>Description</th><th>Description</th></tr>
<tr><td>4</td><td>Updated immediately (ImmedUpd)</td><td>The present segment overrides the previous segment, which means the previous segment will be interrupted so as to execute present segment. See " Special mode" on page 118Special Modes for details.</td></tr>
<tr><td>5</td><td>Loading next segment (Auto)</td><td>The next process segment applies after the DelayTime elapses.</td></tr>
<tr><td>6</td><td>Save (Save)</td><td>0: Do not save
1: Save</td></tr>
<tr><td>7</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>11–8</td><td rowspan="2">No. (H_Idx)</td><td rowspan="2">Parameter number</td></tr>
<tr><td>15–12</td></tr>
<tr><td>19–16</td><td rowspan="2">Tag group (H_Grp)</td><td rowspan="2">Group</td></tr>
<tr><td>23–20</td></tr>
<tr><td>27–24</td><td>DelayTime</td><td>Index of the interval time after the process segment is done executing
Index H22.51 to H22.58.</td></tr>
<tr><td>31–28</td><td>-</td><td>-</td></tr>
</table>

Process segment data	
bit	Value
31–0	Designated parameter data (32-bit)

Halt mode

During operation of the process segment (positioning mode, constant speed mode, or homing mode), if 1000 is written to H22.00 or FunIN.55 (PrSuspend) is triggered, the motor interrupts present operation mode immediately and ramps to stop based on the deceleration time defined by H22.03. After stop, the motor keeps enabled and stays at a standstill. When the process segment is triggered again, the motor resumes normal operation.

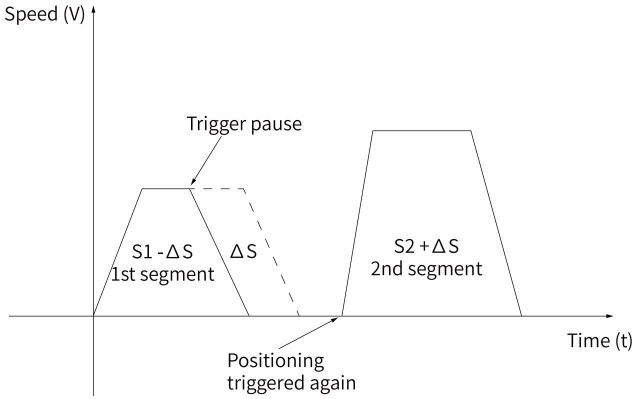


Figure 3-7 Time-Speed curve

Segment 1: positioning mode (The motor ramps to stop when pause is triggered during operation.)

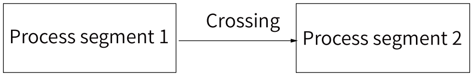
Segment 2: Positioning mode

S1 represents the set displacement 1. S2 represents the set displacement 2. ΔS represents the remaining displacement after stop at specified position.

Special mode

ImmedUpd and OverLap functions are special functions which serve to generate complex process segment paths once triggered.

- **Overlap (OverLap)**
  When the overlap function is in progress, the present process segment can overlap with the next process segment. During overlapping, the interval time of present segment is set to 0 forcibly. The overlap function can be used in positioning control only.



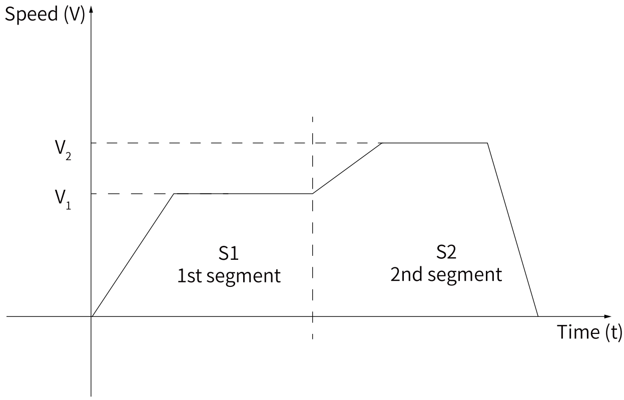


Figure 3-8 Time-Speed curve

Segment 1: positioning mode; Mode = 3; OverLap = 1; V_1: speed set for the positioning mode.

Segment 2: positioning mode; ImmedUpd = 0; V_2: speed set for the positioning mode.

S1 represents the displacement for segment 1 and S2 represents the displacement for segment 2.

- **Updated immediately (ImmedUpd)**
  When the ImmedUpd mode is in progress, the present segment overrides the previous segment, which means the previous segment will be interrupted so as to execute present segment. The ImmedUpd mode can be used in positioning control and constant speed control.

The ImmedUpd mode can be further divided into internal ImmedUpd mode and external ImmedUpd mode.

- Internal ImmedUpd mode

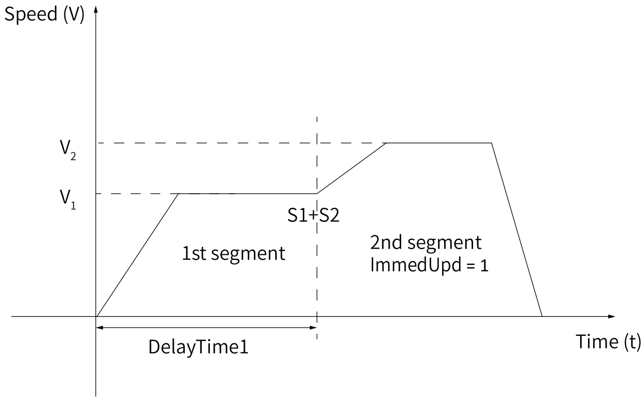


Figure 3-9 Time-Speed curve

Segment 1: positioning mode; Mode = 3; Delaytime1: interval time set for the positioning mode; V_1: speed set for the positioning mode

Segment 2: ImmedUpd = 1, V_2: speed set for segment 2

If segment 2 is positioning mode, S1 is the displacement for segment 1, and S2 is the displacement for segment 2, then the final positioning position is the sum of S1 and S2.

- External ImmedUpd mode

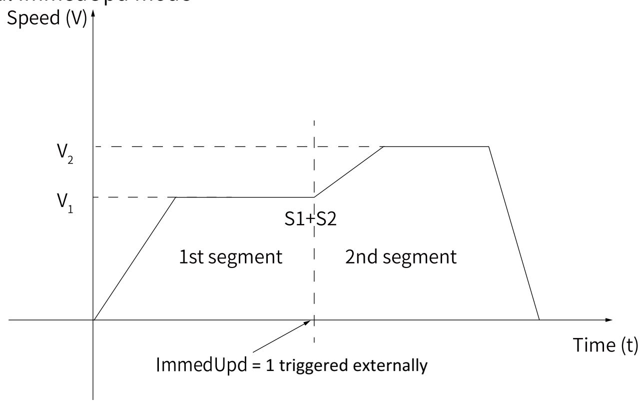


Figure 3-10 Time-Speed curve

Segment 1: positioning mode; V_1: speed set for the positioning mode

Segment 2: ImmedUpd = 1, V_2: speed set for segment 2

If segment 2 is positioning mode, S1 is the displacement for segment 1, and S2 is the displacement for segment 2, then the final positioning position is the sum of S1 and S2.

Note

- The ImmedUpd function has higher priority over the overlap function, which means when the overlap function is set for process segment 1 and the ImmedUpd function is set for process segment 2, the ImmedUpd function will be executed immediately when process segments 1 and 2 are in progress.
- The external ImmedUpd function has higher priority over the internal ImmedUpd function.

3.4.4 DO and Sequence

FunOUT.22 (CmdOK, internal command completed) can be used to check whether the process segment command is done transmitting. FunOUT.5 (COIN, positioning completed) can be used to check whether positioning is done. FunOUT.24 (McOk, motion control completed) can be used to check whether motion control is done.

The sequence for process segment is shown as follows (taking positioning mode and H05.20 = 0 as example):

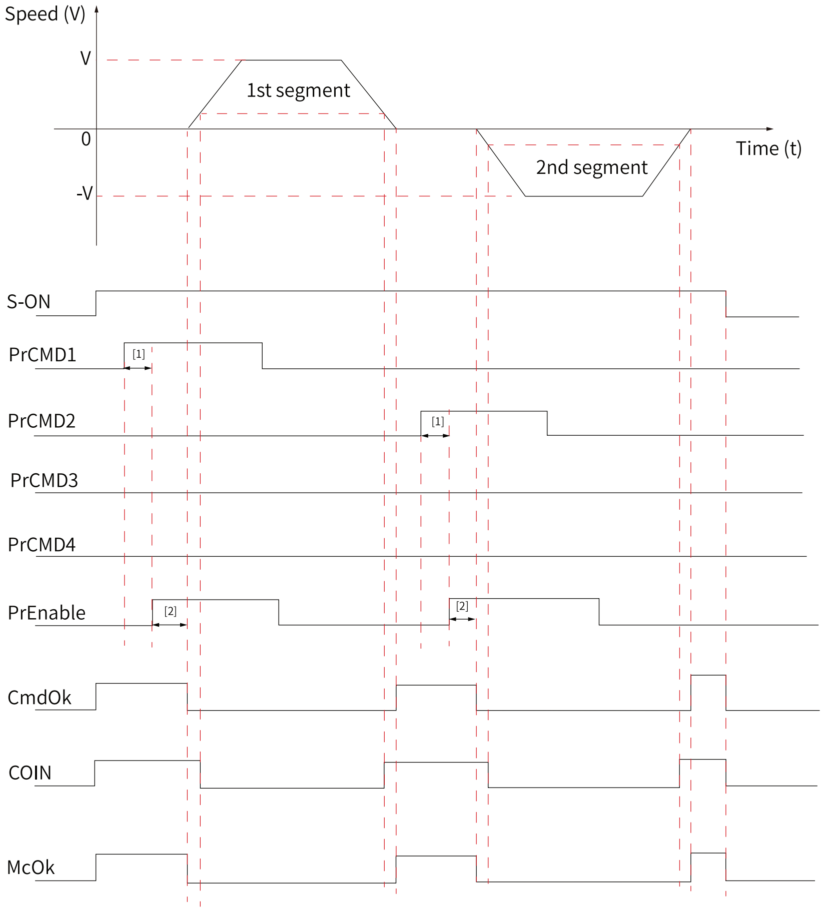


Figure 3-11 Sequence of process segment

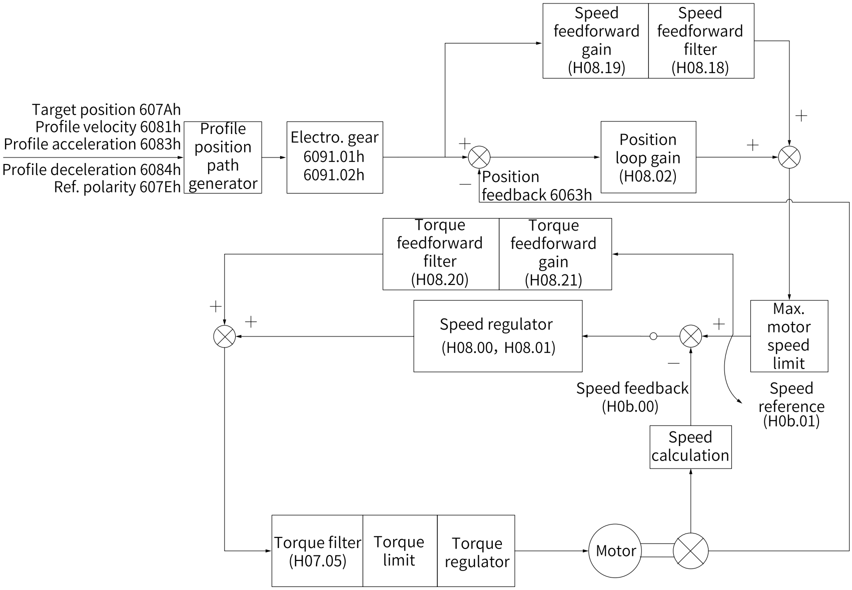
Note

- [1] When DI is used, the effective signal width of the DI must be at least 0.125 ms.
- [2] The PrEnable signal is edge-triggered. The effective signal width of the DI must be at least 0.125 ms.

3.5 Profile Position Mode (PP)

The PP mode mainly applies to point-to-point positioning. In PP mode, the host controller sets the target position, operating speed, acceleration rate, and deceleration rate. The position profile generator inside the servo drive generates position profiles based on preceding settings, and the servo drive executes position control, speed control, and torque control.

3.5.1 Function Block Diagram



3.5.2 Configuration Block Diagram

Profile position mode (6060h = 1)

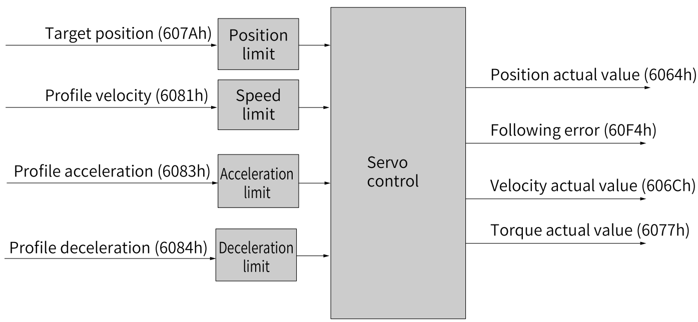


Figure 3-12 PP mode

In PP mode, the target position is triggered and activated based on the sequence of bit4 (New setpoint) of the control word and bit12 (Set-point acknowledge) of the status word.

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. After the controller sets the New set-point to 0, 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, which is called sequential mode. When bit5 is set to 0 (Single-point mode), zero-cross linkage applies to position references, which is called single-point mode.

Sequential mode:

The target position of present segment is in the process of positioning. After the new target position is generated, the controller sets bit4 (New set-point) of the control word to 1, and the servo drive executes positioning towards the new target position.

In the sequential mode, the sequence of bit4 (New set-point) of the control word and bit12 (Set-point acknowledge) of the status word is as follows.

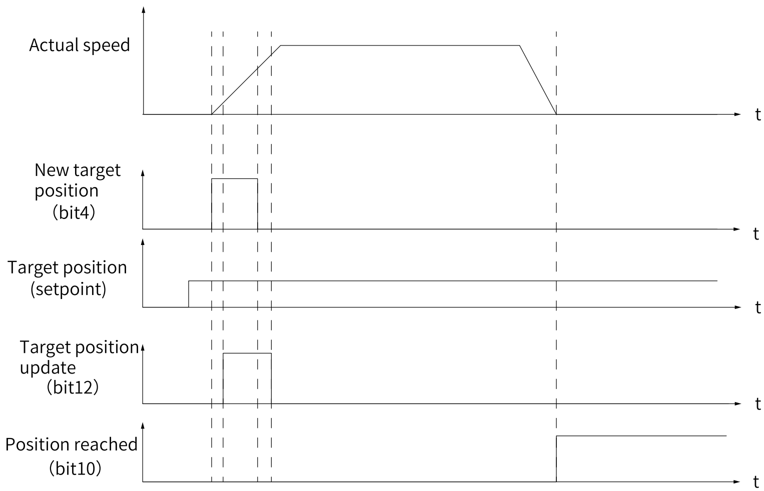
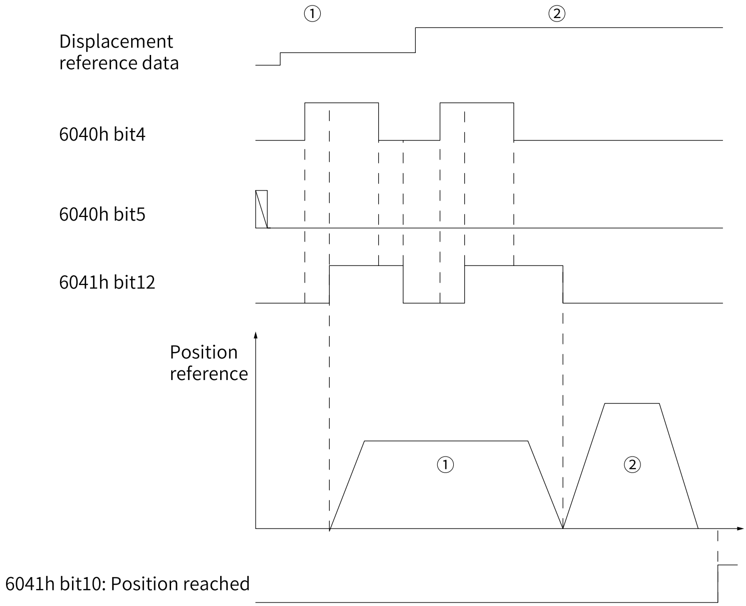


Figure 3-13 Sequence in sequential mode

Single-point mode:

The target position of present segment is in the process of positioning. After the new target position is prepared, 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.

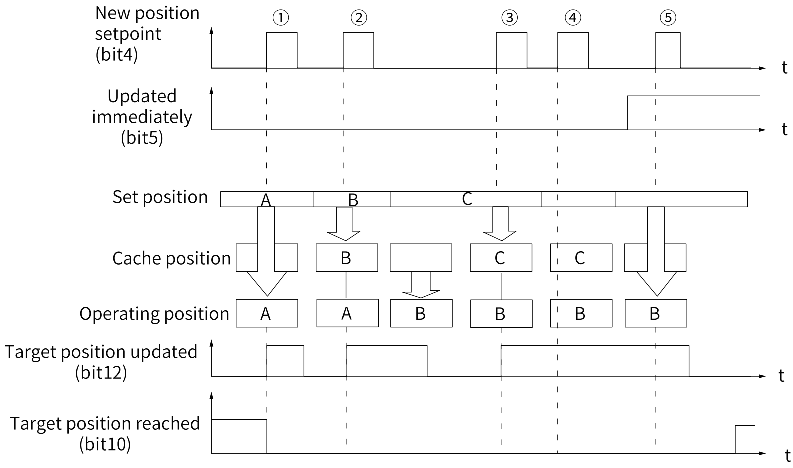
The sequence of bit4 (New set-point) of the control word and bit12 (Set-point acknowledge) of the status word is as follows.



Note: If you need to change any parameter of the displacement reference, send the trigger signal again.

Figure 3-14 Sequence in the single-point mode

In the single-point mode, the drive caches one target position, which is to cache a new segment of target position when current target position is under execution. The sequence diagram is as follows.



- ① If the cache position is empty, the set position will be executed immediately.
- ②③ If a position reference is under execution currently, the new position setpoint will be saved in the cache. After current position reference is done transmitting, the cached setpoint will be executed, after which a new setpoint can be received.
- ④⑤ The new setpoints cannot be received if the cache is full. In this case, you can set the attribute bit (Change set immediately) of the set value to 1 to activate the set value.

3.5.3 Recommended Configuration

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

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
607Ah: target position	6064h: position actual value	Mandatory
6081h: profile velocity	-	Mandatory
6083h: profile acceleration	-	Optional
6084h: profile deceleration	-	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

3.5.4 Related Parameters

6040h Control word

Address: 6040h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16

Default: 0x0 | Change: Real-time

Access: RW | Mapping: RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	S-ON	Switch on	1: Active, 0: Inactive
1	Enable voltage	Enable voltage	1: Active, 0: Inactive
2	Quick stop	Quick stop	0: Active, 1: Inactive
3	Servo ON	Enable operation	1: Active, 0: Inactive
4	New set-point	New set-point	0→1: Trigger new target position 1→0: clear bit12 of the status word
5	Change set immediately	Change set immediately	0: Not immediately 1: Immediately
6	abs/rel	abs/rel	0: abs 1: rel
8	Halt	Halt	0: Keep running 1: Halt

6041h **Status word**

Address: 6041h

Min.: 0x0 | Unit: -

Max.: 0xFFFF | Data Type: UInt16

Default: 0x0 | Change: Unchangeable

Access: RO | Mapping: TPDO

Setpoint:

-

Description:

Indicates the servo drive status.

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Active, 0: Inactive
1	Switch on	Switch on	1: Active, 0: Inactive
2	Operation enabled	Operation enabled	1: Active, 0: Inactive
3	Fault	Fault	1: Active, 0: Inactive
4	Voltage enabled	Voltage enabled	1: Active, 0: Inactive
5	Quick stop	Quick stop	0: Active, 1: Inactive

bit	Name		Description
6	Switch on disabled	Switch on disabled	1: Active, 0: Inactive
7	Alarm	Alarm	1: Active, 0: Inactive
8	Manufacturer-specific	Manufacturer-specific	Undefined
9	Remote	Remote	1: Active, control word effective 0: Inactive
10	Target reach	Target reach	0: The target position is not reached. 1: The target position is reached.
11	Internal limit active	Internal limit active	0: Position reference within the limit 1: Position reference beyond the limit
12	Set-point acknowledge	Set-point acknowledge	0: Acknowledged 1: Not acknowledged
13	Following error	Following error	0: No error 1: Excessive deviation
14	Manufacturer-specific	Manufacturer-specific	Undefined
15	Home find	Home find	0: Homing completed 1: Homing done

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (pv) 4: Profile torque mode (pt) 6: Homing mode (hm) 7: Interpolation mode (ip) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (pv) 4: Profile torque mode (pt) 6: Homing mode (hm) 7: Interpolation mode (ip) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable
6064h	6064h	Position actual value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
6065h	6065h	Following error window	0 to 4294967295	219895614	Reference unit	Real-time
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time
6067h	6067h	Position window	0 to 4294967295	46976	Reference unit	Real-time
6068h	6068h	Position window time	0 ms–65535 ms	0	ms	Real-time
607Ah	607Ah	Target position	-2147483648 to 2147483647	0	Reference unit	Real-time
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6081h	6081h	Profile velocity	0 to 4294967295	111848106	Reference unit/s	Real-time
6083h	6083h	Profile acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
6084h	6084h	Profile deceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time

3.5.5 Related Functions

Positioning completed

Positioning completed: When 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:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6067h	6067h	Position window	0 to 4294967295	46976	Refer ence unit	Real-time
6068h	6068h	Position window time	0 ms–65535 ms	0	ms	Real-time

Note

6067h only reflects the threshold of absolute position deviation when positioning is done. It is not related to the positioning accuracy.

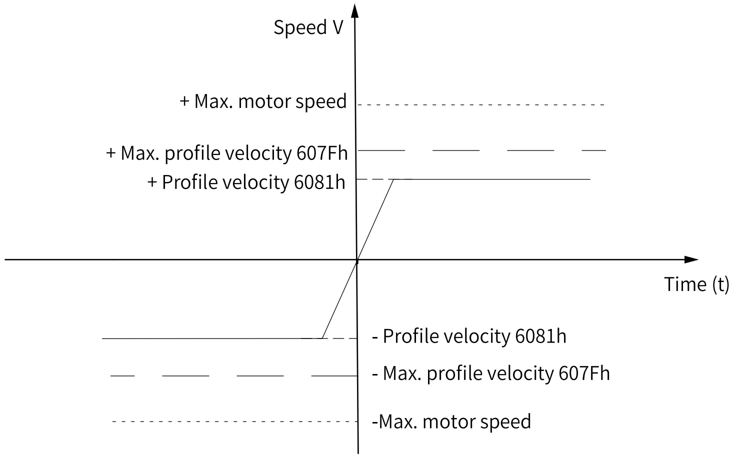
Position deviation monitoring function

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6065h	6065h	Following error window	0 to 4294967295	219895614	Refer ence unit	Real-time
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time

Speed limit

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



☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

Acceleration and deceleration limits

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

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6083h	6083h	Profile acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
6084h	6084h	Profile deceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time

Reference polarity

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

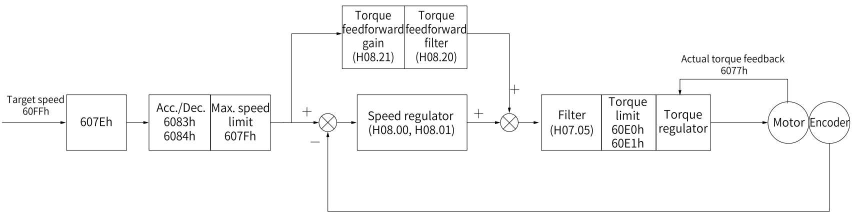
☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

3.6 Profile Velocity Mode (PV)

In PV mode, the host controller sends the target speed, acceleration rate, and deceleration rate to the servo drive. The servo drive generates speed reference profiles and executes speed control and torque control.

3.6.1 Function Block Diagram



3.6.2 Configuration Block Diagram

Profile velocity mode (6060h=3)

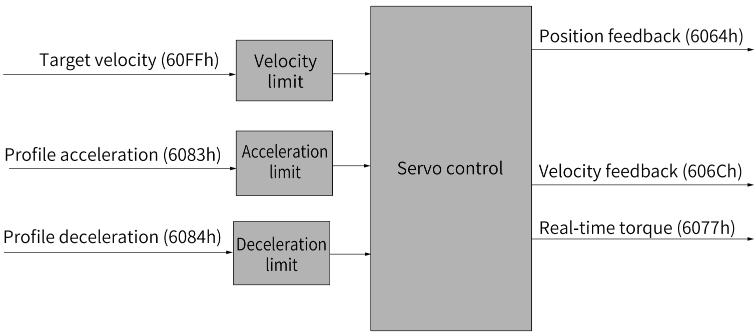


Figure 3-15 PV mode

3.6.3 Recommended Configuration

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

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
60FFh: target velocity	-	Mandatory
-	6064h: position actual value	Optional
-	606Ch: velocity actual value	Optional
6083h: profile acceleration	-	Optional
6084h: profile deceleration	-	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

3.6.4 Related Parameters

6040h **Control word**

Address: 6040h

Min.: 0x0 | Unit: -

Max.: 0xFFFF | Data Type: UInt16

Default: 0x0 | Change: Real-time

Access: RW | Mapping: RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	S-ON	Switch on	1: Active, 0: Inactive
1	Enable voltage	Enable voltage	1: Active, 0: Inactive
2	Quick stop	Quick stop	0: Active, 1: Inactive
3	Operation enabled	Enable operation	1: Active, 0: Inactive
8	Halt	Halt	0: Keep present operating state, 1: Halt

6041h **Status word**

Address: 6041h

Min.: 0x0 | Unit: -

Max.: 0xFFFF | Data Type: UInt16

Default: 0x0 | Change: Unchangeable

Access: RO | Mapping: TPDO

Value Range:

0x0 to 0xFFFF

Description:

Indicates the servo drive status.

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Active, 0: Inactive
1	Switch on	Switch on	1: Active, 0: Inactive
2	Operation enabled	Operation enabled	1: Active, 0: Inactive
3	Fault	Fault	1: Active, 0: Inactive
4	Voltage enabled	Voltage enabled	1: Active, 0: Inactive
5	Quick stop	Quick stop	0: Active, 1: Inactive
6	Switch on disabled	Switch on disabled	1: Active, 0: Inactive
7	Alarm	Alarm	1: Active, 0: Inactive
8	Manufacturer-specific	Manufacturer-specific	Undefined
9	Remote	Remote	1: Active, control word effective 0: Inactive
10	Target reach	Target reach	0: The target velocity is not reached. 1: The target velocity is reached.
11	Internal limit active	Internal limit active	0: Position feedback within the limit 1: Position feedback beyond the limit
12	Speed	Speed	0: Speed is not 0 1: Speed is 0
13	-	N/A	N/A
14	Manufacturer-specific	Manufacturer-specific	Undefined
15	-	N/A	N/A

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
606Ch	606Ch	Actual speed	–2147483648 to +2147483647	0	Reference unit/s	Unchangeable
606Dh	606Dh	Velocity window	0[mm/s]/[rpm]–65535[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time
606Eh	606Eh	Velocity window time	0 ms–65535 ms	0	ms	Real-time
606Fh	606Fh	Zero speed signal threshold	0[mm/s]/[rpm]–65535[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time
6070h	6070h	Velocity threshold time	0 ms–65535 ms	0	ms	Real-time
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time
6083h	6083h	Profile acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
6084h	6084h	Profile deceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
60FFh	60FFh	PV, CSV mode speed reference	–2147483648 to +2147483647	0	Reference unit/s	Real-time

3.6.5 Related Functions

Monitoring on speed reach status

This function serves to check whether the speed reference of the servo drive is consistent with the motor speed feedback.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
606Dh	606Dh	Velocity window	0[mm/s]/[rpm]–65535[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time
606Eh	606Eh	Velocity window time	0 ms–65535 ms	0	ms	Real-time

Monitoring on zero speed

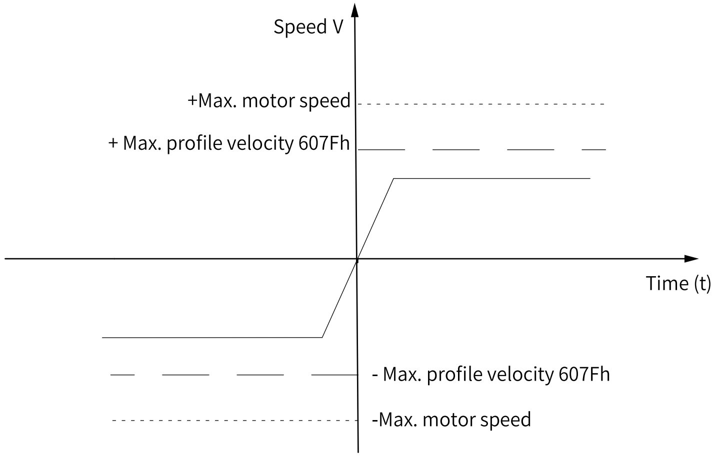
It is used to check whether the absolute value of motor speed feedback is lower than the set threshold. If yes, the motor is considered to be close to standstill (zero speed). Bit12 of 6041h is set to 1.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
606Fh	606Fh	Zero speed signal threshold	0[mm/s]/[rpm]–65535[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time
6070h	6070h	Velocity threshold time	0 ms–65535 ms	0	ms	Real-time

Speed limit

In PV mode, 607Fh can be used to limit the maximum speed in forward/reverse running, but its value must not exceed the max. allowable speed of the motor.



☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

Acceleration and deceleration limits

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

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
60C5h	60C5h	Max. acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
60C6h	60C6h	Max. deceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time

Reference polarity

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

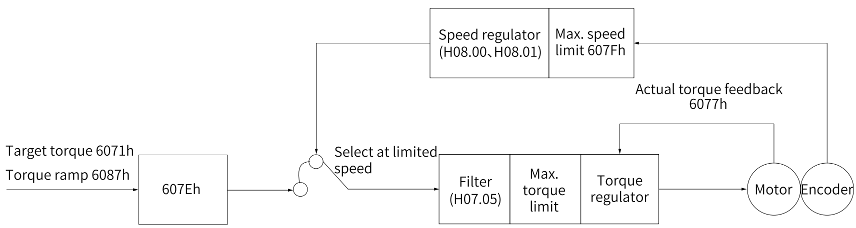
☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

3.7 Profile Torque Mode (PT)

In PT mode, the host controller sends the target torque (6071h) and the torque slope (6087h) to the servo drive. The servo drive generates torque reference profiles and executes torque control.

3.7.1 Function Block Diagram



3.7.2 Configuration Block Diagram

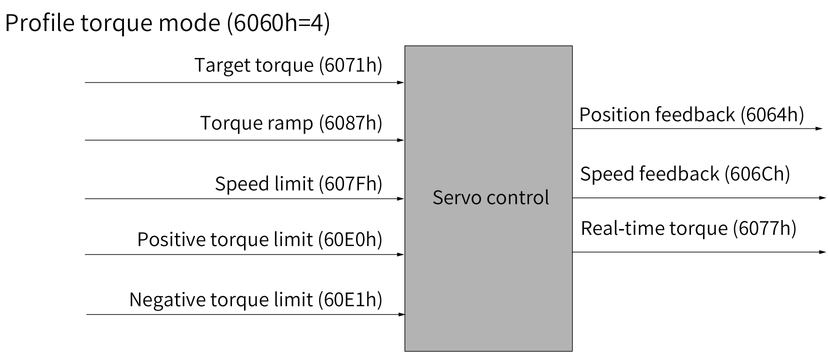


Figure 3-16 PT mode

3.7.3 Recommended Configuration

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

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
6071h: target torque	-	Mandatory
6087h: torque slope	-	Optional
-	6064h: position actual value	Optional
-	606Ch: velocity actual value	Optional
-	6077h: torque actual value	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

3.7.4 Related Parameters

6040h **Control word**

Address:	6040h		
Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Real-time
Access:	RW	Mapping:	RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	Switch on	Switch on	1: Active, 0: Inactive
1	Enable voltage	Enable voltage	1: Active, 0: Inactive
2	Quick stop	Quick stop	0: Active, 1: Inactive
3	Enable operation	Enable operation	1: Active, 0: Inactive
8	Halt	Halt	0: Keep present operating state, 1: Halt

6041h **Status word**

Address:	6041h		
Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Unchangeable
Access:	RO	Mapping:	TPDO

Value Range:
0x0 to 0xFFFF
Description:
Indicates the servo drive status.

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Active, 0: Inactive
1	Switch on	Switch on	1: Active, 0: Inactive
2	Enable operation	Operation enabled	1: Active, 0: Inactive
3	Fault	Fault	1: Active, 0: Inactive
4	Voltage enabled	Voltage enabled	1: Active, 0: Inactive
5	Quick stop	Quick stop	0: Active, 1: Inactive
6	Switch on disabled	Switch on disabled	1: Active, 0: Inactive
7	Alarm	Alarm	1: Active, 0: Inactive
8	Manufacturer-specific	Manufacturer-specific	Undefined
9	Remote	Remote	1: Active, control word effective 0: Inactive
10	Target reach	Target reach	0: Target torque not reached 1: Target torque reached
11	Internal limit active	Internal limit active	0: Position feedback within the limit 1: Position feedback beyond the limit
12–14	No assignment	N/A	No assignment, always being 0
15	-	N/A	N/A

☆ Related parameters:

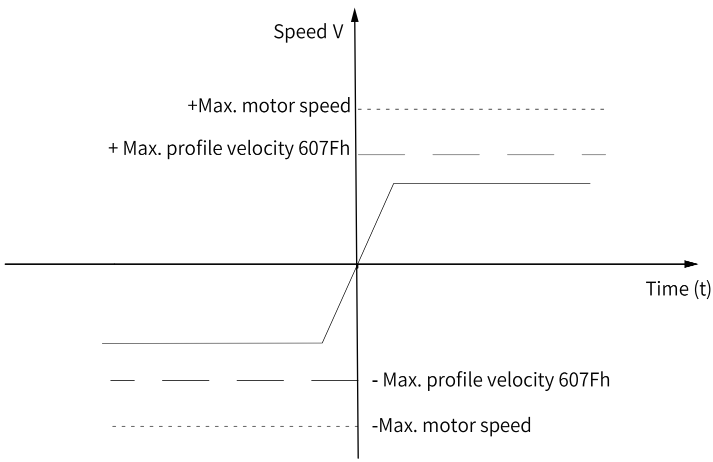
Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.17	2007-12h	Speed limit source	0: Internal speed limit 1: V-LMT 2: H07.19 or H07.20 as defined by DI Note: For SV680P-INT, the parameter takes effect when H02.00 is not 8. For SV680N-INT, the parameter takes effect when H02.00 is not 9.	0	-	Real-time
6060h	6060h	Servo drive mode	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable
6071h	6071h	Target torque	-4000.%–4000.%	0	0.10%	Real-time
6072h	6072h	Max. torque reference	0.%–4000.%	3500	0.10%	Real-time
6074h	6074h	Torque reference	-4000.%–4000.%	0	0.10%	Unchangeable
6077h	6077h	Actual torque	-4000.%–4000.%	0	0.10%	Unchangeable
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6087h	6087h	Torque slope	0%/S to 4294967295%/s	4294967295	0.1%/s	Real-time
60E0h	60E0h	Positive torque limit	0.%–4000.%	3500 Note: For model N, the default value is 3000.	0.10%	Real-time
60E1h	60E1h	Negative torque limit	0.%–4000.%	3500 Note: For model N, the default value is 3000.	0.10%	Real-time

3.7.5 Related Functions

Speed limit in the torque control mode

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

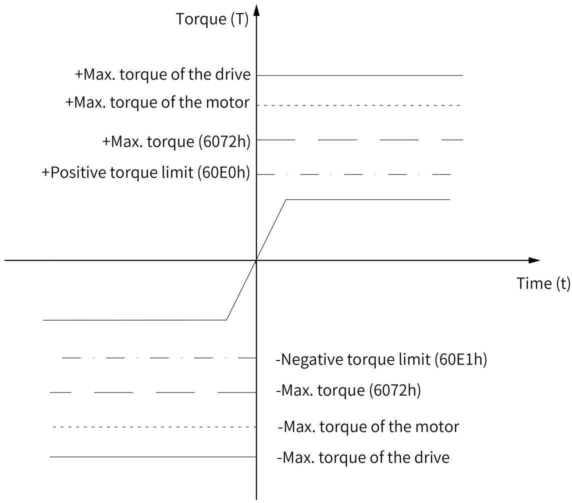


☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

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:

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
6072h	6072h	Max. torque reference	0.%–4000.%	3500	0.10%	Real-time
60E0h	60E0h	Positive torque limit	0.%–4000.%	3500 Note: For model N, the default value is 3000.	0.10%	Real-time
60E1h	60E1h	Negative torque limit	0.%–4000.%	3500 Note: For model N, the default value is 3000.	0.10%	Real-time

Torque reference polarity

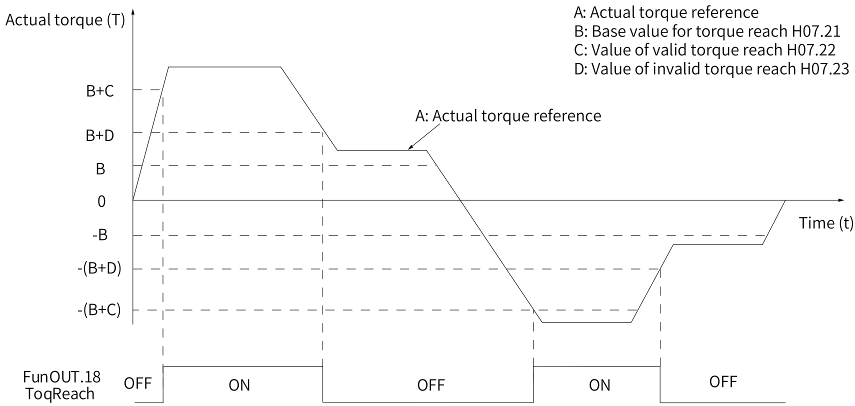
You can change the torque reference direction through setting the torque reference polarity.

☆ Related parameters:

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

Torque reach monitoring

It is used to determine whether the torque reference value reaches the set torque base value. If yes, a corresponding torque reach signal will be output to the host controller.



- Actual torque reference (viewed in H0b.02): A
- Base value for torque reach (H07.21): B
- Threshold of valid torque arrival (H07.22): C
- Threshold of invalid torque reach (H07.23): D

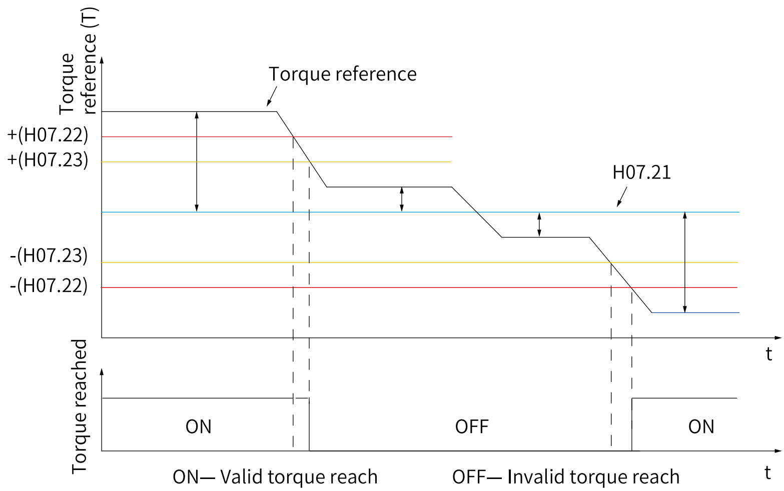
C and D are the offset based on B.

The torque reach DO signal can be activated only when the actual torque reference meets the following condition: $|A| \geqslant B + C$. Otherwise, the torque reach DO signal remains inactive.

The torque reach signal is deactivated only when the actual torque reference meets the following condition: $|A| < B + D$. Otherwise, the torque reach signal remains active.

Torque reach monitoring [N]

It is used to determine whether the torque reference value reaches the set torque base value. If yes, a corresponding torque reach signal will be output to the host controller.



If the absolute difference between the torque reference and H07.21 (Base value for torque reach) is higher than H07.22 (Threshold for valid torque reach), the torque reach signal is active. Otherwise, the original status applies.

If the absolute difference between the torque reference and H07.21 (Base value for torque reach) is lower than H07.23 (Threshold for invalid torque reach), the torque reach signal is inactive. Otherwise, the original status applies.

3.8 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.

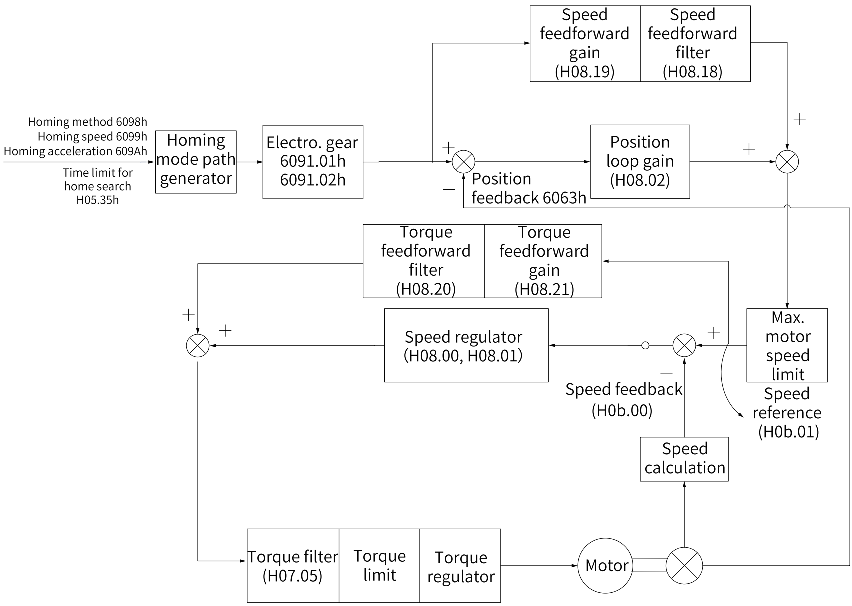
- Mechanical home: a fixed position on the machine, which corresponds to a certain home switch or the motor Z signal.
- Mechanical zero: absolute zero point on the machine

After homing is done, the motor stops at the mechanical home. The relation between the mechanical home and mechanical zero can be set in 607Ch.

Mechanical home = Mechanical zero + 607Ch (Home offset)

When 607C is 0, the mechanical home overlaps with the mechanical zero.

3.8.1 Function Block Diagram



3.8.2 Configuration Block Diagram

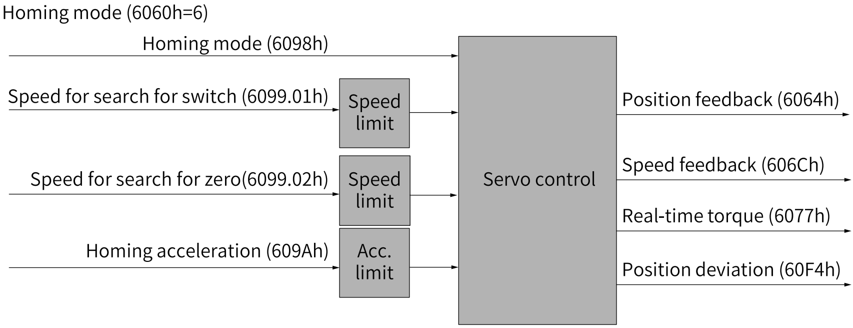


Figure 3-17 HM mode

3.8.3 Recommended Configuration

The basic configuration for the homing mode is shown in the following table.

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
6098h: homing method	-	Optional
6099.01h: speed during search for switch	-	Optional
6099.02h: speed during search for zero	-	Optional
609Ah: homing acceleration	-	Optional
-	6064h: position actual value	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

3.8.4 Related Parameters

6040h **Control word**

Address: 6040h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Real-time
Access:	RW	Mapping:	RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	Switch on	Switch on	1: Active, 0: Inactive
1	Enable voltage	Enable voltage	1: Active, 0: Inactive
2	Quick stop	Quick stop	0: Active, 1: Inactive
3	Enable operation	Enable operation	1: Active, 0: Inactive
4[1]	Enable homing	Enable homing	0→1: Start, 1→0: Stop
8	Halt	Halt	0: Keep present operating state, 1: Halt

Note

[1]: Model P has no bit 4.

6041h **Status word**

Address: 6041h

Min.: 0x0 Unit: -

Max.: 0xFFFF Data Type: UInt16

Default: 0x0 Change: Unchangeable

Access: RO Mapping: TPDO

Value Range:

0x0 to

0xFFFF

Description:

Indicates the servo drive status.

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Active, 0: Inactive
1	Switch on	Switch on	1: Active, 0: Inactive
2	Enable operation	Operation enabled	1: Active, 0: Inactive
3	Fault	Fault	1: Active, 0: Inactive
4	Voltage enabled	Voltage enabled	1: Active, 0: Inactive
5	Quick stop	Quick stop	0: Active, 1: Inactive
6	Switch on disabled	Switch on disabled	1: Active, 0: Inactive
7	Alarm	Alarm	1: Active, 0: Inactive
8	Manufacturer-specific	Manufacturer-specific	Undefined
9	Remote	Remote	1: Active, control word effective 0: Inactive

bit	Name		Description
10	Target reach	Target reach	1: Origin is found or homing is interrupted or failed 0: Disabled or home is not found[1]
11	Internal limit active	Internal limit active	0: Position reference within the limit 1: Position reference beyond the limit
12	Homing attained	Homing attained	0: Homing not attained 1: Homing attained
13	Homing error	Homing error	0: No error 1: Error is present
15	Home find	Home find	0: Homing completed 1: Homing done

Note

[1]: The value of bit 10 of model N is always 1.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	SV680P-INT 1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP) SV680N-INT 1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable
6065h	6065h	Following error window	0 to 4294967295	219895608	Reference unit	Real-time
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time
607Ch	607Ch	Home offset	-2147483648 to 2147483647	0	Reference unit	Real-time
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time
6098h	6098h	Homing method	-3–35	1	-	Real-time
6099.01h	6099-01h	Speed during search for switch	0 to 4294967295	111848106	Reference unit/s	At stop

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6099.02h	6099-02h	Speed during search for zero	0 to 4294967295	11184810	Reference unit/s	At stop
609Ah	609Ah	Homing acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
60C5h	60C5h	Max. acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time

3.8.5 Related Functions

Homing timeout

When the homing duration exceeds the value defined by H05.35 (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 are proper and whether the deceleration point signal and home signal are connected properly.

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
H05.35	2005-24h	Home search time limit	0 ms–65535 ms	10000	ms	Real-time

Actual position calculation method

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

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Ch	607Ch	Home offset	-2147483648 to 2147483647	0	Reference unit	Real-time

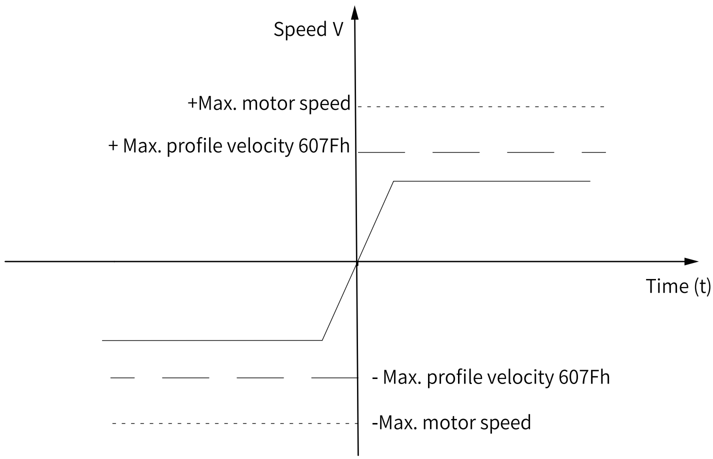
Position deviation monitoring function

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6065h	6065h	Following error window	0 to 4294967295	219895608	Reference unit	Real-time
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time

Speed limit

In HM mode, 607Fh can be used to limit the maximum speed in forward/reverse running, but its value must not exceed the max. allowable speed of the motor.



☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

Acceleration limit

In the homing mode, the change rate of position references can be limited through the acceleration limit.

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
60C5h	60C5h	Max. acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time

3.8.6 Homing Operation

Note

Evaluation conditions for torque homing:

- When 6098h=-3, after the motor reaches the hard limit, and the torque feedback reaches the limit value defined in H05.58 (mechanical limit homing torque evaluation value), the first Z signal in the reverse direction is searched for and regarded as the home after the motor stops.
- When 6098h = -2/-1, the limit value is the minimum of H05.58 (mechanical limit homing torque evaluation value), 6072h (maximum torque command), 60E0h (forward torque limit) and 60E1h (reverse torque limit).

6098h = 1

Mechanical home: motor Z signal

Deceleration point: negative limit switch

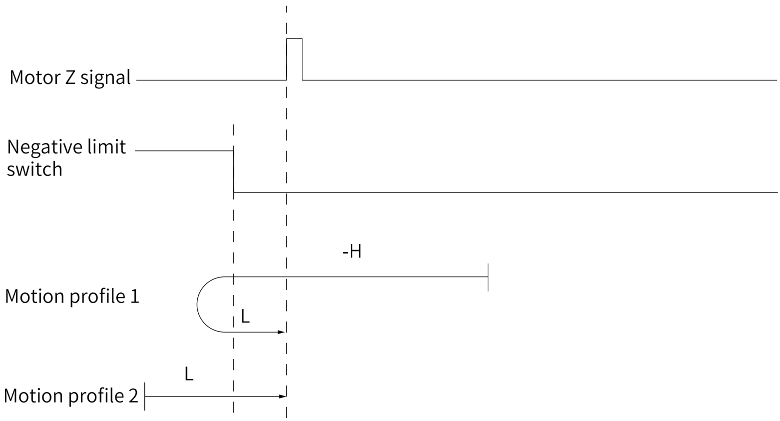


Figure 3-18 Motor running curve and speed in mode 1

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

Note

In the figure, "H" represents high speed 6099.01h, and "L" represents low speed 6099.02h, and “-” indicates reverse run.

6098h = 2

Home: Z signal

Deceleration point: positive limit switch

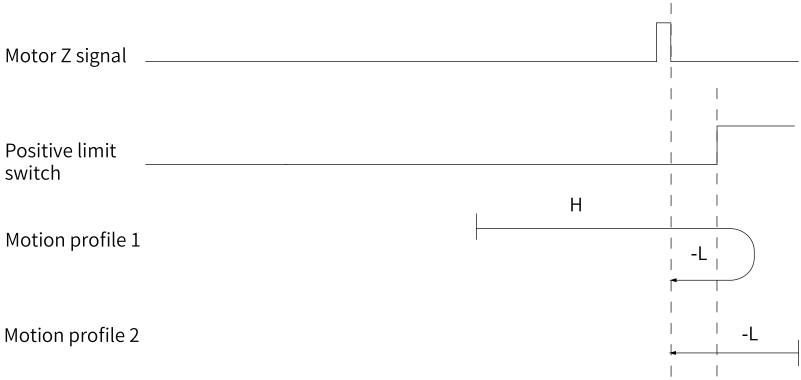


Figure 3-19 Motor running curve and speed in mode 2

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 3

Home: Z signal

Deceleration point: home switch (HW)

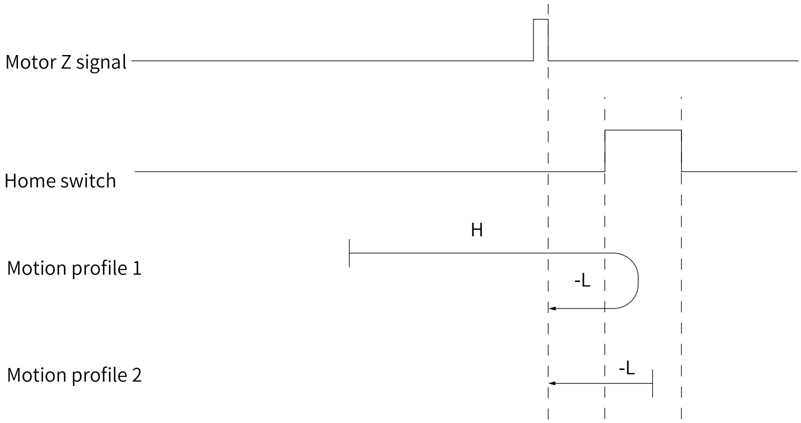


Figure 3-20 Motor running curve and speed in mode 3

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 4

Home: Z signal

Deceleration point: home switch (HW)

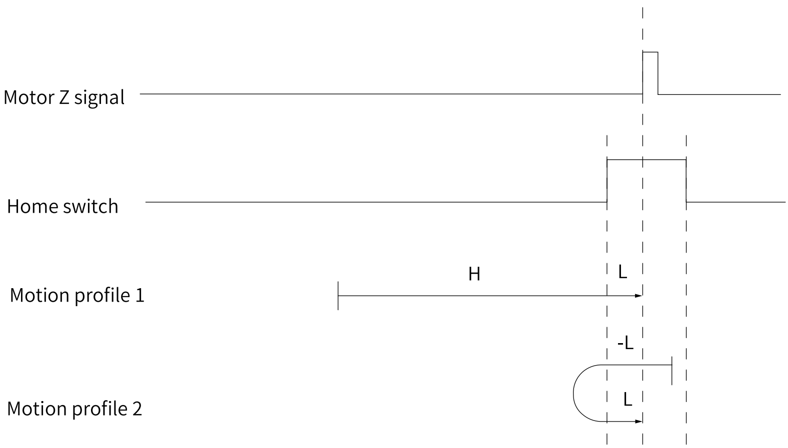


Figure 3-21 Motor running curve and speed in mode 4

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 5

Home: Z signal

Deceleration point: home switch (HW)

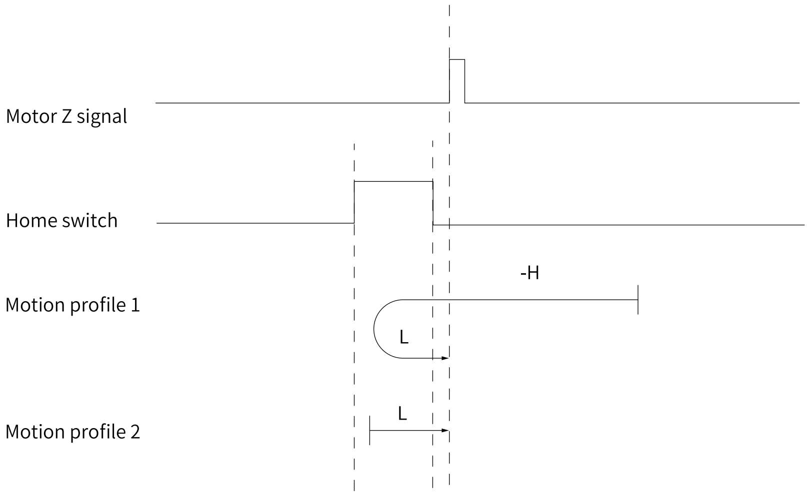


Figure 3-22 Motor running curve and speed in mode 5

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 6

Home: Z signal

Deceleration point: home switch (HW)

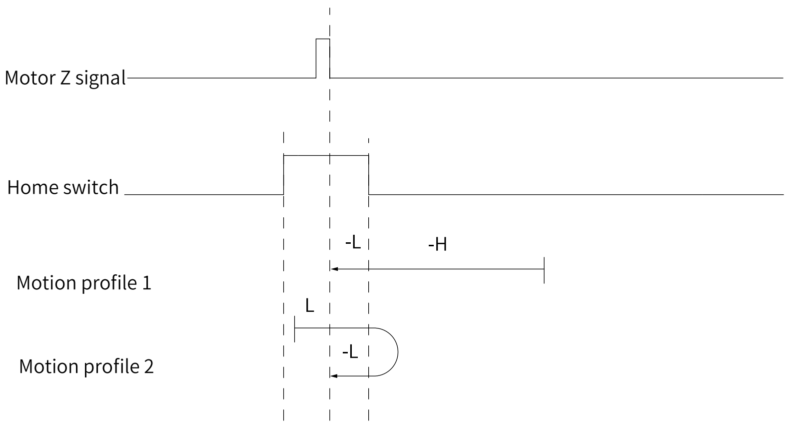


Figure 3-23 Motor running curve and speed in mode 6

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 7

Home: Z signal

Deceleration point: home switch (HW)

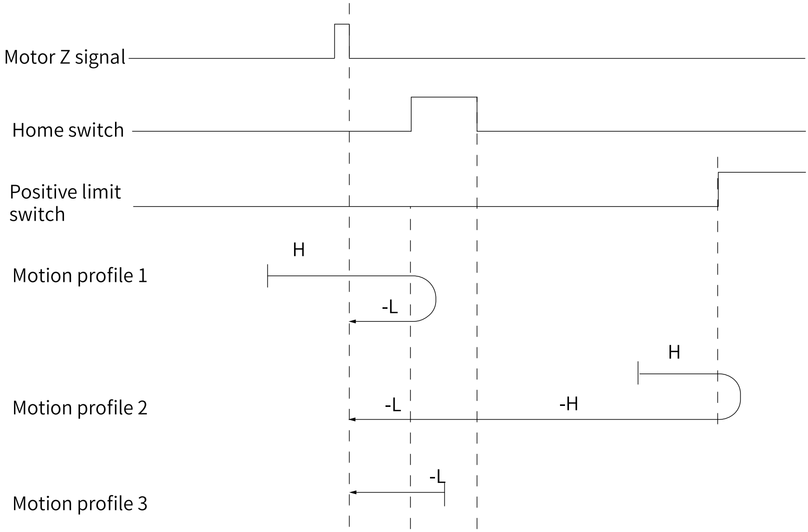


Figure 3-24 Motor running curve and speed in mode 7

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 8

Home: Z signal

Deceleration point: home switch (HW)

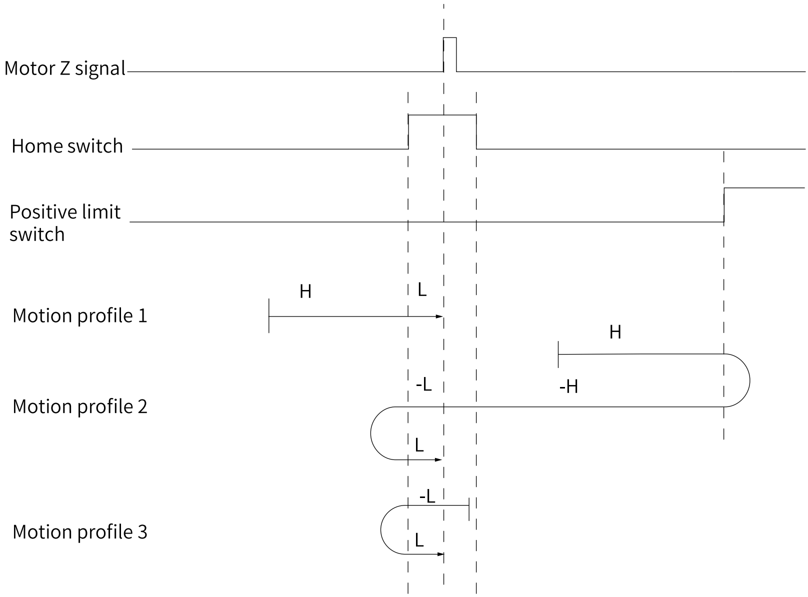


Figure 3-25 Motor running curve and speed in mode 8

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 9

Home: Z signal

Deceleration point: home switch (HW)

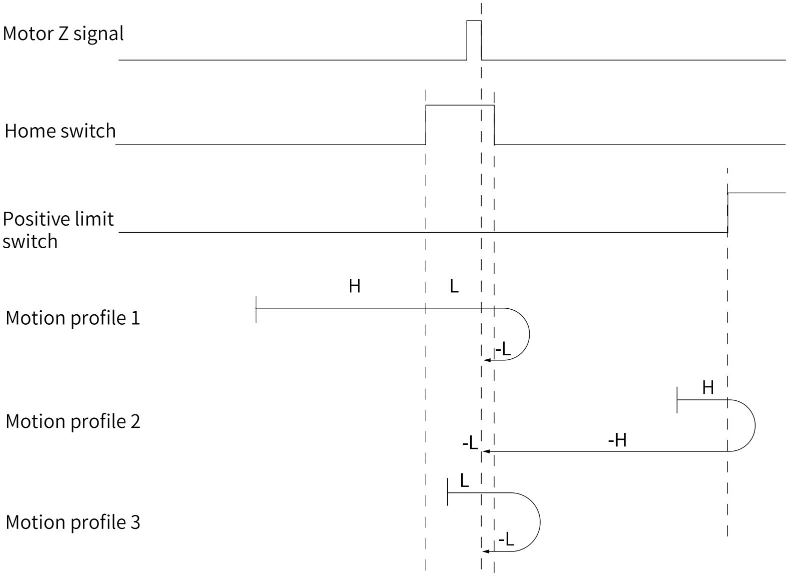


Figure 3-26 Motor running curve and speed in mode 9

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 10

Home: Z signal

Deceleration point: home switch (HW)

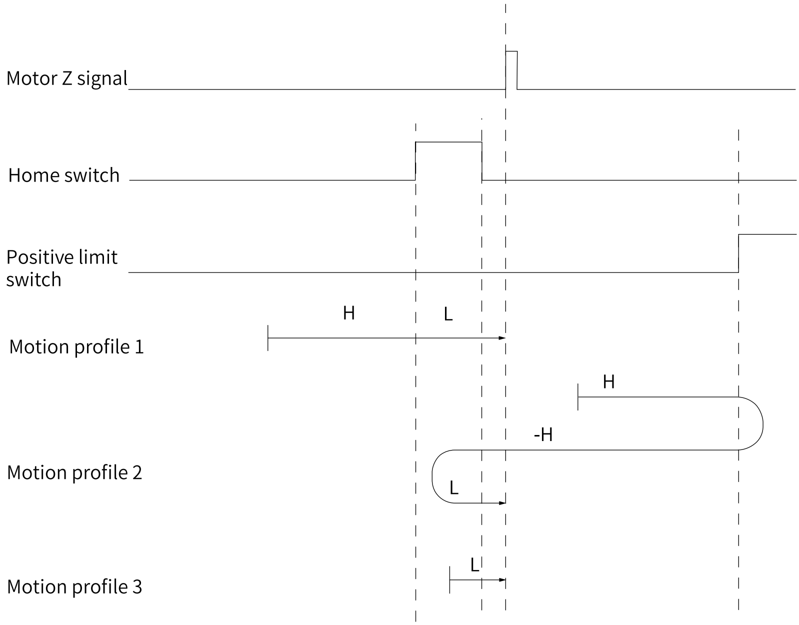


Figure 3-27 Motor running curve and speed in mode 10

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 11

Home: Z signal

Deceleration point: home switch (HW)

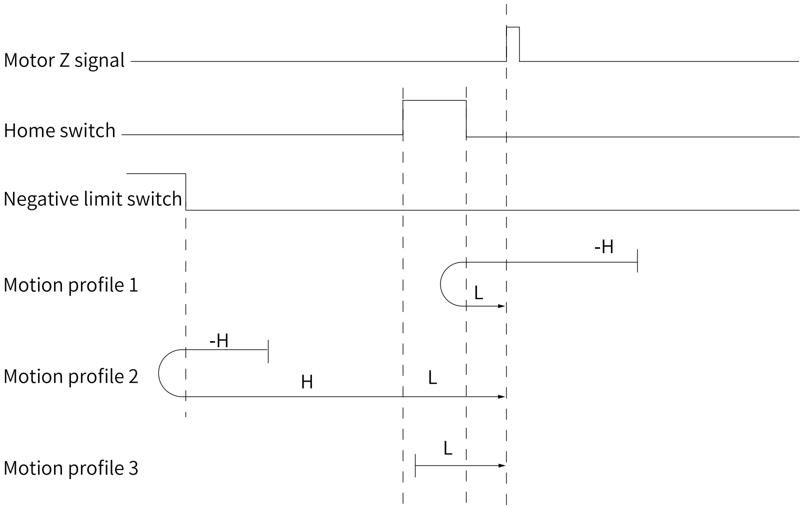


Figure 3-28 Motor running curve and speed in mode 11

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 12

Home: Z signal

Deceleration point: home switch (HW)

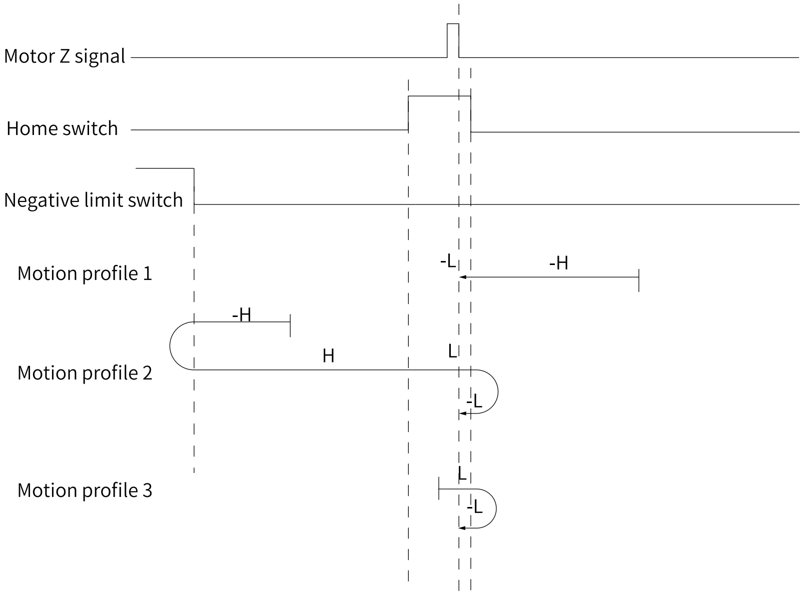


Figure 3-29 Motor running curve and speed in mode 12

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 13

Home: Z signal

Deceleration point: home switch (HW)

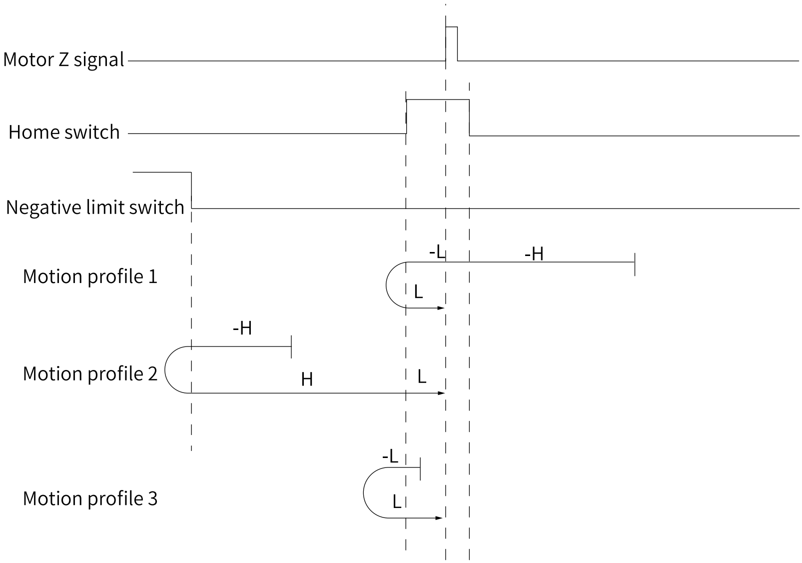


Figure 3-30 Motor running curve and speed in mode 13

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 14

Home: Z signal

Deceleration point: home switch (HW)

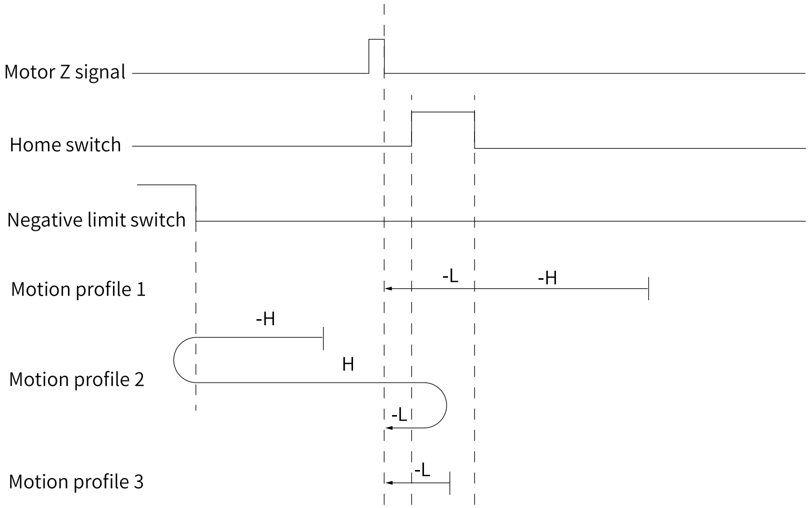


Figure 3-31 Motor running curve and speed in mode 14

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 17

Home: negative limit switch

Deceleration point: negative limit switch

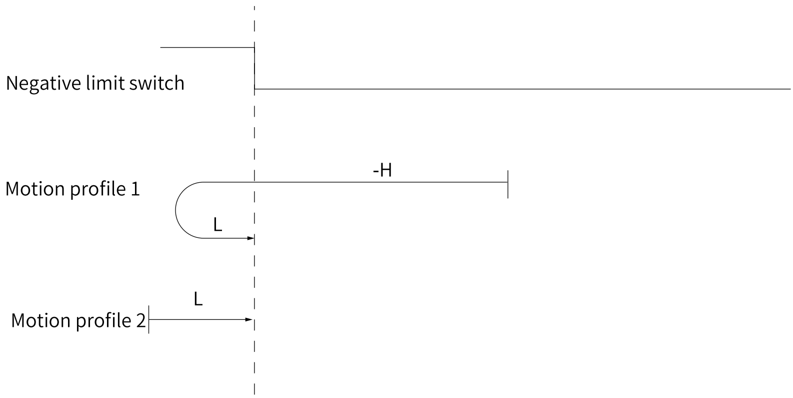


Figure 3-32 Motor running curve and speed in mode 17

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 18

Home: positive limit switch

Deceleration point: positive limit switch

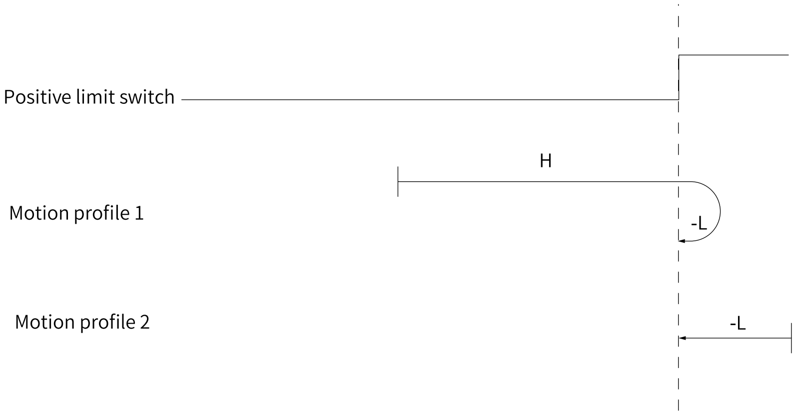


Figure 3-33 Motor running curve and speed in mode 18

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 19

Home: home switch (HW)

Deceleration point: home switch (HW)

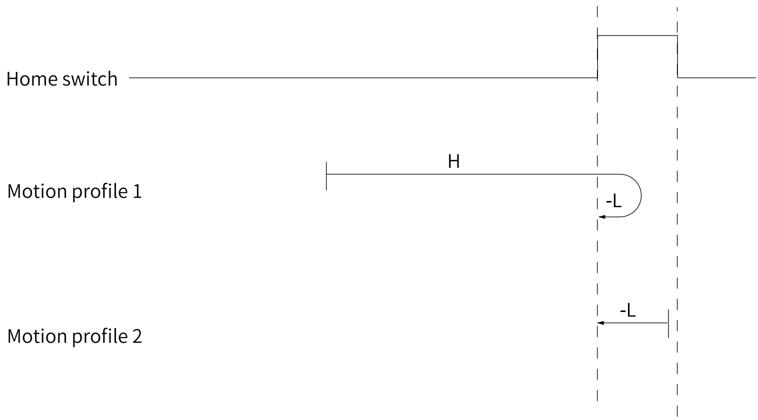


Figure 3-34 Motor running curve and speed in mode 19

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 20

Home: home switch (HW)

Deceleration point: home switch (HW)

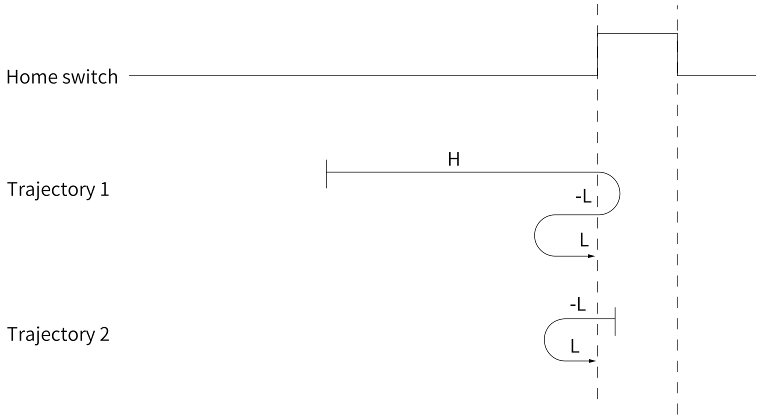


Figure 3-35 Motor running curve and speed in mode 20

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 21

Home: home switch (HW)

Deceleration point: home switch (HW)

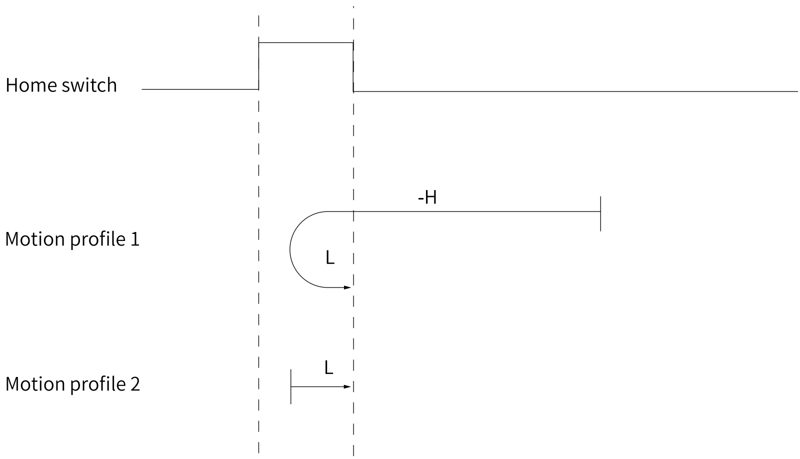


Figure 3-36 Motor running curve and speed in mode 21

- Motion profile 1: Deceleration point signal inactive at start.

- Motion profile 2: Deceleration point signal active at start.

6098h = 22

Home: home switch (HW)

Deceleration point: home switch (HW)

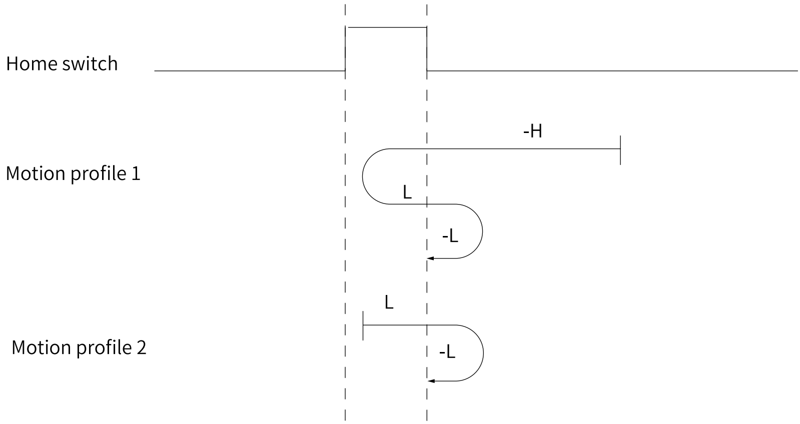


Figure 3-37 Motor running curve and speed in mode 22

- Motion profile 1: Deceleration point signal inactive at start.
- Motion profile 2: Deceleration point signal active at start.

6098h = 23

Home: home switch (HW)

Deceleration point: home switch (HW)

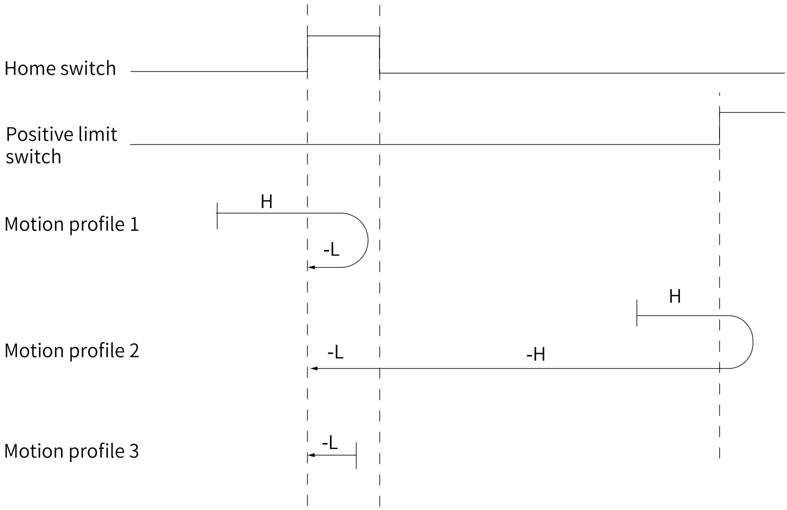


Figure 3-38 Motor running curve and speed in mode 23

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 24

Home: home switch (HW)

Deceleration point: home switch (HW)

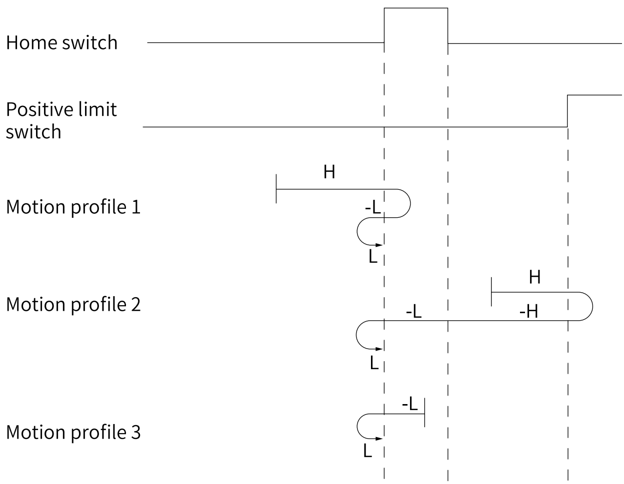


Figure 3-39 Motor running curve and speed in mode 24

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 25

Home: home switch (HW)

Deceleration point: home switch (HW)

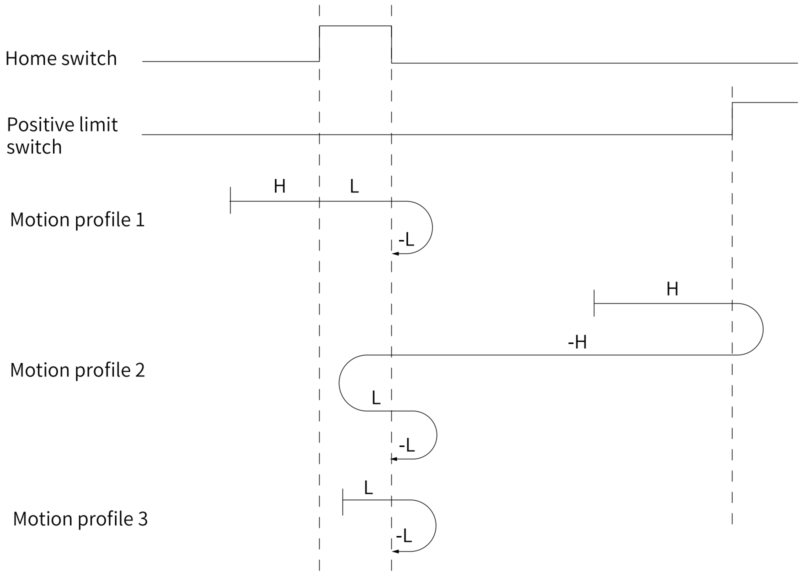


Figure 3-40 Motor running curve and speed in mode 25

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 26

Home: home switch (HW)

Deceleration point: home switch (HW)

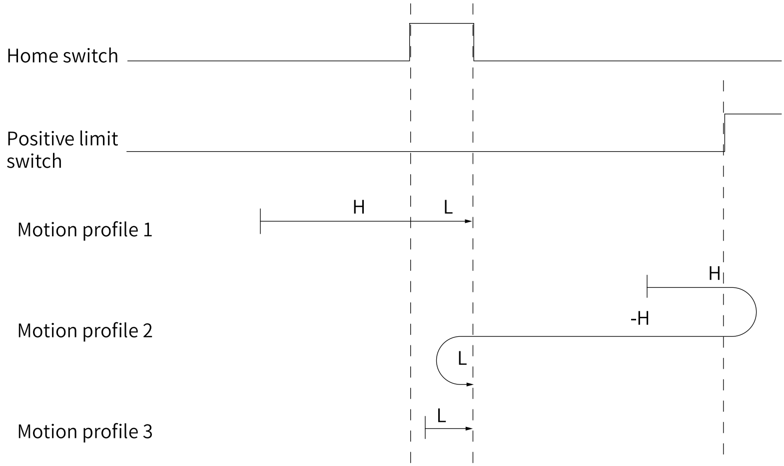


Figure 3-41 Motor running curve and speed in mode 26

- Motion profile 1: Deceleration point signal inactive at start, not hitting the positive limit switch.
- Motion profile 2: HW signal inactive at start, hitting the positive limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 27

Home: home switch (HW)

Deceleration point: home switch (HW)

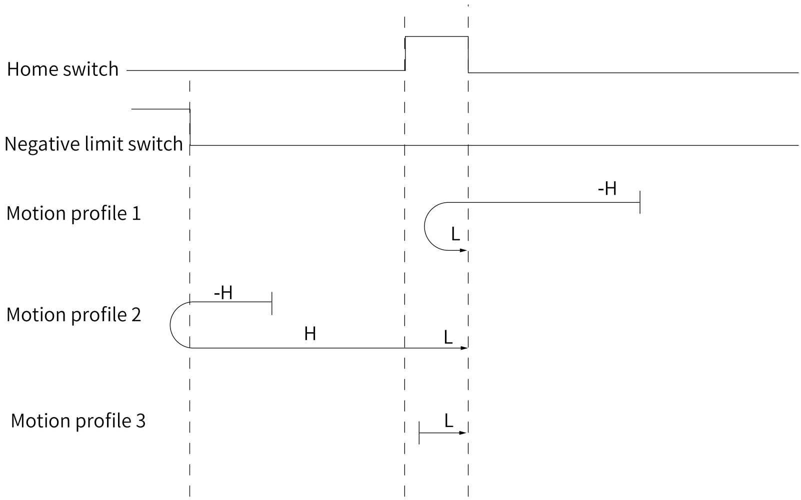


Figure 3-42 Motor running curve and speed in mode 27

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 28

Home: home switch (HW)

Deceleration point: home switch (HW)

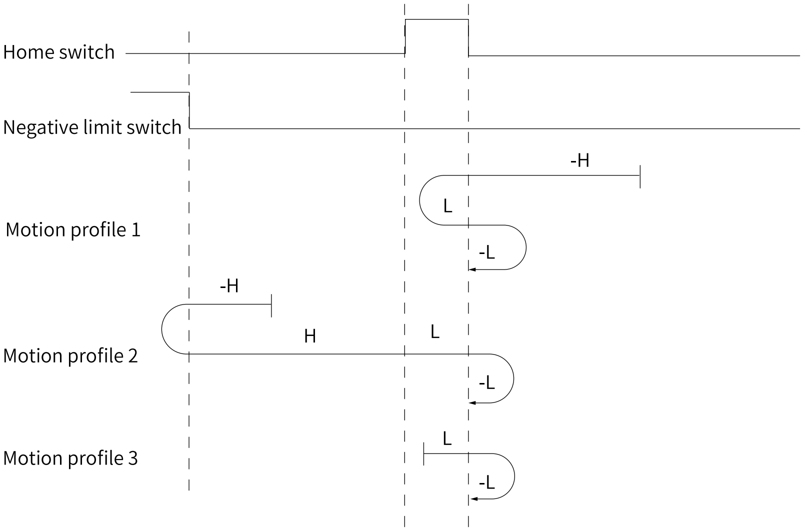


Figure 3-43 Motor running curve and speed in mode 28

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 29

Home: home switch (HW)

Deceleration point: home switch (HW)

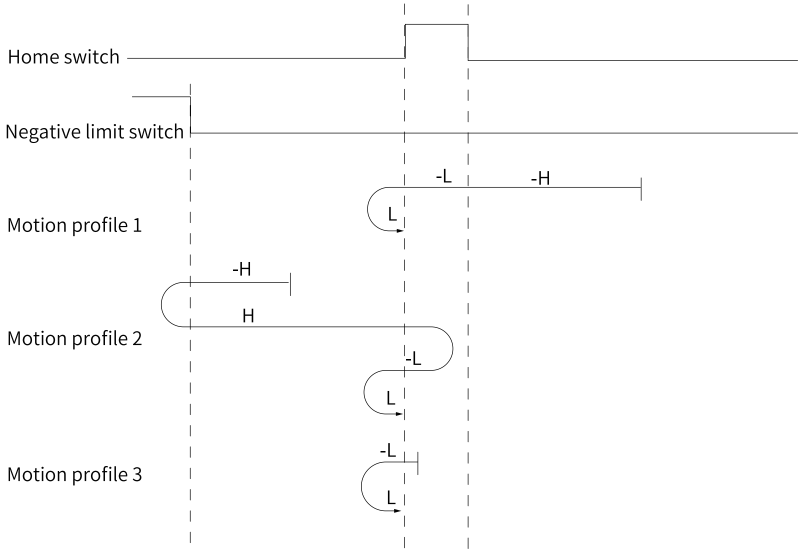


Figure 3-44 Motor running curve and speed in mode 29

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 30

Home: home switch (HW)

Deceleration point: home switch (HW)

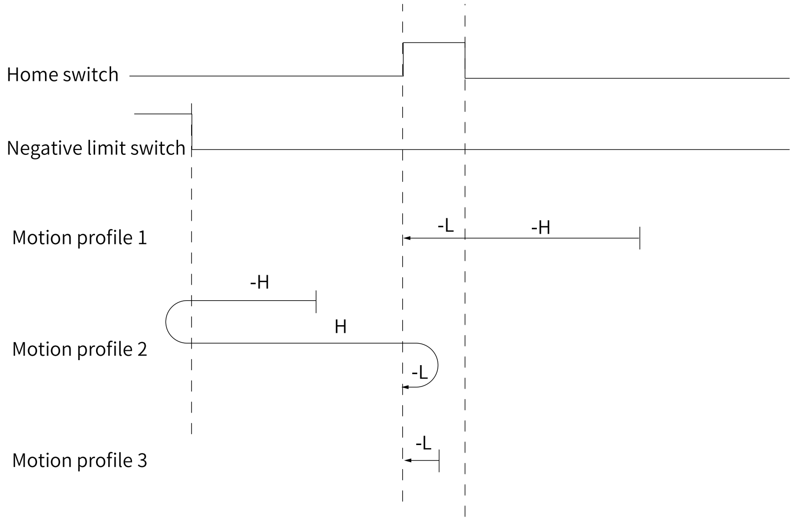


Figure 3-45 Motor running curve and speed in mode 30

- Motion profile 1: Deceleration point signal inactive at start, not hitting the reverse limit switch.
- Motion profile 2: HW signal inactive at start, hitting the reverse limit switch.
- Motion profile 3: Deceleration point signal active at start.

6098h = 31 and 32

This mode is not defined in the CiA402 protocol. It can be used for extension purpose.

6098h = 33/34

Home: Z signal

Deceleration point: None

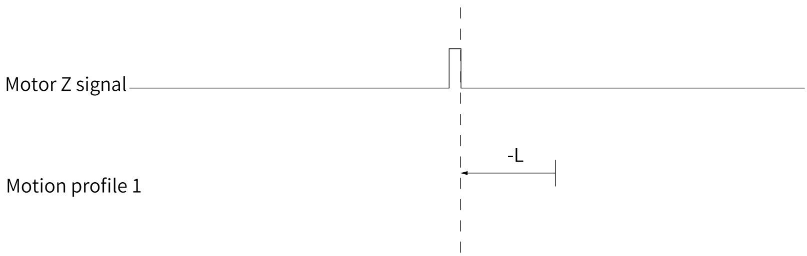


Figure 3-46 Motor running curve and speed in mode 33

- Motion profile 1: The motor runs in the reverse direction at low speed and stops at the first Z signal..

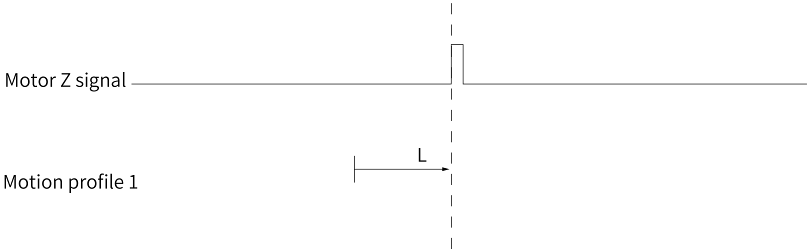


Figure 3-47 Motor running curve and speed in mode 34

- Motion profile 1: The motor runs in the forward direction at low speed and stops at the first Z signal..

6098h = 35

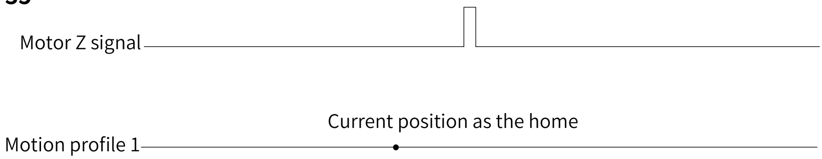


Figure 3-48 Motor running curve and speed in mode 35

Homing mode 35: The present position is taken as the mechanical home. After homing is triggered (control word 6040h: 0x0F → 0x1F).

6098h = -1

The motor runs in the reverse direction at high speed first. If the status where the torque reaches the limit and the speed is near zero after the axis hits the mechanical limit persists, it indicates 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.

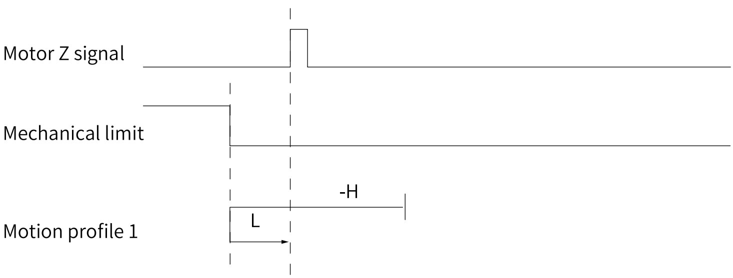


Figure 3-49 Motor running curve and speed in mode -1

6098h = -2

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

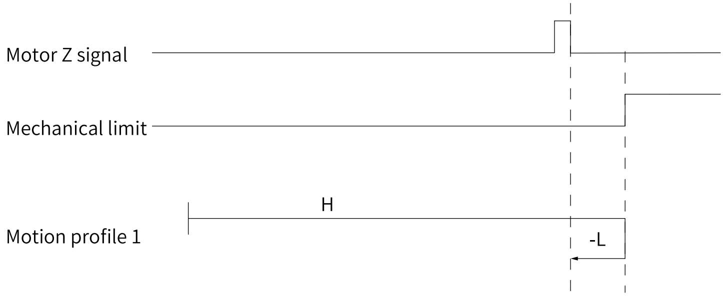


Figure 3-50 Motor running curve and speed in mode -2

6098h = -3

Home: Z signal

Deceleration point: None

- If the single-turn position is close to the reverse home, the homing profile is motion profile 1.
- If the single-turn position is close to the forward home, the homing profile is motion profile 2.

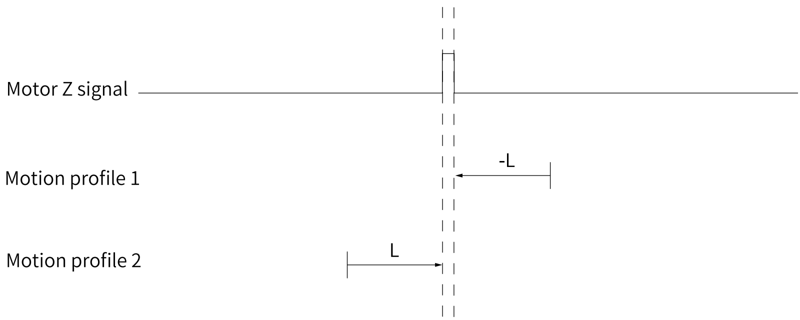


Figure 3-51 Motor running curve and speed in mode -3

- Motion profile 1: The motor runs in the reverse direction at low speed and stops at the first Z signal.
- Motion profile 2: The motor runs in the forward direction at low speed and stops at the first Z signal.

3.9 Position Control Mode

Note

In position control mode, model N only supports multi-position.

★ Definition of terms:

- "Reference unit": Refers to the minimum identifiable value input from the host controller to the drive.
- Encoder unit: Refers to the value of the input reference multiplied/divided by the electronic gear ratio.

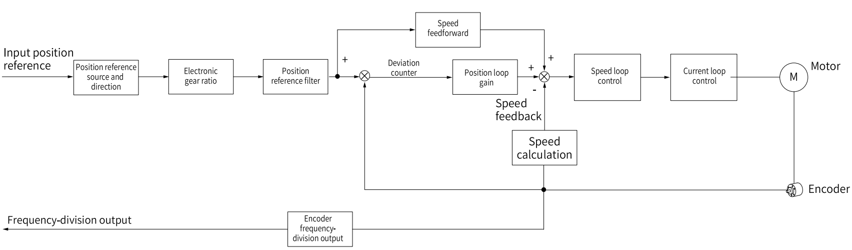


Figure 3-52 Position control diagram

Set H02.00 (Control mode) to 1 (Position control mode) through the keypad or Inovance software tool to make the drive operate in the position control mode. Set the drive parameters based on the mechanical structure and technical indicators.

The following describes basic parameter settings for the position control mode.

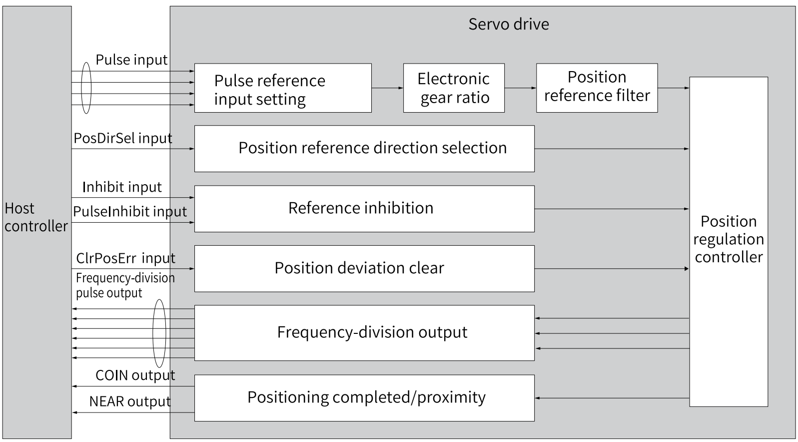


Figure 3-53 Signal exchange between the drive and the host controller

3.9.1 Function Block Diagram

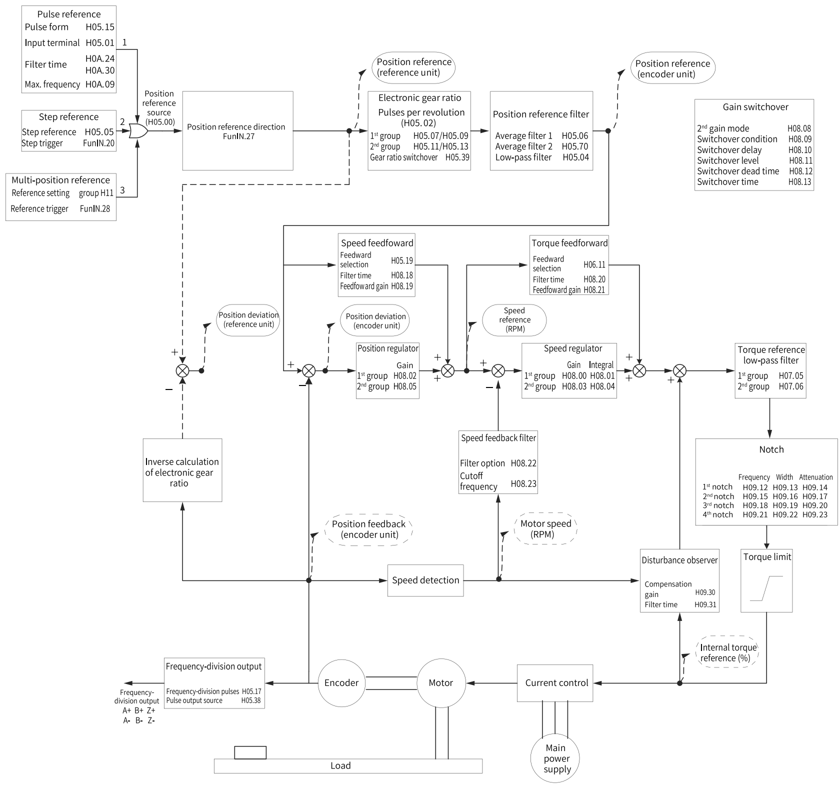


Figure 3-54 Block diagram of position control

3.9.2 Position Reference Input

The position reference input setting includes the position reference source, position reference direction, and FunIN.13 (Position reference inhibited).

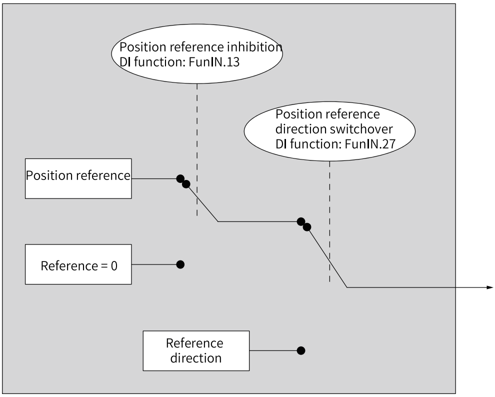


Figure 3-55 Position reference input setting

Position reference source

In the position control mode, set the position reference source in H05.00 first.

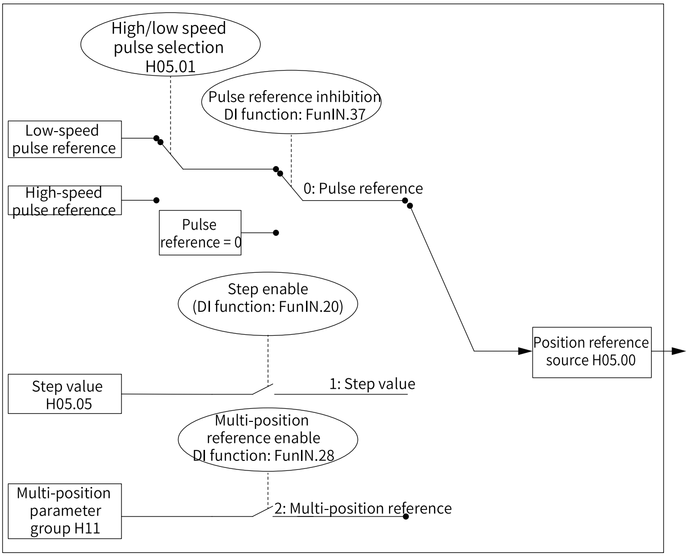


Figure 3-56 Setting the position reference source

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.00	2005-01h	Primary position reference source	0: Pulse reference 1: Step reference 2: Multi-position reference **Note: For model N, only "2: Multi-position reference" is available.**	0 Note: For model N, the default value is 2.	-	Real-time

- **Pulse reference as the source (H05.00 = 0)**

  Perform the following operations to obtain the correct pulse reference form.

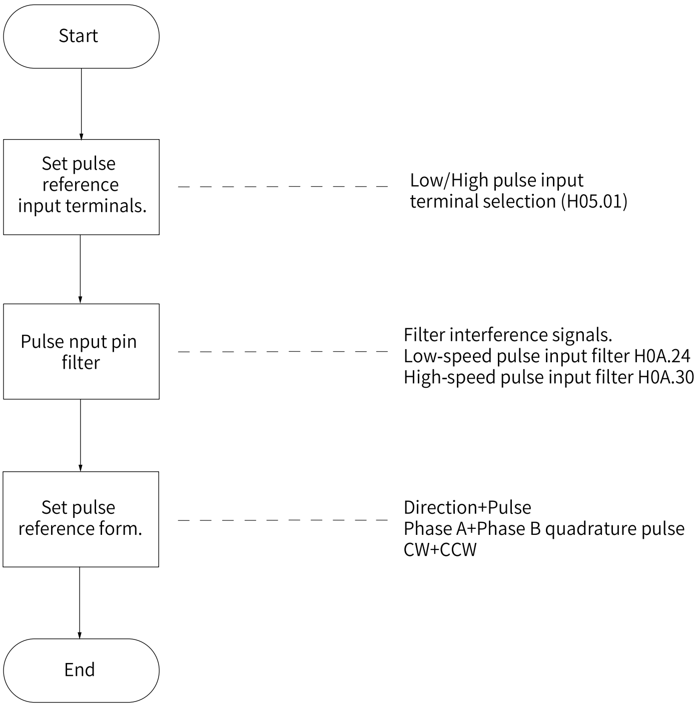
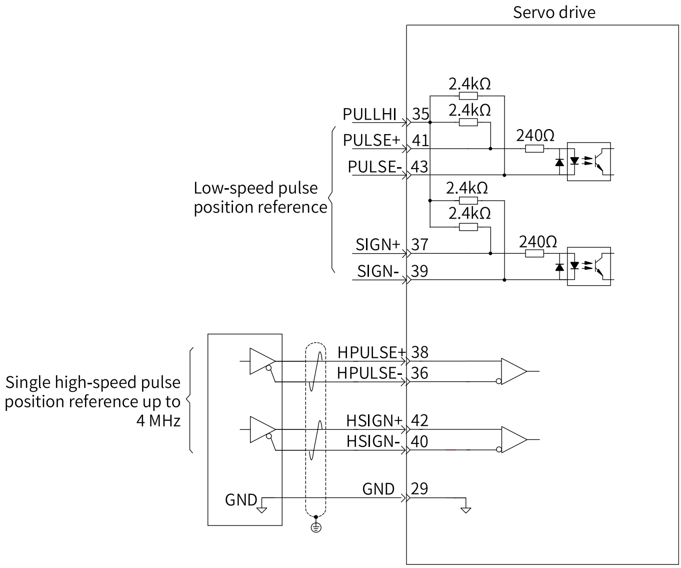


Figure 3-57 Flowchart for setting the pulse reference as the source

- Pulse reference input terminals

  The drive provides two groups of pulse input terminals.



The low-speed pulse input terminals (PULSE+, PULSE-, SIGN+, SIGN-) receive open-collector input (maximum single input frequency is 200 kpps).

The high-speed pulse input terminals (HPULSE+, HPULSE-, HSIGN+, HSIGN-) only receive differential input (maximum single input frequency is 4 Mpps).

Note

Low-speed pulses and high-speed pulses are not allowed to be connected simultaneously.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.01	2005-02h	Position pulse reference input terminal	0: Low speed 1: High speed	0	-	At stop

For details on the interface circuit, see *SV680-INT Series Servo Drive Hardware Guide*.

Table 3–5 Specifications of pulse input

Pulse Type		Maximum Input Frequency	Voltage	Forward Current
High-speed pulse	Differential signal	4M	5 V	< 15 mA
Low-speed pulse	Differential signal	200k	5 V	< 15 mA
	Open-collector signal	200k	24 V	< 15 mA

- Pulse input pin filter

  Set the pin filter time for input terminals of low-speed and high-seed pulses. This is to prevent motor malfunction caused by interference signals.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0A.24	200A-19h	Filter time constant of low-speed pulse input terminal	0 ns–255 ns	30	25ns	At stop
H0A.30	200A-1Fh	Filter time constant of high-speed pulse input terminal	0 ns–255 ns	2	ns	At stop

If the filter time constant for pulse input pins is t_F, the minimum width of input signals is t_{min}, then the input signals before and after filtering are as follows. The filtered input signals will be delayed for t_F over the unfiltered ones.

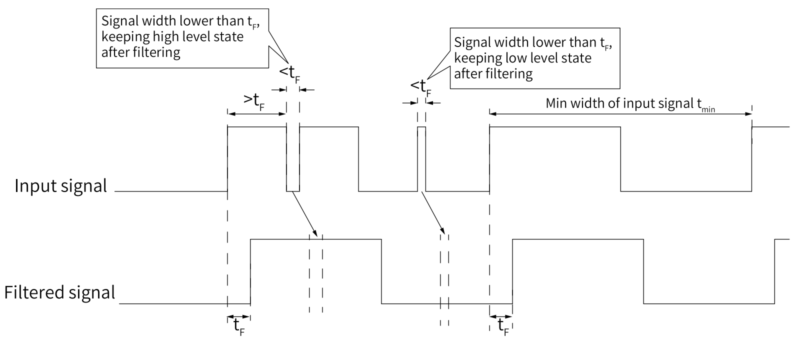


Figure 3-58 Example of filtered signal waveform

The pulse input pin filter time tF must meet the following requirement: $t_F \leqslant (20\%\ to\ 25\%)\ t_{min}$

The recommended filter parameter setting based on the maximum frequency (minimum width) of input pulses is described in the following table.

Table 3–6 Recommended filter time constant

Pulse Input Terminal	Related Parameters	Maximum Frequency of Input Pulses	Recommended Filter Time Constant (25 ns)
Low-speed pulse input terminal	H0A.24	< 167 kbps	30
		167 kbps to 200 kbps	20
High-speed pulse input terminal	H0A.30	200 kpps to 1 M	5
		> 1 Mpps	3

For example, if the filter time constant is set to 30, the actual filter time is 30 x 25 = 750 ns.

- Pulse reference form

  The drive supports the following three types of pulse references:

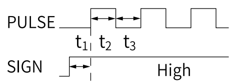
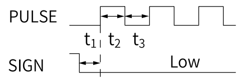
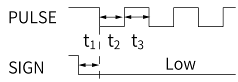
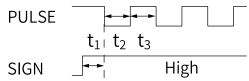
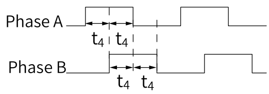
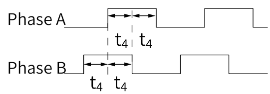
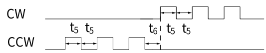
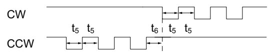
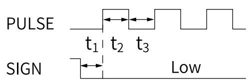
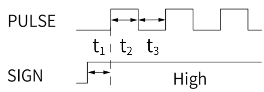
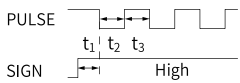
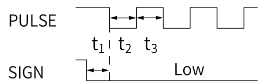
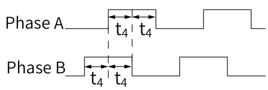
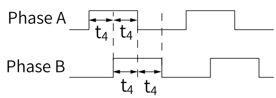
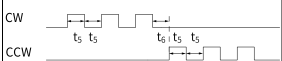
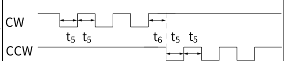
  - Direction + Pulse (positive or negative logic)
  - Phase A + Phase B quadrature pulse, quadrupled frequency
  - CW + CCW

  Set the pulse reference form appropriate for the host controller or other pulse generators.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.15	2005-10h	Pulse reference form	0: Direction + Pulse, positive logic 1: Direction + Pulse, negative logic 2: Phase A + phase B quadrature pulse, quadrupled frequency 3: CW + CCW	0	-	At stop

Table 3–7 Descriptions of the pulse form

H02.02	H05.15	Pulse input form	Signal	Diagram of forward pulses	Diagram of reverse pulses
0	0	Pulse + Direction Positive Logic	PULSE SIGN		
	1	Pulse + Direction Negative Logic	PULSE SIGN		
	2	Phase A + Phase B Quadrature pulse Quadrupled frequency	PULSE (phase A) SIGN (phase B)	Phase A leads phase B by 90°. 	Phase B leads phase A by 90°. 
	3	CW+CCW	PULSE (CW) SIGN (CCW)		
1	0	Pulse + Direction Positive Logic	PULSE SIGN		
	1	Pulse + Direction Negative Logic	PULSE SIGN		
	2	Phase A + Phase B Quadrature pulse Quadrupled frequency	PULSE (phase A) SIGN (phase B)	Phase B leads phase A by 90°. 	Phase A leads phase B by 90°. 
	3	CW+CCW	PULSE (CW) SIGN (CCW)		

The following table describes the maximum frequencies and minimum time widths of position pulse references corresponding to different input terminals.

Table 3–8 Specifications of pulse references

Input terminal	Single-channel max. input frequency (pps)	Min. Time Width (μs)	
High-speed pulse input terminal	4M	t1	0.125
		t2	0.125
		t3	0.125
		t4	0.0625
		t5	0.125
		t6	0.125
Low-speed pulse input terminal	200k	t1	2.5
		t2	2.5
		t3	2.5
		t4	1.25
		t5	2.5
		t6	2.5

The rising time and falling time of position pulse references must be shorter than 0.1 μs.

- Pulse reference frequency
  Set the maximum position pulse frequency in H0A.09.
- EB01.0 (Pulse input error) occurs when the actual input pulse frequency exceeds H0A.09.
  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0A.09	200A-0Ah	Max. pulse input frequency in position control	100 kHz–16000 kHz	16000	kHz	At stop

- **Step reference as position reference source (H05.00 = 1)**

Caution

When the S-ON (Servo ON) signal is active, the motor is in the locked state when the step reference is disabled or in the rotational state when the step reference is enabled. After H05.05 (Step reference) is done executing, the motor stays in the locked state when no step reference is triggered again.

The drive supports step operation, which means the drive can operate at a fixed speed until the set displacement is reached. The setting flowchart is as follows.

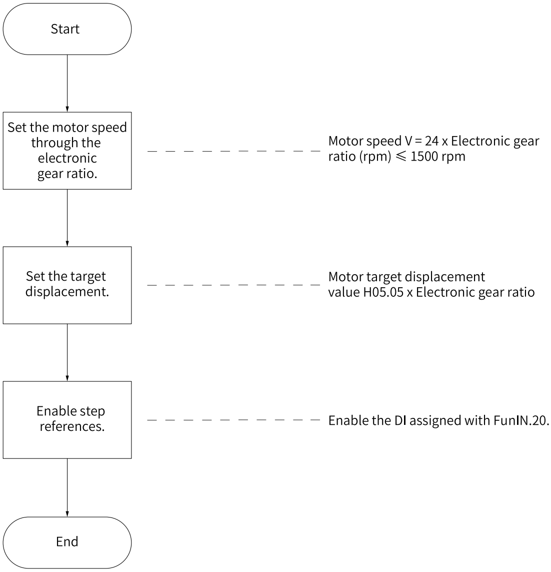


Figure 3-59 Flowchart for setting step reference as the position reference source

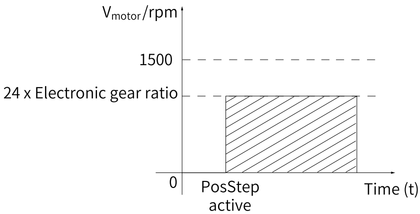


Figure 3-60 Motor operating curve (H05.00 = 1)

The hatched area in the preceding figure indicates the motor displacement: H05.05 x Electronic gear ratio (encoder unit).

- Relationship between the motor speed and electronic gear ratio
  When the step reference is used as the position reference source, the set motor speed will be converted based on the following formula. The motor speed in this case cannot exceed 1500 rpm.

$$V_{motor} = 24 \text{ x Electronic gear ratio (rpm)}$$

- Motor displacement

When the step reference is used as the position reference source, the sum of position references (reference unit) is set in H05.05. The sign of the setpoint of H05.05 determines the motor direction of rotation.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.05	2005-06h	Step amount	-9999 to +9999	50	Reference unit	At stop

- Step reference
  To use the step reference as the position reference source, assign FunIN.20 (PosStep, step reference enable) to a certain DI of the drive, and set the active logic of this DI.

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.20	PosStep	Step reference	S-ON: Active: The position reference defined by H05.05 is input to the servo drive, driving the motor to run. Invalid: Servo motor in locked state

FunIN.20 (Step reference enable) is edge-triggered. The motor is locked after the step reference is done executing. When FunIN.20 is triggered again, the motor executes the step reference defined by H05.05 again.

- **Multi-position reference as the position reference source (H05.00 = 2)**
  The servo drive supports multi-position operation. It stores 16 position references; the displacement, maximum running speed, and acceleration/deceleration time of each can be set. The interval time and switchover mode between positions can also be set according to actual requirements. The setting flowchart is as follows.

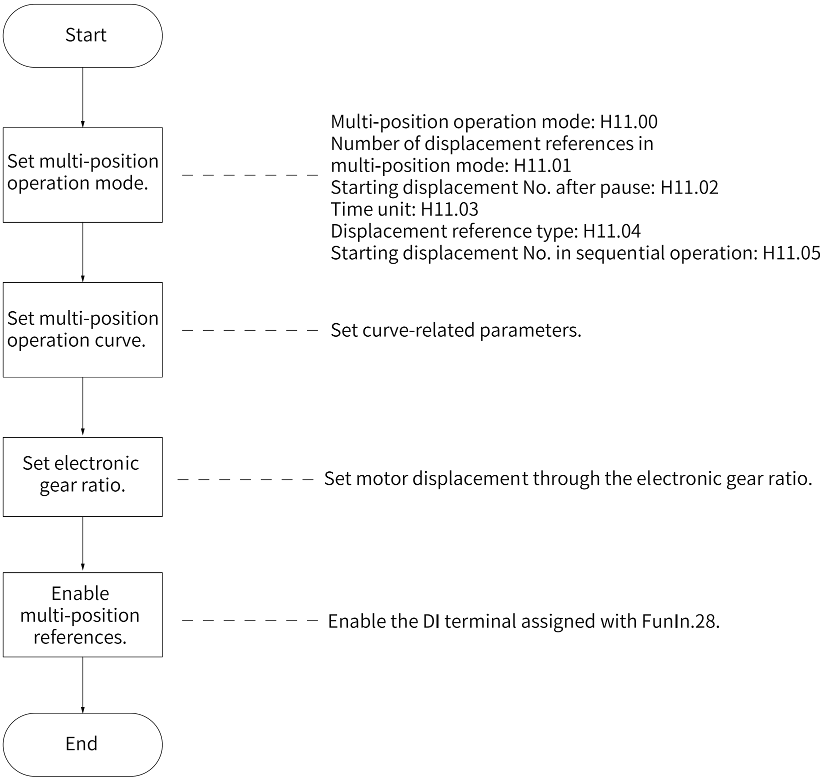


Figure 3-61 Flowchart for setting the multi-position reference as the source

- Setting the multi-position operation mode

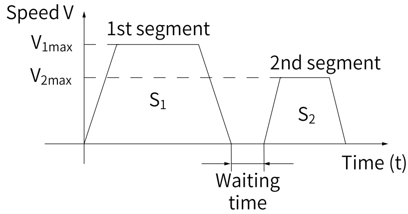
☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H11.00	2011-01h	Multi-position running mode	0: Single run (number of displacements selected in H11.01) 1: Cyclic operation (number of displacement selected in H11.01) 2: DI-based operation (selected by DI) 3: Sequential operation 5: Axis-controlled continuous operation	1	-	At stop
H11.01	2011-02h	Number of displacement references in multi-position mode	1–16	1	-	At stop

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H11.02	2011-03h	Starting displacement No. after pause	0: Continue to execute the unexecuted displacements 1: Start from displacement 1	0	-	At stop
H11.03	2011-04h	Interval time unit	0: ms 1: s	0	-	At stop
H11.04	2011-05h	Displacement reference type	0: Relative displacement reference 1: Absolute displacement reference	0	-	Real-time
H11.05	2011-06h	Starting displacement No. in sequential operation	0–16	0	-	At stop

1. **Individual operation (H11.00 = 0)**

Table 3–9 Description of individual operation

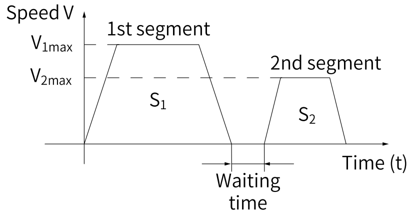
Description	Operating Curve
• The drive stops after one cycle of operation. • The drive switches to the next displacement automatically. • The interval time between displacements can be set as needed. • The PoslnSen (multi-position reference enable) signal is level-triggered.	 V_{1max}, V_{2max}: maximum operating speeds in displacement 1 and displacement 2 S_1, S_2: displacement 1 and displacement 2 • The positioning completed signal is active after each displacement is reached. • If the PosInsen signal is switched off during operation, the drive abandons the unfinished displacement and stops. The COIN (positioning completed) signal is activated after the drive stops. • After the PoslnSen signal is enabled again, the drive executes the displacement defined by H11.02. • If the S-ON signal is switched off during operation, the motor stops as defined by H02.05 (Stop mode at S-ON OFF). The COIN (positioning completed) signal is deactivated after the motor stops. • When a certain displacement is in progress, the logic change of the DI assigned with FunIN.27 (PosDirSel) does not affect the operating direction in this displacement.

★ Definition of terms:

A complete operation cycle covers all the position references defined by H11.01.

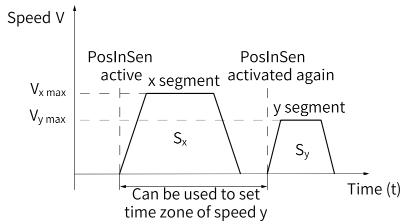
2. **Cyclic running (H11.00 = 1)**

Table 3–10 Descriptions of cyclic operation

Description	Operating Curve
• The drive starts from displacement 1 again after each cycle of operation. • The drive switches to the next displacement automatically. • The interval time between displacements can be set as needed. • The cyclic operation mode is kept when the FunIN.28 (Multi-position reference enable) is active. • The PoslnSen (multi-position reference enable) signal is level-triggered.	 V_{1max}, V_{2max}: maximum operating speeds in displacement 1 and displacement 2 S_1, S_2: displacement 1 and displacement 2 • The positioning completed signal is active after each displacement is reached. • If the PosInsen signal is switched off during operation, the drive abandons the unfinished displacement and stops. The COIN (positioning completed) signal is activated after the drive stops. • After the PoslnSen signal is enabled again, the drive executes the displacement defined by H11.02. • If the S-ON signal is switched off during operation, the motor stops as defined by H02.05 (Stop mode at S-ON OFF). The COIN (positioning completed) signal is deactivated after the motor stops. • When a certain displacement is in progress, the logic change of the DI assigned with FunIN.27 (PosDirSel) does not affect the operating direction in this displacement.

3. **DI-based operation (H11.00 = 2)**

Table 3–11 Descriptions of DI-based operation

Description	Operating Curve
• The displacement to be executed next can be set when the current displacement is in progress. The motor stops after current displacement is done executing. After the PoslnSen (position reference enable) signal is enabled again, the present displacement will be executed. • The speed No. is determined by the DI logic. • The interval time between displacements is determined by the command delay of the host controller. • The PoslnSen (multi-position reference enable) signal is edge-triggered.	 V_{xmax}, V_{ymax}: maximum operating speeds in displacement x and displacement y S_x, S_y: displacement x and displacement y • The positioning completed signal is active after each displacement is reached. • If the PosInsen (multi-position reference enable) signal is switched off during operation, the drive continues to execute the unfinished displacement and outputs the COIN (positioning completed) signal. • The displacements must be switched in the following sequence: a. Wait until displacement x is done executing before switching the displacement no.. b. When displacement x is in progress or done, switch off the PoslnSen (multi-position reference enable) signal first, and then change the displacement No. from x to y (if x = y, the drive executes displacement x again). c. After displacement x is done executing, switch on the PoslnSen (multi-position reference enable) signal again to make the drive execute displacement y. • If the S-ON signal is switched off during operation, the motor stops as defined by H02.05 (Stop mode at S-ON OFF). The COIN (positioning completed) signal is deactivated after the motor stops. • When a certain displacement is in progress, the logic change of the DI assigned with FunIN.27 (PosDirSel) does not affect the operating direction in this displacement.

In the multi-position operation mode, assign four DIs with FunIN.6 to FunIN.9 respectively, and set the active logic of these DIs.

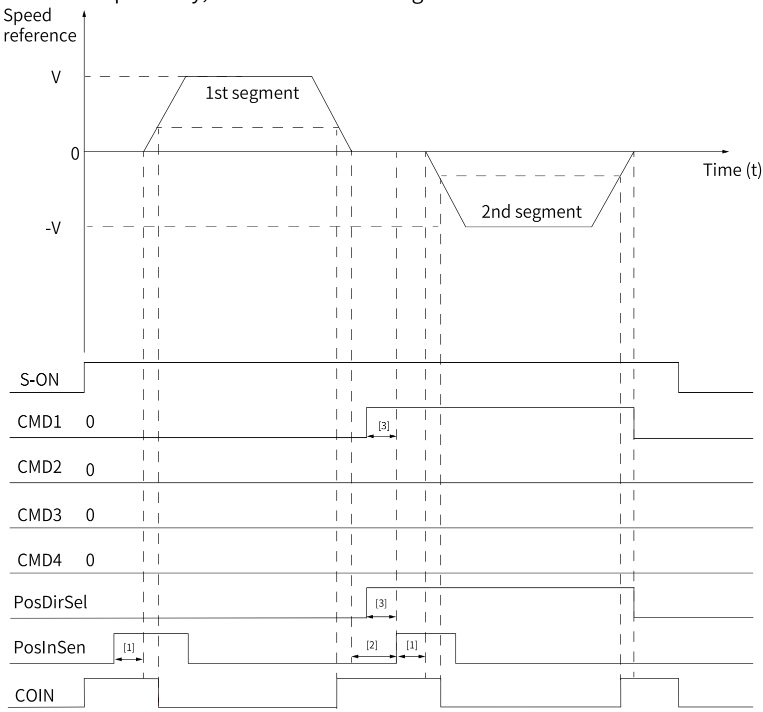


Figure 3-62 Multi-position sequence diagram

Note

- [1] The PosInSen signal is edge-triggered. The minimum signal widths required by the normal DI and high-speed DI are 3 ms and 0.25 ms respectively.
- [2] Area for switching the displacement No.: Refers to the interval that start from the moment the last position reference is done transmitting to the moment the next PosInSen (multi-position reference enable) signal is activated again.
- [3] When a normal DI is used, an effective signal width of 0.125 ms must be kept.

☆ Related parameters:

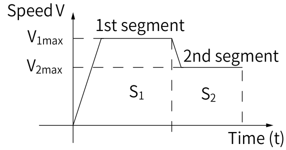
Code	Name	Function Name	Function
FunIN.6	CMD1	Multi-reference switchover 1	The displacement No. is a 4-bit binary. The relationship between the displacement No. and CMD1 to CMD4 is shown in *"Table 3–12 " on page 192*. The DI logic is level-triggered. The CMD value is 1 upon active level input or 0 upon inactive level input.
FunIN.7	CMD2	Multi-reference switchover 2	
FunIN.8	CMD3	Multi-reference switchover 3	
FunIN.9	CMD4	Multi-reference switchover 4	

Table 3–12 Relationship between the displacement No. and CMD1 to CMD4

CMD4	CMD3	CMD2	CMD1	Segment No.
0	0	0	0	1
0	0	0	1	2
…				
1	1	1	1	16

4. **Sequential running (H11.00 = 3)**

Table 3–13 Descriptions of sequential operation

Description	Operating Curve
• The drive stops after one cycle of operation. • (H11.05 = 0 or H11.05 > H11.01). • The starting displacement after the first cycle of operation is defined by H11.05. • The drive switches to the next displacement automatically. • There is no interval time between displacements. • The PoslnSen (multi-position reference enable) signal is level-triggered.	 V_{1max}, V_{2max}: maximum operating speeds in displacement 1 and displacement 2 S_1, S_2: displacement 1 and displacement 2 • The positioning completed signal is active after each displacement is reached. • If the PosInsen signal is switched off during operation, the drive abandons the unfinished displacement and stops. The COIN (positioning completed) signal is activated after the drive stops. • After the PoslnSen signal is enabled again, the drive executes the displacement defined by H11.02. • If the S-ON signal is switched off during operation, the motor stops as defined by H02.05 (Stop mode at S-ON OFF). The COIN (positioning completed) signal is deactivated after the motor stops. • When a certain displacement is in progress, the logic change of the DI assigned with FunIN.27 (PosDirSel) does not affect the operating direction in this displacement.

5. **Axis-controlled continuous operation (H11.00 = 5)**

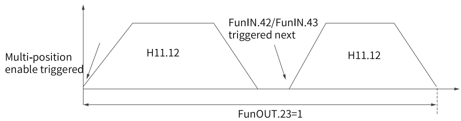
Table 3–14 Description of axis-controlled continuous operation

<table>
<tr><th>Description</th><th>Operating Curve</th></tr>
<tr><td>

- The drives executes one displacement only.
- The individual operation mode, sequential operation mode, and interrupted operation mode are included.
- The PoslnSen (multi-position reference enable) signal is level-triggered.

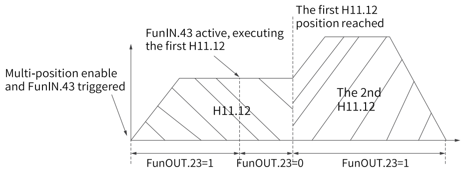
</td><td>

- Individual operation



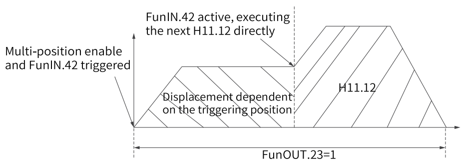
The PoslnSen (multi-position reference enable) signal is triggered only once (FunIN.43/42 triggered later). The drive stops after executing the distance defined by H11.12.

- Sequential operation



The PoslnSen (multi-position reference enable) signal is triggered only once. Write H11.12 again and activate FunIN.43 when the distance defined by the first H11.12 is still in progress.After receiving the new distance (or speed), which is the second H11.12, the drive continues executing the first H11.12 until the distance defined by the first H11.12 is done. Then it starts to execute the second H11.12 directly. The travel distance therefore is the sum of the first H11.12 and the second H11.12.

- Interrupted operation



The PoslnSen (Multi-position reference enable) signal is triggered only once. Write H11.12 (such as 1000000) again and activate FunIN.42 when the first H11.12 (such as 9000000) is still in progress. After receiving the new distance (or speed), which is the second H11.12, the drive stops executing the first H11.12 and turns to executing the second H11.12.

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

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.42	MultiBlockTrig	Axis control command executed immediately	Active: Newly written command activated immediately Inactive: Newly written command not activated
FunIN.43	MultiBlockWr	Axis control command not executed immediately	Active: Newly written command activated after current displacement is done executing Inactive: Newly written command not activated
FunOUT.23	WrNextBlockEn	Command input	Active: Next command input allowed Inactive: Next command input inhibited

- Setting multi-position operating curve
  A total of 16 position references can be set during multi-position operation. The displacement, maximum operating speed, acceleration/deceleration time, and interval time between displacements can be set separately. The following takes displacement 1 as an example.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H11.12	2011-0Dh	Displacement 1	-1073741824 to 1073741824	10000	Reference unit	Real-time
H11.14	2011-0Fh	Max. speed of displacement 1	1[mm/s]/[rpm]–10000[mm/s]/[rpm]	200	[mm/s]/[rpm]	Real-time
H11.15	2011-10h	Acc/Dec time of displacement 1	0 ms–65535 ms	10	ms	Real-time
H11.16	2011-11h	Interval time after displacement 1	0 ms(s) to 10000 ms(s)	10	ms (s)	Real-time

The actual operating curve of the motor based on preceding settings is shown in the following figure.

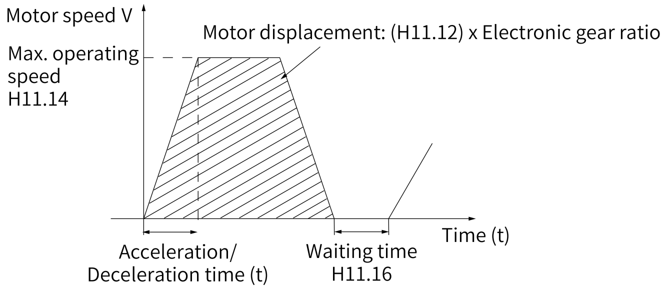


Figure 3-63 Motor operating curve in displacement 1

Actual time (t) taken to accelerate to H11.14:

$$t = \frac{(H11.14)}{1000} \times (H11.15)$$

For settings of other 15 parameters, see *SV680-INT Series Servo Drive Parameter Guide*.

- Setting multi-position reference enable mode
  To use the multi-position reference as the position reference source, assign FunIN.28 (PosInSen, multi-position reference enable) to a certain DI of the drive, and set the active logic of this DI.

  ☆Related function No.:

Code	Name	Function Name	Function
FunIN.28	PosInSen	Multi-position reference enable	Active: The motor executes the multi-position reference. Invalid: Servo motor in locked state Note: • When H11.00 is set to 0, 1, or 3, the logic of the DI assigned with the PosInSen signal is level-triggered. • When H11.00 is set to 2, the logic of the DI assigned with the PosInSen signal is edge-triggered.

Position reference direction

A DI can be used to change the position reference direction, so as to change the motor direction of rotation. Assign FunIN.27 (PosDirSel, position reference direction) to a DI of the drive, and set the active logic of this DI.

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.27	PosDirSel	Position reference direction	Inactive: Actual position reference direction same as the set direction Active: Actual position reference direction opposite to the set direction

The actual motor direction is related to the rotating direction in H02.02, positive/negative of position reference, position reference direction (FunIN.27).

Table 3–15 Motor direction of rotation

H02.02	Sign of Position Reference	FunIN.27	Direction of Rotation
0	+	Inactive	CCW
0	+	Active	CW
0	-	Inactive	CW
0	-	Active	CCW
1	+	Inactive	CW
1	+	Active	CCW
1	-	Inactive	CCW
1	-	Active	CW

Position reference inhibited

FunIN.13 (Inhibit) and FunIN.37 (PulseInhibit) are used to inhibit position references and pulse references.

- Position reference inhibited
  The drive sets all the position references to 0, which means it does not respond to any internal or external position references, and the motor is in the locked state in the position control mode. In this case, the drive can switch to other control modes to continue operating.

  To use FunIN.13 (Inhibit, position reference inhibited), assign FunIN.13 to a certain DI and set the active logic of this DI. It is recommended to use the high-speed DI (DI7 or DI8) terminal.

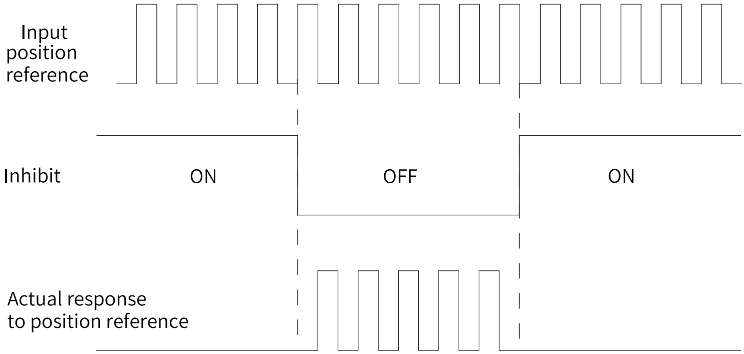


Figure 3-64 Waveform example for position reference inhibited

☆Related function No.:

Code	Name	Function Name	Function
FunIN.13	Inhibit	Position reference inhibited	Inactive: The drive responds to position references in the position control mode. Active: The drive does not respond to any internal or external position references in the position control modes.

- Pulse reference inhibited

  The drive sets all the pulse references to 0, which means it does not respond to any pulse references inputted from the pulse input terminal but it can respond to position references in other forms in the position control mode. In this case, the drive can be switched to other control modes to continue operating.

  When pulse reference inhibition is activated in the position control mode, no other forms of position references are used and pulse signals are input in the pulse input terminal, the input position reference counter (H0b.13) stops counting.

  If position references in other forms are used in the position control mode, the input position reference counter (H0b.13) continues counting the these position references, and these references will be executed.

  To use FunIN.37 (PulseInhibit, pulse reference inhibit), assign FunIN.37 to a certain DI and set the active logic of this DI. It is recommended to use the high-speed DI (DI7 or DI8) terminal.

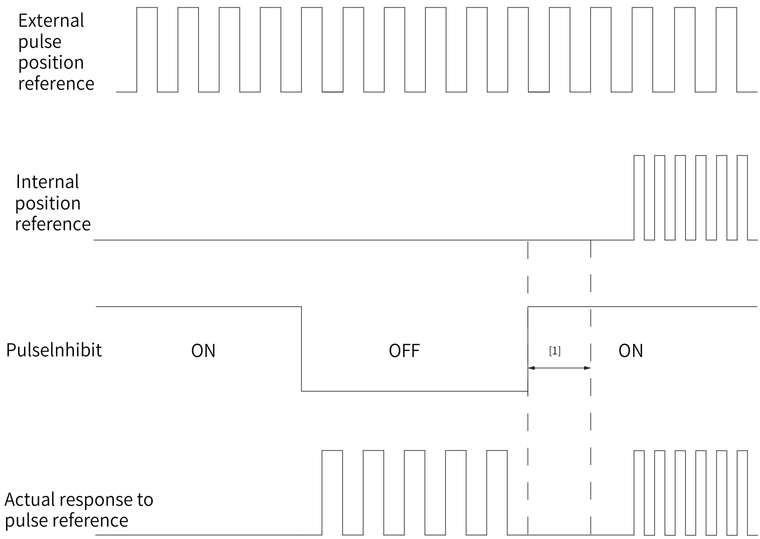


Figure 3-65 Waveform example for pulse reference inhibited

Note

[1] When DI is used, keep an interval of at least 0.5 ms from the moment the DI logic is deactivated to the moment the internal position reference is inputted.

☆Related function No.:

Code	Name	Function Name	Function
FunIN.37	PulseInhibit	Pulse reference inhibited	When the position reference source is pulse reference (H05.00 = 0) in the position control mode: Inactive: The drive responds to pulse references. Active: The drive does not respond to pulse references.

3.9.3 Reference Frequency Division/Multiplication (Electronic Gear Ratio)

Definition of the electronic gear ratio

In the position control mode, the input position reference (reference unit) defines the load displacement; the motor position reference (encoder unit) defines the motor displacement. The electronic gear ratio is used to establish a proportional relationship between the input position reference and motor position reference.

The electronic gear ratio, which allows frequency division (electronic gear ratio < 1) or frequency multiplication (electronic gear ratio > 1), can be used to set the actual displacement corresponding to the input position reference per reference unit, or used to increase the position reference frequency when the motor speed needed cannot be fulfilled due to limited pulse output frequency of the host controller or limited parameter value range.

★ Definition of terms:

- Reference unit: Refers to the minimum identifiable value input from the host controller to the drive.
- Encoder unit: Refers to the value of the input reference multiplied/divided by the electronic gear ratio.

Procedure for setting the electronic gear ratio

The electronic gear ratio varies with the mechanical structure. Set the electronic gear ratio according to the following flowchart.

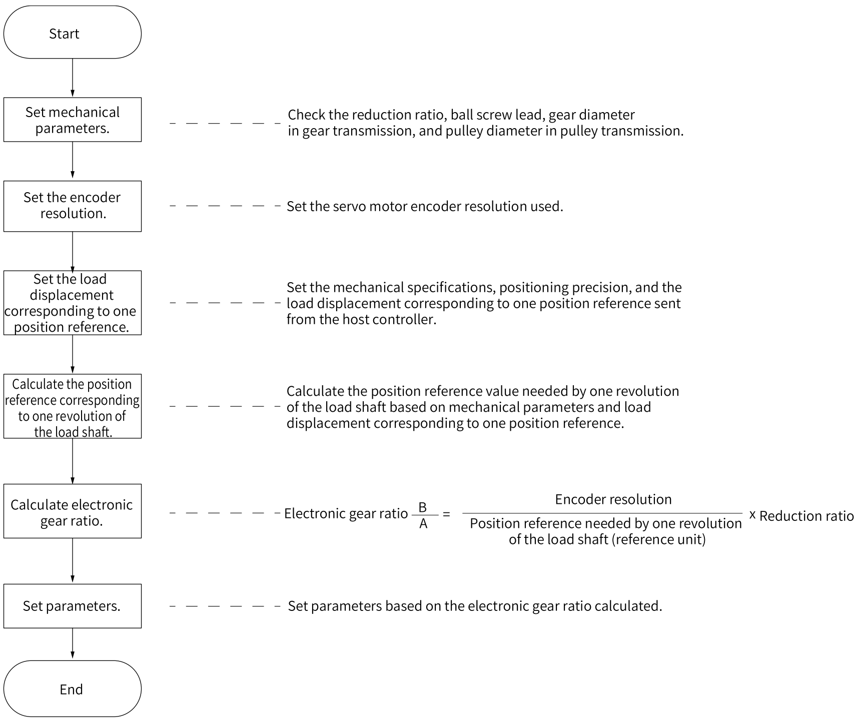


Figure 3-66 Procedure for setting the electronic gear ratio

See the following figure for how to set parameters.

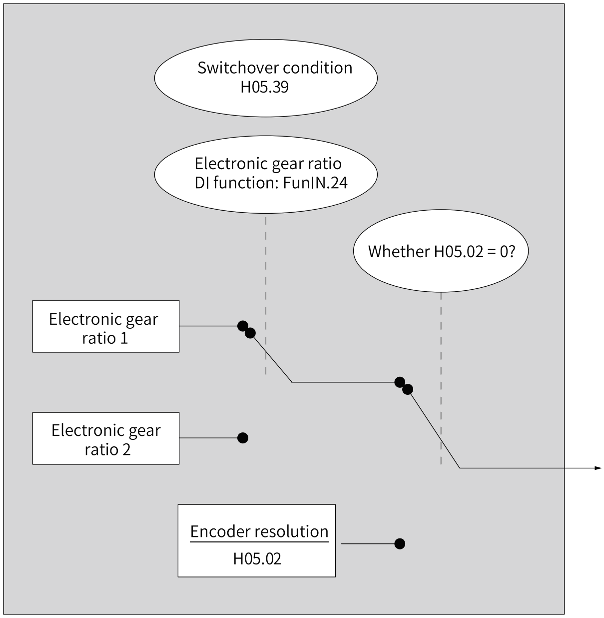


Figure 3-67 Procedure for setting the electronic gear ratio

Note

When the setpoint of H05.02 (Pulses per revolution) is not 0, the following formula applies:

Electronic gear ratio $\frac{B}{A} = \frac{\text{Encoder resolution}}{\text{H05.02}}$. When H05-02 is set to 0, electronic gear ratios 1 and 2 are invalid.

Related parameters

- Setting the electronic gear ratio parameters

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.02	2005-03h	Pulses per revolution	0–4294967295	0	[P/N-N]/ [P/Rev]	At stop
H05.07	2005-08h	Electronic gear ratio 1 (numerator)	1–1073741824	67108864 Note: For model N, the default value is 1.	-	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.09	2005-0Ah	Electronic gear ratio 1 (denominator)	1–1073741824	10000 Note: For model N, the default value is 1.	-	Real-time
H05.11	2005-0Ch	Electronic gear ratio 2 (numerator)	1–1073741824	67108864 Note: For model N, the default value is 1.	-	Real-time
H05.13	2005-0Eh	Electronic gear ratio 2 (denominator)	1–1073741824	10000 Note: For model N, the default value is 1.	-	Real-time

- Switching the electronic gear ratio

Caution

The motor speed may fluctuate significantly if the electronic gear ratio changes sharply in real time or electronic gear ratio 1 differs greatly from electronic gear ratio 2. In this case, set H05.04 (First-order low-pass filter time constant) properly to allow smooth switchover of the position reference.

- The electronic gear ratio can be switched when H05.02 (Pulses per revolution) is set to 0. Determine whether to switch between electronic gear ratios 1 and 2 based on mechanical conditions and set the condition for switching the electronic gear ratio.
- Only one electronic gear ratio is effective at any moment.
- The effective time of real-time change in the electronic gear ratio is also restricted by the switchover condition.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.39	2005-28h	Electronic gear ratio switchover condition	0: Switchover after position reference is kept 0 for 2.5 ms 1: Switched in real time	0	-	At stop

Assign FunIN.24 (GEAR-SEL, electronic gear ratio selection) to a certain DI and set the active logic of this DI.

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.24	GEAR_SEL	Electronic gear ratio selection	Inactive: Electronic gear ratio 1 used in the position control mode Active: Electronic gear ratio 2 used in the position control mode

See the following table for the electronic gear ratio used by the servo drive.

H05.02	H05.39	Level of the DI Assigned with FunIN.24	Electronic gear ratio
0	0	Inactive	$\frac{H05.07}{H05.09}$
		Active	$\frac{H05.11}{H05.13}$
	1	Inactive	$\frac{H05.07}{H05.09}$
		Active	$\frac{H05.11}{H05.13}$
1–1048576	-		-

The resolution of the serial encoder is 2^n(P/r), where "n" is the number of bits of the serial encoder.

For example, the resolution of a 26-bit serial encoder is 2^{26}(P/r), which is 67108864 (P/r).

- Calculating the electronic gear ratio
  The following figure shows the relationship among the position reference (reference unit), load displacement, and electronic gear ratio.

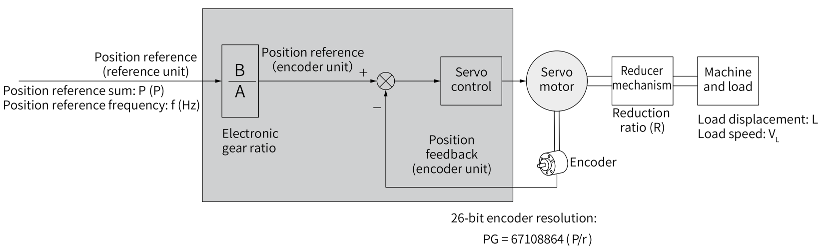


Figure 3-68 Relationship among the position reference (reference unit), load displacement, and electronic gear ratio

Take the ball screw in linear motion as an example, with P_B (mm) as the screw lead, P_G as the encoder resolution, and R as the reduction ratio of the reducer.

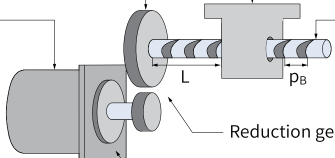


Figure 3-69 Ball screw

- When the load displacement per pulse ΔL (mm) is known:

  The load shaft rotates $\frac{\Delta L}{p_B}$ circles and the motor shaft rotates $\frac{\Delta L}{p_B} \times R$ circles when the mechanical displacement is ΔL. Then the following formula applies:

$$1 \times \frac{B}{A} = \frac{\Delta L}{p_B} \times R \times P_G$$

  Therefore, the electronic gear ratio is as follows.

$$\frac{B}{A} = \frac{\Delta L}{p_B} \times R \times P_G$$

- When the load displacement L (mm) and position reference sum P (P) are known:

  The load shaft rotates $\frac{L}{p_B}$ circles, and the motor shaft rotates $\frac{L}{p_B} \times R$ circles when the mechanical displacement is L. Then the following formula applies:

$$P \times \frac{B}{A} = \frac{L}{p_B} \times R \times P_G$$

  Therefore, the electronic gear ratio is as follows.

$$\frac{B}{A} = \frac{L}{p_B} \times R \times P_G \times \frac{1}{P}$$

- When the load moving speed VL (mm/s) and position reference frequency f (Hz) are known:

  Load shaft speed: $\frac{v_L}{p_B}$ (r/s)

  Motor speed: $v_M = \frac{v_L}{p_B} \times R$ (r/s)

  The relationship among the position reference frequency, electronic gear ratio, and motor speed is as follows:

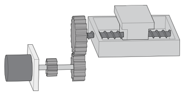
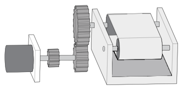
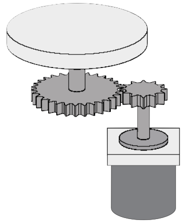
$$f \times \frac{B}{A} = v_M \times P_G$$

Therefore, the electronic gear ratio is as follows.

$$\frac{B}{A} = \frac{v_M \times P_G}{f}$$

- Example for setting the electronic gear ratio

Table 3–16 Example for setting electronic gear ratio

Item	Name	Mechanical Structure		
		Transmission With Ball Screw	Transmission With Belt Pulley	Rotary Load
-				
1	Mechanical parameters	Reduction ratio (R): 1/1 Screw lead: 0.01 m	Reduction ratio (R): 5/1 Diameter of belt pulley: 0.2 m (Circumference of belt pulley): 0.628 m	Reduction ratio (R): 10/1 Load angle of rotation per revolution of the load shaft: 360°
2	Resolution	26-bit = 67108864 PPR	26-bit = 67108864 PPR	26-bit = 67108864 PPR
3	Load displacement per position reference (reference unit)	0.0001 m	0.000005 m	0.01°
4	Position references per revolution of the load shaft (reference unit)	$\frac{0.01}{0.0001} = 100$	$\frac{0.628}{0.000005} = 125600$	$\frac{360}{0.01} = 36000$
5	Calculation	$\frac{B}{A} = \frac{67108864}{100} \times \frac{1}{1}$	$\frac{B}{A} = \frac{67108864}{125600} \times \frac{5}{1}$	$\frac{B}{A} = \frac{67108864}{36000} \times \frac{10}{1}$
6	Setting	H05.07 = 67108864 H05.09 = 100	H05.07 = 335544320 H05.09 = 125600	H05.07 = 671088640 H05.09 = 36000

3.9.4 Position reference filter

Position reference filter serves to filter the position references (in encoder unit) multiplied or divided by the electronic gear ratio, which includes first-order low-pass filtering and moving average filtering. It involves the first-order filter and moving average filter.

It is applicable to the following conditions:

- The acceleration/deceleration process is not performed on the position references sent from the host controller.
- The pulse reference frequency is low.
- The electronic gear ratio is larger than 10.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.04	2005-05h	First-order low-pass filter time constant	0.0 ms–6553.5 ms	0.0	ms	At stop
H05.06	2005-07h	Moving average filter time constant 1	0.0 ms–128.0 ms	0.0	ms	At stop

Note

This function does not affect the displacement value (position reference sum).

An excessively high setpoint delays the responsiveness, so set a proper filter time constant based on actual conditions.

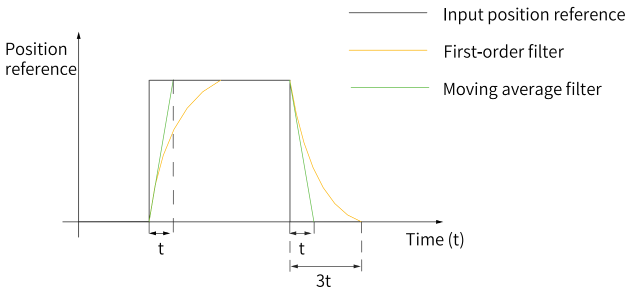


Figure 3-70 First-order filter and moving average filter for rectangular position references

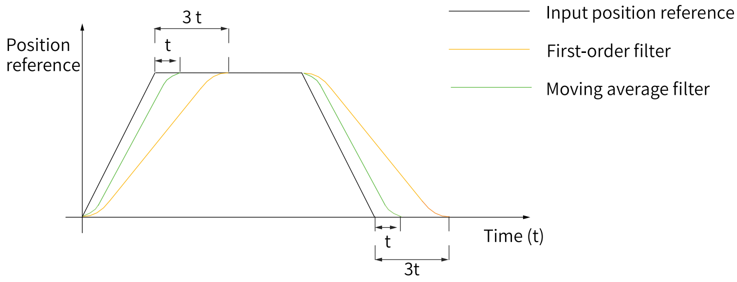


Figure 3-71 First-order filter and moving average filter for trapezoid position references

3.9.5 Position Deviation Clearance

Position deviation = Position reference sum – Position feedback sum

This function serves to clear the position deviation when the condition defined by H05.16 (Clear action selection) is met.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.16	2005-11h	Clear action	0: Position deviation cleared upon S-OFF or non-RUN state 1: Position deviation cleared upon fault or non-RUN state 2: Position deviation cleared upon active DI function 35 or non-RUN state	0	-	At stop

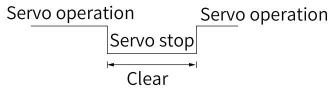
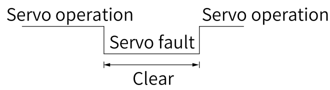
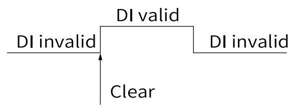
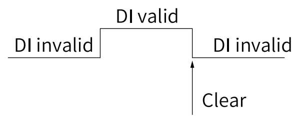
When H05.16 is set to 2, assign FunIN.35 (ClrPosErr, clear position deviation) to a certain DI and set the active logic of this DI. It is recommended to use the high-speed DI (DI7 or DI8) terminal.

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.35	ClrPosErr	Position deviation cleared	Active: Position deviation cleared Inactive: Position deviation not cleared

The setting method is shown as follows.

Table 3–17 Position deviation clear

Value	Clear Condition	Clear Time
H05.16 = 0	Position deviation is cleared upon S-OFF or in the non-operational state.	
H05.16 = 1	Position deviation is cleared upon S-OFF or a fault.	
H05.16 = 2	Position deviation is cleared upon S-OFF or active DI function 35 (ClrPosErr, clear position deviation).	 (Rising edge-triggered)  (Falling edge-triggered)

3.9.6 Frequency-division Output

Caution

It is recommended to use the active edge output by the Z signal in cases where a high precision frequency-division output of Z signal is required.

Parameter	bit	Description
H05.41	Bit 0: Frequency-division Z signal output polarity	0: Positive (falling edge-triggered) 1: Negative (rising edge-triggered)
	Bit 1: OCZ signal output polarity	0: Positive (falling edge-triggered) 1: Negative (rising edge-triggered)

The frequency-division output function outputs the position reference pulses or encoder feedback position references as A/B phase quadrature pulses.

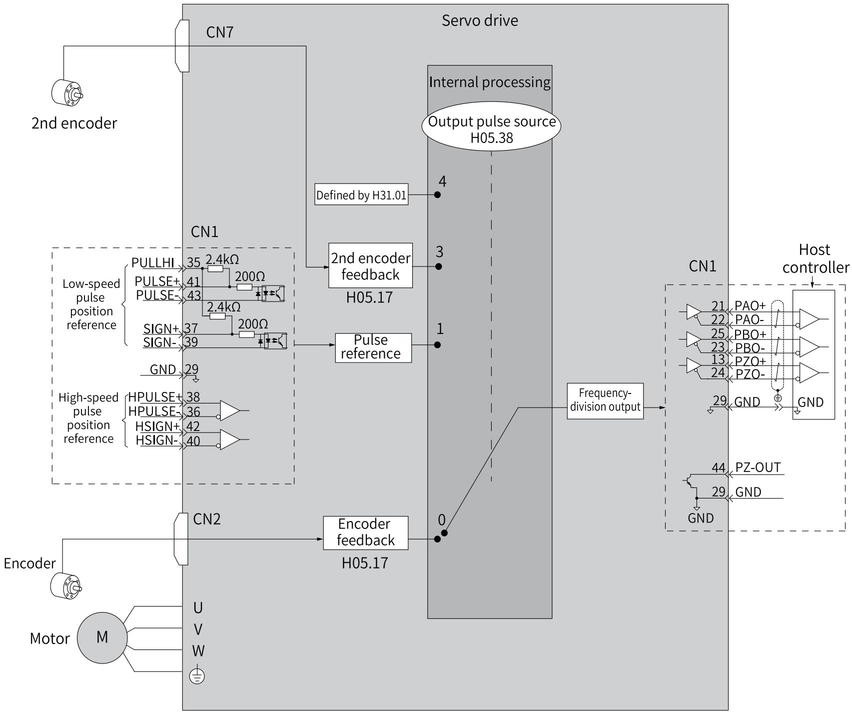


Figure 3-72 Schematic diagram of frequency-division output

- It is recommended to use synchronous output (H05.38 = 1) of pulse references in case of synchronous tracing of multi-axis servo pulses. When the host controller is used for closed-loop feedback, it is recommended to use encoder frequency-division output (H05.38 = 0).
- when the host controller provides full closed-loop feedback, encoder frequency-division output (H05.38 = 3) is recommended. When the output frequency setpoint is used, it is recommended to use H31.01 frequency division output setting mode , that is, H05.38=4.

The drive offers one group of frequency-division terminals, as described below:

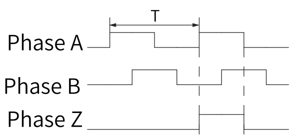
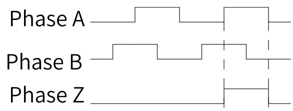
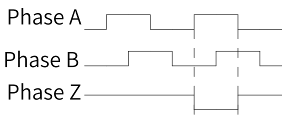
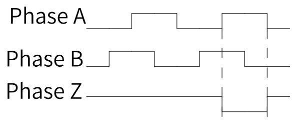
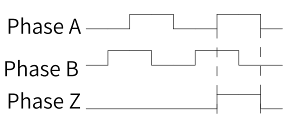
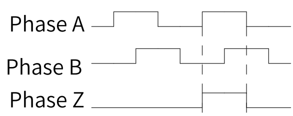
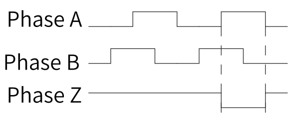
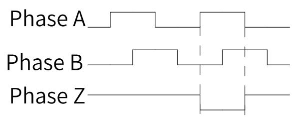
- Phase A pulses: PAO+ and PAO-, differential output, maximum output pulse frequency: 4 Mpps
- Phase B pulses: PBO+ and PBO-, differential output, maximum output pulse frequency: 4 Mpps
- Phase Z pulses: PZO+ and PZO-, differential output, maximum output pulse frequency: 4 Mpps
- PZ-OUT, GND, open-collector output, maximum output pulse frequency: 100 kpps

When using the frequency-division output function, set the output pulse source (H05.38), phase (H02.03), resolution (H05.17), and phase Z pulse polarity (H05.41) according to requirements.

When the output source is encoder frequency-division pulse (H05.38 = 0), the motor rotates one revolution and the phase A/B output pulses per motor revolution are determined by H05.17 (Encoder frequency-division pulses). The pulse width (T) of phase A/B is determined by the motor speed. The phase Z, whose width is also T, is synchronized with phase A. For communication motors, Z signal is output once per motor revolution.

When the output source is H31.01 (H05.38 = 4), the A/B phase output pulse frequency (quadruple) is determined by H31.01, and there is no Z phase pulse output.

Table 3–18 Pulse diagrams of encoder frequency-division output (H05.38 = 0)

H02.03 (Output pulse phase)	H05.41 (Z pulse output polarity)	Pulse Output Diagram of Forward RUN	Pulse Output Diagram of Reverse RUN
0	0	 Phase A leads phase B by 90°.	 Phase B leads phase A by 90°.
	1	 Phase A leads phase B by 90°.	 Phase B leads phase A by 90°.
1	0	 Phase B leads phase A by 90°.	 Phase A leads phase B by 90°.
	1	 Phase B leads phase A by 90°.	 Phase A leads phase B by 90°.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H02.03	2002-04h	Output pulse phase	0: Phase A leads phase B 1: Phase A lags behind phase B	0	-	At stop
H05.17	2005-12h	Number of encoder frequency-division pulses	0–4194303	2500	[P/N-N]/[P/Rev]	At stop
H05.38	2005-27h	Frequency-division output source	0: Encoder frequency-division output 1: Pulse reference synchronous output 2: Frequency-division output inhibited 3: Second encoder frequency-division output 4: H31.01 reference frequency output Note: For model N, only 0, 2, 3 and 4 are available.	0	-	Real-time
H05.41	2005-2Ah	Z pulse output polarity	bit0: Frequency-division Z output polarity 0: Positive (high level upon active Z pulse) 1: Negative (low level upon active Z pulse) bit1: OCZ output polarity 0: Positive (high level upon active Z pulse) 1: Negative (low level upon active Z pulse) bit2: Inner loop probe Z signal source 0: Motor Z signal 1: Frequency-division output Z signal	0x1	-	At stop

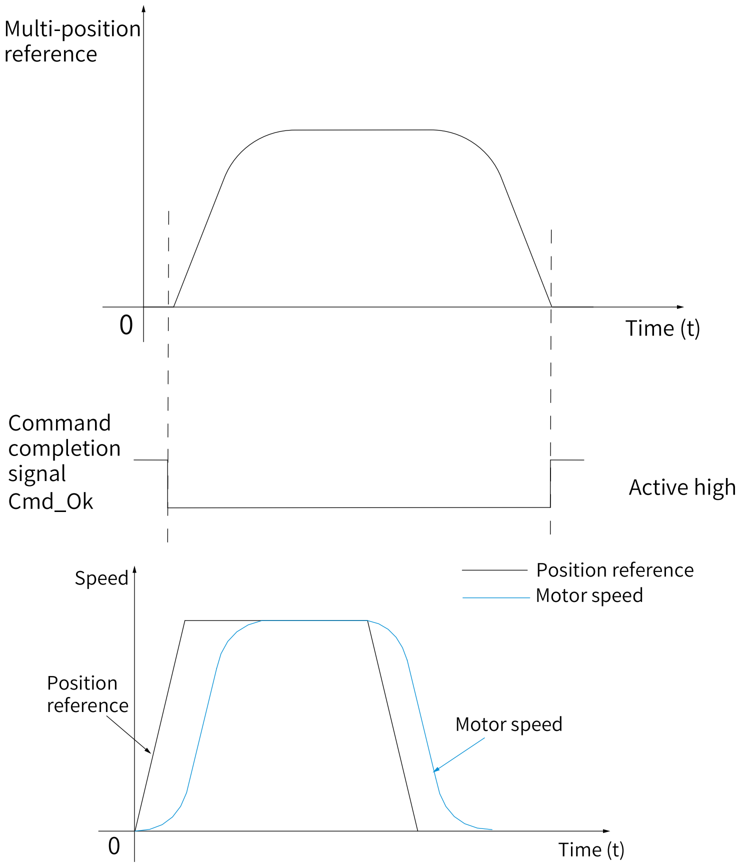
3.9.7 Motion Control Completed, Internal Command Completed, Positioning Completed, Proximity

- "Motion control completed" refers to the completion of command transmission and positioning in the position control mode. In this case, the servo drive outputs a McOK (motion control completed) signal, and the host controller, upon receiving the signal, acknowledges the motion control is done.
- "Internal command completed" refers to the completion of command transmission. In this case, the internal multi-position reference is zero. The servo drive therefore outputs a CmdOk (Internal command completed) signal, and the host controller, upon receiving the signal, acknowledges the internal command

transmission is done. Internal instruction completion is not used to evaluate whether homing is completed.

- Positioning completed: When the position deviation fulfills the condition set by users (H05.20), it indicates the positioning in position control mode is completed. Meanwhile, the servo drive outputs positioning completed (COIN) signal, and the host controller, after receiving this signal, confirms the positioning is completed.

The following figure shows the schematic diagram.



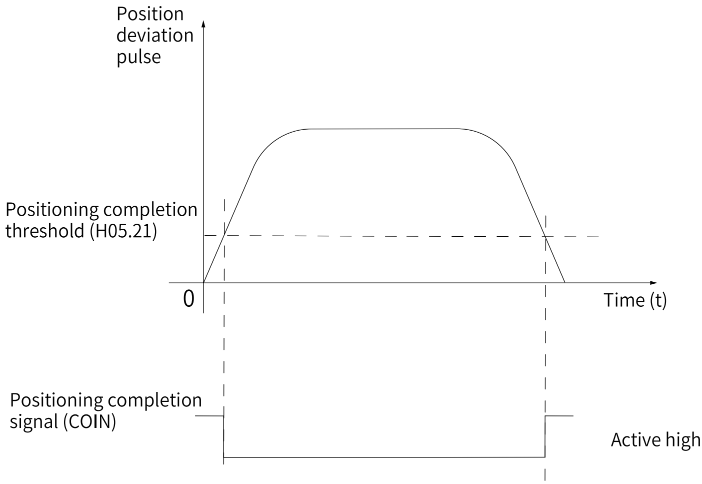


Figure 3-73 Description of positioning completed/proximity functions

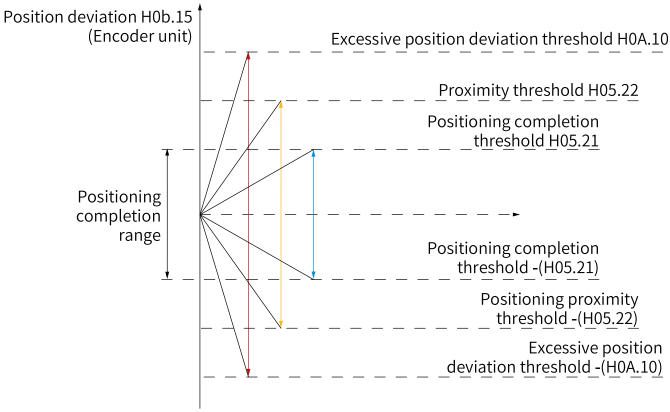


Figure 3-74 Signals related to position deviation

You can set the unit for positioning completed, proximity, and excessive position deviation in H0A.17. When position deviation meets the condition defined by H05.20, the servo drive outputs a NEAR signal to prepare for positioning completed.

Before applying the positioning completed/proximity function, set H05.20, H05.21, H05.22, H05.59, and H05.60 first. The schematic diagram for the window time (H05.59) and hold time (H05.60) of positioning completed signal is as follows.

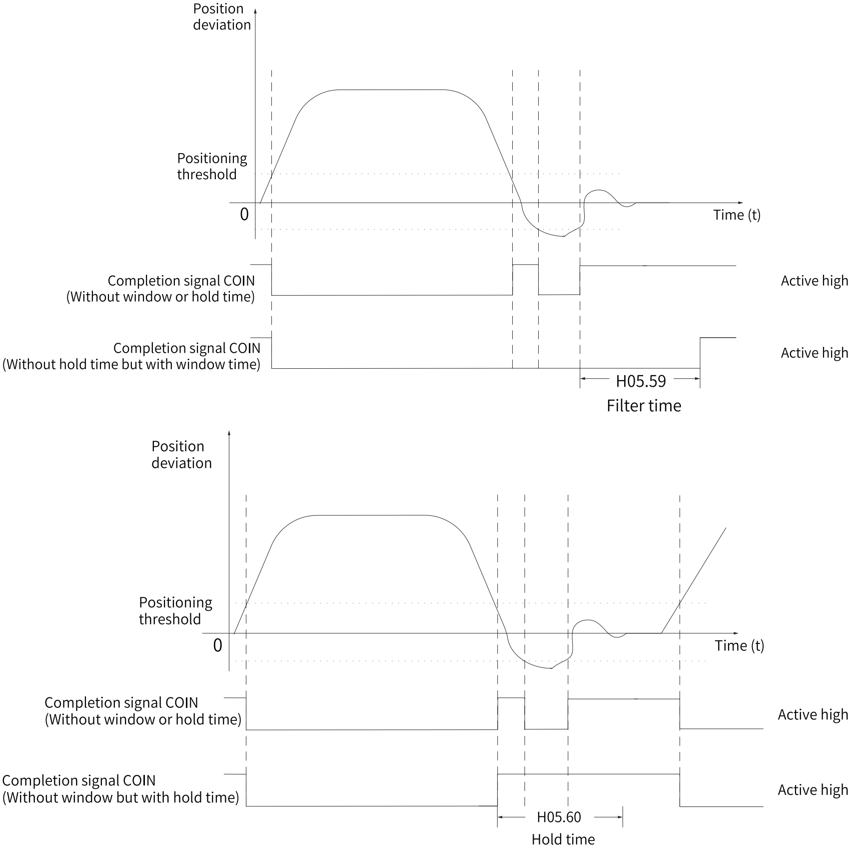


Figure 3-75 Schematic diagram for the window time (H05.59) and hold time (H05.60) of positioning completed signal

When the COIN (positioning completed) signal has a hold time of 0, it remains active until the next position reference is received.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.20	2005-15h	Condition for positioning completed signal output	0: When absolute value of position deviation is smaller than the value of H05.21, a positioning completion ON signal is output. 1: When filtered position command is 0 and absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 2: When unfiltered position command is 0 and absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 3: When the unfiltered position command is 0 and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. Thereafter, when the position command is 0, a positioning completion ON signal is output within the positioning holding time H05.60. After the positioning holding time H05.60 elapsed, the output of the positioning completion signal is determined according to the unfiltered position command and the absolute value of the position deviation. 4: When the filtered position command is 0 and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. Thereafter, when the position command is 0, a positioning completion ON signal is output within the positioning holding time H05.60. After the positioning holding time H05.60 elapsed, the output of the positioning completion signal is determined according to the filtered position command and the absolute value of the position deviation.	0	-	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.20	2005-15h	Condition for positioning completed signal output	5: When the unfiltered position command is 0, the zero-speed signal is ON and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 6: When the filtered position command is 0, the zero-speed signal is ON and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 7: When the unfiltered position command is 0, positioning completion evaluation starts after the delay time H05.60 elapses. When the unfiltered position command is 0 and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 8: When the filtered position command is 0, positioning completion evaluation starts after the delay time H05.60 elapses. When the filtered position command is 0 and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 9: When the unfiltered position command is 0 and the absolute value of the position deviation is less than H05.21, positioning completion evaluation starts after the delay time H05.60 elapses. When the unfiltered position command is 0 and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. 10: When the filtered position command is 0 and the absolute value of the position deviation is less than H05.21, positioning completion evaluation starts after the delay time H05.60 elapses. When the filtered position command is 0 and the absolute value of the position deviation is less than H05.21, a positioning completion ON signal is output. Note: For SV680P-INT, the parameter takes effect when H02.00 is not 8. For SV680N-INT, the parameter takes effect when H02.00 is not 9.	0	-	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.21	2005-16h	Threshold of positioning completed	1 to 65535 Note: For SV680P-INT, the parameter takes effect when H02.00 is not 8. For SV680N-INT, the parameter takes effect when H02.00 is not 9.	46976	Encoder unit	Real-time
H05.22	2005-17h	Proximity threshold	1 to 65535 Note: For SV680P-INT, the parameter takes effect when H02.00 is not 8. For SV680N-INT, the parameter takes effect when H02.00 is not 9.	65535	Encoder unit	Real-time
H05.59	2005-3Ch	Positioning window time	0 ms–30000 ms	0	ms	Real-time
H05.60	2005-3Dh	Hold time of positioning completed	0 ms–30000 ms	0	ms	Real-time
H0A.17	200A-12h	Reference pulse selection	0: Pulse unit 1: Reference unit	0 Note: For model N, the default value is 1.	-	At stop

Caution

- Set H05.22 to a value higher than H05.21 in general cases.
- H05.21 only reflects the absolute threshold when the positioning completed signal is active. It is not related to the positioning precision.
- An excessively high speed feedforward gain (H08.19) or low-speed operation reduces the absolute position deviation. In this case, the COIN (positioning completed) signal may keep active if H05.21 is set to an excessively high value. To improve the positioning accuracy, decrease the value of H05.21.
- When H05.21 is set to a low value along with small position deviation, you can change the condition for outputting the COIN (positioning completed) signal in H05.20.
- An inactive S-ON signal deactivates the COIN (positioning completed) signal and NEAR (proximity) signal output.
- The output of position proximity DO is not affected by H05.60 (positioning completion holding time) or H05.59 (positioning window time) and you need not to evaluate the change of the positioning command.

To use the motion control/internal command/positioning completion/proximity functions, assign FunOUT.24 (McOk, motion control completed), FunOUT.22 (CmdOk, internal command completed), FunOUT.5 (COIN, positioning completed), and FunOUT.6 (NEAR) to four DOs respectively, and set the active logic of these DOs.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.60	2005-3Dh	Hold time of positioning completed	0 ms–30000 ms	0	ms	Real-time

☆ Related parameters:

Code	Name	Function Name	Function
FunOUT.5	COIN	Positioning completed	Active: The absolute position deviation meets the threshold defined by H05.21 in the position control mode, indicating positioning is done. Inactive: The servo drive is in the process of completion in the position control mode.
FunOUT.6	NEAR	Proximity	Active: The absolute position deviation meets the condition defined by H05.22, indicating the servo drive is close to the target position. Inactive: The servo drive is in the process of proximity in the position control mode.
FunOUT.22	CmdOk	Internal command completed	Active: The transmission of the multi-position reference or interrupt positioning reference is done in the position control mode. Inactive: The transmission of the multi-position reference or interrupt positioning reference is in progress in the position control mode.
FunOUT.24	McOk	Motion control completed	Active: The transmission of the multi-position reference or interrupt positioning reference and the positioning process are done in the position control mode. Inactive: The transmission of the multi-position reference or interrupt positioning reference or positioning is in progress in the position control mode.

3.9.8 Interrupt Positioning

Caution

The interrupt positioning signal cannot be triggered during homing.

Description

If interrupt positioning is triggered in the position control mode, the servo drive halts current operation and turns to executing the pre-set fixed distance. To be specific, when the S-ON signal is active in the position control mode, if this function is enabled, the servo motor runs the position reference for interrupt positioning in the original direction (before the function is triggered).

When interrupt positioning is in progress, the servo drive does not respond to any other internal/external position references (including another interrupt positioning command). In this case, the input position reference counter (H0b.13) counts the interrupt positioning reference only. After interrupt positioning is done, the servo drive may or may not respond to the position references depending on the setpoint of H05.29 (Interrupt positioning clear signal). The position references received during interrupt positioning are invalid.

After interrupt positioning is done, the servo drive outputs the interrupt positioning completed (FunOUT.15: XintCoin) signal and positioning completed (FunOUT.5: COIN) signal, while the host controller, upon receiving XintCoin signal, acknowledges interrupt positioning is done. The XintCoin signal output is not related to the S-ON signal or the logic of DI8.

Interrupt positioning is effective only when the following conditions are met:

- The motor speed is higher than or equal to 10 rpm before interrupt positioning is triggered, or the setpoints of H05.26 (Constant operating speed in interrupt positioning) and H05.24 (Displacement of interrupt positioning) are not 0.
- The DI assigned with FunIN.33 (Interrupt positioning inhibited) is not used or the logic of this DI is inactive.

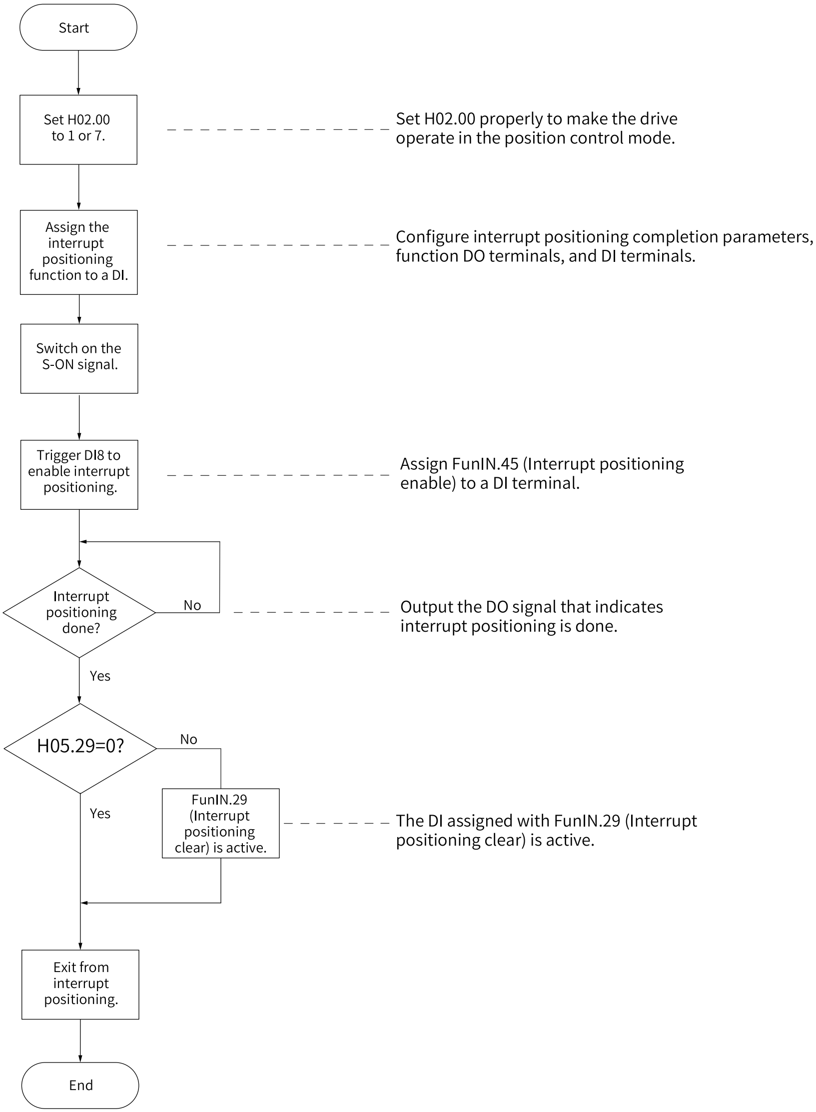


Figure 3-76 Flowchart of interrupt positioning signal

Setting parameters

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.24	2005-19h	Interrupt positioning displacement	-1073741824 to 1073741824	10000	Reference unit	Real-time
H05.26	2005-1Bh	Constant operating speed in interrupt positioning	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	200	[mm/s]/[rpm]	Real-time
H05.27	2005-1Ch	Acc./Dec. time of interrupt positioning	0 ms–65535 ms	10	ms	Real-time
H05.29	2005-1Eh	Interruption fixed length unlock	0: Disabled 1: Enabled	1	-	Real-time

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.29	XintFree	Interrupt positioning clear	Active: The interrupt positioning state is cleared, which means the servo drive can respond to other position references. Inactive: The interrupt positioning state is locked, which means the servo drive cannot respond to other position references.
FunIN.33	XintInHibit	Interrupt positioning inhibited	Active: Interrupt positioning inhibited Inactive: Interrupt positioning allowed
FunIN.45	XintEn	Interrupt positioning selection	Active: Interrupt positioning enabled Inactive: Interrupt positioning disabled The DI assigned with FunIN.45 (Interrupt positioning enable) is used to trigger interrupt positioning.
FunOut.15	XintCoin	Interrupt positioning completed	Active: Interrupt positioning completed in position control Inactive: Displacement in interrupt positioning not completed in position control

When DI7 is assigned with FunIN.45, the active logic of DI7 is as follows:

Table 3–19 Active logic of DI7 during interrupt positioning

H03.15	Active Logic of DI7
0	Active low
1	Active high

The constant operating speed during interrupt positioning is shown in the following figure.

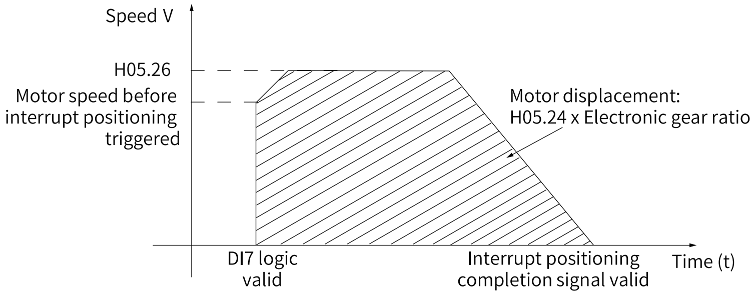


Figure 3-77 Motor operating curve during interrupt positioning

Table 3–20 Motor speed during interrupt positioning

H05.26	Motor Speed (rpm) Before Triggering Interrupt Positioning	Interrupt Positioning	Constant operating speed in interrupt positioning
0	< 10	Inactive	-
	⩾ 10	Active	Motor Speed before Triggering Interrupt Positioning
1–6000	-	Active	H05.26

3.9.9 Homing

Caution

- The homing trigger signal is shielded when interrupt positioning or multi-position reference is in progress.
- To use the homing function, ensure H11.00 is not set to 5 as the setpoint 5 indicates enhanced axis control mode, in which the homing function is shielded.
- Do not set H05.30 to 65 or 8 when the motor is operating by commands. Otherwise, speed fluctuation will occur.

Description

- Home (or mechanical home): Indicates the position of the home switch or Z signal depending on the value of H05.31 (Homing mode).

- Zero: positioning target point, represented as home + offset (set in H05.36). When H05.36 (Mechanical home offset) is set to 0, the zero position coincides with the home.

In the position control mode, when homing is triggered after the S-ON signal is activated, the motor starts searching for the zero position.

When homing is in progress, the servo drive does not respond to other position references (including another homing trigger signal) until homing is done.

This function includes two actions:

- Home attaining: After receiving the homing signal, the servo drive proactively locates the relative position between the motor shaft and the preset mechanical home reference point; it finds the home and then moves through the offset from the home reference point to the zero point. The homing mode usually applies in initial searching for the zero position.
- Electrical homing: After determining the absolute zero position through homing, the drive takes current position as the start position to execute a relative displacement.

After the homing function (both homing and electrical homing) is executed, The absolute position of the motor (H0b.07) is consistent with the home offset (H05.36).

The servo drive outputs the homing completed signal (FunOUT.16: HomeAttain) or electrical homing completed signal (FunOUT.17: ElecHomeAttain), and the host controller, upon receiving these two signals, acknowledges the homing function is done executing. HomeAttain or ElecHomeAttain signal is not related to the operation mode or operation state of the servo drive.

Table 3–21 Comparison between homing and electrical homing

<table>
<tr><th>Mode</th><th>Homing trigger mode (H05.30)</th><th>Homing Direction, Deceleration Point, Home</th><th>Trigger Signal</th><th>Total Motor Displacement</th></tr>
<tr><td rowspan="6">Homing</td><td>0</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1</td><td rowspan="3">Determined by H05.31</td><td>HomingStart signal</td><td rowspan="3">Determined by the mechanical home coordinate and offset displacement</td></tr>
<tr><td>3</td><td>Servo ON</td></tr>
<tr><td>4</td><td>Servo ON</td></tr>
<tr><td>6</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>8</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Electrical homing</td><td>2</td><td rowspan="2">The homing direction is consistent with the motor displacement sign (+/-). The deceleration point or home signal is not needed.</td><td>HomingStart signal</td><td rowspan="2">(H05.36 - H0b.07) x Electronic gear ratio</td></tr>
<tr><td>5</td><td>Servo ON</td></tr>
</table>

Homing

Caution

- Do not set H05.30 to 6 or 8 when the motor is operating by commands. Otherwise, speed fluctuation will occur.
- Set mechanical limit switches before enabling the homing function. For homing upon hit-and-stop, set the offset to a value within the travel range to prevent the machine from collision due to high-speed operation during homing.
- When the motor hits the limit switch during homing, the drive reports E950.0 (Forward overtravel) or E952.0 (Reverse overtravel), and the motor, if H05.40 is set to 0 or 1, stops in the stop mode defined by H02.07.

The following part takes an example to describe homing attaining:

- Forward, home switch as deceleration point and home (H05.31 = 0)
- Reverse, home switch as deceleration point and home (H05.31 = 1)
- Forward, Z signal as deceleration point and home (H05.31 = 2)
- Reverse, Z signal as deceleration point and home (H05.31 = 3)
- Forward, home switch as deceleration point and Z signal as home (H05.31 = 4)
- Reverse, home switch as deceleration point and Z signal as home (H05.31 = 5)

- Forward direction, deceleration point and home being forward limit switch signal (H05.31 = 6)
- Reverse, negative limit switch as deceleration point and home (H05.31 = 7)
- Forward, positive limit switch as deceleration point and Z signal as home (H05.31 = 8)
- Reverse, negative limit switch as deceleration point and Z signal as home (H05.31 = 9)
- Forward, mechanical limit position as deceleration point and home (H05.31 = 10)
- Reverse, mechanical limit position as deceleration point and home (H05.31 = 11)
- Forward, mechanical limit position as deceleration point and Z signal as home (H05.31 = 12)
- Reverse, mechanical limit position as deceleration point and Z signal as home (H05.31 = 13)
- Forward single-turn homing (H05.31 = 14)
- Reverse single-turn homing (H05.31 = 15)
- Single-turn nearby homing (H05.31 = 16)

- Forward, home switch as deceleration point and home (H05.31 = 0)

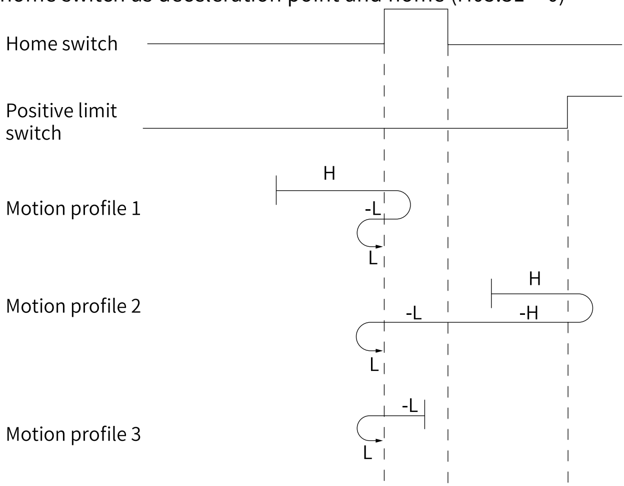


Figure 3-78 Motor running curve and speed in mode 0

  - Motion profile 1: The home switch (deceleration point) signal is active when the motor starts running, with the positive limit switch not triggered in the whole process.
  - Motion profile 2: The home switch (deceleration point) signal is inactive when the motor starts to run, with the positive limit switch triggered.
  - Motion profile 3: The home switch (deceleration point) signal is active when the motor starts running, with the positive limit switch not triggered in the whole process.

Note

In the figure, "H" represents high speed 6099.01h, and "L" represents low speed 6099.02h, and “-” indicates reverse run.

- Reverse, home switch as deceleration point and home (H05.31 = 1)

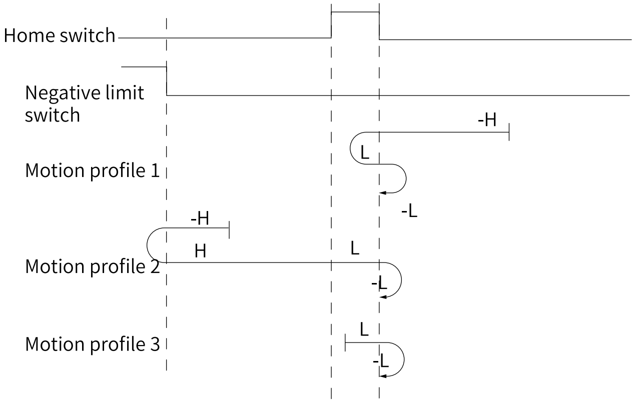


Figure 3-79 Motor running curve and speed in mode 1

  - Motion profile 1: The home switch (deceleration point) signal is active when the motor starts running, with the negative limit switch not triggered in the whole process.
  - Motion profile 2: The home switch (deceleration point) signal is inactive when the motor starts running, with the negative limit switch triggered.
  - Motion profile 3: The home switch (deceleration point) signal is active when the motor starts running, with the negative limit switch not triggered in the whole process.

- Forward, Z signal as deceleration point and home (H05.31 = 2)

Caution

Note: In Modes 2 and 3 (H05.31 = 2 or 3) where the motor Z signal acts as the home and deceleration point, the actual stop position of the motor may not be on the rising edge on the same side of the motor Z signal. A deviation of ±1 pulse (in encoder unit) may be present in the stop position.

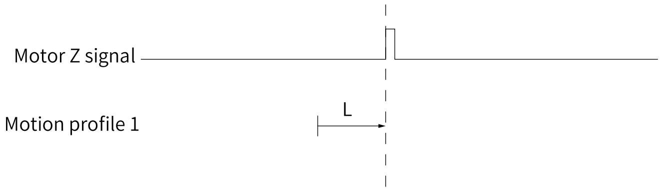


Figure 3-80 Motor running curve and speed in mode 2

- Motion profile 1: The Z signal is inactive when the motor starts running, with the positive limit switch not triggered in the whole process.

- Reverse, Z signal as deceleration point and home (H05.31 = 3)

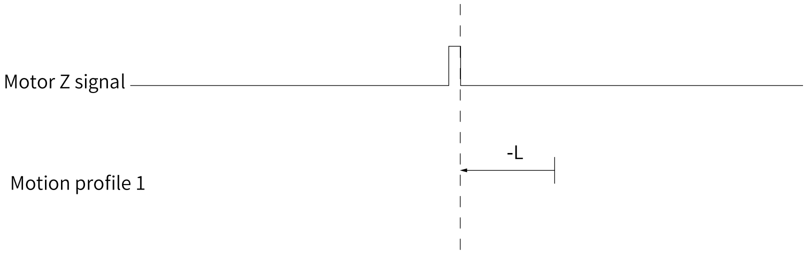


Figure 3-81 Motor running curve and speed in mode 3

- Motion profile 1: The Z signal is inactive when the motor starts running, with the negative limit switch not triggered in the whole process.

- Forward, home switch as deceleration point and Z signal as home (H05.31 = 4)

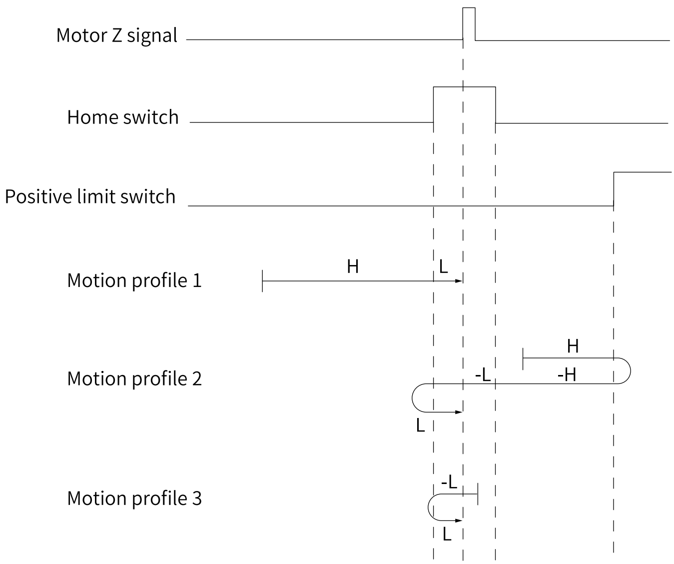


Figure 3-82 Motor running curve and speed in mode 4

- Motion profile 1: The home switch signal is inactive when the motor starts running, with the positive limit switch not triggered in the whole process.
- Motion profile 2: The home switch signal is inactive when the motor starts running, with the positive limit switch triggered.
- Motion profile 3: The home switch signal is active when the motor starts running, with the positive limit switch not triggered in the whole process.

- Reverse, home switch as deceleration point and Z signal as home (H05.31 = 5)

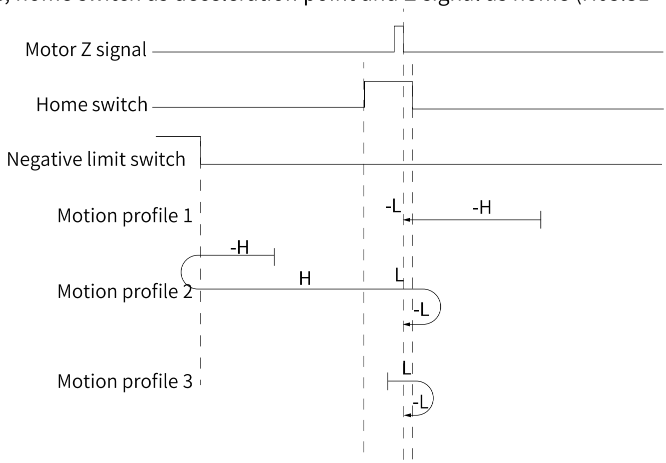


Figure 3-83 Motor running curve and speed in mode 5

- Motion profile 1: The home switch signal is inactive when the motor starts running, with the negative limit switch not triggered in the whole process.
- Motion profile 2: The home switch signal is inactive when the motor starts running, with the negative limit switch triggered.
- Motion profile 3: The home switch signal is active when the motor starts running, with the negative limit switch not triggered in the entire process.

- Forward direction, deceleration point and home being forward limit switch signal (H05.31 = 6)

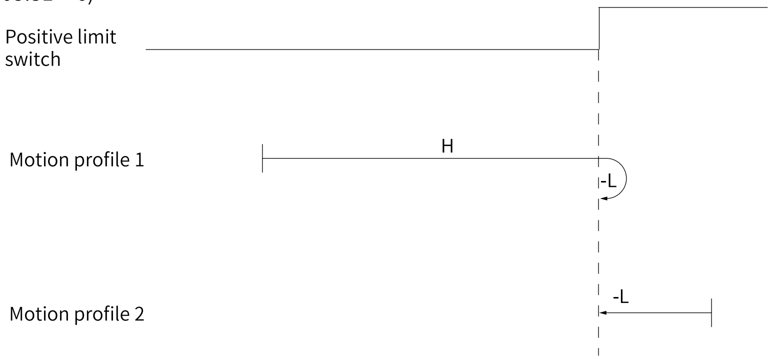


Figure 3-84 Motor running curve and speed in mode 6

- Motion profile 1: The positive limit switch signal is inactive when the motor starts running.
- Motion profile 2: The positive limit switch signal is active when the motor starts running.

- Reverse, negative limit switch as deceleration point and home (H05.31 = 7)

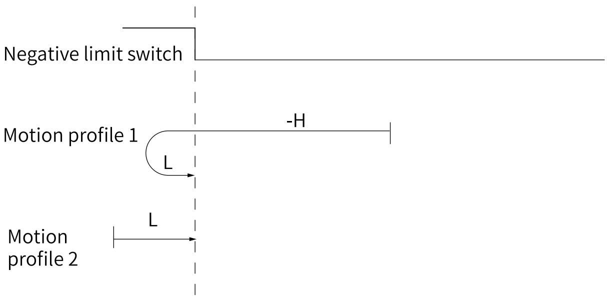


Figure 3-85 Motor running curve and speed in mode 7

- Motion profile 1: The negative limit switch signal is inactive when the motor starts running.
- Motion profile 2: The negative limit switch signal is active when the motor starts running.

- Forward, positive limit switch as deceleration point and Z signal as home (H05.31 = 8)

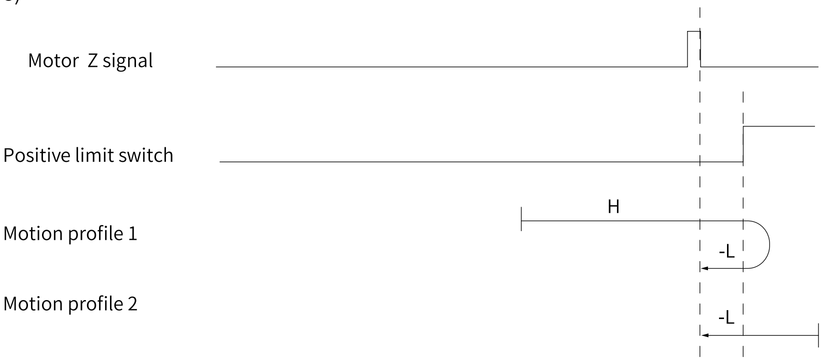


Figure 3-86 Motor running curve and speed in mode 8

  - Motion profile 1: The positive limit switch signal is inactive when the motor starts running.
  - Motion profile 2: The positive limit switch signal is active when the motor starts running.

- Reverse, negative limit switch as deceleration point and Z signal as home (H05.31 = 9)

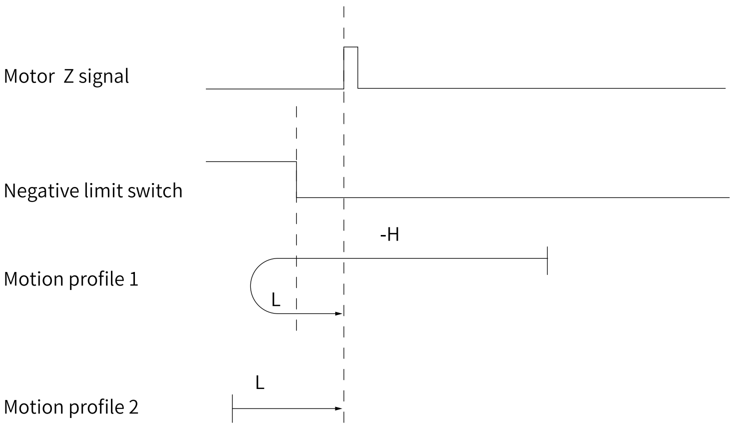


Figure 3-87 Motor running curve and speed in mode 9

  - Motion profile 1: The negative limit switch signal is inactive when the motor starts running.
  - Motion profile 2: The negative limit switch signal is active when the motor starts running.

- Forward, mechanical limit position as deceleration point and home (H05.31 = 10)

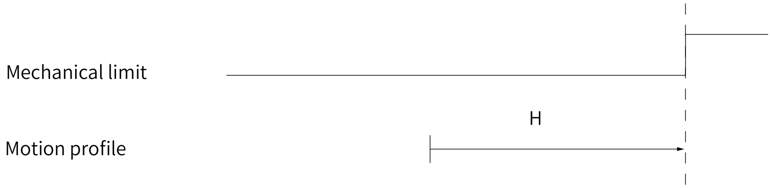


Figure 3-88 Motor running curve and speed in mode 10

- Motion profile: The positive limit switch signal is inactive when the motor starts running.

- Reverse, mechanical limit position as deceleration point and home (H05.31 = 11)

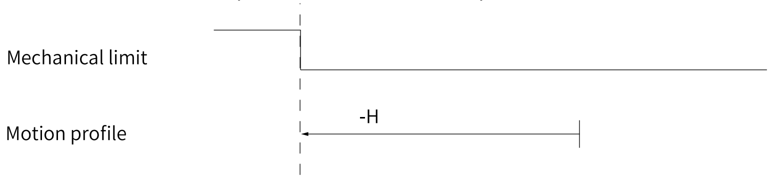


Figure 3-89 Motor running curve and speed in mode 11

- Motion profile: The negative limit switch signal is inactive when the motor starts running.

- Forward, mechanical limit position as deceleration point and Z signal as home (H05.31 = 12)

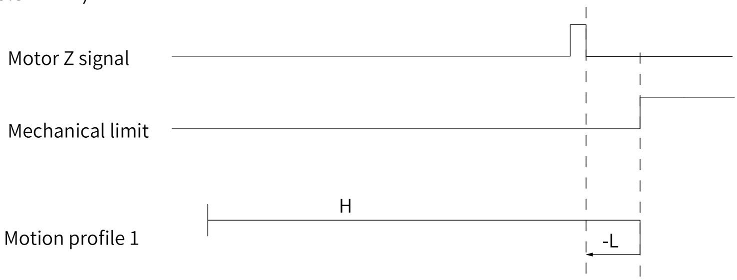


Figure 3-90 Motor running curve and speed in mode 12

- Motion profile 1: The positive limit switch signal is inactive when the motor starts running.

- Reverse, mechanical limit position as deceleration point and Z signal as home (H05.31 = 13)

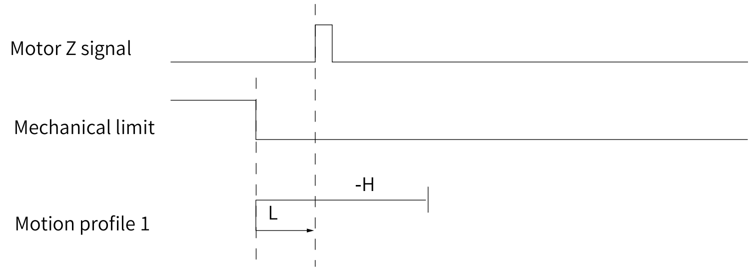


Figure 3-91 Motor running curve and speed in mode 13

- Motion profile 1: The negative limit switch signal is inactive when the motor starts running.

- Forward single-turn homing (H05.31 = 14)

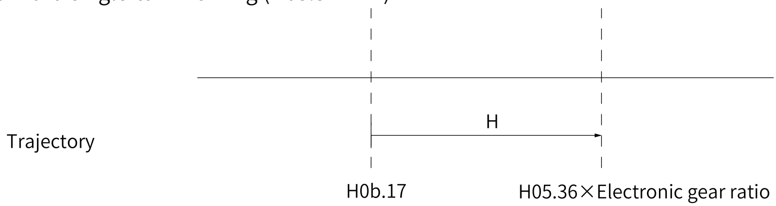


Figure 3-92 Motor running curve and speed in mode 14

- Motion profile: The positive limit switch signal is inactive when the motor starts running.

Note

- When H05.31=14/15/16, the single-turn homing is only effective in absolute position single-turn mode (H02.01 = 4).
- If the home offset is set (H05.36 ≠ 0) and the mechanical home does not coincide with the mechanical zero (H05.40 = 0 or 2), the motor keeps running until H0b.07 = H05.36, and the absolute position defined by H0b.07 is cleared.
- If the home offset is set (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor keeps running until H0b.07 = 0.

- Reverse single-turn homing (H05.31 = 15)

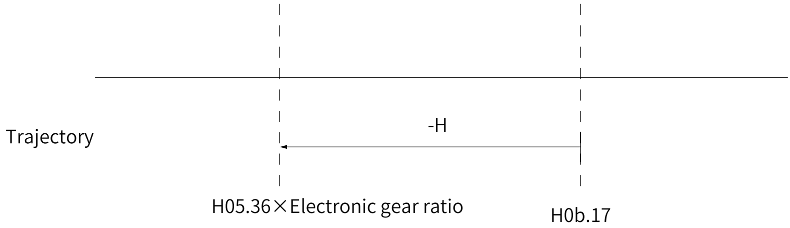


Figure 3-93 Motor running curve and speed in mode 15

- Motion profile: The negative limit switch signal is inactive when the motor starts running.

Note

- When H05.31=14/15/16, the single-turn homing is only effective in absolute position single-turn mode (H02.01 = 4).
- If the home offset is set (H05.36 ≠ 0) and the mechanical home does not coincide with the mechanical zero (H05.40 = 0 or 2), the motor keeps running until H0b.07 = H05.36, and the absolute position defined by H0b.07 is cleared.
- If the home offset is set (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor keeps running until H0b.07 = 0.

- Single-turn nearby homing (H05.31 = 16)

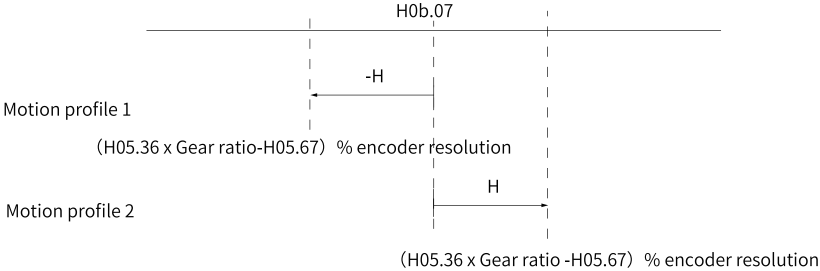


Figure 3-94 Motor running curve and speed in mode 16

- Motion profile 1: The positive limit switch signal is inactive when the motor starts running.
- Motion profile 2: The negative limit switch signal is inactive when the motor starts running.

Note

- When H05.31=14/15/16, the single-turn homing is only effective in absolute position single-turn mode (H02.01 = 4).
- If the home offset is set (H05.36 ≠ 0) and the mechanical home does not coincide with the mechanical zero (H05.40 = 0 or 2), the motor keeps running until H0b.07 = H05.36, and the absolute position defined by H0b.07 is cleared.
- If the home offset is set (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor keeps running until H0b.07 = 0.

Evaluation condition for torque homing: After the motor reaches the hard limit, and the torque feedback reaches the limit value defined in H05.58 (mechanical torque limit, in 0.1%), the first Z signal in the reverse direction is searched for and regarded as the home after the motor stops.

Electrical homing: starting electrical homing (H05.30 = 5)

The mechanical zero position is obtained after homing is done. In this case, you can make the motor move from current position (H0b.07) to the designated position (H05.36) by setting H05.36 (Mechanical home offset).

In the electrical homing mode, the motor runs at the speed defined by H05.32 in the direction defined by the sign (+/-) of the displacement value. The total displacement is determined by the difference between H05.36 and H0b.07. The motor stops immediately after the displacement reference is done executing.

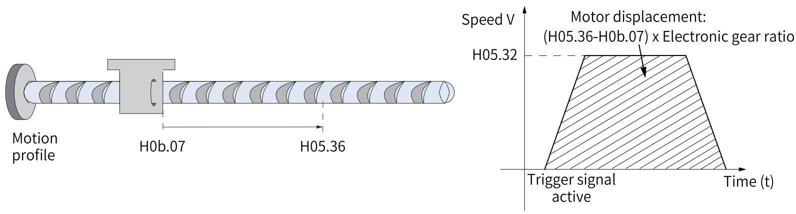
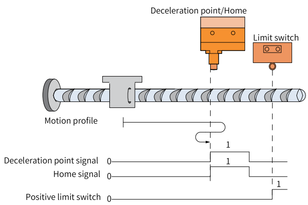
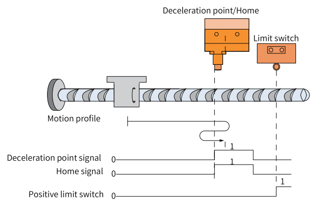
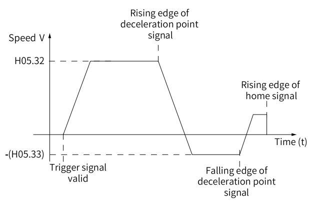
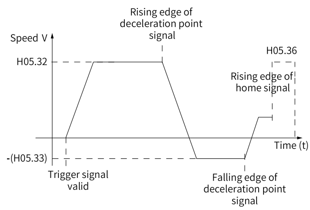


Figure 3-95 Motor running curve and speed in electrical homing

Mechanical home and mechanical zero

The following takes "H05.30 = 0" as example to describe the difference between mechanical home and mechanical zero.

Table 3–22 Description of mechanical home and mechanical zero

Mechanical Zero Different From Mechanical Home Reference Point	Mechanical Zero Same As Mechanical Home Reference Point
If the home offset is present (H05.36 ≠ 0) and the mechanical home differs from the mechanical zero (H05.40 = 0 or 2), the motor stops immediately after reaching the rising edge of the home signal during acceleration or forward operation at constant speed. After stop, the motor absolute position (H0b.07) is changed to the setpoint of H05.36 (Mechanical home offset) forcibly.	If the home offset is present (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor continues running after reaching the rising edge of the home switch signal during acceleration or forward operation at constant speed until the absolute position (H0b.07) reaches the setpoint of H05.36 (Mechanical home offset).
	
	

Setting parameters

- Homing mode setting

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.30	2005-1Fh	Homing enable selection	0: Disabled 1: Homing enabled through the HomingStart signal input from DI 2: Electrical homing enabled through the HomingStart signal input from DI 3: Homing started immediately upon power-on 4: Homing executed immediately 5: Electrical homing started 6: Current position as home 8: D-triggered position as home Note: For model N, only 0 and 6 is available.	0	-	Real-time
H05.31	2005-20h	Homing mode	0: Forward, home switch as deceleration point and home 1: Reverse, home switch as deceleration point and home 2: Forward, Z signal as deceleration point and home 3: Reverse, motor Z signal as deceleration point and home 4: Forward, home switch as deceleration point and Z signal as home 5: Reverse, home switch as deceleration point and Z signal as home 6: Forward, positive limit switch as deceleration point and home 7: Reverse, negative limit switch as deceleration point and home 8: Forward, positive limit switch as deceleration point and Z signal as home 9: Reverse, negative limit switch as deceleration point and Z signal as home 10: Forward, mechanical limit position as deceleration point and home 11: Reverse, mechanical limit position as deceleration point and home 12: Forward, mechanical limit position as deceleration point and Z signal as home 13: Reverse, mechanical limit position as deceleration point and Z signal as home 14: Forward single-turn homing 15: Reverse single-turn homing 16: Nearby single-turn homing	0	-	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.40	2005-29h	Mechanical home offset and action upon overtravel	0: H05.36 as the coordinate after homing, reverse homing applied after homing triggered again on overtravel 1: H05.36 as the relative offset after homing, reverse homing applied after homing triggered again on overtravel 2: H05.36 as the coordinate after homing, reverse homing auto-applied on overtravel 3: H05.36 as the relative offset after homing, reverse homing auto-applied on overtravel	0	-	Real-time

- Homing curve setting

  If the home signal is activated before the deceleration triggered by an active deceleration point signal is fully done executing, the final positioning may be unstable. Take the displacement required by deceleration into account before setting the deceleration point and homing signal input position. The acceleration/deceleration time during homing (H05.34) also affect the positioning stability.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.32	2005-21h	Speed of high-speed search for home switch signal	0 RPM to 3000 RPM	100	rpm	Real-time
H05.33	2005-22h	Speed of low-speed search for home switch signal	0 rpm to 1000 rpm	10	rpm	Real-time
H05.34	2005-23h	Acceleration/ Deceleration time during homing	0 ms–1000 ms	1000	ms	Real-time
H05.35	2005-24h	Home search time limit	0–65535	10000	-	Real-time
H05.36	2005-25h	Mechanical home offset	-2147483648 to 2147483647	0	Reference unit	Real-time

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.31	HomeSwitch	Home switch	Active: Current position as home Set the logic of the DI assigned with FunIN.31 to "active high" or "active low" based on the output of the host controller. See the following table for details. See the following table for details.
FunIN.32	HomingStart	Homing enable	Active: Homing enabled (The HomingStart signal cannot be triggered repeatedly during homing.) Inactive: Homing inhibited
FunIN.41	HomingRecord	DI-triggered point as the home	The edge-triggered position is taken as the home.
FunOut.16	HomeAttain	Home find	Active: Homing completed in the position control mode Inactive: Homing not completed
FunOut.17	ElecHomeAttain	Electrical homing completed	Active: Electrical homing completed in the position control mode Inactive: Electrical homing not completed

DI Logic Set by HomeSwitch	Actual Active Level
0 (low level)	Low level
1 (high level)	High level

Sequence

- H05.30 = 1 or 2

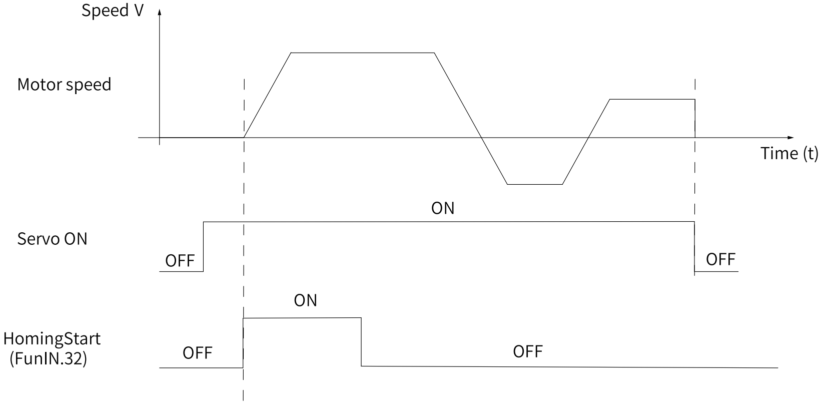


Figure 3-96 Sequence example

- Switch on the S-ON signal first and then the HomingStart signal.

  - During homing, the S-ON signal remains active and the change of the HomingStart signal is shielded.
  - During homing, the motor stops if the S-ON signal is switched off. To enable homing again, switch on the S-ON signal first and then the HomingStart signal.
  - If E601.0 (Homing timeout) occurs, the motor stops, but the S-ON signal remains active. In this case, trigger the HomingStart signal again to reset E601.0, and execute homing again.
  - The homing operation can be triggered repeatedly.

- H05.30 = 3
  - The homing operation is executed only when the S-ON signal is switched on for the first time after power-on.
  - The motor stops when E601.0 (Homing timeout) occurs. To reset E601.0, deactivate the S-ON signal.
  - The homing operation can only be triggered again at next power-on.

- H05.30 = 4 or 5
  - The homing operation is executed immediately after the S-ON signal is switched on upon power-on.
  - If the S-ON signal is deactivated during homing, the motor stops immediately. To trigger homing again, activate the S-ON signal again.
  - When E601.0 (Homing timeout) occurs, H05.30 is set to 0 and the motor stops. To reset E601.0, deactivate the S-ON signal. To perform homing again, reset H05.30. After homing is done, H05.30 is set to 0. To perform homing again, set H05.30 again.

- H05.30 = 6
  - To take the current position as the home and achieve home offset (H05.40 = 0 or 2, H05.36 $\neq$ 0), set H05.36 and H05.40 first, and then set H05.30 to 6. Failing to do so will cause H0b.07 to keep the previous value of H05.36 rather than the one set currently.
  - After homing is done, H05.30 will be set to 0. To enable homing again, re-write H05.36 and set H05.30 to 6.

- H05.30 = 8
  - To take the DI-triggered position as the home, assign FunIN.41 to a DI first and set the current position as the home.
  - To achieve home offset (H05.40 = 0 or 2, H05.36 $\neq$ 0), set H05.36 and H05.40 first, and then set H05.30 to 6. Failing to do so will cause H0b.07 to keep the previous value of H05.36 rather than the one set currently.

3.10 Speed Control Mode

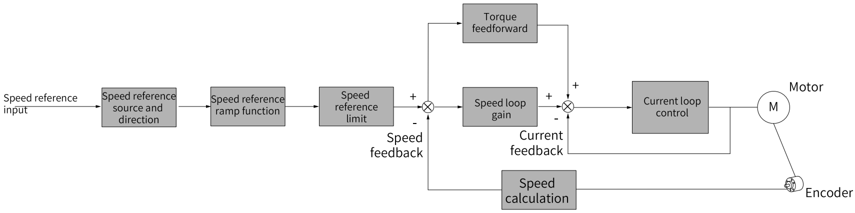


Figure 3-97 Block diagram of speed control

Set H02.00 (Control mode selection) to 0 (Speed control mode) through the keypad or Inovance software tool to make the servo drive operate in the speed control mode. Set the drive parameters based on the mechanical structure and technical indicators. The following part uses the basic parameter setting to describe the speed control mode.

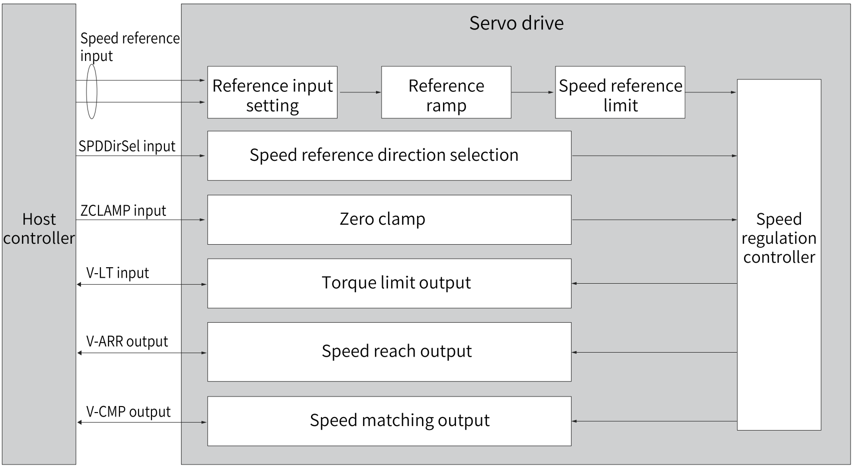


Figure 3-98 Signal exchange between the drive and the host controller

3.10.1Function Block Diagram

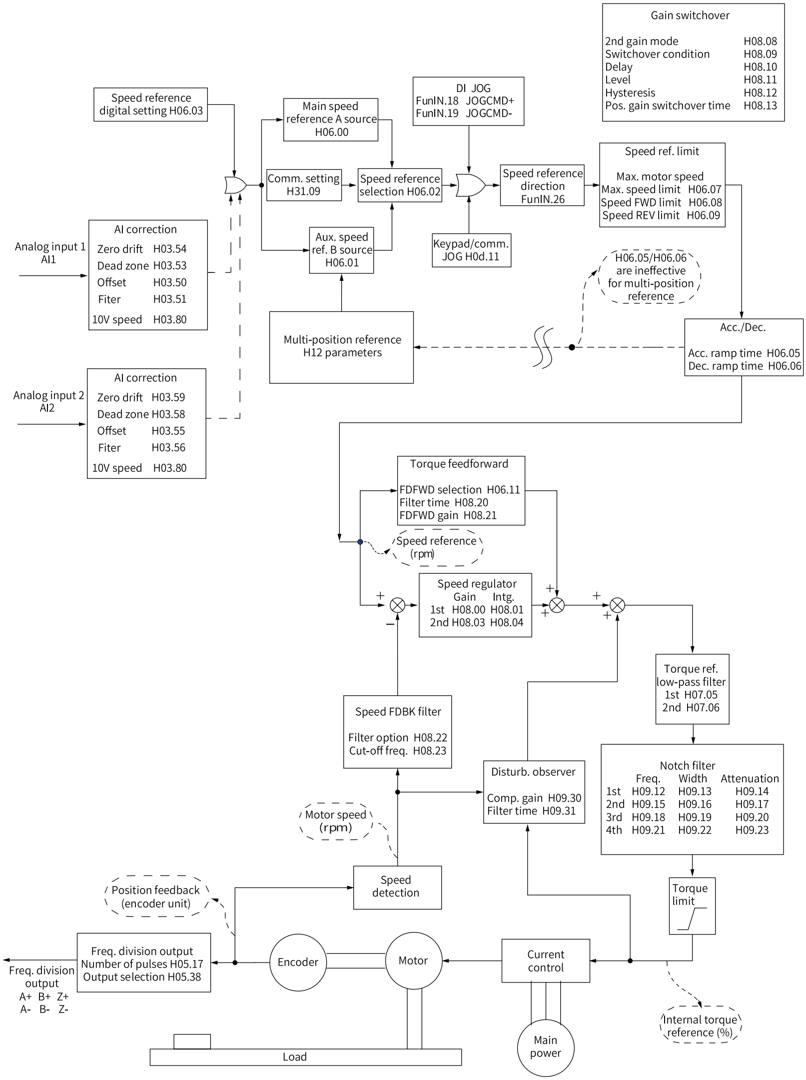


Figure 3-99 Block diagram of speed control parameters

3.10.2Speed Reference Input

Speed reference source

Five speed reference sources are available in the speed control mode, which can be set in H06.02.

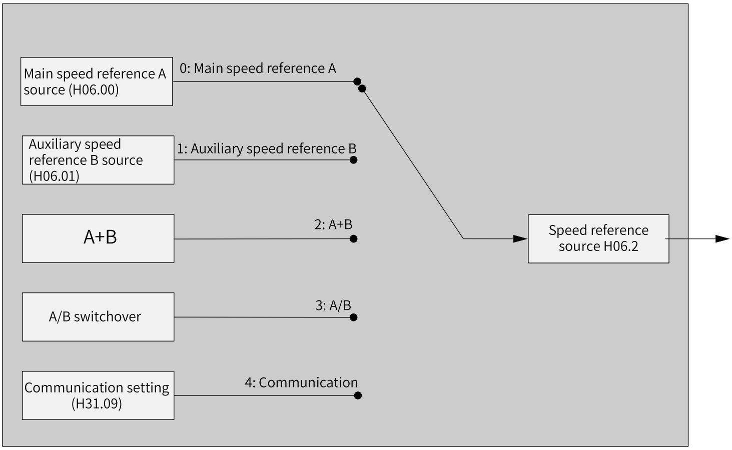


Figure 3-100 Speed reference source

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.02	2006-03h	Speed reference source	0: Source of main speed reference A 1: Source of auxiliary speed reference B 2: A+B 3: Switched between A and B 4: Communication	0	-	At stop

- **Source of main speed reference A**
  The sources of main speed reference A include digital setting and analog voltage setting. Digital setting refers to the internal speed reference. Analog voltage setting refers to the external speed reference.

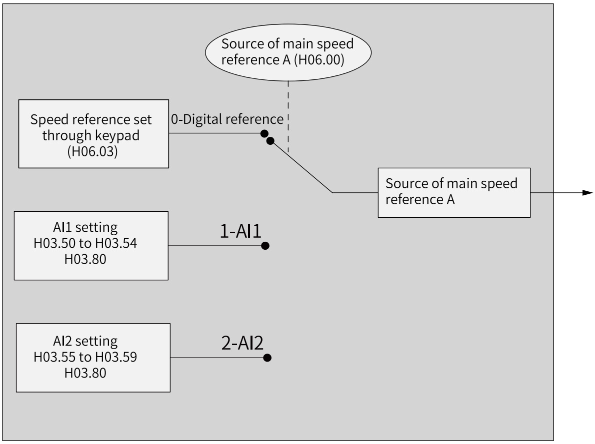


Figure 3-101 Source of main speed reference A

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.00	2006-01h	Source of main speed reference A	0: Digital setting (H06.03) 1: AI1 2: AI2	0	-	At stop

- **Digital setting**

  The speed reference is set in H06.03.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.03	2006-04h	Speed reference set through keypad	-10000[mm/s]/[rpm]–10000[mm/s]/[rpm]	200	[mm/s]/[rpm]	Real-time

- **Analog voltage setting**

  The analog voltage signal output by the host controller or other devices is used as the speed reference after being processed.

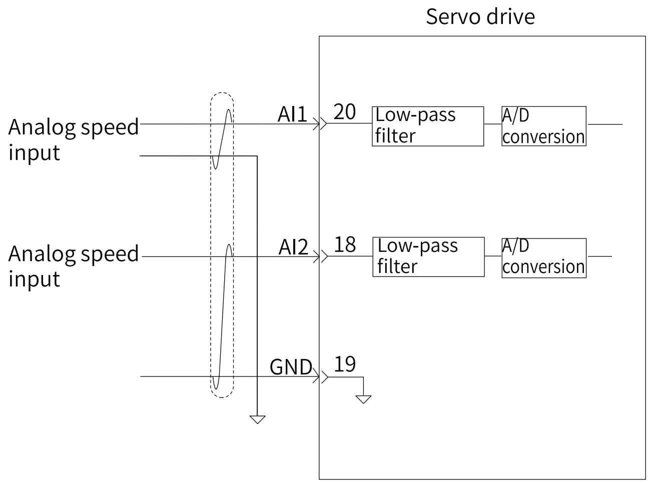
  Analog voltage input terminal:

  The servo drive comes with 2 AI channels for control: AI1 and AI2.

  AI1 voltage input: 16-bit, -10 V to +10 V; max. allowable voltage: ±12 VDC; input impedance: approx. 74 kΩ.

AI2 voltage input: 12-bit, -10 V to +10 V; max. allowable voltage: ±12 VDC; input impedance: approx. 74 kΩ.

Analog input circuit:



Steps:

The following figure takes AI1 as an example to show how to set speed references through analog voltage.

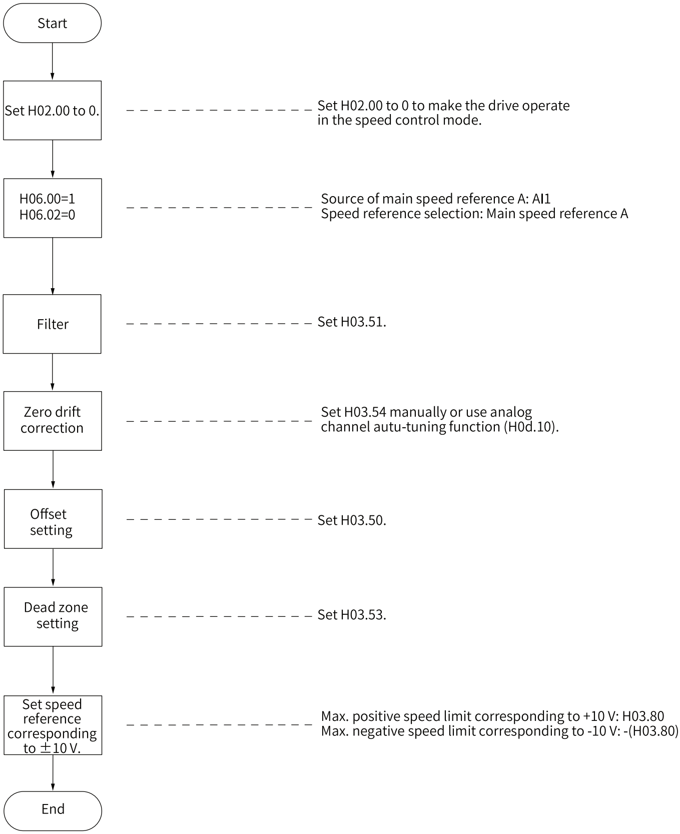


Figure 3-102 Flowchart for setting speed references through analog voltage

Definition of terms:

- Zero drift: Refers to the value of the drive sampling voltage relative to GND upon zero AI voltage.
- Offset: Refers to the AI voltage upon zero sampling voltage after zero drift correction.
- Dead zone: Refers to the AI voltage range upon zero sampling voltage.

In the following figure, y_1 represents the unprocessed AO voltage, y_6 represents the final speed reference after being processed by the servo drive.

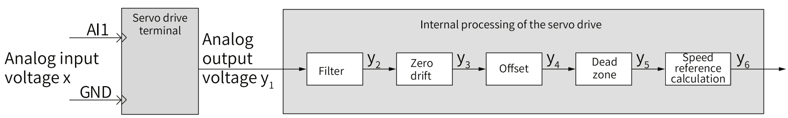


Figure 3-103 AI processing of the servo drive

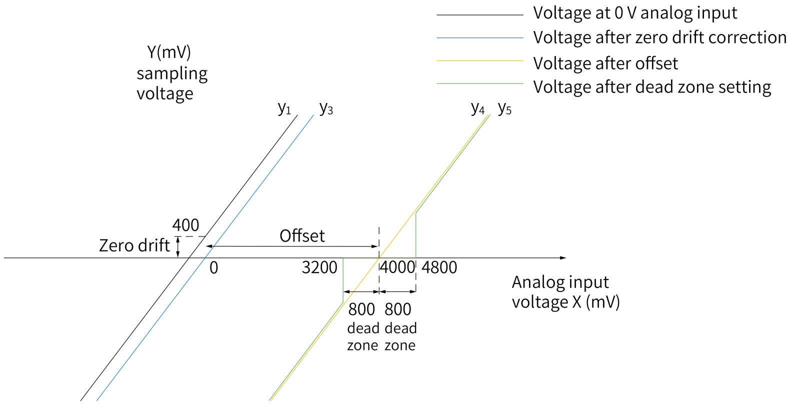


Figure 3-104 Example of the sampling voltage processed by AI

- **Filter:**
  The servo drive provides the analog channel filter function. Setting the filter time constant in H03.56 prevents motor reference fluctuation due to unstable AI voltage and eliminates motor malfunction caused by signal interference. The filter function cannot eliminate or suppress zero drift or dead zone.

- **Zero drift correction**
  Zero drift is used to correct the AO voltage value that deviates from 0 V upon 0 V voltage input.

  In the preceding figure, y_1 represents the AO voltage not processed by the servo drive. If H03.51 is set to 0.00 ms, the filtered sampling voltage y_2 is the same as y_1.

  Therefore, when the actual input voltage x is 0 and the output voltage y_1 is 400 mV, the zero drift is 400 mV.

  Set H03.54 to 400.0 (mV) manually. The sampling voltage after zero drift correction is shown by y_3. $y_3 = y_1 - 400.0$

  Zero drift can also be corrected automatically through H0d.10.

- **Offset setting**
  Offset setting is used to define the actual input voltage corresponding to zero sampling voltage.

  As shown in the preceding figure, when the preset sampling voltage y_4 is 0, the actual input voltage x is 4000 mV, therefore, the offset value is 4000 mV.

Set H03.50 to 4000 (mV) manually. The sampling voltage y_4 after offset = x - 4000 = y_3 - 4000.

- **Dead zone correction**

  Dead zone correction is used to define the effective voltage input range when the sampling voltage is not 0.

  After the offset is set, if the sampling voltage is always 0 when the input voltage x is within 3200 mV to 4800 mV, the dead zone is 800 mV.

  Set H03.53 to 800.0. The sampling voltage after dead zone correction is shown by y_5 .

$$y_5 = \begin{cases} 0 & 3200 \leqslant x \leqslant 4800 \\ y_4 & 4800 < x \leqslant 10000 \text{ or } -10000 \leqslant x < 3200 \end{cases}$$

- **Speed reference calculation**

  After setting the zero drift, offset, and dead zone, set the speed reference corresponding to 10 V (10000 mV) in H03.80 (Speed corresponding to 10 V) to obtain the actual speed reference y_6 :

$$y_6 = \frac{y_5}{10000} \times \text{(H03.80)}$$

This value is used as the analog speed reference value in the speed control mode.

The left figure below applies when no offset exists. The right figure below applies when offset exists. After proper settings, you can view the AI1 sampling voltage value through H0b.21 in real time or view the speed reference value corresponding to the input analog value through H0b.01.

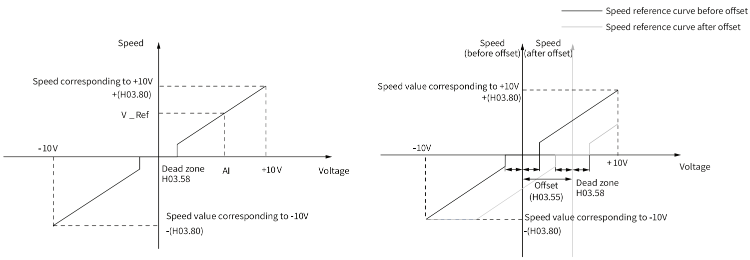


Figure 3-105 AI1 without offset (left) & AI1 after offset (right)

The relationship between the final speed reference y_6 and the input voltage x is as follows:

$$y_6 = \begin{cases} 0 & B\text{-}C \leqslant x \leqslant B+C \\ x\text{-}B & B+C<x \leqslant 10000 \text{ or } -10000 \leqslant x < B\text{-}C \end{cases}$$

in which, B represents the offset and C represents the dead zone.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H03.50	2003-33h	Voltage-type AI1 offset	-5000 mV to 5000 mV	0	mV	Real-time
H03.51	2003-34h	Voltage-type AI1 input filter time constant	0.00 ms–655.35 ms	2.00	ms	Real-time
H03.53	2003-36h	Voltage-type AI1 dead zone	0.0 mV to 1000.0 mV	10.0	mV	Real-time
H03.54	2003-37h	Voltage-type AI1 zero drift	-500.0 mV–500.0 mV	0.0	mV	Real-time
H03.55	2003-38h	Voltage-type AI2 offset	-5000 mV to 5000 mV	0	mV	Real-time
H03.56	2003-39h	Voltage-type AI2 input filter time constant	0.00 ms–655.35 ms	2.00	ms	Real-time
H03.58	2003-3Bh	Voltage-type AI2 dead zone	0.0 mV to 1000.0 mV	10.0	mV	Real-time
H03.59	2003-3Ch	Voltage-type AI2 zero drift	-500.0 mV–500.0 mV	0.0	mV	Real-time
H03.80	2003-51h	Speed corresponding to analog 10 V	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	3000	[mm/s]/[rpm]	At stop
H0d.10	200d-0Bh	Analog channel auto adjusting	0: No operation 1: Adjusted through AI1 2: Adjusted through AI2	0	-	At stop

- **Source of auxiliary speed reference B**
  The sources of auxiliary speed reference B include digital setting, analog voltage setting, and multi-speed references. Digital setting and multi-speed references produce the internal speed reference, and analog setting produces the external speed reference.

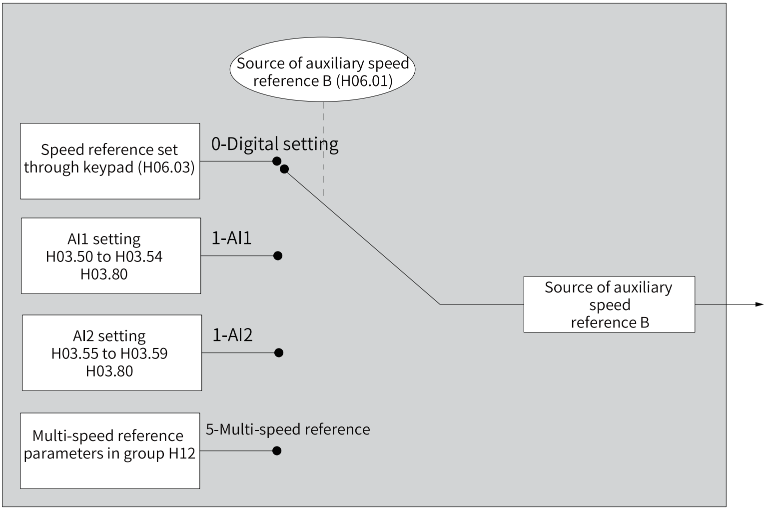


Figure 3-106 Source of auxiliary speed reference B

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.01	2006-02h	Source of auxiliary speed reference B	0: Digital setting (H06.03) 1: AI1 2: AI2 5: Multi-speed reference	1	-	At stop

The digital setting mode is the same as H06.00. The following describes multi-speed references.

The servo drive supports multi-speed operation. The servo drive stores 16 speed references, and the maximum running speed and running time of each can be set. Four groups of acceleration/deceleration time are optional. The setting flowchart is as follows.

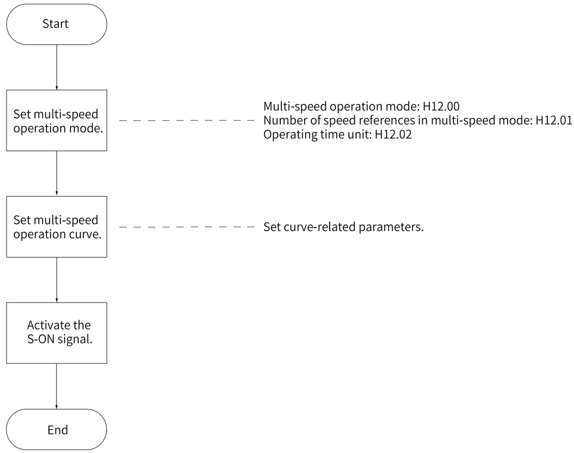


Figure 3-107 Flowchart for setting multi-speed operation

1. Set the multi-speed operation mode.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H12.00	2012-01h	Multi-speed operation mode	0: Individual operation (number of speeds selected in H12.01) 1: Cyclic operation (number of speeds selected in H12.01) 2: DI-based operation	1	-	At stop
H12.01	2012-02h	Number of speed references in multi-speed mode	1–16	16	-	At stop
H12.02	2012-03h	Operating time unit	0: s 1: min	0	-	At stop

You can assign FunIN.5 (DIR- SEL) to an external DI to select the multi-speed reference direction.

☆ Related parameters:

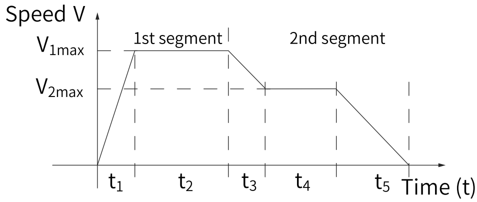
Code	Name	Function Name	Function
FunIN.5	DIR-SEL	Multi-reference direction	Inactive: Reference direction by default Active: Opposite to the reference direction

The following takes "H12.01 = 2" as an example to describe each mode.

- Individual operation (H12.00 = 0)
  Set H12.00 to 0 to select the individual operation mode.

  Set H12.01 and H12.02 as needed. Then set the reference value, operating time, and acceleration/deceleration time of each speed. The drive executes multi-speed references in a sequence from speed 1 to speed N. After all the speeds are executed, the drive stops.

Table 3–23 Description of individual operation

Description	Operating Curve
• The drive stops after one cycle of operation. • The drive switches to the next displacement automatically.	 • V_{1max}, V_{2max}: reference values of speed 1 and speed 2 • t_1: actual acceleration/deceleration time of speed 1 • t_3, t_5: acceleration/deceleration time of speed 2 • Operating time = Time taken in switching from the last speed to current speed + Duration of constant-speed operation at current speed (For example, the operating time of speed 1 is the sum of t_1 and t_2; the operating time of speed 2 is the sum of t_3 and t_4.) • Do not set the operating time of a certain speed to 0. Otherwise, the drive skips this speed and switches to the next speed directly. • The speed reach signal is activated when the motor speed feedback reaches the maximum operating speed set for this speed. • If the S-ON signal is switched off during operation, the motor stops in the mode defined by H02.05 (Stop mode at S-ON OFF).

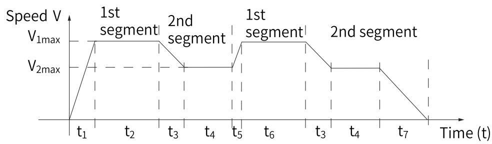
★ Definition of terms:

A complete operation cycle covers all the multi-speed references defined by H12.01.

- Cyclic running (H12.00 = 1)
  Set H12.00 to 1 to select the cyclic operation mode.

Set H12.01 and H12.02 based on the number of speeds and the operating time unit. Then set the reference value, operating time and acceleration/ deceleration time for each speed. The drive executes the set speeds in a sequence from speed 1 to speed N (last speed). After all the speeds are executed, the drive jumps to speed 1 and repeats the preceding process.

Table 3–24 Descriptions of cyclic operation

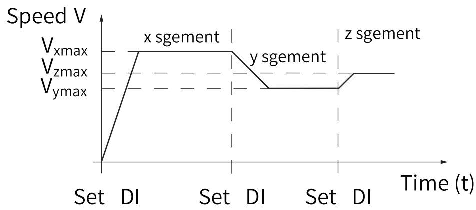
Description	Operating Curve
• The drive starts from displacement 1 again after each cycle of operation. • The drive switches to the next displacement automatically. • The cyclic operation state remains active as long as the S-ON signal is active.	 • V_{1max} , V_{2max} : maximum operating speeds in displacement 1 and displacement 2 • Operating time = Time taken in switching from the last speed to current speed + Duration of constant-speed operation at this speed (For example, the operating time of speed 1 is the sum of t_1 and t_2 ; the operating time of speed 2 is the sum of t_3 and t_4 .) • Do not set the operating time of a certain speed to 0. Otherwise, the drive skips this speed and switches to the next speed directly. • The speed reach signal is activated when the motor speed feedback reaches the maximum operating speed set for this speed. • If the S-ON signal is switched off during operation, the motor stops in the mode defined by H02.05 (Stop mode at S-ON OFF).

- DI-based operation (H12.00 = 2)

  Set H12.00 to 2 to select DI-based operation.

  Set H12.01 and H12.02 based on the number of speeds to be executed and the operating time unit. Then set the reference value, operating time and acceleration/deceleration time for each speed. The drive executes the speed references according to ON/OFF combination of the external DIs (CMDx).

Table 3–25 Descriptions of DI-based operation

Description	Operating Curve
• The drive operates continuously as long as the S-ON signal is active. • The speed No. is determined by the DI logic. • The operating time of each speed is determined only by the interval time of speed switchover.	 • x, y: speed No. (The relationship between the speed No. and the DI logic is described below.) • The operating time is independent of the parameter setpoint. If the speed No. changes during operation, the drive switches to the new speed No. immediately. • The speed reach signal is activated when the motor speed feedback reaches the maximum operating speed set for this speed. • If the S-ON signal is switched off during operation, the motor stops in the mode defined by H02.05 (Stop mode at S-ON OFF).

When the multi-speed operation mode is DI-based operation, assign DI functions 6...9 (multi-reference switchover) to four DIs and set the active logic of these DIs. In addition, assign FunIN.5 (DIR-SEL, direction selection in DI-based multi-speed operation) to a certain DI to switch the speed reference direction.

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.5	DIR-SEL	Direction switchover through DI in multi-speed mode	Defines the speed reference direction in the DI-based operation mode. Inactive: Reference direction Active: Opposite to the reference direction
FunIN.6	CMD1	Multi-reference switchover 1	The speed No. is a 4-bit binary value. The relationship between the speed no. and CMD1 to CMD4 is shown in *"Table 3–26 " on page 254*. The value of CMD is 1 upon active DI level and 0 upon inactive DI level.
FunIN.7	CMD2	Multi-reference switchover 2	
FunIN.8	CMD3	Multi-reference switchover 3	
FunIN.9	CMD4	Multi-reference switchover 4	

Table 3–26 Relationship between the segment No. and CMD1 to CMD4

CMD4	CMD3	CMD2	CMD1	Segment No.
0	0	0	0	1
0	0	0	1	2
...				
1	1	1	1	16

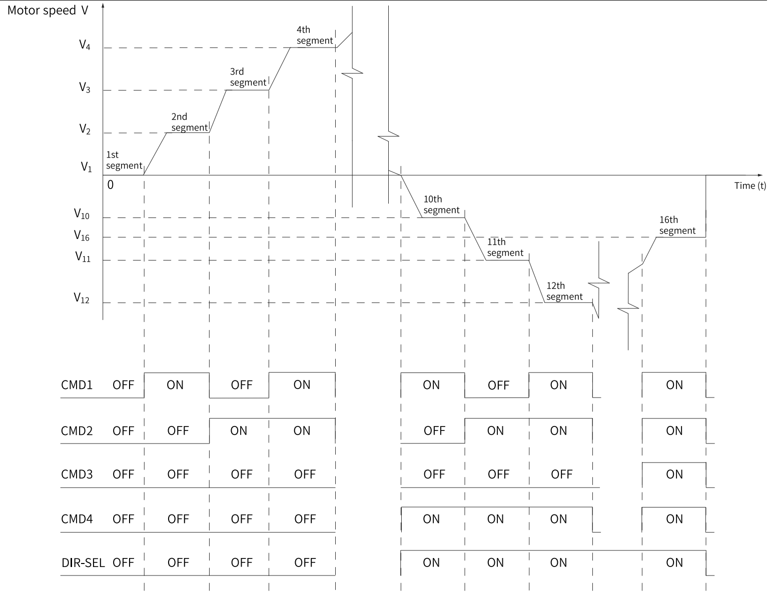


Figure 3-108 Example of multi-speed curve

2. Setting the multi-speed curve

The following takes speed 1 as an example.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H12.03	2012-04h	Acceleration time 1	0 ms–65535 ms	10	ms	Real-time
H12.04	2012-05h	Deceleration time 1	0 ms–65535 ms	10	ms	Real-time
H12.09	2012-0Ah	Acceleration time 4	0 ms–65535 ms	150	ms	Real-time
H12.10	2012-0Bh	Deceleration time 4	0 ms–65535 ms	150	ms	Real-time
H12.20	2012-15h	1st speed reference	-10000[mm/s]/[rpm]–10000[mm/s]/[rpm]	0	[mm/s]/[rpm]	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H12.21	2012-16h	Operating time of speed 1	0.0s(m) to 6553.5s(m)	5.0	s (m)	Real-time
H12.22	2012-17h	1st speed rise/ drop and curve smoothing parameter time	bit0-bit7: Speed rise and drop time 0: Zero acc and dec time 1: Acc and dec time 1 2: Acc and dec time 2 3: Acc and dec time 3 4: Acc and dec time 4 bit8-bit15: S curve smoothing parameter 1: Smoothing parameter 1 2: Smoothing parameter 2 3: Smoothing parameter 3 4: Smoothing parameter 4 5: Smoothing parameter 5 6: Smoothing parameter 6 7: Smoothing parameter 7 8: Smoothing parameter 8	256	-	Real-time

For speed references in the multi-speed operation mode, besides the reference value and operating time, four groups of acceleration/ deceleration time options are also available. There is no acceleration/ deceleration time by default.

The following describes the actual acceleration/deceleration time and the operating time in cases where H12.00 (Multi-speed operation mode) is set to 1 (Individual operation).

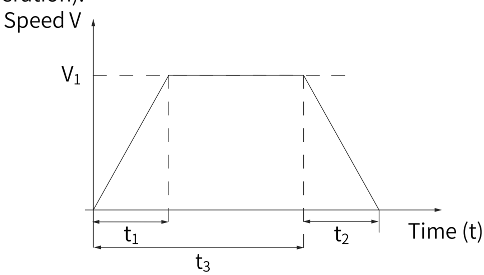


Figure 3-109 Example of multi-speed curve

As shown in the preceding figure, the speed reference is V_1 and the actual acceleration time t_1 is as follows.

$$t_1 = \frac{V_1}{1000} \times \text{ Acceleration time set for this speed}$$

The actual deceleration time t_2 is:

$$t_2 = \frac{V_1}{1000} \times \text{ Deceleration time set for this speed}$$

Operating time = Time taken in switching from the last speed to present speed + Duration of constant-speed operation at present speed (as shown by t_3 in the preceding figure)

- **Switched between A and B**
  When setting H06.02 (speed reference source) to 3 (Switched between A and B), you need to assign FunIN.4 (DI-SEL) to the corresponding DI. The input signal of this DI determines which source (A or B) is active.

  ☆ Related parameters:

Code	Name	Function Name	Description
FunIN.4	CMD-SEL	Main/Auxiliary reference switchover	Inactive: Current reference being A Active: Current reference being B

- **Communication**
  When H06.02 (Speed reference source) is set to 4 (Communication), the speed reference is the setpoint of H31.09. H31.09 is not displayed on the keypad, it can be set through communication only.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H31.09	2031-0Ah	Speed reference set through communication	-9999.000[mm/s]/[rpm]–9999.000[mm/s]/[rpm]	0.000	[mm/s]/[rpm]	Real-time

Speed reference direction setting

To switch the speed reference direction through DI, assign FunIN.26 to the corresponding DI. The input signal of this DI determines the speed reference direction.

☆ Related parameters:

Code	Name	Function Name	Description
FunIN.26	SPDDirSel	Speed reference direction	Inactive: Forward Active: Reverse

The actual direction of rotation is related to the setting of H02.02 (Direction of rotation), the sign (+/-) of the speed reference value, and the logic of FunIN.26.

Table 3–27 Actual direction of rotation in the speed control mode

H02.02	Sign of Speed Reference	FunIN.26	Direction of Rotation
0	+	Inactive	CCW
0	+	Active	CW
0	-	Inactive	CW
0	-	Active	CCW
1	+	Inactive	CW
1	+	Active	CCW
1	-	Inactive	CCW
1	-	Active	CW

3.10.3Ramp Function

The ramp function is used to smooth the acceleration rate of speed references through acceleration/deceleration time setting.

In the speed control mode, a high acceleration rate easily leads to motor jerk or intense vibration. In this case, increasing the acceleration/deceleration time smoothens the motor speed change, preventing mechanical damage caused by jerk or vibration.

Caution

- When the speed reference source is digital setting, analog voltage setting or jog speed, the acceleration time and deceleration time are set through parameters H06.05 and H06.06.
- When the speed reference source is multi-speed reference, the acceleration time and deceleration time are set in parameter group H12. For details, see *SV680-INT Series Servo Drive Parameter Guide*.

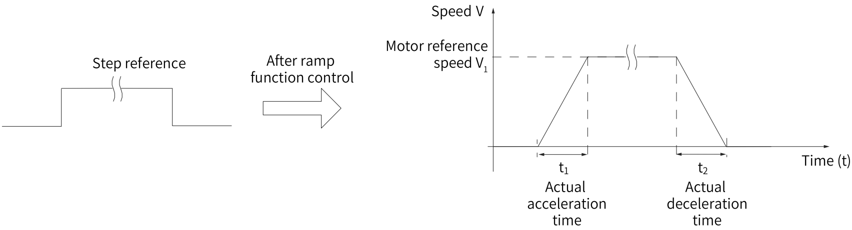


Figure 3-110 Ramp function definition

- H06.05 defines the time for the speed reference to change from 0 rpm to 1000 rpm.
- H06.06 defines the time for the speed reference to change from 1000 rpm to 0 rpm.

The formulas for calculating the actual acceleration/deceleration time are as follows:

$$\text{Actual acceleration time } t_1 = \frac{\text{Speed reference}}{1000} \times \text{Speed reference acceleration ramp time}$$

$$\text{Actual deceleration time } t_2 = \frac{\text{Speed reference}}{1000} \times \text{Speed reference deceleration ramp time}$$

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.05	2006-06h	Acc. ramp time of speed reference	0 ms–65535 ms	0	ms	Real-time
H06.06	2006-07h	Dec. ramp time of speed reference	0 ms–65535 ms	0	ms	Real-time

3.10.4Zero Clamp

Caution

- The zero speed clamp function is used in the system in which the host controller does not construct the position loop in speed control mode.
- If servo motor oscillation occurs in zero speed clamp state, adjust the position loop gain.

In the speed control mode, if FunIN.12 (ZCLAMP) is enabled, and the speed reference amplitude is smaller than or equal to the value of H06.15, the motor enters zero position clamp state. In this case, a position loop is built inside the drive and the speed reference is invalid.

The motor is clamped the minimum quantization error of the encoder. Even if it rotates due to external force, it will return to the zero position and be clamped.

When the speed reference amplitude exceeds the value of H06.15, the motor exits from the zero clamp state and continues running according to the speed reference received. Zero clamp is deactivated when the ZCLAMP (FunIN.12) signal is inactive.

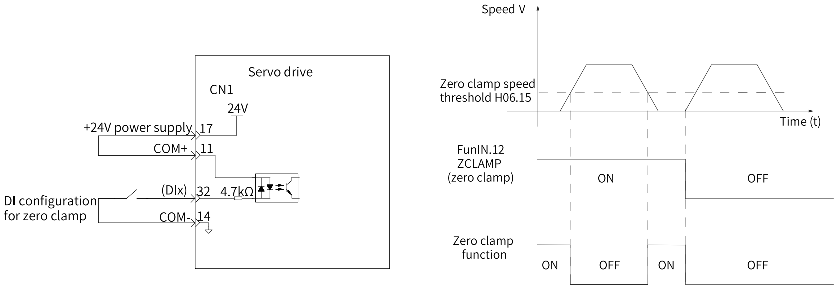


Figure 3-111 Wiring and waveform of zero clamp

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.15	2006-10h	Zero clamp speed threshold	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time

☆ Related parameters:

Code	Name	Function Name	Description
FunIN.12	ZCLAMP	Zero speed clamp	Inactive: Zero clamp disabled Active: Zero clamp enabled

3.10.5Speed Reference Limit

Caution

When the actual speed of the motor exceeds H0A.08 (Overspeed threshold), E500.0 (Motor overspeed) occurs. For details of H0A.08, see *SV680-INT Series Servo Drive Parameter Guide*. The speed reference limit must be lower than H0A.08.

In the speed control mode, the sources of speed reference limit include:

- H06.07 (Maximum speed limit): Defines the speed reference limit in both directions. The limit value applies when speed references exceed it.
- H06.08 (Forward speed limit): Defines the speed limit in the forward direction.The limit value applies when forward speed references exceed it.
- H06.09 (Reverse speed limit): Defines the speed limit in the reverse direction.The limit value applies when reverse speed references exceed it.
- Maximum speed of the motor (default threshold): Depends on the motor model.

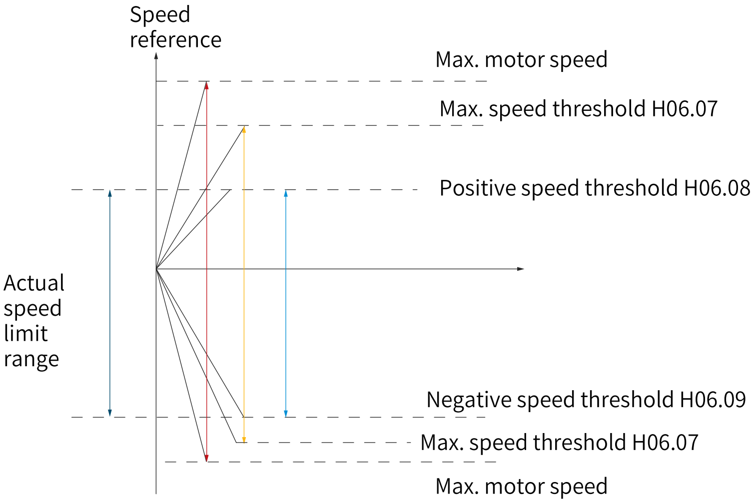


Figure 3-112 Example of speed reference limit

The actual motor speed limit meets the following requirements:

- |Forward speed limit| ⩽ min {maximum motor speed, H06.07, H06.08}
- |Reverse speed limit| ⩽ min {maximum speed of the motor, H06.07, H06.09}

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.07	2006-08h	Maximum speed limit	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	7000	[mm/s]/[rpm]	Real-time
H06.08	2006-09h	Forward speed threshold	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	7000	[mm/s]/[rpm]	Real-time
H06.09	2006-0Ah	Reverse speed threshold	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	7000	[mm/s]/[rpm]	Real-time

3.10.6Speed-Related DO

The filtered speed feedback can be compared with different thresholds, generating DO signals for use by the host controller. The filter time constant is set in H0A.27 (Speed DO filter time constant).

Motor rotation DO signal

When the absolute value of the filtered actual motor speed reaches the value of H06.16 (Threshold of TGON (motor rotation) signal), the motor is acknowledged to be rotating. In this case, the drive outputs the motor rotation signal (FunOUT.2: TGON) to acknowledge that the motor is rotating. When the absolute value of the filtered actual motor speed is lower than the value of H06.16, the motor is not rotating.

Judgment on the motor rotation signal (FunOUT.2, TGON) is not affected by the operating state or control mode of the drive.

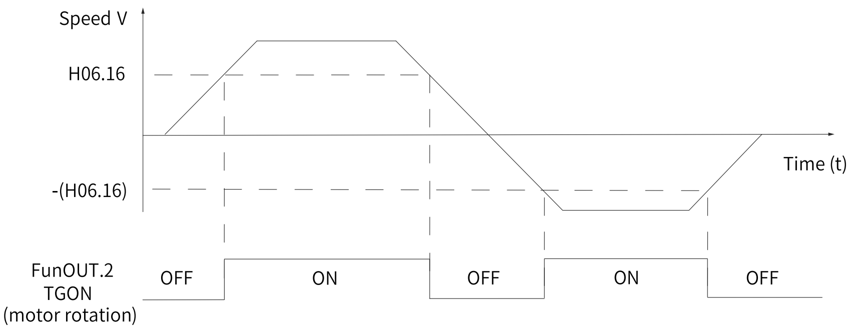


Figure 3-113 Waveform of motor rotation (TGON) signal

Note

In the preceding figure, ON indicates that the motor rotation DO signal is active. OFF indicates that the motor rotation DO signal is inactive.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.16	2006-11h	Threshold of TGON (motor rotation) signal	0[mm/s]/[rpm]–1000[mm/s]/[rpm]	20	[mm/s]/[rpm]	Real-time

To use the TGon signal, assign a DO with FunOUT.2 (TGon, motor rotation) and set the active logic of this DO.

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.2	TGon	Motor rotation	Inactive: The absolute value of filtered motor speed is lower than the setpoint of H06.16. Active. The absolute value of filtered motor speed reaches the setpoint of H06.16.

Speed matching DO signal

A delay of 10 rpm is present in the speed matching signal.

When the absolute value of the difference between the motor speed after filter and the speed reference satisfies the setting of H06.17, the actual motor speed is considered to reach the speed reference. At this moment, the servo drive outputs the speed matching signal (FunOUT.4: V-CMP). When the absolute value of the difference between the motor speed after filter and the speed reference exceeds the setting of H06-17, the speed matching signal is inactive.

If the drive is not in the operational state or the speed control mode, the speed matching signal (FunOUT.4: V-Cmp) is always inactive.

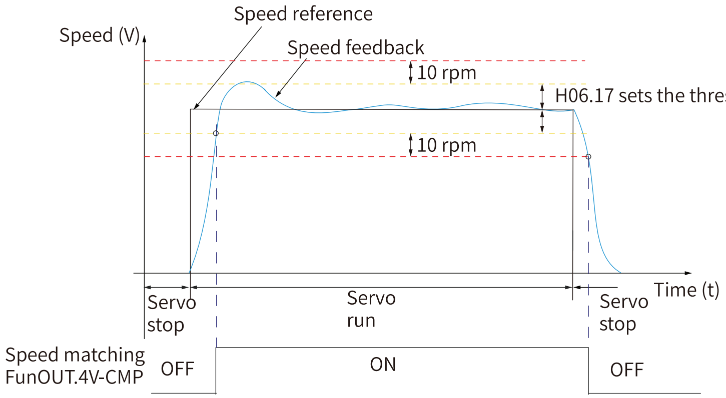


Figure 3-114 Waveform of speed matching (V-Cmp) signal

Note

In the preceding figure, "ON" indicates the the V-Cmp (speed matching) signal is active. "OFF" indicates the V-Cmp signal is inactive.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.17	2006-12h	Threshold of V-Cmp (speed matching) signal	0[mm/s]/[rpm]–100[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time

To use the V-Cmp (speed matching) signal, assign FunOUT.4 (V-Cmp, speed matching) to a certain DO and set the active logic of this DO.

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.4	V-Cmp	Speed matching	Inactive: The absolute difference between the filtered actual motor speed and the speed reference is higher than the value of H06.17. Active: The absolute difference between the filtered actual motor speed and the speed reference is lower than or equal to the value of H06.17.

Speed reach DO signal

A delay of 10 rpm is present in the speed reach signal. When the absolute value of the motor speed after filter exceeds H06.18 + 10 rpm, the motor speed is considered to reach the desired value. At this moment, the servo drive outputs the speed arrival signal (FunOUT.19: V-Arr). On the contrary, when the absolute value of filtered motor speed is lower than H06.18 - 10 rpm, the speed reach signal is inactive.

Acknowledgment of the speed reach (FunOUT.19: V-Arr) signal is not affected by the operating state or control mode of the drive.

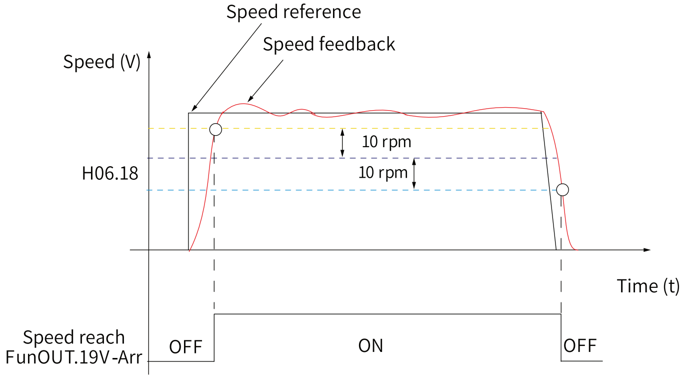


Figure 3-115 Waveform of the speed reach (V-Arr) signal

Note

In the preceding figure, "ON" indicates the V-Arr (speed reached) signal is active. "OFF" indicates the V-Arr (speed reached) signal is inactive.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.18	2006-13h	Threshold of speed reach signal	20[mm/s]/[rpm]–10000[mm/s]/[rpm]	1000	[mm/s]/[rpm]	Real-time

To use the V-Arr signal, assign FunOUT.19 (V-Arr, speed reach) to a DO and set the active logic of this DO.

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.19	V-Arr	Speed reach	Inactive: The absolute value of filtered motor speed feedback exceeds H06.18. Active: The absolute value of filtered motor speed feedback is lower than or equal to the value of H06.18.

Zero speed DO signal

A delay of 10 rpm is present in the zero speed signal. The drive outputs zero speed (FunOUT.3: ZERO) signal only when the absolute value of actual motor speed is lower than the threshold defined by H06.19. On the contrary, when the absolute value of actual motor speed is higher than H06.19 + 10 rpm, the motor is in the rotational state and the V-Zero (zero speed) signal is inactive.

The zero speed signal is not influenced by the servo drive status and control mode.

The interference in the speed feedback can be filtered by the speed feedback DO filter. You can set the corresponding filter time constant in H0A.27.

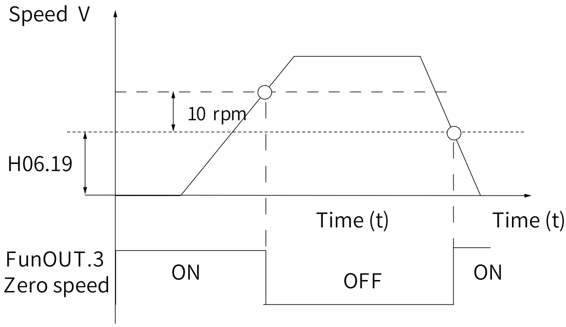


Figure 3-116 Waveform of the zero speed (V-Zero) signal

Note

In the preceding figure, "ON" indicates the V-Zero (zero speed) signal is active. "OFF" indicates the V-Zero (zero speed) signal is inactive.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H06.19	2006-14h	Threshold of zero speed output signal	1[mm/s]/[rpm]–10000[mm/s]/[rpm]	10	[mm/s]/[rpm]	Real-time

To use the zero speed signal, assign FunOUT.3: ZERO, zero speed to a DO and set the active logic of this DO.

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.3	ZERO	Zero speed signal	Inactive: The difference between motor speed feedback and the reference value is higher than the setpoint of H06.19. Active: The difference between motor speed feedback and the reference value is lower than or equal to the value of H06.19.

3.11 Torque Control Mode

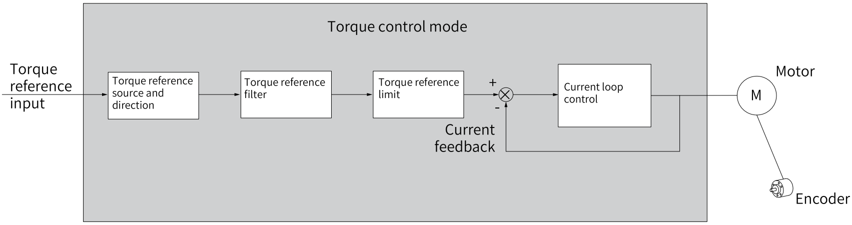


Figure 3-117 Block diagram of torque control mode

Set H02.00 (Control mode selection) to 2 (Torque control mode) through the keypad or the Inovance software tool to make the drive operate in the torque control mode. Set the drive parameters based on the mechanical structure and technical indicators. The following describes basic parameter settings in the torque control mode.

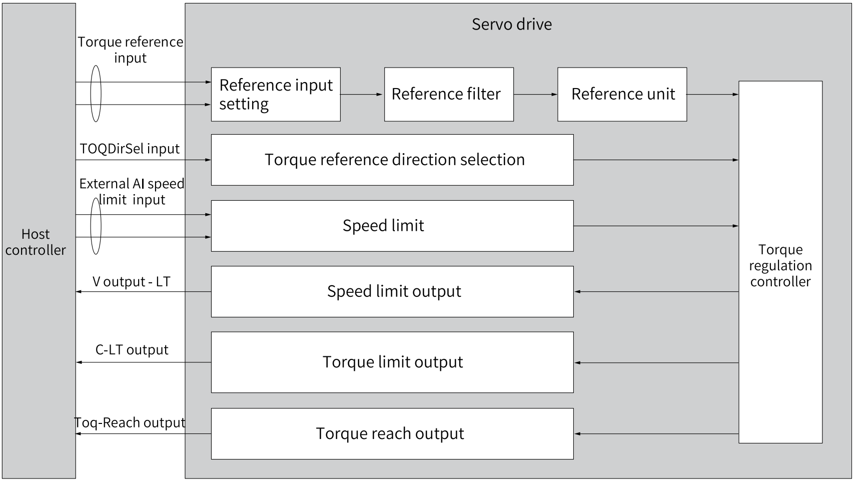


Figure 3-118 Signal exchange between the drive and the host controller

3.11.1Function Block Diagram

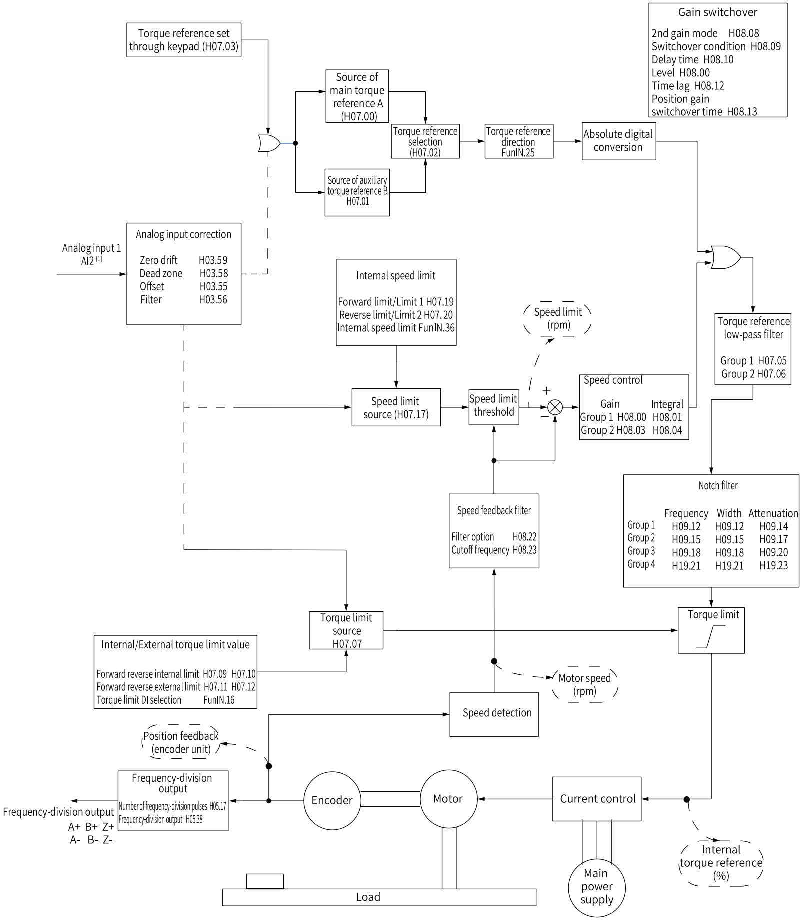


Figure 3-119 Block diagram of torque control

Note

[1]: When the analog input is AI1, the corresponding parameters are: zero drift: H03.54, dead time: H03.53, offset: H03.50, and filter H03.51.

3.11.2Torque Reference

Torque reference source

Five torque reference sources are available in the torque control mode, which can be set in H07.02.

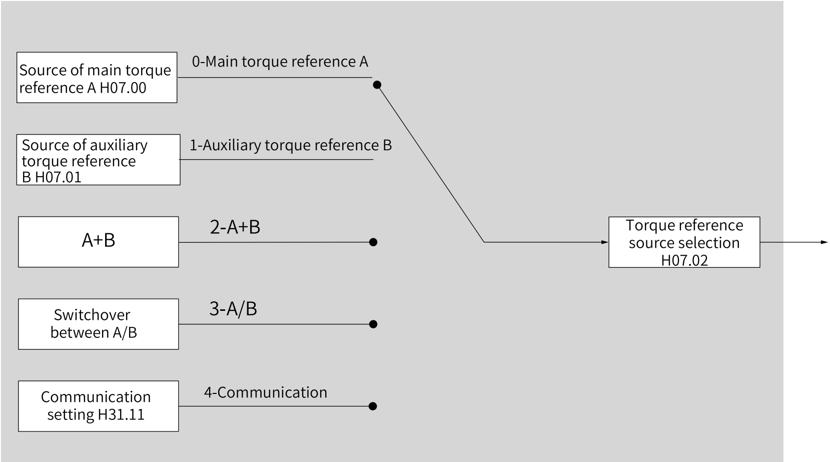


Figure 3-120 Torque reference sources

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.02	2007-03h	Torque reference source	0: Source of main torque reference A 1: Source of auxiliary torque reference B 2: Source of A+B 3: Switched between A and B 4: Communication	0	-	At stop

- **Source of main torque reference A**
  The source of main torque reference A include digital setting and analog voltage setting. Digital setting refers to the internal torque reference. Analog voltage setting refers to the external torque reference.

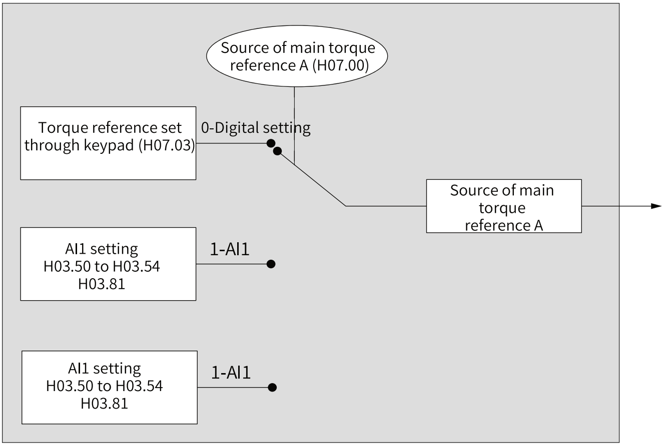


Figure 3-121 Description of source of main torque reference A

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.00	2007-01h	Source of main torque reference A	0: Keypad (H07.03) 1: AI1 2: AI2	0	-	At stop

- **Digital setting**

  In digital setting, the torque reference is set in H07.03, which defines the percentage of the torque reference to the rated torque of the motor.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.03	2007-04h	Torque reference set through keypad	-400.0% to 400.0%	0.0	%	Real-time

- **Analog voltage setting**

  The analog voltage signal output by the host controller or other devices is used as the torque reference after being processed.

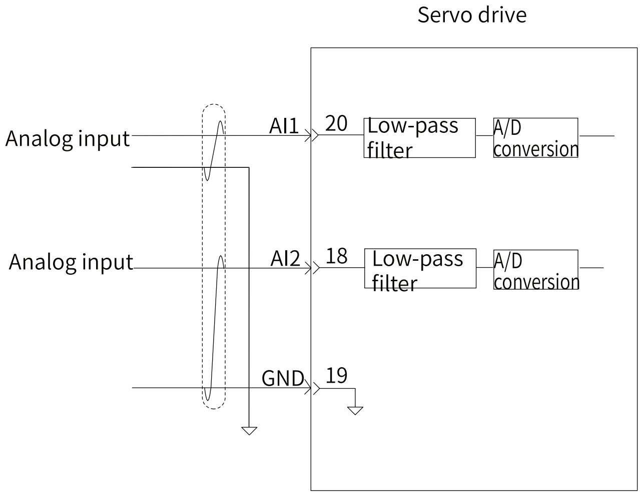
  Analog voltage input terminal:

  The servo drive comes with 2 AI channels for control: AI1 and AI2.

AI1 voltage input: 16-bit, -10 V to +10 V; max. allowable voltage: ±12 VDC; input impedance: approx. 74 kΩ.

AI2 voltage input: 12-bit, -10 V to +10 V; max. allowable voltage: ±12 VDC; input impedance: approx. 74 kΩ.

Analog input circuit:



Steps:

The following takes AI1 as an example to describe how to set torque references through analog voltage.

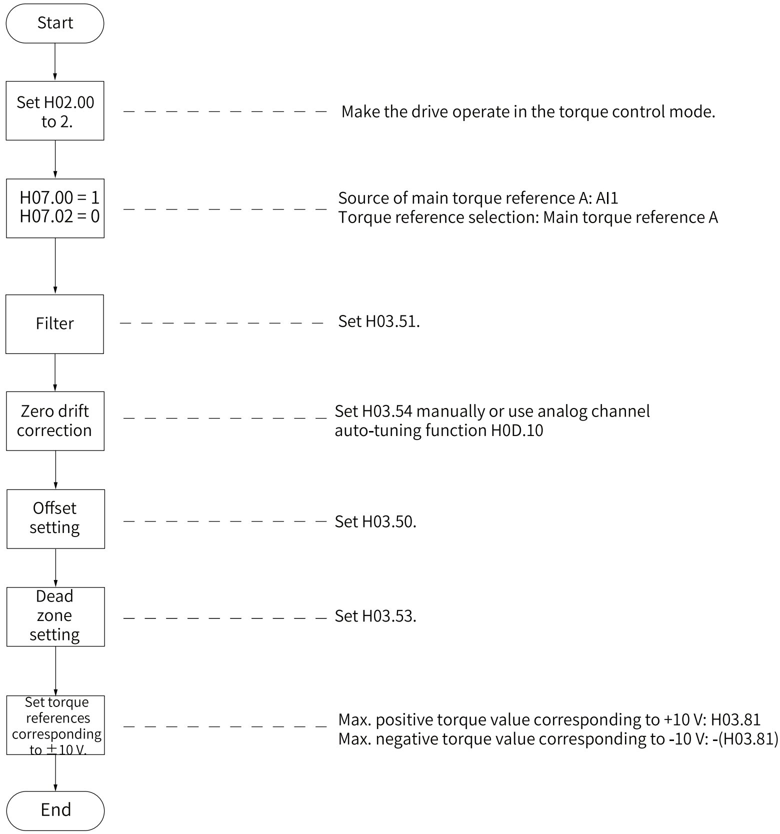


Figure 3-122 Operation flowchart for setting torque references through analog voltage

★ Definition of terms:

- Zero drift: Refers to the value of the drive sampling voltage relative to GND upon zero AI voltage.
- Offset: Refers to the AI voltage upon zero sampling voltage after zero drift correction.
- Dead zone: Refers to the AI voltage range upon zero sampling voltage.

In the following figure, y_1 represents the unprocessed AO voltage, y_6 represents the final torque reference after being processed by the servo drive.

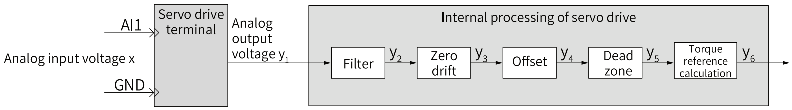


Figure 3-123 AI processing of the servo drive

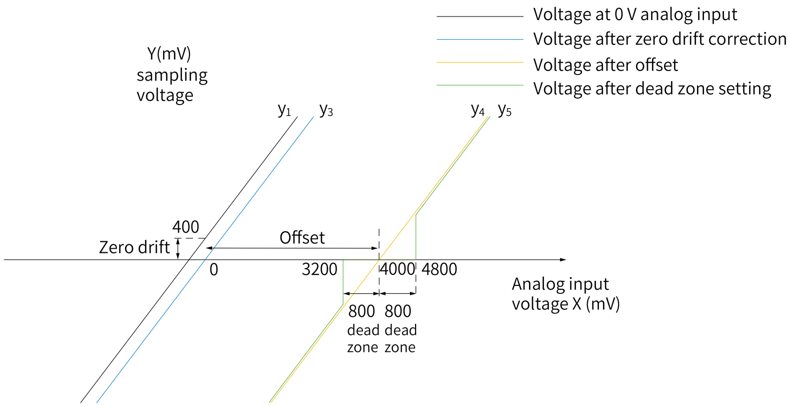


Figure 3-124 Example of the sampling voltage processed by AI

- **Filter:**

  The servo drive provides the analog channel filter function. Setting the filter time constant in H03.51 prevents motor reference fluctuation due to unstable AI voltage and eliminates motor malfunction caused by signal interference. The filter function cannot eliminate or suppress zero drift or dead zone.

- **Zero drift correction**

  Zero drift is used to correct the AO voltage value that deviates from 0 V upon 0 V voltage input.

  In the preceding figure, y_1 represents the AO voltage not processed by the servo drive. If H03.51 is set to 0.00 ms, the filtered sampling voltage y_2 is the same as y_1.

  Therefore, when the actual input voltage x is 0 and the output voltage y_1 is 400 mV, the zero drift is 400 mV.

  Set H03.54 to 400.0 (mV) manually. The sampling voltage after zero drift correction is shown by y_3. $y_3 = y_1 - 400.0$

  Zero drift can also be corrected automatically through H0d.10.

- **Offset setting**

Offset setting is used to define the actual input voltage corresponding to zero sampling voltage.

As shown in the preceding figure, when the preset sampling voltage y_4 is 0, the actual input voltage x is 4000 mV, therefore, the offset value is 4000 mV.

Set H03.50 to 4000 (mV) manually. The sampling voltage y_4 after offset = x - 4000 = y_3 - 4000.

- **Dead zone correction**

Dead zone correction is used to define the effective voltage input range when the sampling voltage is not 0.

After the offset is set, if the sampling voltage is always 0 when the input voltage x is within 3200 mV to 4800 mV, the dead zone is 800 mV.

Set H03.53 to 800.0. The sampling voltage after dead zone correction is shown by y_5.

$$y_5=\begin{cases} 0 & 3200 \leqslant x \leqslant 4800 \\ y_4 & 4800<x \leqslant 10000 \text{ or } -10000 \leqslant x<3200 \end{cases}$$

- **Torque reference**

After setting the zero drift, offset, and dead zone, set the speed reference corresponding to 10 V (10000 mV) in H03.81 (Speed corresponding to 10 V) to obtain the actual torque reference y_6:

$$y_6=\frac{y_5}{10000} \times (\text{H03.81})$$

This value is used as the torque reference set via analog in the torque control mode.

The left figure below applies when no offset exists. The right figure below applies when offset exists. After proper settings, you can view the AI1 sampling voltage value through H0b.21 in real time or view the torque reference value corresponding to the input analog value through H0b.01.

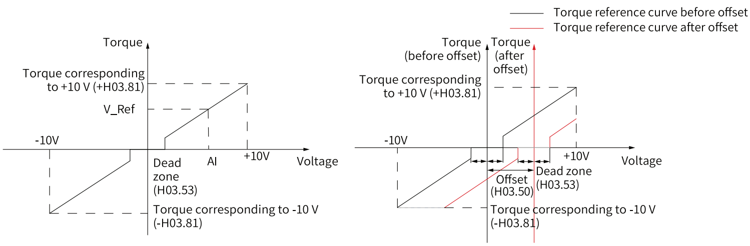


Figure 3-125 AI1 without offset (left) & AI1 after offset (right)

The relationship between the final torque reference y_6 and the input voltage x is as follows:

$$y_6 = \begin{cases} 0 & B-C \leqslant x \leqslant B+C \\ x-B & B+C < x \leqslant 10000 \text{ or } -10000 \leqslant x < B-C \end{cases}$$

in which, B represents the offset and C represents the dead zone.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H03.50	2003-33h	Voltage-type AI1 offset	-5000 mV to 5000 mV	0	mV	Real-time
H03.51	2003-34h	Voltage-type AI1 input filter time constant	0.00 ms–655.35 ms	2.00	ms	Real-time
H03.53	2003-36h	Voltage-type AI1 dead zone	0.0 mV to 1000.0 mV	10.0	mV	Real-time
H03.54	2003-37h	Voltage-type AI1 zero drift	-500.0 mV–500.0 mV	0.0	mV	Real-time
H03.55	2003-38h	Voltage-type AI2 offset	-5000 mV to 5000 mV	0	mV	Real-time
H03.56	2003-39h	Voltage-type AI2 input filter time constant	0.00 ms–655.35 ms	2.00	ms	Real-time
H03.58	2003-3Bh	Voltage-type AI2 dead zone	0.0 mV to 1000.0 mV	10.0	mV	Real-time
H03.59	2003-3Ch	Voltage-type AI2 zero drift	-500.0 mV–500.0 mV	0.0	mV	Real-time
H03.80	2003-51h	Speed corresponding to analog 10 V	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	3000	[mm/s]/[rpm]	At stop
H0d.10	200d-0Bh	Analog channel auto adjusting	0: No operation 1: Adjusted through AI1 2: Adjusted through AI2	0	-	At stop

- **Source of auxiliary torque reference B**
  Auxiliary torque reference B is set in the same way as main torque reference A. For the descriptions of related parameters, see *SV680-INT Series Servo Drive Parameter Guide*.

- **Switched between A and B**
  When setting H07.02 (Torque reference source) to 3 (Switched between A and B), you need to assign FunIN.4 (DI-SEL) to the corresponding DI. The input signal of this DI determines which source (A or B) is active.

☆ Related parameters:

Code	Name	Function Name	Description
FunIN.4	CMD-SEL	Reference switchover	OFF: Active reference being A ON: Active reference being B

- **Communication**

  When H07.02 (Torque reference source) is set to 4 (Communication), the torque reference is the value of H31.11. H31.11 is not displayed on the keypad, it can be set through communication only.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H31.11	2031-0Ch	Torque reference set through communication	-100.000% to 100.000%	0.000	%	Real-time

Torque reference direction

To switch the torque reference direction through DI, assign FunIN.25 (TorDirSel, torque reference direction) to the corresponding DI. The input signal of this DI determines the torque reference direction.

☆ Related parameters:

Code	Name	Function Name	Description
FunIN.25	ToqDirSel	Torque reference direction	Inactive: The actual torque reference direction is the same as the set direction. Active: The actual torque reference direction is opposite to the set direction.

The actual direction of rotation is related to the setting of H02.02 (Direction of rotation), the sign (+/-) of the torque reference value, and the logic of FunIN.25.

Table 3–28 Actual direction of rotation in the torque control mode

H02.02	Sign (+/-) of the Torque Reference Value	FunIN.25	Direction of Rotation
0	+	Inactive	CCW
0	+	Active	CW
0	-	Inactive	CW

H02.02	Sign (+/-) of the Torque Reference Value	FunIN.25	Direction of Rotation
0	-	Active	CCW
1	+	Inactive	CW
1	+	Active	CCW
1	-	Inactive	CCW
1	-	Active	CW

3.11.3Torque Reference Filter

Caution

Pay attention to the responsiveness during setting as an excessively high setpoint lowers down the responsiveness.

The servo drive smoothens torque references through the low-pass filter to reduce vibration in all the control modes.

The servo drive offers two low-pass filters for torque references, in which the low-pass filter 1 is used by default.

The servo drive switches to low-pass filter 2 when gain switchover is enabled (H08.08 = 1 and H08.09 ≠ 0) and the condition defined by H08.09 is met.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.05	2007-06h	Torque reference filter time constant 1	0.00 ms to 30.00 ms	0.50	ms	Real-time
H07.06	2007-07h	Torque reference filter time constant 2	0.00 ms to 30.00 ms	0.27	ms	Real-time

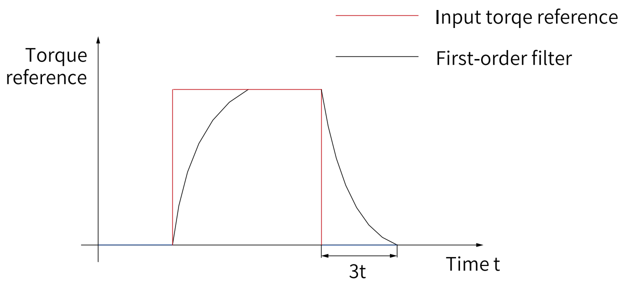


Figure 3-126 First-order filter for rectangular torque references

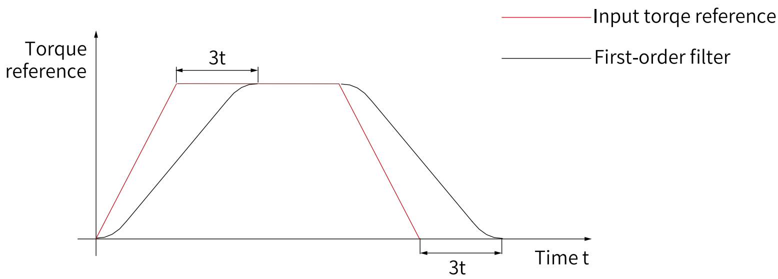


Figure 3-127 First-order filter for trapezoid torque references

3.11.4Torque Reference Limit

Caution

Torque reference limit is needed and active in all the control modes.

The torque reference limit is used to protect the servo drive and the motor.

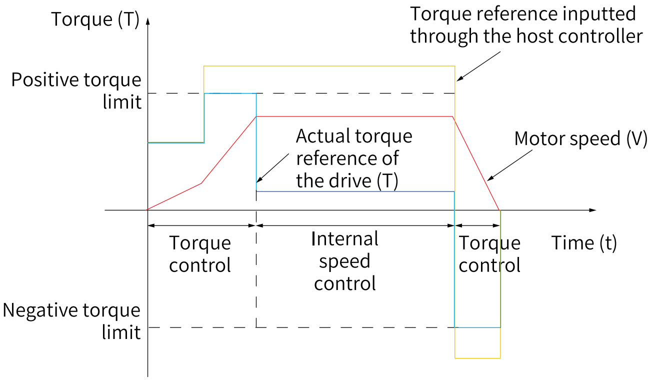


Figure 3-128 Torque reference and torque limit

When the absolute value of the torque reference input from the host controller or output by the speed regulator is higher than the absolute value of the torque reference limit, the actual torque reference of the drive is limited to the torque reference limit. Otherwise, the torque reference input from the host controller or output by the speed regulator is used.

Only one torque reference limit is valid at a moment. The positive/negative torque limit must be lower than or equal to the maximum torque of the drive and the motor and ±400.0% of the rated torque.

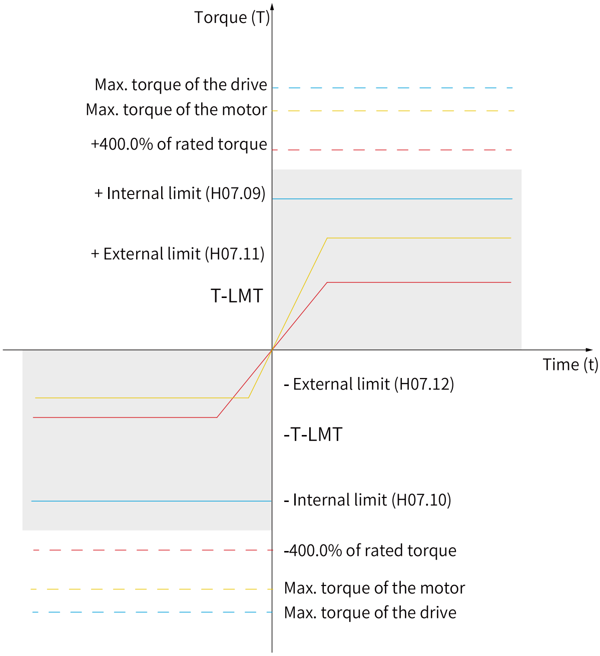


Figure 3-129 Example of torque limit

Torque limit source

You can set the torque limit source in H07.07.

After the torque limit is set, the torque limit applies when the torque reference exceeds the limit. The torque limit must be set according to the load conditions. An excessively low limit may weaken the acceleration/deceleration ability of the motor, causing the actual motor speed to fall below the required value during operating at a constant torque.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.07	2007-08h	Torque Limit source	0: Positive/Negative internal torque limit 1: Internal or external limit as defined by DI 2: T_LMT 3: T_LMT or external limit as defined by DI (FunIN.16 or FunIN.17) 4: T_LMT or internal limit (FunIN.16 or FunIN.17) as defined by DI	0	-	Real-time

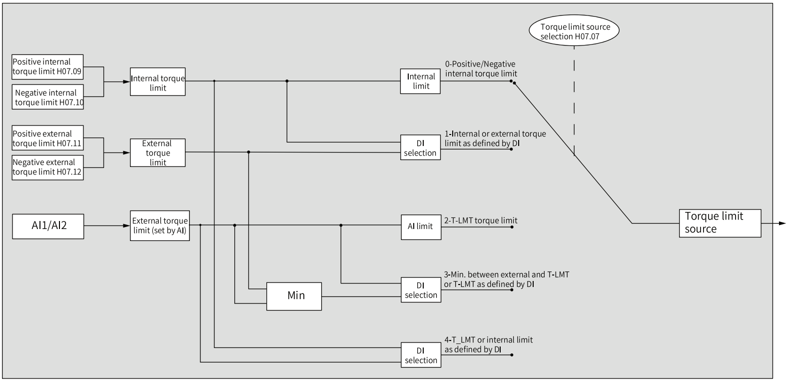


Figure 3-130 Torque Limit source

The following figures show examples in which absolute values of torque references input from the host controller exceed the absolute value of the torque limit in the torque control mode.

- H07.07 = 0 (Positive/Negative internal torque limit)
  The torque reference limit is determined only by H07.09 and H07.10.

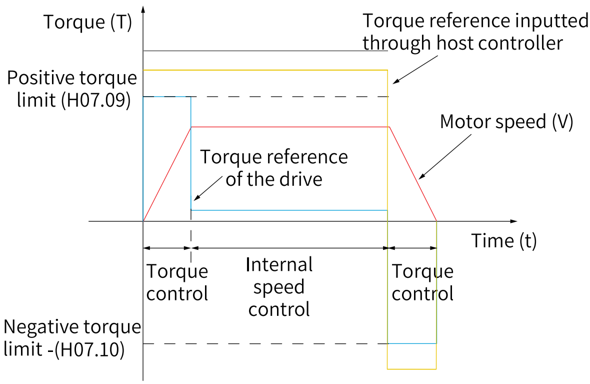


Figure 3-131 Torque limit curve (H07.07 = 0)

- H07.07 = 1 (internal or external limit as defined by DI)
  The torque reference limit is determined by the logic of the external DI signal. The positive torque limit is selected between H07.09 (Positive internal torque limit) and H07.11 (Positive external torque limit). The negative torque limit is selected between H07.10 (Negative internal torque limit) and H07.12 (Negative external torque limit).

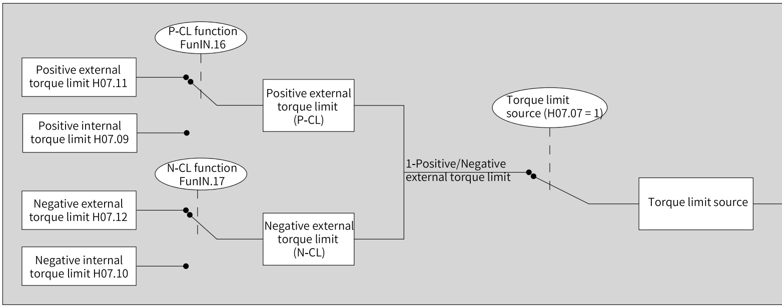
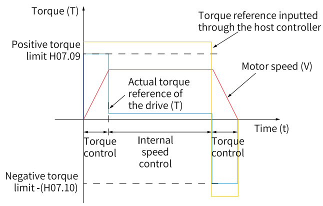
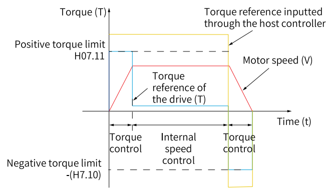
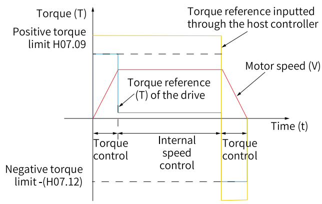
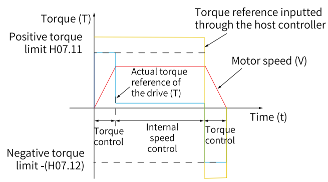


Figure 3-132 Torque limit source (H07.07 = 1)

Table 3–29 Description of H07.07 = 1

<table>
<tr><th colspan="2" rowspan="2">DI state</th><th colspan="2">P-CL</th></tr>
<tr><th>OFF</th><th>ON</th></tr>
<tr><td rowspan="2">N-CL</td><td>OFF</td><td>
</td><td>
</td></tr>
<tr><td>ON</td><td>
</td><td>
</td></tr>
</table>

Assign FunIN.16 (P-CL: Positive external torque limit) and FunIN.17 (N-CL: Negative external torque limit) to two DI of the drive and set the active logic of these DIs.

☆ Related parameters:

Code	Name	Function Name	Description
FunIN.16	P-CL	Positive external torque limit	The torque limit source is switched based on H07.07 (Torque limit source). H07.07 = 1: Active: Positive external torque limit activated Inactive: Positive internal torque limit activated
FunIN.17	N-CL	Negative external torque limit	The torque limit source is switched based on H07.07 (Torque limit source). H07.07 = 1: Active: Negative external torque limit activated Inactive: Negative internal torque limit activated

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.09	2007-0Ah	Positive internal torque limit	0.0% to 400.0%	350.0	%	Real-time
H07.10	2007-0Bh	Negative internal torque limit	0.0% to 400.0%	350.0	%	Real-time
H07.11	2007-0Ch	Positive external torque limit	0.0% to 400.0%	350.0	%	Real-time
H07.12	2007-0Dh	Negative external torque limit	0.0% to 400.0%	350.0	%	Real-time

- H07.07 = 2 (T-LMT as torque limit)

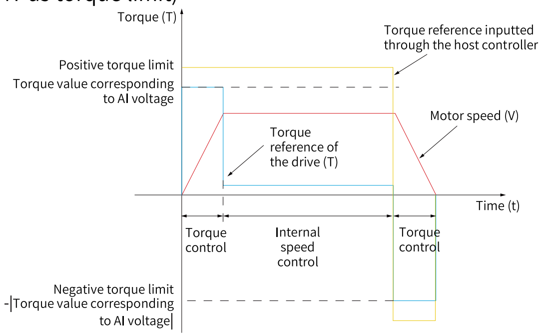


Figure 3-133 AI torque limit curve

- H07.07 = 3: T_LMT or external limit used as torque limit as defined by DI (FunIN.16 or 17)
  When the logic of the external DI signal (P-CL) is inactive, the positive torque limit is defined by the torque value corresponding to the input voltage of external AI. When the logic of the external DI signal (P-CL) is active, the positive torque limit is defined by the minimum of H07.11 and the AI value corresponding to the AI voltage.

  When the logic of the external DI signal (N-CL) is inactive, the negative torque limit is defined by the torque value corresponding to the external AI voltage. When the logic of the external DI signal (N-CL) .is active, the negative torque limit is defined by the minimum of H07.12 and the torque value corresponding to the AI voltage.

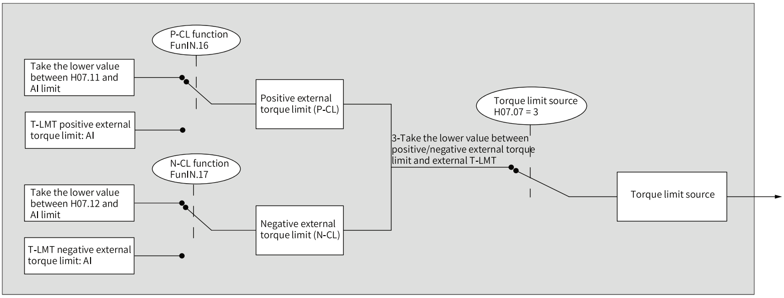
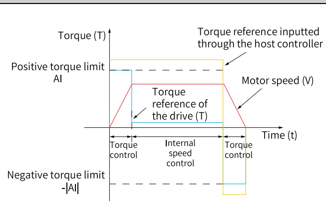
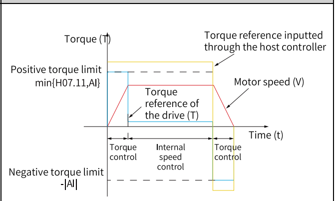
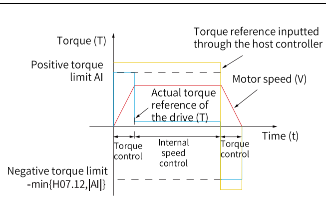
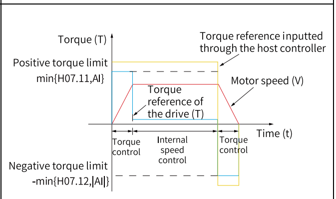


Figure 3-134 Torque limit source (H07.07 = 3)

Table 3–30 Description of H07.07 = 3

<table>
<tr><th colspan="2" rowspan="2">DI state</th><th colspan="2">P-CL</th></tr>
<tr><th>OFF</th><th>ON</th></tr>
<tr><td rowspan="2">N-CL</td><td>OFF</td><td>
</td><td>
</td></tr>
<tr><td>ON</td><td>
</td><td>
</td></tr>
</table>

- H07.07 = 4: T_LMT or internal limit used as torque limit as defined by DI

When the logic of the external DI signal (P-CL) is inactive, the positive torque limit is defined by H07.09. When the logic of the external DI (P-CL) is active, the positive torque limit is defined by the torque value corresponding to the AI voltage.

When the logic of the external DI signal (N-CL) is inactive, the negative torque limit is defined by H07.10. When the logic of the external DI-CL) is active, the negative torque limit is defined by the torque value corresponding to the AI voltage.

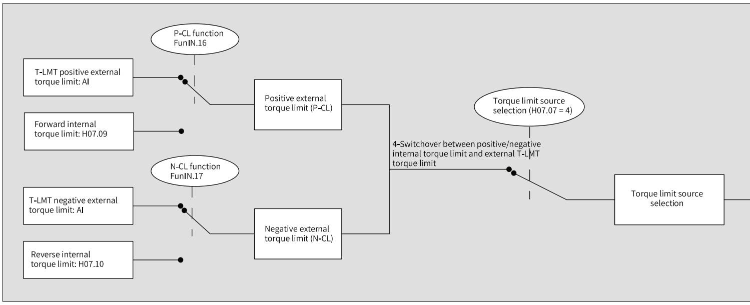
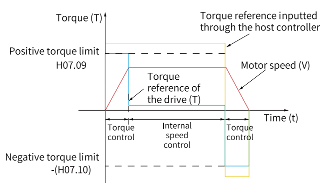
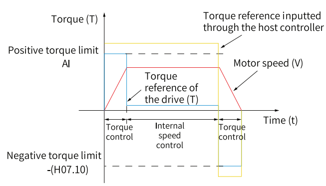
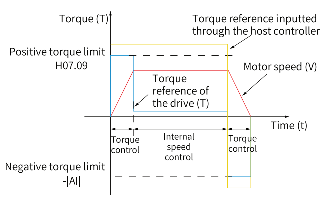
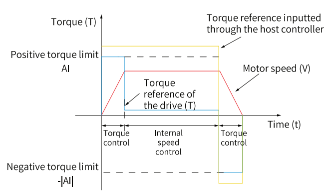


Figure 3-135 Torque limit source (H07.07 = 4)

Table 3–31 Description of H07.07 = 4

DI state		P-CL	
		OFF	ON
N-CL	OFF		
	ON		

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.09	2007-0Ah	Positive internal torque limit	0.0% to 400.0%	350.0	%	Real-time
H07.10	2007-0Bh	Negative internal torque limit	0.0% to 400.0%	350.0	%	Real-time
H07.11	2007-0Ch	Positive external torque limit	0.0% to 400.0%	350.0	%	Real-time
H07.12	2007-0Dh	Negative external torque limit	0.0% to 400.0%	350.0	%	Real-time

Setting torque limit DO signal

The drive outputs the C-LT (FunOUT.7: torque limit) signal to the host controller when the torque reference reaches the limit. In this case, assign FunOUT.7 to a DO of the drive and set the active logic of this DO.

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.7	C-LT	Torque limit signal	Active: The torque reference value reaches the torque limit and is limited by the torque limit. Inactive: The torque reference does not reach the torque limit.

3.11.5Speed Limit in Torque Control Mode

In the torque control mode, the motor accelerates continuously if the torque reference is higher than the load torque on the machine side, which may lead to overspeed and damage the machine. A speed limit therefore must be set to protect the machine.

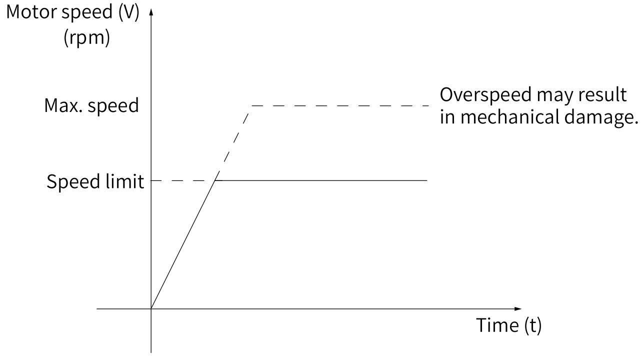


Figure 3-136 Speed limit in the torque control mode

Setting the speed limit source

In the torque control mode, you can set the speed limit source in H07.17. After the speed limit is set, the actual motor speed will be limited. After reaching the speed limit, the motor keeps operating at the speed limit constantly. Set the speed limit based on the operating requirements of the load.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.17	2007-12h	Speed limit source	0: Internal speed limit 1: V-LMT 2: H07.19 or H07.20 as defined by DI Note: For SV680P-INT, the parameter takes effect when H02.00 is not 8. For SV680N-INT, the parameter takes effect when H02.00 is not 9.	0	-	Real-time

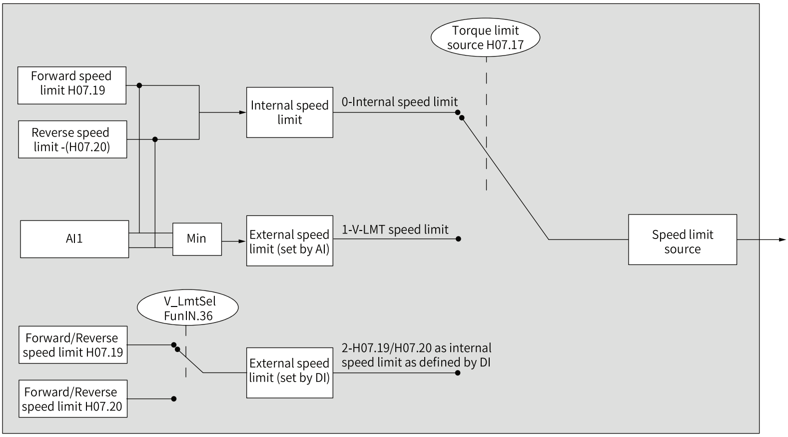


Figure 3-137 Speed limit source

- H07.17 = 0 (Internal speed limit)
  The speed limit is determined only by H07.19 (Positive speed limit) and H07.20 (Negative speed limit).

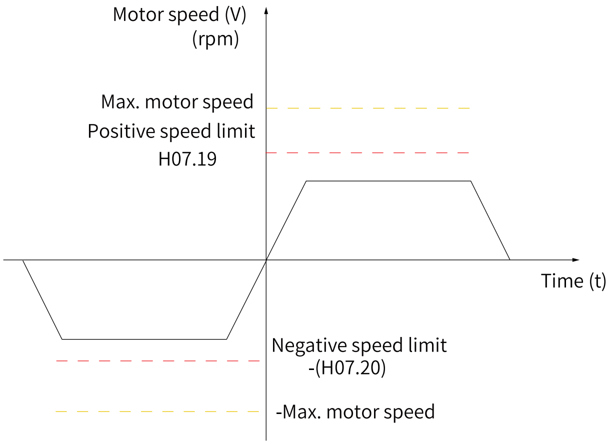


Figure 3-138 Speed limit curve (H07.17 = 0)

- H07.17 = 1 (V- LMT as speed limit)
  When the speed limit defined by AI is lower than the internal speed limit (H07.19/ H07.20), the former applies. When the speed limit defined by AI is higher than the internal speed limit (H07.19/H07.20), the latter applies.

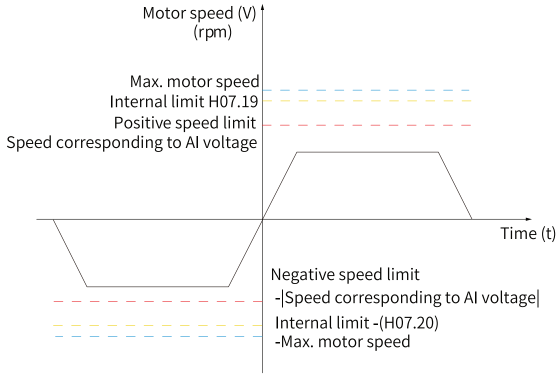


Figure 3-139 Speed limit curve (H07.17 = 1)

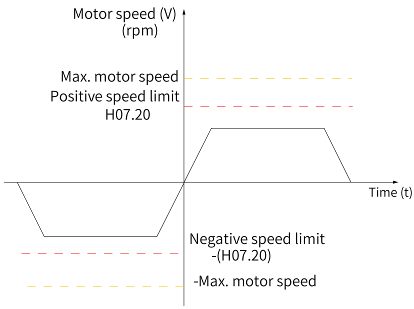
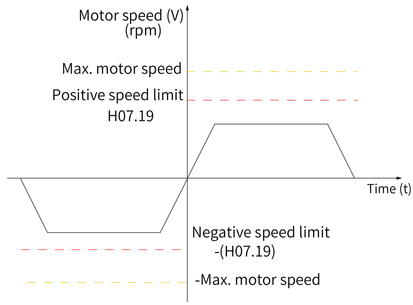
- H07.17 = 2 (H07.19 or H07.20 used as speed limit as defined by DI)
  H07.19 or H07.20 is used as the speed limit based on the logic of the DI.

  Before setting H107.17 to 2, assign FunIN.36 (V-LmtSel: internal speed limit source) to a DI first, and then set the active logic of this DI.

  ☆ Related parameters:

Code	Name	Function Name	Description
FunIN.36	V_LmtSel	Internal speed limit source	Inactive: H07.19 used as positive/ negative internal speed limit Active: H07.20 used as positive/ negative internal speed limit

Table 3–32 Descriptions of speed limit

V_LmtSel	
ON	OFF
	

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.19	2007-14h	Positive speed limit/Speed limit 1 in torque control	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	3000	[mm/s]/[rpm]	Real-time
H07.20	2007-15h	Negative speed limit/Speed limit 2 in torque control	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	3000	[mm/s]/[rpm]	Real-time

Speed limit DO signal

In the torque control mode, the servo drive outputs the V- LT (FunOUT.8: speed limit) signal to the host controller when the absolute value of the motor speed keeps exceeding the speed limit in the period defined by H07.40. If either of the preceding two conditions is not satisfied, the speed limit signal will be deactivated.

Acknowledgment of the V-LT (Speed limit) signal is executed only during operation in the torque control mode.

To use the V-LT signal, assign FunOUT.8 to a DO of the drive and set DO active logic of this DO.

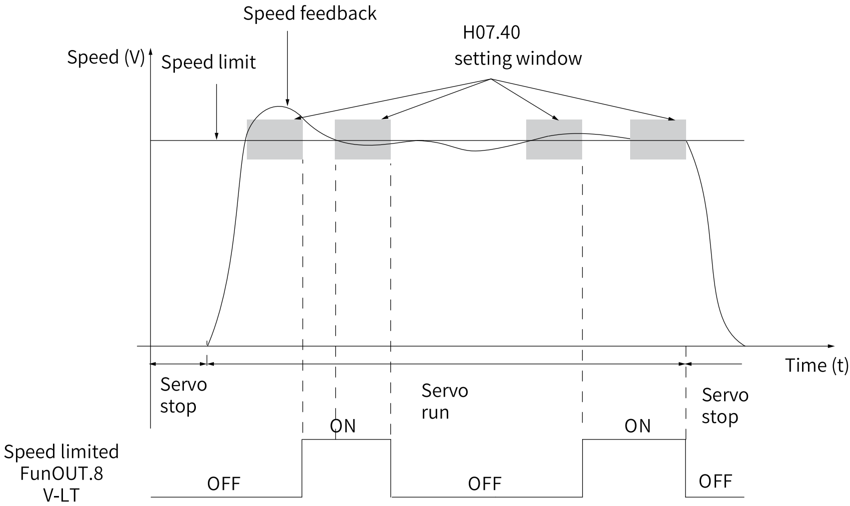


Figure 3-140 Example of speed limit DO waveform

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.8	V-LT	Speed limit	Inactive: The motor speed does not reach the speed limit. Active: The motor speed reaches the speed limit and a speed loop is built based on this limit.

3.11.6Torque Reach Output

The torque reach output is used to determine whether the actual torque reference reaches the set range. The drive outputs TorReach (FunOUT.18: torque reach) signal to the host controller when the actual torque reference reaches the torque reference threshold.

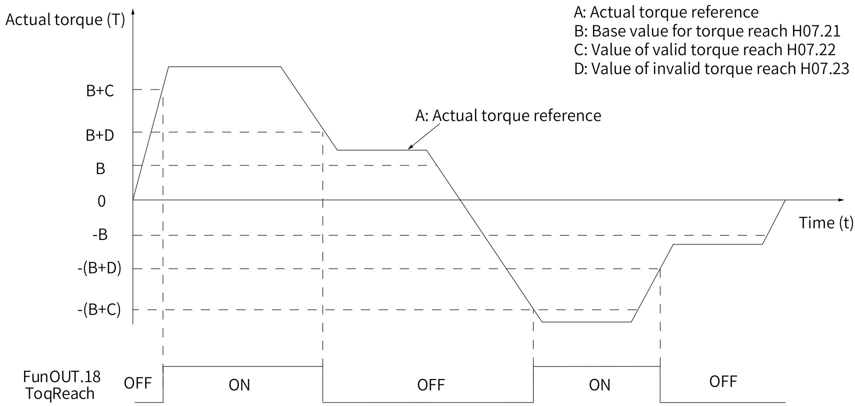


Figure 3-141 Example of TorReach signal waveform

- Actual torque reference (viewed in H0b.02): A
- Base value for torque reach (H07.21): B.
- Threshold of valid torque reach H07.22: C
- Threshold of invalid torque reach (H07.23): D.

C and D are the offset based on B.

The torque reach DO signal can be activated only when the actual torque reference meets the following condition: |A| ⩾ B + C. Otherwise, the torque reach DO signal remains inactive.

The torque reach signal is deactivated only when the actual torque reference meets the following condition: |A| < B + D. Otherwise, the torque reach signal remains active.

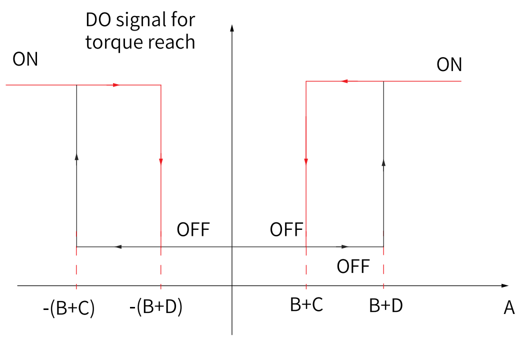


Figure 3-142 Description of torque reach output

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H07.21	2007-16h	Torque reach base value	0.0% to 400.0%	0.0	%	Real-time
H07.22	2007-17h	Torque reach valid value	0.0% to 400.0%	20.0	%	Real-time
H07.23	2007-18h	Torque reach invalid value	0.0% to 400.0%	10.0	%	Real-time

To use the TorReach (Torque reach) signal, assign FunOUT.18 (ToqReach, torque reach) to a DO of the drive and set the active logic of this DO.

☆ Related parameters:

Code	Name	Function Name	Description
FunOUT.18	ToqReach	Torque reach	Active: The absolute value of the torque reference reaches the setpoint. Inactive: The absolute value of the torque reference is lower than the setpoint.

4 Control Mode [P]

4.1 Mixed Control Mode

In the compound control mode, the control mode can be switched when the S-ON signal is switched on and the servo drive is in the "run" state. The following four compound control modes are available:

- Torque control mode → Speed control mode
- Speed control mode → Position control mode
- Torque control mode → Position control mode
- Speed control mode → Position control mode → Torque control mode

You can enable the compound control mode by setting H02.00 through the keypad or the software tool.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H02.00	2002-01h	Control mode	0: Speed control mode 1: Position control mode 2: Torque control mode 3: Torque/Speed control mode 4: Speed/Position control mode 5: Torque/Position control mode 6: Torque/Speed/Position compound mode 7: Process segment 8: CANopen mode	1	-	At stop

Set the parameters for different control modes based on the mechanical structure and technical indicators. For details, see *SV680-INT Series Servo Drive Parameter Guide*.

When H02.00 is set to 3, 4, or 5, assign a DI with FunIN.10 (M1_SEL, mode switchover 1) and set the active logic of this DI. When H02.00 is set to 6, assign two DIs with FunIN.10 (Mode switchover 1) and FunIN.11 (Mode DI 2) and set the active logic of these two DIs.

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.10	M1_SEL	Mode switchover 1	Defines the present control mode during compound control when the servo drive is in the "run" state, as shown in *"Table 4–1 " on page 295*.
FunIN.11	M2_SEL	Mode switchover 2	Defines the present control mode during compound control when the servo drive is in the "run" state, as shown in *"Table 4–2 " on page 295*.

Table 4–1 Servo drive control mode

H02.00	M1_SEL terminal logic	Control mode
3	Inactive	Torque control mode
	Active	Speed control mode
4	Inactive	Speed control mode
	Active	Position control mode
5	Inactive	Torque control mode
	Active	Position control mode

Table 4–2 Servo drive control mode

H02.00	M2_SEL terminal logic	M1_SEL terminal logic	Control mode
6	-	Active	Position control mode
	Active	Inactive	Speed control mode
	Inactive	Inactive	Torque control mode

Note

It is recommended to switch from other control modes to the position control mode only in the zero speed state.

4.2 Interpolation Mode (IP)

The interpolation mode can be used to achieve synchronous operations of multi-axis servo drives or single-axis servo drives. When the servo drive is not enabled, after the host controller sets the interpolation cycle, the displacement curve is planned in advance according to actual application requirements. When the servo drive is running, different absolute position points on the displacement curve are periodically sent to the slave. The slave synchronously receives the displacement reference, subdivides and evenly transmits the displacement reference increment based on the position loop control cycle. The servo drive executes the position control, speed control, and torque control.

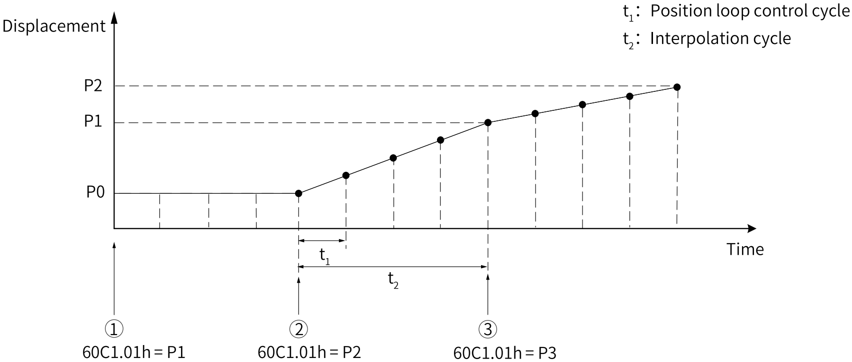
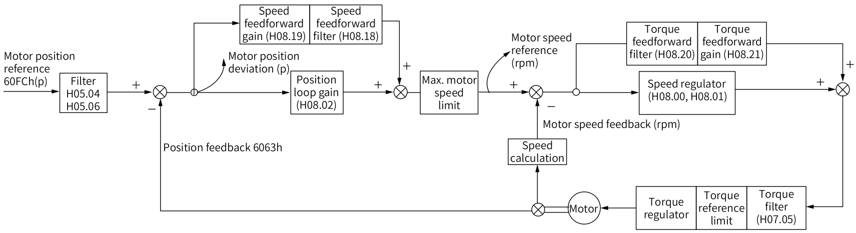


Figure 4-1 Displacement curve of single-axis linear interpolation motor

Note

- 1: The current absolute position of the motor is P0. After receiving the first absolute position reference P1, planning of the first displacement profile starts.
- 2: The current absolute position of the motor is P0. The motor starts to operate towards the first absolute position P1 and receives the second absolute position reference P2 at the same time, after which, planning of the second displacement profile starts.
- 3: After reaching the first absolute position P1, the motor starts to operate towards the second absolute position P2 and receives the 3rd absolute position reference P3 at the same time, after which, planning of the third displacement profile starts.
- t_1 - position loop control cycle, which is determined by the servo drive
- t_2 - interpolation cycle, which is set in the object dictionary 60C2h The SV680-INT servo drive supports the synchronization cycle in the range 1 ms to 20 ms. When a synchronization cycle beyond the range is set, the synchronization cycle is set to a limited value.
- P0/P1/P2 - absolute position. An absolute position reference is sent through 60C1.1h. The interpolation mode supports absolute position references only.
- The displacement reference increments in each synchronization cycle are P1-P0 and P2-P1.
- When using the interpolation mode, set the position loop period to 1 k.
- The displacement reference increments in each synchronization cycle are P1-P0 and P2-P1.

4.2.1 Function Block Diagram



4.2.2 Configuration Block Diagram

Interpolation mode (6060h = 7)

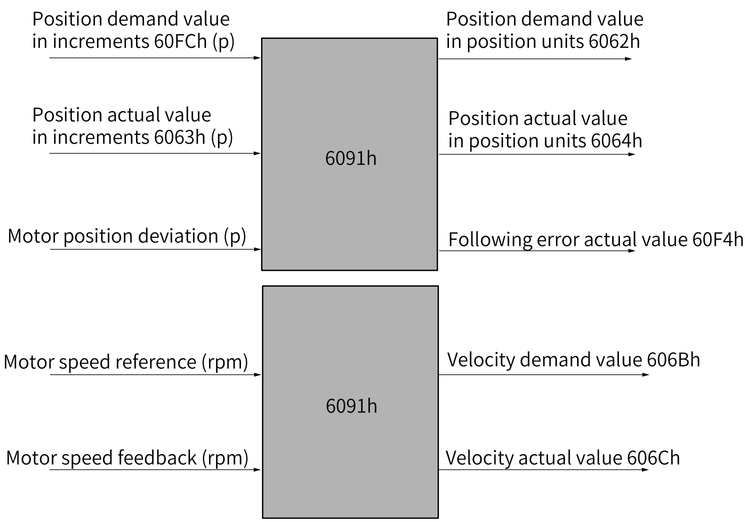


Figure 4-2 IP mode configuration

4.2.3 Recommended Configuration

Basic configuration:

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
60C1.01h: target position	6064h: position actual value	Mandatory
6060h: modes of operation	6061h: modes of operation display	Optional

4.2.4 Related Parameters

The control word 6040h in the IP mode is described as follows:

6040h **Control word**

Address: 6040h

Min.: 0x0 | Unit: -

Max.: 0xFFFF | Data Type: UInt16

Default: 0x0 | Change: Real-time

Access: RW | Mapping: RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name	Value	Description
0–3	-	See the relationship between status switching and control commands	See the object dictionary.
4	Interpolation mode enable	-	0: Interpolation interrupted 1: Interpolation enabled bit4 must always be 1 during interpolation. bit12 of 6041h can be used as a feedback indicating whether the interpolation mode is activated.
5–6	N/A	-	-
7–15	-	See the relationship between status switching and control commands	See the object dictionary.

6041h **Status word**

Address: 6041h

Min.: 0x0 | Unit: -

Max.: 0xFFFF | Data Type: UInt16

Default: 0x0 | Change: Unchangeable

Access: RO | Mapping: TPDO

Value Range:

0x0 to 0xFFFF

Description:

Indicates the servo drive status.

bit	Name	Value	Description
0–9	-	See the relationship between status switching and control commands	See the object dictionary.
10	The target position is reached.	-	0: The target position is not reached. 1: The target position is reached.
11	Software internal setting exceeding limit	-	0: The position actual value does not reach the software internal position limit. 1: The actual position value reaches the software position limit.
12	Interpolation mode activated	-	0: Interpolation is not activated. 1: Interpolation is activated.
13	Position deviation	-	0: Acceptable position deviation 1: Excessive position deviation
14	N/A	-	-
15	Homing is completed.	-	0: Homing is not performed or done. 1: Homing is complete.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP)	0	-	Real-time
6061h	6061h	Operation mode display	1: Profile position mode (pp) 3: Profile velocity mode (PV) 4: Profile torque mode (PT) 6: Homing mode (HM) 7: Interpolation mode (IP)	0	-	Unchangeable
6064h	6064h	Position actual value	-2147483648 to 2147483647	0	Reference unit	Unchangeable

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time
60C1.01h	60C1-01h	Interpolation displacement	-2147483648 to 2147483647	0	Reference unit	Real-time
60C2.01h	60C2-01h	Interpolation time period	1–20	1	-	Real-time
6081h	6081h	Profile velocity	0 to 4294967295	111848106	Reference unit/s	Real-time
6083h	6083h	Profile acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time
6084h	6084h	Profile deceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real-time

4.2.5 Related Functions

Positioning completed

Positioning completed: When position deviation fulfills the set condition, the positioning process is done. In this case, the servo drive sets bit10 of the status word 6041h, and the host controller, once receives the signal, acknowledges that positioning has been completed.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6067h	6067h	Position window	0 to 4294967295	46976	Reference unit	Real-time
6068h	6068h	Position window time	0 ms–65535 ms	0	ms	Real-time

Detection on excessive position deviation

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6065h	6065h	Following error window	0 to 4294967295	219895614	Reference unit	Real-time

Reference polarity

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

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

4.3 Homing

Caution

- The homing trigger signal is shielded when interrupt positioning or multi-position reference is in progress.
- To use the homing function, ensure H11.00 is not set to 5 as the setpoint 5 indicates enhanced axis control mode, in which the homing function is shielded.
- Do not set H05.30 to 65 or 8 when the motor is operating by commands. Otherwise, speed fluctuation will occur.

Description

- Home (or mechanical home): Indicates the position of the home switch or Z signal depending on the value of H05.31 (Homing mode).
- Zero: positioning target point, represented as home + offset (set in H05.36). When H05.36 (Mechanical home offset) is set to 0, the zero position coincides with the home.

In the position control mode, when homing is triggered after the S-ON signal is activated, the motor starts searching for the zero position.

When homing is in progress, the servo drive does not respond to other position references (including another homing trigger signal) until homing is done.

This function includes two actions:

- Home attaining: After receiving the homing signal, the servo drive proactively locates the relative position between the motor shaft and the preset mechanical home reference point; it finds the home and then moves through the offset from the home reference point to the zero point. The homing mode usually applies in initial searching for the zero position.
- Electrical homing: After determining the absolute zero position through homing, the drive takes current position as the start position to execute a relative displacement.

After the homing function (both homing and electrical homing) is executed, The absolute position of the motor (H0b.07) is consistent with the home offset (H05.36).

The servo drive outputs the homing completed signal (FunOUT.16: HomeAttain) or electrical homing completed signal (FunOUT.17: ElecHomeAttain), and the host controller, upon receiving these two signals, acknowledges the homing function is done executing. HomeAttain or ElecHomeAttain signal is not related to the operation mode or operation state of the servo drive.

Table 4–3 Comparison between homing and electrical homing

Mode	Homing trigger mode (H05.30)	Homing Direction, Deceleration Point, Home	Trigger Signal	Total Motor Displacement
Homing	0	-	-	-
	1	Determined by H05.31	HomingStart signal	Determined by the mechanical home coordinate and offset displacement
	3		Servo ON	
	4		Servo ON	
	6	-	-	-
	8	-	-	-
Electrical homing	2	The homing direction is consistent with the motor displacement sign (+/-). The deceleration point or home signal is not needed.	HomingStart signal	(H05.36 - H0b.07) x Electronic gear ratio
	5		Servo ON	

Homing

Caution

- Do not set H05.30 to 6 or 8 when the motor is operating by commands. Otherwise, speed fluctuation will occur.
- Set mechanical limit switches before enabling the homing function. For homing upon hit-and-stop, set the offset to a value within the travel range to prevent the machine from collision due to high-speed operation during homing.
- When the motor hits the limit switch during homing, the drive reports E950.0 (Forward overtravel) or E952.0 (Reverse overtravel), and the motor, if H05.40 is set to 0 or 1, stops in the stop mode defined by H02.07.

The following part takes an example to describe homing attaining:

- Forward, home switch as deceleration point and home (H05.31 = 0)
- Reverse, home switch as deceleration point and home (H05.31 = 1)
- Forward, Z signal as deceleration point and home (H05.31 = 2)
- Reverse, Z signal as deceleration point and home (H05.31 = 3)
- Forward, home switch as deceleration point and Z signal as home (H05.31 = 4)
- Reverse, home switch as deceleration point and Z signal as home (H05.31 = 5)
- Forward direction, deceleration point and home being forward limit switch signal (H05.31 = 6)
- Reverse, negative limit switch as deceleration point and home (H05.31 = 7)
- Forward, positive limit switch as deceleration point and Z signal as home (H05.31 = 8)
- Reverse, negative limit switch as deceleration point and Z signal as home (H05.31 = 9)
- Forward, mechanical limit position as deceleration point and home (H05.31 = 10)
- Reverse, mechanical limit position as deceleration point and home (H05.31 = 11)
- Forward, mechanical limit position as deceleration point and Z signal as home (H05.31 = 12)
- Reverse, mechanical limit position as deceleration point and Z signal as home (H05.31 = 13)
- Forward single-turn homing (H05.31 = 14)
- Reverse single-turn homing (H05.31 = 15)
- Single-turn nearby homing (H05.31 = 16)

- Forward, home switch as deceleration point and home (H05.31 = 0)

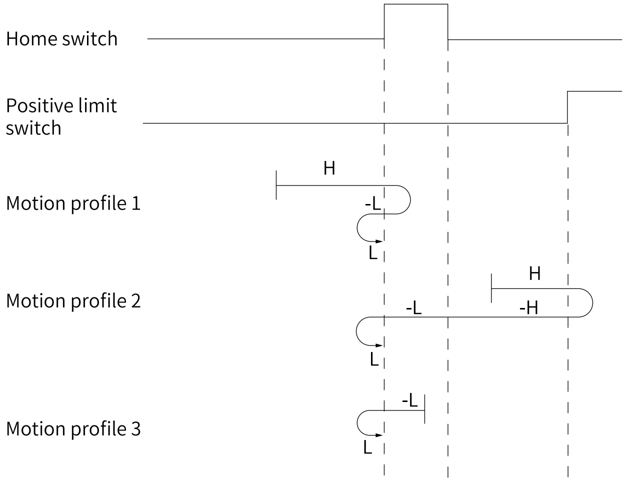


Figure 4-3 Motor running curve and speed in mode 0

- Motion profile 1: The home switch (deceleration point) signal is active when the motor starts running, with the positive limit switch not triggered in the whole process.
- Motion profile 2: The home switch (deceleration point) signal is inactive when the motor starts to run, with the positive limit switch triggered.
- Motion profile 3: The home switch (deceleration point) signal is active when the motor starts running, with the positive limit switch not triggered in the whole process.

Note

In the figure, "H" represents high speed 6099.01h, and "L" represents low speed 6099.02h, and “-” indicates reverse run.

- Reverse, home switch as deceleration point and home (H05.31 = 1)

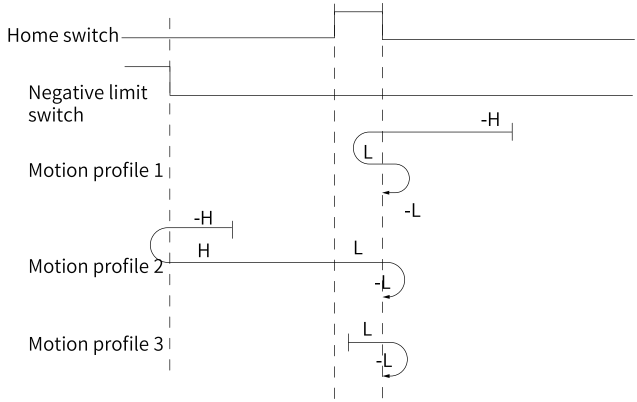


Figure 4-4 Motor running curve and speed in mode 1

- Motion profile 1: The home switch (deceleration point) signal is active when the motor starts running, with the negative limit switch not triggered in the whole process.
- Motion profile 2: The home switch (deceleration point) signal is inactive when the motor starts running, with the negative limit switch triggered.
- Motion profile 3: The home switch (deceleration point) signal is active when the motor starts running, with the negative limit switch not triggered in the whole process.

- Forward, Z signal as deceleration point and home (H05.31 = 2)

Caution

Note: In Modes 2 and 3 (H05.31 = 2 or 3) where the motor Z signal acts as the home and deceleration point, the actual stop position of the motor may not be on the rising edge on the same side of the motor Z signal. A deviation of ±1 pulse (in encoder unit) may be present in the stop position.

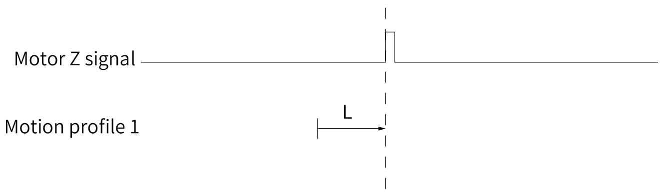


Figure 4-5 Motor running curve and speed in mode 2

- Motion profile 1: The Z signal is inactive when the motor starts running, with the positive limit switch not triggered in the whole process.

- Reverse, Z signal as deceleration point and home (H05.31 = 3)

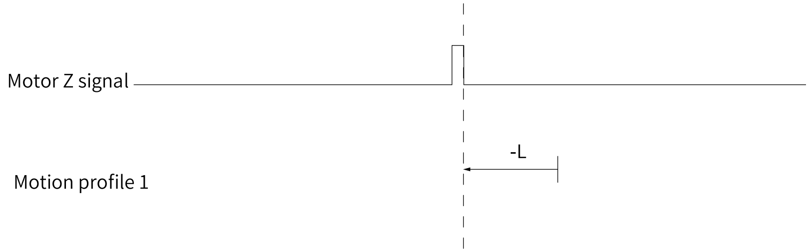


Figure 4-6 Motor running curve and speed in mode 3

  - Motion profile 1: The Z signal is inactive when the motor starts running, with the negative limit switch not triggered in the whole process.

- Forward, home switch as deceleration point and Z signal as home (H05.31 = 4)

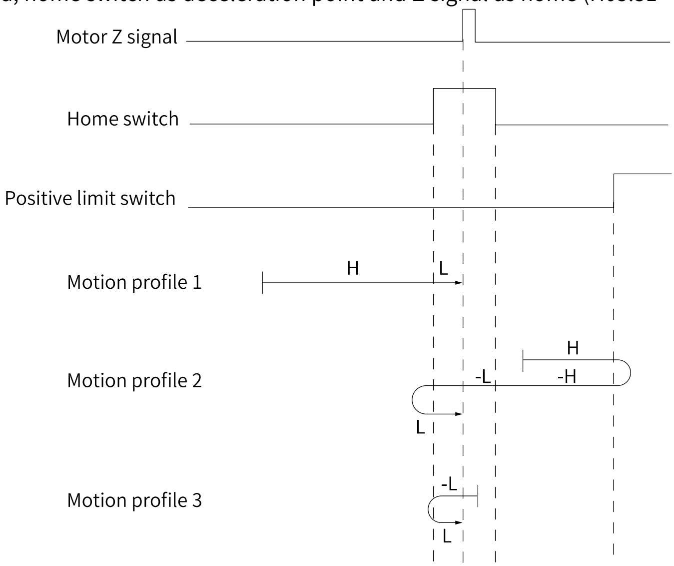


Figure 4-7 Motor running curve and speed in mode 4

  - Motion profile 1: The home switch signal is inactive when the motor starts running, with the positive limit switch not triggered in the whole process.
  - Motion profile 2: The home switch signal is inactive when the motor starts running, with the positive limit switch triggered.
  - Motion profile 3: The home switch signal is active when the motor starts running, with the positive limit switch not triggered in the whole process.

- Reverse, home switch as deceleration point and Z signal as home (H05.31 = 5)

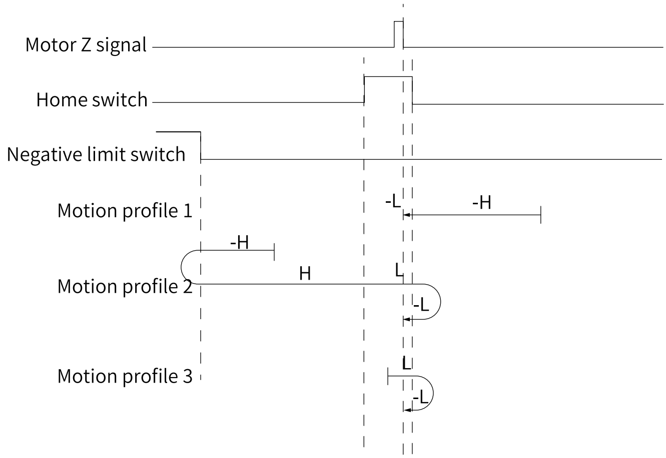


Figure 4-8 Motor running curve and speed in mode 5

- Motion profile 1: The home switch signal is inactive when the motor starts running, with the negative limit switch not triggered in the whole process.
- Motion profile 2: The home switch signal is inactive when the motor starts running, with the negative limit switch triggered.
- Motion profile 3: The home switch signal is active when the motor starts running, with the negative limit switch not triggered in the entire process.

- Forward direction, deceleration point and home being forward limit switch signal (H05.31 = 6)

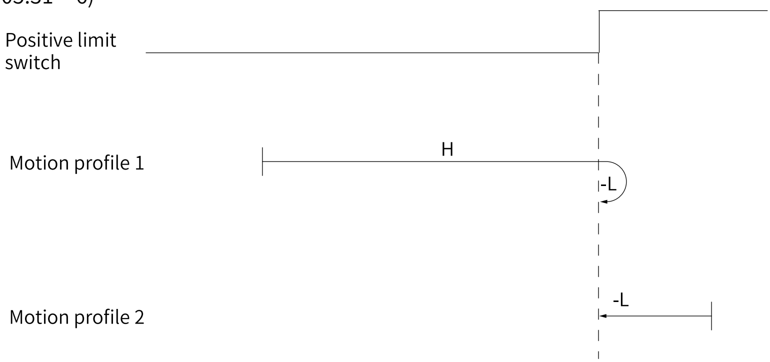


Figure 4-9 Motor running curve and speed in mode 6

- Motion profile 1: The positive limit switch signal is inactive when the motor starts running.
- Motion profile 2: The positive limit switch signal is active when the motor starts running.

- Reverse, negative limit switch as deceleration point and home (H05.31 = 7)

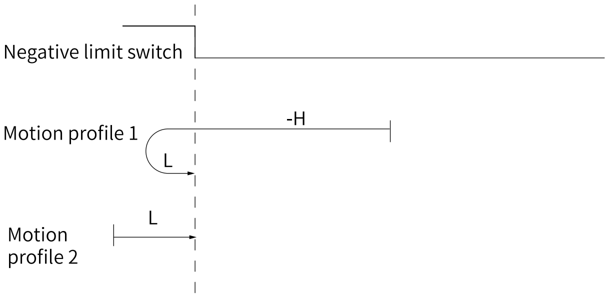


Figure 4-10 Motor running curve and speed in mode 7

- Motion profile 1: The negative limit switch signal is inactive when the motor starts running.
- Motion profile 2: The negative limit switch signal is active when the motor starts running.

● Forward, positive limit switch as deceleration point and Z signal as home (H05.31 = 8)

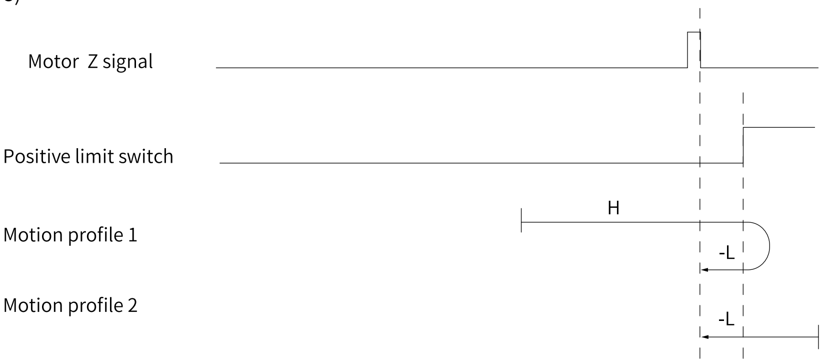


Figure 4-11 Motor running curve and speed in mode 8

- Motion profile 1: The positive limit switch signal is inactive when the motor starts running.
- Motion profile 2: The positive limit switch signal is active when the motor starts running.

● Reverse, negative limit switch as deceleration point and Z signal as home (H05.31 = 9)

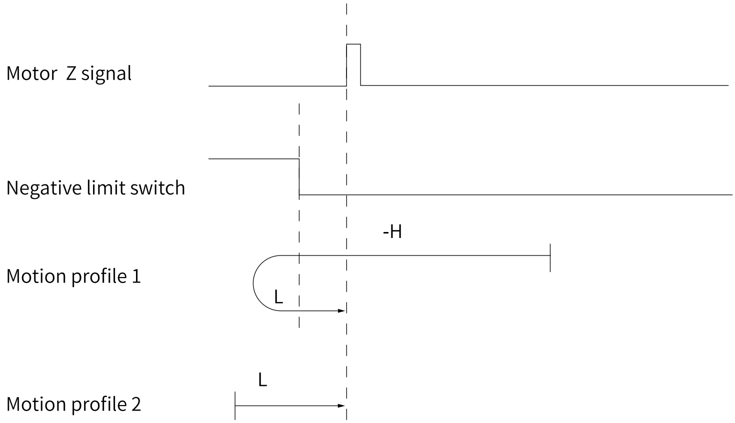


Figure 4-12 Motor running curve and speed in mode 9

- Motion profile 1: The negative limit switch signal is inactive when the motor starts running.
- Motion profile 2: The negative limit switch signal is active when the motor starts running.

- Forward, mechanical limit position as deceleration point and home (H05.31 = 10)

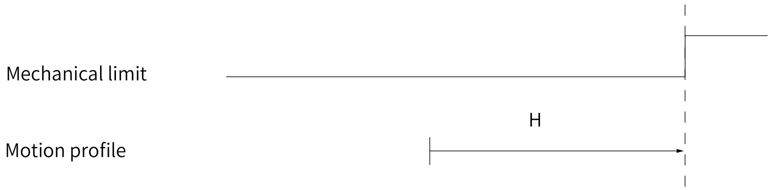


Figure 4-13 Motor running curve and speed in mode 10

- Motion profile: The positive limit switch signal is inactive when the motor starts running.

- Reverse, mechanical limit position as deceleration point and home (H05.31 = 11)

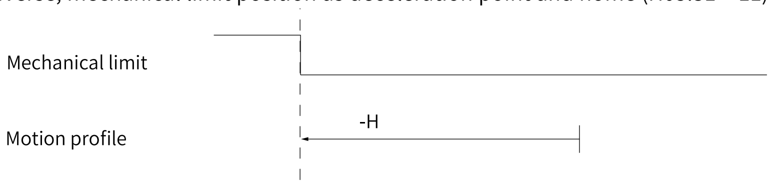


Figure 4-14 Motor running curve and speed in mode 11

- Motion profile: The negative limit switch signal is inactive when the motor starts running.

- Forward, mechanical limit position as deceleration point and Z signal as home (H05.31 = 12)

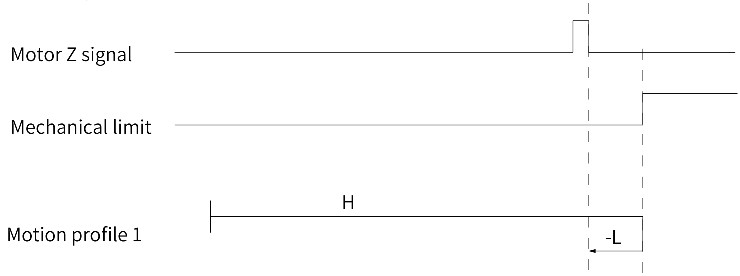


Figure 4-15 Motor running curve and speed in mode 12

  - Motion profile 1: The positive limit switch signal is inactive when the motor starts running.

- Reverse, mechanical limit position as deceleration point and Z signal as home (H05.31 = 13)

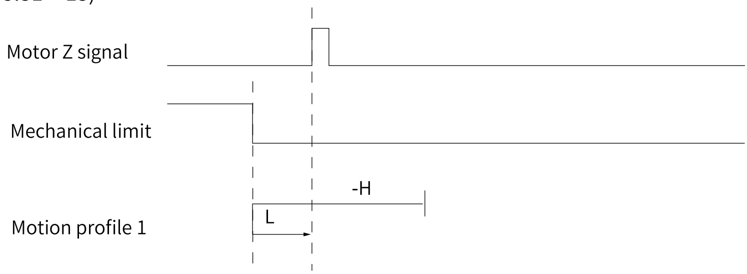


Figure 4-16 Motor running curve and speed in mode 13

  - Motion profile 1: The negative limit switch signal is inactive when the motor starts running.

- Forward single-turn homing (H05.31 = 14)

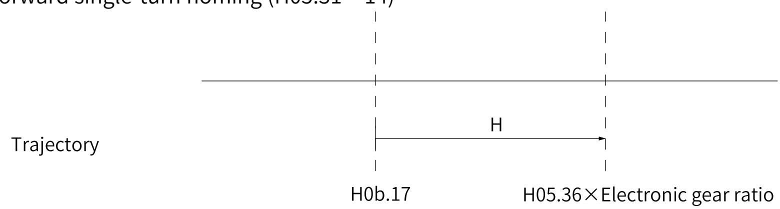


Figure 4-17 Motor running curve and speed in mode 14

  - Motion profile: The positive limit switch signal is inactive when the motor starts running.

Note

- When H05.31=14/15/16, the single-turn homing is only effective in absolute position single-turn mode (H02.01 = 4).
- If the home offset is set (H05.36 ≠ 0) and the mechanical home does not coincide with the mechanical zero (H05.40 = 0 or 2), the motor keeps running until H0b.07 = H05.36, and the absolute position defined by H0b.07 is cleared.
- If the home offset is set (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor keeps running until H0b.07 = 0.

- Reverse single-turn homing (H05.31 = 15)

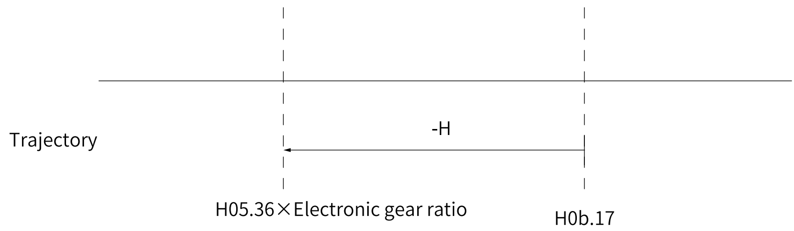


Figure 4-18 Motor running curve and speed in mode 15

  - Motion profile: The negative limit switch signal is inactive when the motor starts running.

Note

- When H05.31=14/15/16, the single-turn homing is only effective in absolute position single-turn mode (H02.01 = 4).
- If the home offset is set (H05.36 ≠ 0) and the mechanical home does not coincide with the mechanical zero (H05.40 = 0 or 2), the motor keeps running until H0b.07 = H05.36, and the absolute position defined by H0b.07 is cleared.
- If the home offset is set (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor keeps running until H0b.07 = 0.

- Single-turn nearby homing (H05.31 = 16)

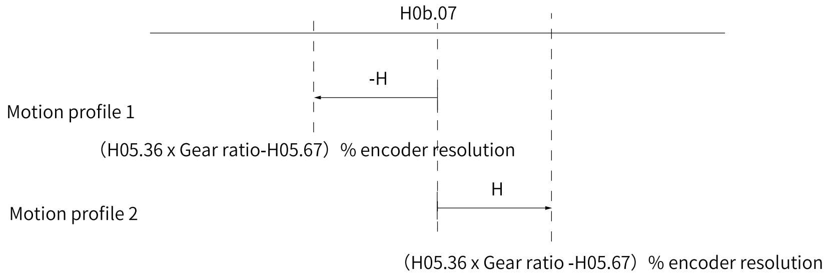


Figure 4-19 Motor running curve and speed in mode 16

- Motion profile 1: The positive limit switch signal is inactive when the motor starts running.
- Motion profile 2: The negative limit switch signal is inactive when the motor starts running.

Note

- When H05.31=14/15/16, the single-turn homing is only effective in absolute position single-turn mode (H02.01 = 4).
- If the home offset is set (H05.36 ≠ 0) and the mechanical home does not coincide with the mechanical zero (H05.40 = 0 or 2), the motor keeps running until H0b.07 = H05.36, and the absolute position defined by H0b.07 is cleared.
- If the home offset is set (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor keeps running until H0b.07 = 0.

Evaluation condition for torque homing: After the motor reaches the hard limit, and the torque feedback reaches the limit value defined in H05.58 (mechanical torque limit, in 0.1%), the first Z signal in the reverse direction is searched for and regarded as the home after the motor stops.

Electrical homing: starting electrical homing (H05.30 = 5)

The mechanical zero position is obtained after homing is done. In this case, you can make the motor move from current position (H0b.07) to the designated position (H05.36) by setting H05.36 (Mechanical home offset).

In the electrical homing mode, the motor runs at the speed defined by H05.32 in the direction defined by the sign (+/-) of the displacement value. The total displacement is determined by the difference between H05.36 and H0b.07. The motor stops immediately after the displacement reference is done executing.

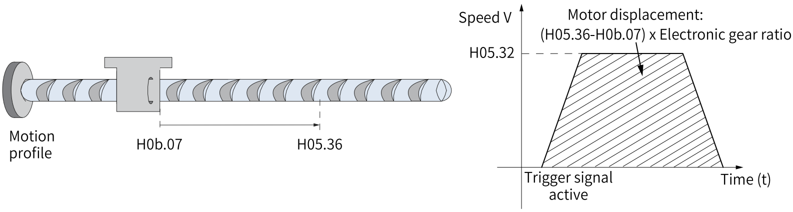
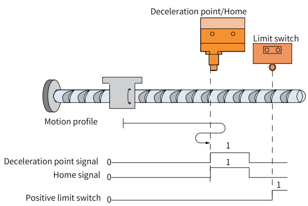
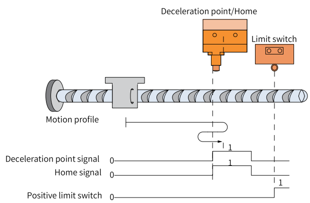
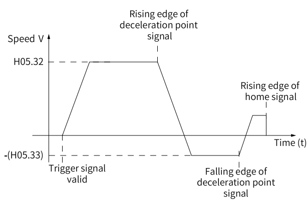
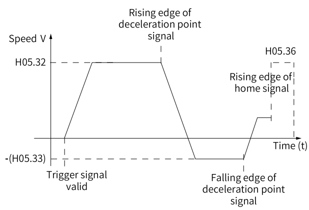


Figure 4-20 Motor running curve and speed in electrical homing

Mechanical home and mechanical zero

The following takes "H05.30 = 0" as example to describe the difference between mechanical home and mechanical zero.

Table 4–4 Description of mechanical home and mechanical zero

Mechanical Zero Different From Mechanical Home Reference Point	Mechanical Zero Same As Mechanical Home Reference Point
If the home offset is present (H05.36 ≠ 0) and the mechanical home differs from the mechanical zero (H05.40 = 0 or 2), the motor stops immediately after reaching the rising edge of the home signal during acceleration or forward operation at constant speed. After stop, the motor absolute position (H0b.07) is changed to the setpoint of H05.36 (Mechanical home offset) forcibly.	If the home offset is present (H05.36 ≠ 0) and the mechanical home coincides with the mechanical zero (H05.40 = 1 or 3), the motor continues running after reaching the rising edge of the home switch signal during acceleration or forward operation at constant speed until the absolute position (H0b.07) reaches the setpoint of H05.36 (Mechanical home offset).
	
	

Setting parameters

- Homing mode setting

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.30	2005-1Fh	Homing enable selection	0: Disabled 1: Homing enabled through the HomingStart signal input from DI 2: Electrical homing enabled through the HomingStart signal input from DI 3: Homing started immediately upon power-on 4: Homing executed immediately 5: Electrical homing started 6: Current position as home 8: D-triggered position as home Note: For model N, only 0 and 6 is available.	0	-	Real-time
H05.31	2005-20h	Homing mode	0: Forward, home switch as deceleration point and home 1: Reverse, home switch as deceleration point and home 2: Forward, Z signal as deceleration point and home 3: Reverse, motor Z signal as deceleration point and home 4: Forward, home switch as deceleration point and Z signal as home 5: Reverse, home switch as deceleration point and Z signal as home 6: Forward, positive limit switch as deceleration point and home 7: Reverse, negative limit switch as deceleration point and home 8: Forward, positive limit switch as deceleration point and Z signal as home 9: Reverse, negative limit switch as deceleration point and Z signal as home 10: Forward, mechanical limit position as deceleration point and home 11: Reverse, mechanical limit position as deceleration point and home 12: Forward, mechanical limit position as deceleration point and Z signal as home 13: Reverse, mechanical limit position as deceleration point and Z signal as home 14: Forward single-turn homing 15: Reverse single-turn homing 16: Nearby single-turn homing	0	-	Real-time

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.40	2005-29h	Mechanical home offset and action upon overtravel	0: H05.36 as the coordinate after homing, reverse homing applied after homing triggered again on overtravel 1: H05.36 as the relative offset after homing, reverse homing applied after homing triggered again on overtravel 2: H05.36 as the coordinate after homing, reverse homing auto-applied on overtravel 3: H05.36 as the relative offset after homing, reverse homing auto-applied on overtravel	0	-	Real-time

- Homing curve setting
  If the home signal is activated before the deceleration triggered by an active deceleration point signal is fully done executing, the final positioning may be unstable. Take the displacement required by deceleration into account before setting the deceleration point and homing signal input position. The acceleration/deceleration time during homing (H05.34) also affect the positioning stability.

  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.32	2005-21h	Speed of high-speed search for home switch signal	0 RPM to 3000 RPM	100	rpm	Real-time
H05.33	2005-22h	Speed of low-speed search for home switch signal	0 rpm to 1000 rpm	10	rpm	Real-time
H05.34	2005-23h	Acceleration/ Deceleration time during homing	0 ms–1000 ms	1000	ms	Real-time
H05.35	2005-24h	Home search time limit	0–65535	10000	-	Real-time
H05.36	2005-25h	Mechanical home offset	-2147483648 to 2147483647	0	Reference unit	Real-time

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.31	HomeSwitch	Home switch	Active: Current position as home Set the logic of the DI assigned with FunIN.31 to "active high" or "active low" based on the output of the host controller. See the following table for details. See the following table for details.
FunIN.32	HomingStart	Homing enable	Active: Homing enabled (The HomingStart signal cannot be triggered repeatedly during homing.) Inactive: Homing inhibited
FunIN.41	HomingRe cord	DI-triggered point as the home	The edge-triggered position is taken as the home.
FunOut.16	HomeAttain	Home find	Active: Homing completed in the position control mode Inactive: Homing not completed
FunOut.17	ElecHomeAt tain	Electrical homing completed	Active: Electrical homing completed in the position control mode Inactive: Electrical homing not completed

DI Logic Set by HomeSwitch	Actual Active Level
0 (low level)	Low level
1 (high level)	High level

Sequence

- H05.30 = 1 or 2

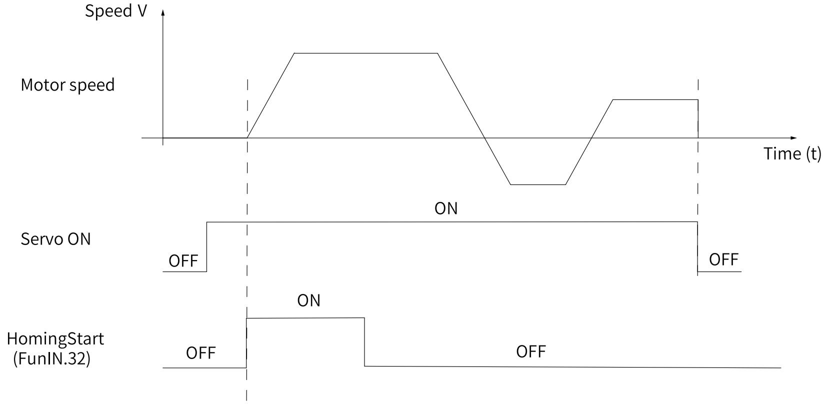


Figure 4-21 Sequence example

- Switch on the S-ON signal first and then the HomingStart signal.

- During homing, the S-ON signal remains active and the change of the HomingStart signal is shielded.
- During homing, the motor stops if the S-ON signal is switched off. To enable homing again, switch on the S-ON signal first and then the HomingStart signal.
- If E601.0 (Homing timeout) occurs, the motor stops, but the S-ON signal remains active. In this case, trigger the HomingStart signal again to reset E601.0, and execute homing again.
- The homing operation can be triggered repeatedly.

- H05.30 = 3
  - The homing operation is executed only when the S-ON signal is switched on for the first time after power-on.
  - The motor stops when E601.0 (Homing timeout) occurs. To reset E601.0, deactivate the S-ON signal.
  - The homing operation can only be triggered again at next power-on.
- H05.30 = 4 or 5
  - The homing operation is executed immediately after the S-ON signal is switched on upon power-on.
  - If the S-ON signal is deactivated during homing, the motor stops immediately. To trigger homing again, activate the S-ON signal again.
  - When E601.0 (Homing timeout) occurs, H05.30 is set to 0 and the motor stops. To reset E601.0, deactivate the S-ON signal. To perform homing again, reset H05.30. After homing is done, H05.30 is set to 0. To perform homing again, set H05.30 again.
- H05.30 = 6
  - To take the current position as the home and achieve home offset (H05.40 = 0 or 2, H05.36 ≠ 0), set H05.36 and H05.40 first, and then set H05.30 to 6. Failing to do so will cause H0b.07 to keep the previous value of H05.36 rather than the one set currently.
  - After homing is done, H05.30 will be set to 0. To enable homing again, re-write H05.36 and set H05.30 to 6.
- H05.30 = 8
  - To take the DI-triggered position as the home, assign FunIN.41 to a DI first and set the current position as the home.
  - To achieve home offset (H05.40 = 0 or 2, H05.36 ≠ 0), set H05.36 and H05.40 first, and then set H05.30 to 6. Failing to do so will cause H0b.07 to keep the previous value of H05.36 rather than the one set currently.

4.4 Interrupt Positioning

Caution

The interrupt positioning signal cannot be triggered during homing.

Description

If interrupt positioning is triggered in the position control mode, the servo drive halts current operation and turns to executing the pre-set fixed distance. To be specific, when the S-ON signal is active in the position control mode, if this function is enabled, the servo motor runs the position reference for interrupt positioning in the original direction (before the function is triggered).

When interrupt positioning is in progress, the servo drive does not respond to any other internal/external position references (including another interrupt positioning command). In this case, the input position reference counter (H0b.13) counts the interrupt positioning reference only. After interrupt positioning is done, the servo drive may or may not respond to the position references depending on the setpoint of H05.29 (Interrupt positioning clear signal). The position references received during interrupt positioning are invalid.

After interrupt positioning is done, the servo drive outputs the interrupt positioning completed (FunOUT.15: XintCoin) signal and positioning completed (FunOUT.5: COIN) signal, while the host controller, upon receiving XintCoin signal, acknowledges interrupt positioning is done. The XintCoin signal output is not related to the S-ON signal or the logic of DI8.

Interrupt positioning is effective only when the following conditions are met:

- The motor speed is higher than or equal to 10 rpm before interrupt positioning is triggered, or the setpoints of H05.26 (Constant operating speed in interrupt positioning) and H05.24 (Displacement of interrupt positioning) are not 0.
- The DI assigned with FunIN.33 (Interrupt positioning inhibited) is not used or the logic of this DI is inactive.

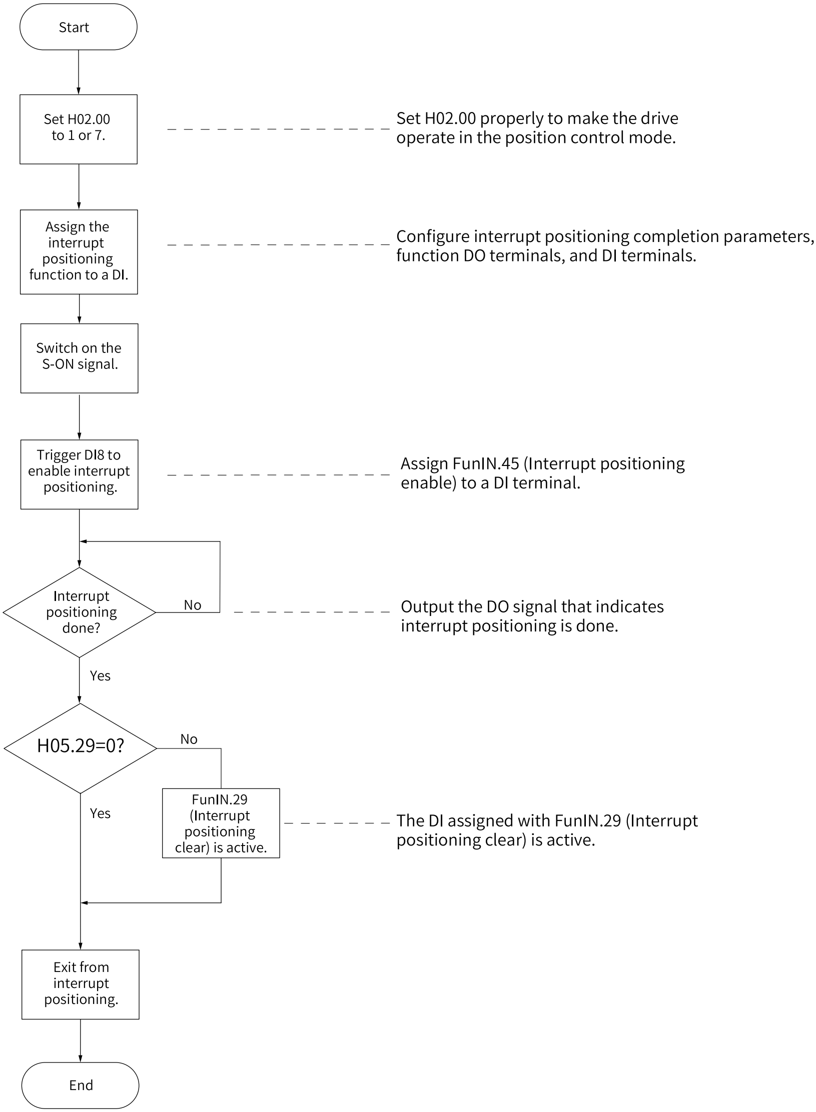


Figure 4-22 Flowchart of interrupt positioning signal

Setting parameters

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.24	2005-19h	Interrupt positioning displacement	-1073741824 to 1073741824	10000	Reference unit	Real-time
H05.26	2005-1Bh	Constant operating speed in interrupt positioning	0[mm/s]/[rpm]–10000[mm/s]/[rpm]	200	[mm/s]/[rpm]	Real-time
H05.27	2005-1Ch	Acc./Dec. time of interrupt positioning	0 ms–65535 ms	10	ms	Real-time
H05.29	2005-1Eh	Interruption fixed length unlock	0: Disabled 1: Enabled	1	-	Real-time

☆ Related parameters:

Code	Name	Function Name	Function
FunIN.29	XintFree	Interrupt positioning clear	Active: The interrupt positioning state is cleared, which means the servo drive can respond to other position references. Inactive: The interrupt positioning state is locked, which means the servo drive cannot respond to other position references.
FunIN.33	XintInHibit	Interrupt positioning inhibited	Active: Interrupt positioning inhibited Inactive: Interrupt positioning allowed
FunIN.45	XintEn	Interrupt positioning selection	Active: Interrupt positioning enabled Inactive: Interrupt positioning disabled The DI assigned with FunIN.45 (Interrupt positioning enable) is used to trigger interrupt positioning.
FunOut.15	XintCoin	Interrupt positioning completed	Active: Interrupt positioning completed in position control Inactive: Displacement in interrupt positioning not completed in position control

When DI7 is assigned with FunIN.45, the active logic of DI7 is as follows:

Table 4–5 Active logic of DI7 during interrupt positioning

H03.15	Active Logic of DI7
0	Active low
1	Active high

The constant operating speed during interrupt positioning is shown in the following figure.

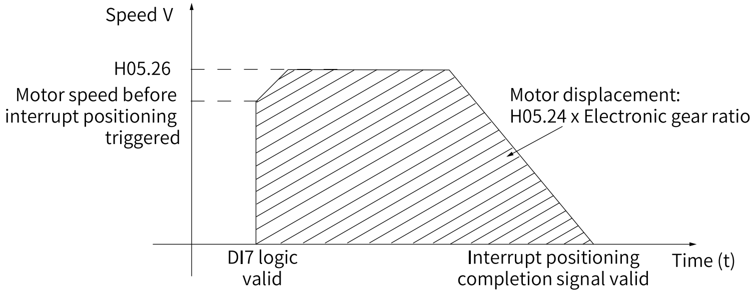


Figure 4-23 Motor operating curve during interrupt positioning

Table 4–6 Motor speed during interrupt positioning

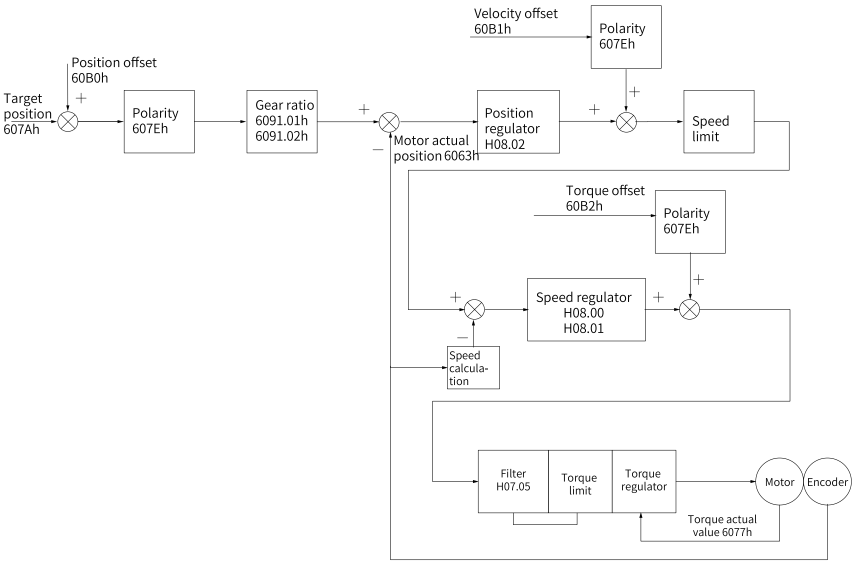
H05.26	Motor Speed (rpm) Before Triggering Interrupt Positioning	Interrupt Positioning	Constant operating speed in interrupt positioning
0	< 10	Inactive	-
	⩾ 10	Active	Motor Speed before Triggering Interrupt Positioning
1–6000	-	Active	H05.26

5 Control Mode [N]

5.1 Cyclic Synchronous Position Mode (CSP)

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

5.1.1 Function Block Diagram



5.1.2 Configuration Block Diagram

CSP mode (6060h = 8)

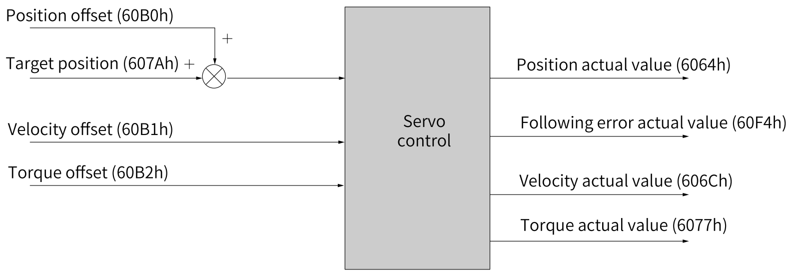


Figure 5-1 Cyclic synchronous position mode

5.1.3 Recommended Configuration

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
607Ah: target position	6064h: position actual value	Mandatory
6060h: modes of operation	6061h: modes of operation display	Optional

5.1.4 Related Parameters

6040h **Control word**

Address: 6040h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Real-time
Access:	RW	Mapping:	RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	S-ON	Switch on	1: Enabled, 0: Disabled
1	Enable voltage	Enable voltage	1: Enabled, 0: Disabled
2	Quick stop	Quick stop	0: Enabled, 1: Disabled
3	Servo ON	Enable operation	1: Enabled, 0: Disabled

The CSP mode only supports absolute position references.

6041h **Status word**

Address: 6041h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Unchangeable
Access:	RO	Mapping:	TPDO

Value Range:

0x0 to 0xFFFF

Description:

Indicates the servo drive status.

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

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable
6064h	6064h	Position actual value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
6065h	6065h	Following error window	0 to 4294967295	219895614	Reference unit	Real-time
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time
606Ch	606Ch	Actual speed	–2147483648 to +2147483647	0	Reference unit/s	Unchangeable
6077h	6077h	Actual torque	-4000.%–4000.%	0	0.10%	Unchangeable
607Ah	607Ah	Target position	-2147483648 to 2147483647	0	Reference unit	Real-time
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time
60B0h	60B0h	Position offset	-2147483648 to 2147483647	0	Reference unit	Real-time
60B1h	60B1h	Velocity offset	–2147483648 to +2147483647	0	Reference unit/s	Real-time
60B2h	60B2h	Torque offset	-4000.%–4000.%	0	0.10%	Real-time
60F4h	60F4h	Position deviation	-2147483648 to 2147483647	0	Reference unit	Unchangeable

5.1.5 Related Functions

Position deviation monitoring function

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6065h	6065h	Following error window	0 to 4294967295	219895614	Reference unit	Real-time
6066h	6066h	Defines the time lapse to trigger excessive position deviation (EB00.0).	0 ms–65535 ms	0	ms	Real-time

Position reference polarity

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

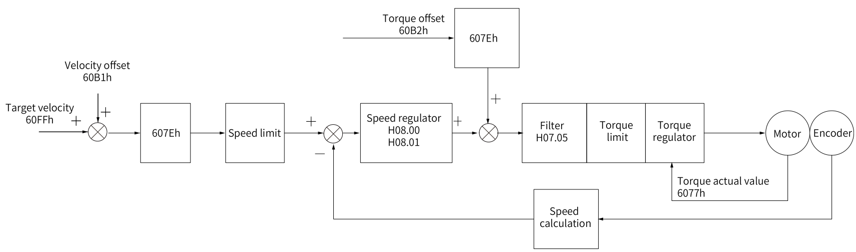
☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

5.2 Cyclic Synchronous Velocity Mode (CSV)

In CSV mode, the host controller sends the target speed to the servo drive through cyclic synchronization. The servo drive executes speed control and torque control.

5.2.1 Function Block Diagram



5.2.2 Configuration Block Diagram

CSV mode (6060h = 9)

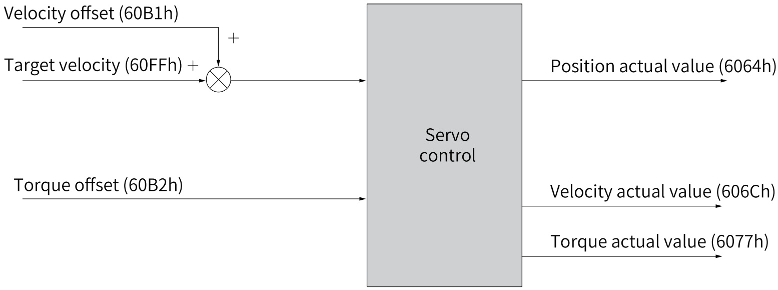


Figure 5-2 CSV mode

5.2.3 Recommended Configuration

Basic configuration:

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
60FFh: target velocity	-	Mandatory
-	6064h: position actual value	Optional
-	606Ch: velocity actual value	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

5.2.4 Related Parameters

6040h **Control word**

Address: 6040h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Real-time
Access:	RW	Mapping:	RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	S-ON	Switch on	1: Enabled, 0: Disabled
1	Enable voltage	Enable voltage	1: Enabled, 0: Disabled

bit	Name		Description
2	Quick stop	Quick stop	0: Enabled, 1: Disabled
3	Servo ON	Enable operation	1: Enabled, 0: Disabled

6041h Status word

Address: 6041h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Unchangeable
Access:	RO	Mapping:	TPDO

Value Range:

0x0 to 0xFFFF

Description:

Indicates the servo drive status.

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Enabled, 0: Disabled
1	Switch on	Switch on	1: Enabled, 0: Disabled
2	Enable operation	Operation enabled	1: Enabled, 0: Disabled
3	Fault	Fault	1: Enabled, 0: Disabled
4	Voltage enabled	Voltage enabled	1: Enabled, 0: Disabled
5	Quick stop	Quick stop	0: Enabled, 1: Disabled
6	Switch on disabled	Switch on disabled	1: Enabled, 0: Disabled
7	Alarm	Alarm	1: Enabled, 0: Disabled
8	Manufacturer-specific	Manufacturer-specific	Undefined
9	Remote	Remote	1: Enabled, control word activated 0: Disabled
10	Target reach	Target reach	Not supported, always being 1
11	Internal limit active	Internal limit active	0: Position reference within the limit 1: Position reference beyond the limit
12	Drive follows the command value	Drive follows the command value	Not supported, always being 1
13	-	N/A	N/A
14	Manufacturer-specific	Manufacturer-specific	Undefined
15	-	N/A	N/A

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable
6064h	6064h	Position actual value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
606Ch	606Ch	Actual speed	–2147483648 to +2147483647	0	Reference unit/s	Unchangeable
6077h	6077h	Actual torque	-4000–4000	0	0.001	Unchangeable
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time
60B1h	60B1h	Velocity offset	–2147483648 to +2147483647	0	Reference unit/s	Real-time
60B2h	60B2h	Torque offset	-4000–4000	0	0.001	Real-time
60FFh	60FFh	PV, CSV mode speed reference	–2147483648 to +2147483647	0	Reference unit/s	Real-time

5.2.5 Related Functions

Velocity reference polarity

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

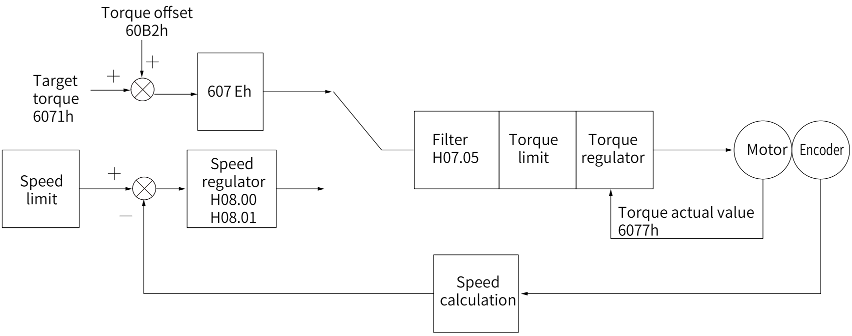
☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

5.3 Cyclic Synchronous Torque Mode (CST)

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

5.3.1 Function Block Diagram



5.3.2 Configuration Block Diagram

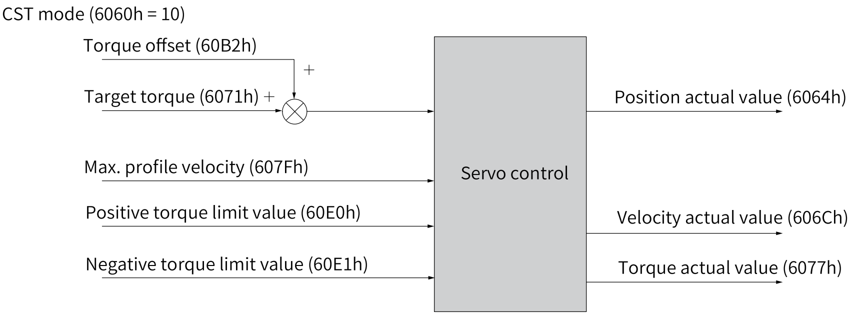


Figure 5-3 CST mode

5.3.3 Recommended Configuration

Basic configuration:

RPDO	TPDO	Remarks
6040h: control word	6041h: status word	Mandatory
6071h: target torque	-	Mandatory
-	6064h: position actual value	Optional
-	606Ch: velocity actual value	Optional
-	6077h: torque actual value	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

5.3.4 Related Parameters

6040h **Control word**

Address: 6040h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Real-time
Access:	RW	Mapping:	RPDO

Value Range:

0x0 to 0xFFFF

Description:

Defines the control command.

bit	Name		Description
0	S-ON	Switch on	1: Enabled, 0: Disabled
1	Enable voltage	Enable voltage	1: Enabled, 0: Disabled
2	Quick stop	Quick stop	0: Enabled, 1: Disabled
3	Servo ON	Enable operation	1: Enabled, 0: Disabled

6041h **Status word**

Address: 6041h

Min.:	0x0	Unit:	-
Max.:	0xFFFF	Data Type:	UInt16
Default:	0x0	Change:	Unchangeable
Access:	RO	Mapping:	TPDO

Value Range:

0x0 to 0xFFFF

Description:

Indicates the servo drive status.

bit	Name		Description
0	Ready to switch on	Ready to switch on	1: Enabled, 0: Disabled
1	Switch on	Switch on	1: Enabled, 0: Disabled
2	Enable operation	Operation enabled	1: Enabled, 0: Disabled
3	Fault	Fault	1: Enabled, 0: Disabled
4	Voltage enabled	Voltage enabled	1: Enabled, 0: Disabled
5	Quick stop	Quick stop	0: Enabled, 1: Disabled
6	Switch on disabled	Switch on disabled	1: Enabled, 0: Disabled
7	Alarm	Alarm	1: Enabled, 0: Disabled
8	Manufacturer-specific	Manufacturer-specific	Undefined

bit	Name		Description
9	Remote	Remote	1: Enabled, control word activated 0: Disabled
10	Target reach	Target reach	Not supported, always being 1
11	Internal limit active	Internal limit active	0: Position reference within the limit 1: Position reference beyond the limit
12	Drive follows the command value	Drive follows the command value	Not supported, always being 1
13	-	N/A	N/A
14	Manufacturer-specific	Manufacturer-specific	Undefined
15	-	N/A	N/A

☆ Related parameters:

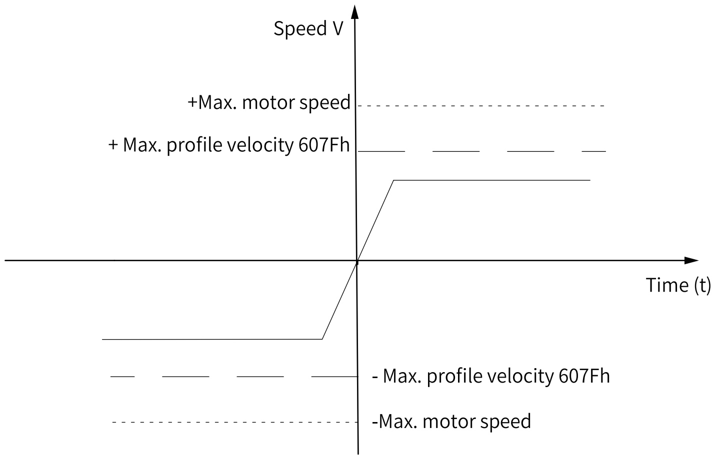
Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6060h	6060h	Servo drive mode	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real-time
6061h	6061h	Operation mode display	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Unchangeable
6071h	6071h	Target torque	-4000.%–4000.%	0	0.10%	Real-time
6072h	6072h	Max. torque reference	0.%–4000.%	3500	0.10%	Real-time
6074h	6074h	Torque reference	-4000.%–4000.%	0	0.10%	Unchangeable
6077h	6077h	Actual torque	-4000.%–4000.%	0	0.10%	Unchangeable
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time
60B2h	60B2h	Torque offset	-4000.%–4000.%	0	0.10%	Real-time

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
60E0h	60E0h	Positive torque limit	0.%–4000.%	3000	0.10%	Real-time
60E1h	60E1h	Negative torque limit	0.%–4000.%	3000	0.10%	Real-time

5.3.5 Related Functions

Speed limit in the torque control mode

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

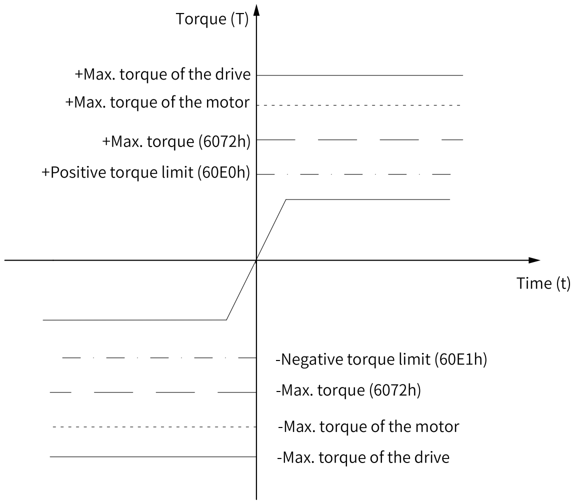


☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Fh	607Fh	Max. speed	0 to 4294967295	4294967295	Reference unit/s	Real-time

Torque limit

To protect mechanical devices, you can limit the torque reference in the position, speed, and torque control modes by setting 6072h (Maximum 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:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
6072h	6072h	Max. torque reference	0–4000	3500	0.001	Real-time
60E0h	60E0h	Positive torque limit	0–4000	3000	0.001	Real-time
60E1h	60E1h	Negative torque limit	0–4000	3000	0.001	Real-time

Torque reference polarity

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

☆ Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode
607Eh	607Eh	Reference polarity	0x0 to 0xFF	0x0	-	Real-time

6 Function Applications

6.1 Absolute System

6.1.1 Overview

- For the servo motor:
  The absolute encoder is used to detect the motor position within one turn and count the number of motor revolutions. For example, a 26-bit encoder has a single-turn resolution of 67108864 (2^{26}),and can record 26-bit multi-turn data. The absolute system integrated with the absolute encoder works in absolute position linear mode or absolute position rotating mode. These modes apply to position control, speed control, and torque control modes. The absolute encoder with a battery can back up data when the servo drive is powered off. This enables the servo drive to calculate the absolute mechanical position upon power-on again. Therefore, the homing operation is not required.

  To match an Inovance 26-bit absolute encoder with the SV680-INT, set H00.00 (Motor code) to 14102 (Inovance 26-bit absolute encoder). Then set H02.01 (Absolute system selection) based on actual conditions. E731.0 (Encoder battery failure) will occur upon initial power-on of the battery. Set H0d.20 (Absolute encoder reset function) to 1 to reset E731.0 before performing the homing operation.

- For the direct drive motor:
  There are two types of absolute systems: absolute position linear mode and incremental mode, which can be used in position, speed and torque control modes. With the absolute mode, the drive can calculate the absolute mechanical position through the encoder feedback after re-power-on, removing the need for homing. Set H02.01 (absolute system selection) according to the matched motor.

Note

When you change the value of H02.02 (Direction of rotation) or H0d.20 (Absolute encoder reset selection), the absolute position recorded by the encoder changes suddenly, causing the mechanical absolute position reference to change. In this case, perform the homing operation. After homing is done, the deviation between the mechanical absolute position and that recorded in the encoder will be calculated automatically and saved in the EEPROM of the servo drive.

Table 6–1 Absolute modes supported by the motor of SV680-INT

Type	Incremental mode	Absolute position linear mode	Absolute position rotation mode	Single-turn absolute mode
DDL motor + ABZ incremental encoder	√	×	×	×
DDL motor + Inovance incremental encoder	√	×	×	×
DDL motor + Analog encoder + Inovance T5 interpolator	√	×	×	×
DDL motor + BiSS-C encoder	√	√[1]	×	×
DDL motor + SSI encoder	√	√[1]	×	×
DDL motor + EnDat 2.2 encoder	√	√[1]	×	×
DDR motor + ABZ incremental encoder	√	×	×	×
DDR motor + Inovance absolute encoder	√	√	√	√
DDR motor + Analog encoder + Inovance T5 interpolator	√	×	×	×
DDR motor + BiSS-C encoder	√	×	×	√
Servo motor + ABZ incremental encoder	√	×	×	×
Servo motor + Inovance absolute encoder	√	√	√	√
Servo motor + Analog encoder + Inovance T5 interpolator	√	×	×	×

Type	Incremental mode	Absolute position linear mode	Absolute position rotation mode	Single-turn absolute mode
Servo motor + BiSS-C encoder	√	×	×	√
Servo motor + EnDat 2.2 encoder	√	×	×	√
Servo motor +Nikon absolute encoder	√	√	√	√
Servo motor + TAMAGAWA absolute encoder	√	√	√	√

Note 1.

- Check whether the used encoder is compatible.
- Set H02.01 absolute mode according to the above table. If the mode is not supported, E122.0 will be triggered.

6.1.2 Related Parameters

Absolute encoder system settings

Select the motor through H00.00, and select the absolute position mode through H02.01.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H00.00	2000-01h	Motor SN	20000: linear motor-pulse encoder 14203: linear motor-BissC encoder 14206: linear motor-SSI encoder 14207: linear motor-Endat2.2 encoder 14202: linear motor-Inovance communication 23-bit encoder 14205: linear motor-Inovance interpolator 23-bit encoder 20001: DDR motor-pulse encoder 14210: DDR motor-Inovance interpolator 23-bit encoder 14201: DDR motor-Inovance communication 23-bit encoder 14211: DDR motor-BissC encoder 14212: DDR motor-Endat2.2 encoder 14213: DDR motor-SSI encoder 20002: rotary motor-pulse encoder 14000: rotary motor-Inovance communication 20-bit encoder 14101: rotary motor-Inovance communication 23-bit encoder 14102: rotary motor-Inovance communication 26-bit encoder 14020: rotary motor-Harmonic 20-bit encoder 14021: rotary motor-Harmonic 17-bit encoder 14022: rotary motor-Harmonic 17-bit encoder 14120: rotary motor-Nikon 20-bit encoder 14121: rotary motor-Nikon 17-bit encoder 14122: rotary motor-Nikon 17-bit encoder 14130: rotary motor-TAMAGAWA 17-bit encoder 14131: rotary motor-TAMAGAWA 23-bit encoder 14140: rotary motor-Endat2.2 20-bit encoder 14150: rotary motor-SSI encoder 14160: rotary motor-BissC encoder	14102	-	At stop
H00.08	2000-09h	Bus encoder type	0–65535	0	-	At stop

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H02.01	2002-02h	Absolute system selection	0: Incremental mode 1: Absolute position linear mode 2: Absolute position rotation mode 3: Absolute position linear mode (without encoder overflow alarm) 4: Absolute position single-turn mode	0	-	At stop

Note

In the absolute position mode, the system detects the motor code automatically to check whether the motor used is configured with an absolute encoder. If not, E122.0 (Product mismatch in the absolute position mode) occurs.

Encoder feedback data

The encoder feedback data is divided into the number of revolutions and the single-turn position. For the incremental position mode and single-turn absolute position mode, the number of revolutions is not recorded.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0b.70	200b-47h	Number of absolute encoder revolutions	-32768Rev to 32767Rev	0	Rev	Unchangeable
H0b.71	200b-48h	Single-turn position fed back by the absolute encoder	0 to 2147483647	0	Encoder unit	Unchangeable
H0b.77	200b-4Eh	Encoder position (low 32 bits)	0 to 4294967295	0	Encoder unit	Unchangeable
H0b.79	200b-50h	Encoder position (high 32 bits)	-2147483648 to 2147483647	0	Encoder unit	Unchangeable

Absolute position linear mode

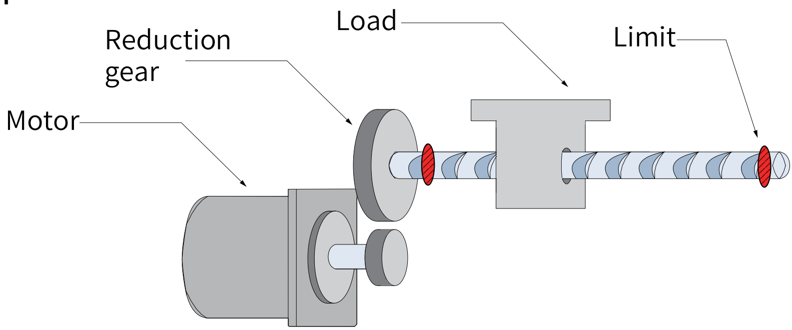


Figure 6-1 Servo motor linear mode mechanism

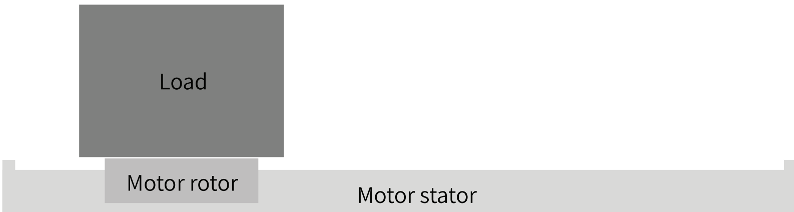


Figure 6-2 Linear motor linear mode mechanism

The SV680-INT is compatible with DDL motors, BiSS-C encoders and EnDat 2.2 encoders, and is suitable for absolute position linear mode.

Assume that the electronic gear ratio is B ÷ A, the mechanical absolute position (H0b.58 and H0b.60) is P_M, then the following formula applies: H0b.07 (Absolute position counter) = P_M ÷ (B ÷ A) H0b.07 indicates present mechanical absolute position (in reference unit).

The range of H0b.70 (absolute encoder revolutions) is -32768 to 32767. If H0b.70 overflows, E735.0 (Encoder multi-turn counting overflow) occurs. In this case, set H0d.20 to 2 (Reset multi-turn data), and then perform homing again. In special occasions, you can set H0A.36 to 1 to hide E735.0 or use absolute position linear mode 2.

☆ Related parameters:

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
H05.36	2005-25h	Mechanical home offset	-2147483648 to 2147483647	0	Refer ence unit	Real-time
H05.46	2005-2Fh	DI selection of multi-turn frequency-division Z starting point	0: No operation 1: DI1 2: DI2 3: DI3 4: DI4 ...	0	-	Real-time
H0b.07	200b-08h	Absolute position counter	-2147483648 to 2147483647	0	Refer ence unit	Unchangea ble
H0b.58	200b-3Bh	Mechanical absolute position (low 32 bits)	0 to 4294967295	0	Encoder unit	Unchangea ble
H0b.60	200b-3Dh	Mechanical absolute position (high 32 bits)	-2147483648 to 2147483647	0	Encoder unit	Unchangea ble

Absolute position rotation mode

This mode applies in cases where the load travel range is unlimited and the number of unidirectional revolutions is lower than 32767 upon power failure, as shown in the following figure.

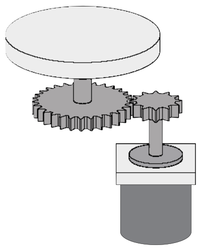
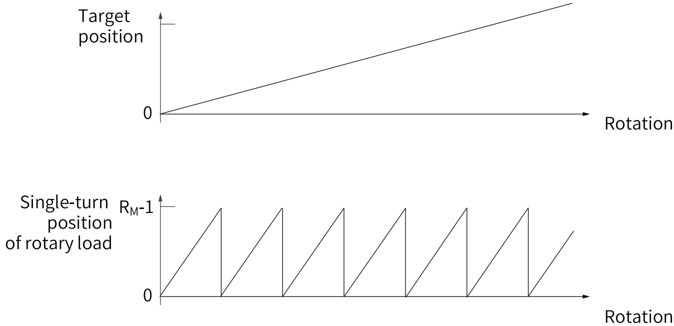
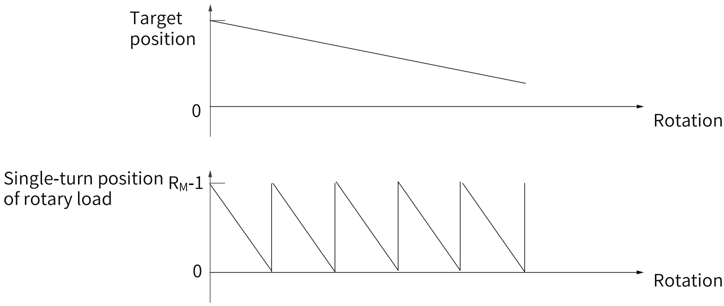


Figure 6-3 Application of the linear mode

The single-turn position range of the rotary load is 0 to (RM - 1) (RM: Encoder pulses per load revolution). When the gear ratio is 1:1, the variation law of the target position and the single-turn position of the rotary load during forward operation is shown as follows.



The variation law of the target position and the single-turn position of the rotary load during reverse operation is shown as follows.



When the motor operates in the absolute rotation mode and the 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 drive reports EE09.1.

The multi-turn data range is unlimited in the absolute position rotation mode. Therefore, E735.0 (Encoder multi-turn counting overflow) is hidden automatically.

Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H05.50	2005-33h	Mechanical gear ratio in absolute position rotation mode (numerator)	1–65535	1	-	At stop
H05.51	2005-34h	Mechanical gear ratio in absolute position rotation mode (denominator)	1–65535	1	-	At stop
H05.52	2005-35h	Pulses per revolution of the load in absolute position rotation mode (low 32 bits)	0 to 4294967295	0	Encoder unit	At stop
H05.54	2005-37h	Pulses per revolution of the load in absolute position rotation mode (high 32 bits)	0 to 4294967295	0	Encoder unit	At stop
H0b.81	200b-52h	Single-turn position of the rotary load (low 32 bits)	0 to 4294967295	0	Encoder unit	Unchangeable
H0b.83	200b-54h	Single-turn position of the rotary load (high 32 bits)	-2147483648 to 2147483647	0	Encoder unit	Unchangeable
H0b.85	200b-56h	Single-turn position of the rotary load (reference unit)	0 to 4294967295	0	Reference unit	Unchangeable

Single-turn absolute mode

This mode applies to applications where the load travel 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.

- Target position input range

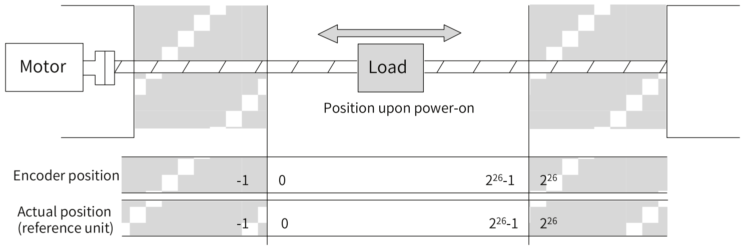
If a 26-bit absolute encoder is used in the single-turn absolute mode, the drive operates in the position control mode, and the electronic gear ratio 1:1, then:

When H05.36 (Mechanical home offset) is set to 0, the target position range is 0 to (2^{26} - 1).

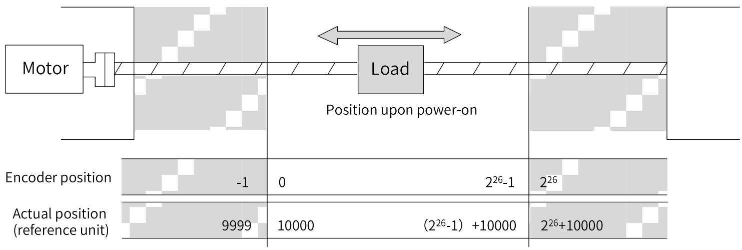
After homing is done, the target position range is H05.36 to (2^{26} - 1 + H05.36).

- Example

Gear ratio: 1:1; H05.36 = 0:



Gear ratio: 1:1; H05.36 = 10000:



6.1.3 Precautions for Using the Battery Box

This section only applies to Inovance servo motors.

E731.0 (Encoder battery failure) will occur at initial power-on of the battery. Set H0d.20 (Absolute encoder reset function) to 1 to reset E731.0 before further operations.

When the battery voltage detected is lower than 3.0 V, E730.0 (Encoder battery alarm) occurs.

In this case, replace the battery according to the following steps.

1. Power on the servo drive and make it stay in the non-operational state.
2. Replace the battery.
3. After the servo drive resets E730.0 automatically. If no other alarm occurs, continue to operate the servo drive.

Note

- If you replace the battery after powering off the servo drive, E731.0 (Encoder battery failure) will occur at next power-on, leading to an abrupt change in the multi-turn data. In this case, set H0d.20 to 1 to reset the encoder fault. Then perform the homing operation again.
- Ensure the maximum motor speed does not exceed 6000 rpm upon power-down of the servo drive. This is to enable the encoder to record the position accurately.
- Keep the battery in environments within the required ambient temperature range and ensure the battery is in reliable contact and carries sufficient power capacity. Otherwise, encoder data loss may occur.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0d.20	200d-15h	Absolute encoder reset	0: No operation 1: Reset fault 2: Reset fault and multi-turn data 3: Reset Inovance 2nd encoder fault 4: Reset Inovance 2nd encoder fault and multi-turn data	0	-	At stop

Note

The absolute position recorded by the encoder changes abruptly after multi-turn data reset. In this case, perform mechanical homing.

6.2 Full Closed-loop

6.2.1 Full Closed-loop Parameter Setting

After setting basic gain parameters, check that the servo drive operates properly without overshoot and stops without generating unexpected noise. When basic operating conditions are met, set the closed-loop parameters based on the following procedure.

1. **Set the external encoder feedback type.**
   Set H0F.03 based on the external encoder type.

Note

- The SV680-INT supports five secondary encoder types, including the ABZ incremental encoder, Inovance communication encoder, BiSS-C encoder, SSI encoder and EnDat 2.2 encoder.
- After enabling the fully closed-loop function, enable the JOG function to observe whether the value of H0F.20 (External position pulse feedback display) changes. In the case of improper wiring, the value of H0F.20 does not change and a fully closed-loop fault will be reported. In this case, rectify the fault and perform a power cycling until the value of H0F.20 changes without fault alarm.
- If the feedback type of the external encoder is ABZ incremental pulses without Z signal, set H0F.22 to 1 to hide the detection on phase Z.

Note

- BiSS-C encoder:
  - The BiSS-C encoder generally has a data bit and an error bit. You can obtain their data lengths in the corresponding encoder user guide. The data length of the error bit is usually 2 bits.
  - You can obtain the communication frequency and recovery time from the encoder user guide.
  - CRC is used.
  - You need to configure the communication frequency (baud rate) and recovery time (from the first falling edge of the clock signal to the first rising edge of the data signal).
- SSI encoder:
  - The SSI encoder generally has a data bit and an error bit. You can obtain their data lengths in the corresponding encoder user guide.
  - Parity check is used.
  - You need to configure the communication frequency (baud rate) and recovery time (from the first falling edge of the clock signal to the first rising edge of the data signal).
- EnDat2.2 encoder:
  - You need to set the data length for the EnDat2.2 encoder.
  - You need to configure the communication frequency (baud rate) and recovery time (from the first falling edge of the clock signal to the first rising edge of the data signal).

2. **Confirm the operating direction of the external encoder.**

Check whether the operating directions of the internal and external encoders are the same, if not, runaway can occur due to positive feedback.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0F.01	200F-02h	External encoder usage mode	0: Standard operating direction 1: Reverse operating direction	0	-	Real-time

The following describes how to confirm the operating direction of the external encoder.

Enter the JOG mode, and perform jogging at low speed in one direction. Observe the value of H0F.18 (Feedback pulse counter of internal encoder) and H0F.20 (Feedback pulse counter of external). If these two values change in the same way (increase or decrease simultaneously), set H0F.01 to 0; if not, set H0F.01 to 1.

Caution

- Perform necessary inspections before motor trial run. See *SV680-INT Series Servo Drive Quick Installation and Commissioning Guide* for details.
- Set H0F.01 properly. If H0F.01 is set improperly, runaway fault may occur.

3. **Determine the resolution of external encoder (external encoder pulses per revolution)**

Rotate the motor and observe the value of H0F.18 (Feedback pulse counter of internal encoder) to confirm the motor has rotated for a full turn. Then calculate the variation of H0F.20 (Feedback pulse counter of external encoder), and incorporate this value into H0F.04.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0F.04	200F-05h	External encoder pulses per revolution	1–2147483647	10000	-	At stop

Caution

- Suppose the values of H0F.18 and H0F.20 before the motor rotates are X_1 and Y_1 respectively, and their values change to X_2 and Y_2 after the motor rotates, then the following formula applies:

$$\text{H0F.04} = \text{Number of internal encoder pulses per motor revolution} \times \frac{Y_2-Y_1}{X_2-X_1}$$

- The calculation result must be a positive value. If it is a negative value, it indicates H0F.01 is set improperly. In this case, check the value of H0F.01 again.
- Set H0F.04 properly. If H0F.04 is set to a wrong value, EB02.0 (Position deviation too large in fully closed-loop mode) may occur when the drive is operating.

4. **Set the electronic gear ratio of external encoder.**

   If H0F.00 is set to 1, set H05.07/H05.09. If H0F.00 is set to 2, set H05.07/H05.09 for inner loop H05.11/H05.13 for outer loop.

   See *"3.2 Conversion Factor" on page 93* for how to set the electronic gear ratio. Suppose for a fully closed-loop device, the external mechanical displacement corresponding to each X_1 pulse reference sent by the host controller is Y_1.

   Then perform the following operations:

   a. Step 1: Set the electronic gear ratio to 1:1.

   b. Step 2: Make the host controller send X_2 pulses. The external mechanical displacement measured is Y_2,

   then the electronic gear ratio fulfills the needs.

Note

- To set the fully closed-loop electronic gear ratio in internal/external closed-loop position switchover mode, set the electronic gear switchover switch (Gear_Sel) to the external closed-loop state.
- This method also applies to internal closed-loop mode. In the internal closed-loop mode, ensure the present state is internal closed-loop state.
- Set the electronic gear ratio correctly. Failure to comply will result in mechanical deviation.

5. **Set the alarm threshold.**

   Set H0F.08 and H0F.10 as follows.

   - Set H0F.08 (Excessive deviation in compound control).

H0F.08 is used to set the allowable tolerance between the present motor position and the present position fed back by external encoder. Its unit is one reference unit (same as one external encoder unit).

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0F.08	200F-09h	Excessive deviation threshold in compound control mode	0–2147483647	1000	-	Real-time

For example, if H0F.08 is set to 1000, EB02.0 (Position deviation too large in fully closed-loop mode) will be outputted if the deviation between the mechanical displacement driven by the motor and the mechanical displacement (compound deviation) measured by the external encoder exceeds the displacement corresponding to 1000 external encoder pulses.

Note

- If it is set to 0, EB02.0 (Position deviation too large in fully closed loop) will not be output.
- H0F.08 must be set to a value (such as H0F.04 x H0F.10 x 50%) lower than H0F.04 x H0F.10. Otherwise, EB02.0 cannot be outputted.

- Set H0F.10 (Clear deviation in compound control).
  The value of H0F.10 indicates the revolutions to be ran by the motor per deviation clear in the compound control mode.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0F.10	200F-0Bh	Clear deviation in compound control mode	0 RPM –100 RPM	1	rpm	Real-time

If its value is set to 0, the deviation in compound control will not be cleared.

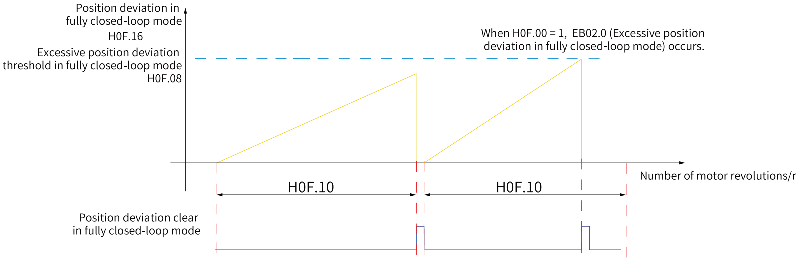


Figure 6-4 Description of position deviation clear in the fully closed-loop mode

The number of revolutions defined by H0F.10 is detected through internal encoder feedback pulses.

For example, if H0F.10 is set to 50, the servo drive detects whether the deviation in compound control exceeds the pulse unit defined by H0F.08 when the motor is in the process of rotating within 50 turns. If yes, EB02.0 will be reported. If not, the servo drive clears the deviation after the motor rotates for more than 50 turns, and then starts monitoring again.

- Set the first-order low-pass filter for deviation in compound control.
  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0F.13	200F-0Eh	Compound vibration suppression filter time	0.0 ms–6553.5 ms	0.0	ms	At stop

The first-order filter time constant is used to filter vibration of the deviation in compound control, smoothening the speed in fully closed-loop mode.

- Set the source of touch probe Z signal in fully closed-loop mode.
  ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0F.25	200F-1Ah	Set the source of touch probe Z signal in fully closed-loop mode.	0: Motor Z signal 1: External feedback Z signal	0	-	Real-time

H0F.25 (Source of touch probe Z signal in fully closed-loop mode) defines the source of Z signal during homing in the fully closed-loop mode. The setpoint 0 indicates Z signal of inner loop of used as the source and the setpoint 1 indicates Z signal of the outer loop is used as the source. When the Z signal of outer loop is used as the source, ensure Z signal is wired correctly. Otherwise, Z signal may fail to be detected.

Caution

- Set H0F.10 properly for clearing deviation in compound control. Given the setpoint of H0F.08, if H0F.10 is set to an excessively low value, protection against excessive deviation in compound control can fail.
- Pay attention to encoder limit setting during use.
- Set this warning properly. Failure to comply may incur physical injuries due to runaway accident.

6.2.2 Enable Fully Closed-loop

After setting preceding fully closed-loop parameters, observe the internal/external encoder feedback through H0F.18 and H0F.20, and check whether the fully closed-loop wiring and the application mode of the external encoder are proper. If yes, enable the fully closed-loop function.

Set the following parameters while enabling the fully closed-loop function:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H03.02	2003-03h	DI1 function	For details, see the commissioning software or *SV680-INT Series Servo Drive Parameter Guide*.	14	-	Real-time
H0F.00	200F-01h	Encoder feedback mode	0: Internal encoder feedback 1: External encoder feedback 2: Inner/Outer loop switchover	0	-	Real-time

Note

To switch between inner and outer loops, you need to set H0F.00 to 2, rather than changing it to 0 or 1 in realtime.

6.3 Software Limit

Function

Hardware position limit is implemented by inputting external encoder signals to CN1 of the servo drive.

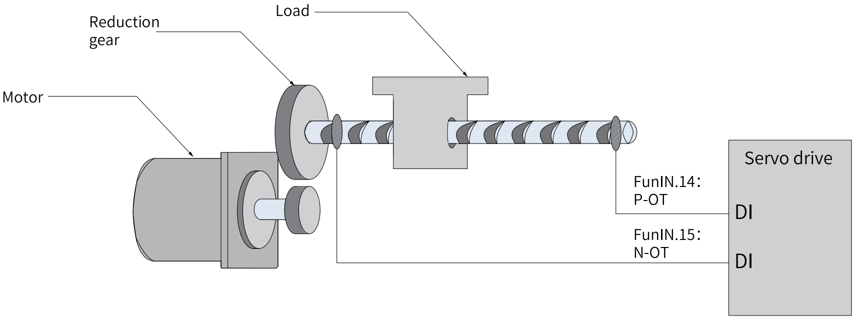


Figure 6-5 Installation of limit switches

Software position limit is implemented through a comparison between the internal position feedback and the set limit value. If the set limit value is exceeded, the servo drive reports a warning and stops immediately. Software position limit is available both in the absolute position mode and the incremental position mode. To use the software position limit in the incremental position mode, set H0A.01 (Software position limit) to 2 (Enabled after homing) first, and then perform homing upon power-on before applying software position limit.

Table 6–2 Comparison between the hardware position limit and software position limit

Hardware Position Limit		Software position limit	
1	Restricted to linear motion and single-turn rotational motion.	1	Applicable to both the linear motion and the rotational motion.
2	Requires an external mechanical limit switch.	2	Removes the need for hardware wiring, preventing malfunction due to poor cable contact.
3	Suffered from the risk of mechanical slip.	3	Prevents malfunction due to mechanical slip through internal position comparison.
4	Unable to sense or detect an overtravel fault after power-off.		

Related objects

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0A.00	200A-01h	Power input phase loss protection	0: Enable 1: Disable	0	-	Real-time
H0A.41	200A-2Ah	Forward position of software position limit	-2147483648 to 2147483647	2147483647	Encoder unit	At stop
H0A.43	200A-2Ch	Reverse position of software position limit	-2147483648 to 2147483647	-2147483648	Encoder unit	At stop

Communication mode:

- When H0A.01 is set to 0 (disable absolute position limit), software limit is disabled.
- When H0A.01 is set to 1 (enable absolute position limit), software limit is enabled immediately upon power-on. 607D.01h (min. position limit) and 607D.02h (max. position limit) are used by the function. Ensure the value of 607D.01h is lower than or equal to 607D.02h. If 607D.01h is set to a value higher than 607D.02h, EE09.0 (Software limit setting error) will occur.
- If H0A.01 is set to 2 (enable absolute position limit after homing), software position limit is not enabled after homing upon power-on. When the value of the absolute position counter is higher than the value of 607D.02h after homing, E950.0 (Forward overtravel warning) occurs and the drive stops accordingly. When the value of the absolute position counter is lower than the value of 607D.01h after homing, E952.0 (Reverse overtravel warning) occurs and the drive stops accordingly.

Non-communication mode:

- When H0A.01 is set to 0 (disable absolute position limit), software limit is disabled.
- When H0A.01 is set to 1 (enable absolute position limit), software limit is enabled immediately upon power-on. When the value of the absolute position counter (H0b.07) is higher than the value of H0A.41, E950.0 (Forward overtravel warning) occurs and the drive stops accordingly.
  When the value of the absolute position counter (H0b.07) is lower than the value of H0A.43, E952.0 (Reverse overtravel warning) occurs and the drive stops accordingly.
- If H0A.01 is set to 2 (enable absolute position limit after homing), software limit is not enabled after homing upon power-on. When the value of the absolute position counter (H0b.07) is higher than the value of H0A.41 after homing, E950.0 (Forward overtravel warning) occurs and the drive stops accordingly. When the value of the absolute position counter (H0b.07) is lower than the value of H0A.43 after homing, E952.0 (Reverse overtravel warning) occurs and the drive stops accordingly.

Note

Ensure the value of 607Ch (Home offset) is within the software position limit. Otherwise, the servo drive reports EE09.1.

6.4 Software Reset

Function

The software reset function applies when power cycling of the drive is not allowed on the application site.

Related objects

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0d.00	200d-01h	Software Reset	0: No operation 1: Enable	0	-	At stop

6.5 Motor Protection

Motor overload protection

The motor generates heat continuously due to thermal effect of the current after power-on. The heat is then dissipated to the surroundings. When the heat generated exceeds the heat dissipated, the motor temperature will rise to a point that could damage the motor. To prevent such risks, the drive offers the motor overload protection function to prevent the motor from being damaged due to over-temperature.

The motor is compliant with NEC and CEC requirements and equipped with protective functions against overload and overtemperature.

Set the motor overload protection gain (H0A.04) to adjust the report time of fault E620.0. Use the default value of H0A.04 in general conditions, however, in case of one of the following situations, modify H0A.04 based on the actual heating condition.

- The motor works in environments with high temperature.
- The motor is in the cyclic motion featuring short motion cycle and frequent acceleration/deceleration.

You can also hide motor overload detection (H0A.26 = 1) when you are sure that the motor will not be damaged due to overtemperature.

Caution

Take caution when hiding the motor overload fault as it may damage the motor.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0A.04	200A-05h	Motor overload protection gain	50–300	100	-	Real-time
H0A.26	200A-1Bh	Motor overload detection	0: Show motor overload alarm (E909.0) and fault (E620.0) 1: Hide motor overload alarm (E909.0) and fault (E620.0)	0	-	Real-time

Locked rotor over-temperature protection

When the motor is stalled, the motor speed is nearly 0 RPM while the current is large. In this case, the motor is overheated significantly. The motor is capable of operating upon stall in an allowable period of time, exceeding of which can damage the motor due to overtemperature. To prevent such risks, the drive offers motor overtemperature protection to protect the motor from being damaged by overtemperature.

You can set the time for reporting E630.0 (Motor stall over-temperature fault) by setting the time threshold for motor overtemperature protection (H0A.32). The motor overtemperature protection function is enabled by default (H0A.33 = 1).

Caution

Take caution when hiding motor stall over-temperature protection as it may result in a damage to the motor.

Use the dedicated motor for the SV680P series servo drive. Failure to comply will result in the risk of short circuit due to aging of insulation.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0A.32	200A-21h	Time threshold for locked motor overheat protection	10 ms–65535 ms	200	ms	Real-time
H0A.33	200A-22h	Locked motor overheat protection	0: Disabled 1: Enabled	1	-	Real-time

Motor overspeed protection

An excessively high speed may damage the motor or machine. Motor overspeed protection is used to protect the motor in case of overspeed, preventing the motor or machine from being damaged due to overtemperature.

$$\text{Overspeed threshold} = \begin{cases} \text{Max. motor speed x 1.2} & \text{H0A.08 = 0} \\ & \text{or H0A.08 > Max. motor speed x 1.2} \\ \text{H0A.08} & \text{H0A.08} \neq 0 \\ & \text{and H0A.08 < Max. motor speed x 1.2} \end{cases}$$

Caution

- The servo drive also offers motor runaway protection to prevent motor stall caused by lose of control.
- In applications where the motor drives a vertical axis or is driven by load, set H0A.12 to 0 to hide runaway fault detection. Use this function with caution.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H0A.08	200A-09h	Overspeed threshold	0[mm/s]/[rpm]–20000[mm/s]/[rpm]	0	[mm/s]/[rpm]	Real-time
H0A.12	200A-0Dh	Runaway protection enable	0: Disabled 1: Runaway protection scheme 1 2: Runaway protection scheme 2	1	-	At stop

Besides runaway protection, the drive also allows you to set the speed limit in the speed/torque control mode to protect the motor and the machine.

6.6 DI Filter Time [P]

Function

The drive provides 8 physical DI terminals, in which DI1 to DI6 are normal DI terminals, and DI7 to DI8 are high-speed DI terminals. Assign the function of interrupt positioning to DI7 or DI8 to guarantee precision.

When regular functions (touch probe and interrupt position functions excluded) are assigned to DIs, the filter time of these DIs is set in H03.60...H03.67. Ensure the effective level hold time of the DI assigned with regular function is above 0.5 ms. Otherwise, the DI function may not be responded to.

When a high-speed DI is assigned with the touch probe function, the filter time of this DI is defined by H0A.19 and H0A.20. When a high-speed DI is DI with the interrupt positioning function, the filter time of this DI is defined by H0A.19. Ensure the effective level hold time of the high-speed DI is longer than the filter time.

Related objects

The drive provides two high-speed DIs with input signal frequency up to 4 kHz. When the DI signal is being disturbed, set the filter time in H0A.19 and H0A.20.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H03.60	2003-3Dh	DI1 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.61	2003-3Eh	DI2 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.62	2003-3Fh	DI3 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.63	2003-40h	DI4 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.64	2003-41h	DI5 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.65	2003-42h	DI6 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.66	2003-43h	DI7 fitter time	0.00 ms–500.00 ms	0.00	ms	Real-time
H03.67	2003-44h	DI8 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H0A.19	200A-14h	Filter time constant of touch probe 1	0.00µs to 6.30µs	2.00	µs	Real-time
H0A.20	200A-15h	Filter time constant of touch probe 2	0.00µs to 6.30µs	2.00	µs	Real-time

6.7 DI Filter Time [N]

Function

The drive provides 5 physical DI terminals, in which DI1 to DI3 are normal DI terminals, and DI4 to DI5 are high-speed DI terminals. Assign the probe function to DI4 or DI5 to guarantee precision.

When regular functions (touch probe excluded) are assigned to DIs, the filter time of these DIs is set in H03.60...H03.62. Ensure the effective level hold time of the DI assigned with regular function is above 0.5 ms. Otherwise, the DI function may not be responded to.

When a high-speed DI is assigned with the touch probe function, the filter time of this DI is defined by H0A.19 and H0A.20. Ensure the effective level hold time of the high-speed DI is longer than the filter time.

Related objects

The drive provides two high-speed DIs with input signal frequency up to 4 kHz. When the DI signal is being disturbed, set the filter time in H0A.19 and H0A.20.

☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H03.60	2003-3Dh	DI1 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.61	2003-3Eh	DI2 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H03.62	2003-3Fh	DI3 fitter time	0.00 ms–500.00 ms	3.00	ms	Real-time
H0A.19	200A-14h	Filter time constant of touch probe 1	0.00μs to 6.30μs	2.00	μs	Real-time
H0A.20	200A-15h	Filter time constant of touch probe 2	0.00μs to 6.30μs	2.00	μs	Real-time

6.8 Communication-forced DO [P]

Function

When CANopen switches to the operational (OP) status, the forced DO is determined by 60FE.01h and 60FE.02h. In the non-operational (non-OP) status (including CAN network), the following two DO options are available by default:

- Status unchanged: The servo status switches to the non-OP status and the forced DO status stays unchanged.
- No output: No forced DO is generated when the servo drive is in the non-OP status.

Related objects

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
H04.23	2004-18h	Communication-forced DO logic in non-OP status	bit0: DO1 0: Status unchanged 1: No output bit1: DO2 0: Status unchanged 1: No output bit2: DO3 0: Status unchanged 1: No output bit3: DO4 0: Status unchanged 1: No output bit4: DO5 0: Status unchanged 1: No output	0	-	Real-time

Setting method:

1. Assign DO function 31 to the DO to be controlled forcibly by CiA402 protocol, and then set the bit of H04.23 as needed to select the forced DO status in the non-OP status.
2. Configure 60FE.01h/02h as RPDO, and operate on bit16...bit20 to control the DO.

6.9 EtherCAT-forced DO [N]

Function

Two DO options are available by default in the non-operational (non-OP) status (including network offline) for EtherCAT-forced DO status:

1. Status unchanged in the non-OP status: The servo status switches to the non-OP status and the forced DO status stays unchanged.
2. Initialization status: No forced DO is generated when the servo drive is in the non-OP status.
   When the network switches to the operational (OP) status, the forced DO is determined by 60FE.01h and 60FE.02h.

Select the forced DO function by bits. You can select the DO as EtherCAT-forced DO by bits, which means both the local functions and EtherCAT forced-DO function can be supported by the DO.

Related objects

See the following for related parameter settings.

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
H04.23	2004-18h	ECAT communication-forced DO logic in non-OP status	Bit0: DO1 0: Maintain output 1: No output Bit1: DO2 0: Maintain output 1: No output	0	-	Real-time

Descriptions for the setpoints are shown in the following *"Table 6–3 " on page 361**table*.

Table 6–3 Description of setpoints

Value	DO Function
0	Status of DO1 and DO2 is unchanged in the nonoperational status
1	No output in DO1 and status of DO2 unchanged in the non-operational status
2	No output in DO2 and status of DO1 unchanged in the non-operational status
3	No output in DO1 and DO2 in the nonoperational status

Setting method:

1. Assign DO function 31 (EtherCAT-forced DO) to the DO to be controlled forcibly by EtherCAT, and then set the bit of H04.23 as needed to select the forced DO status in the non-OP status.
2. Configure 60FE.01h/60FE.02h as RPDO, and operate on bit16...bit18 to control the DO.

6.10 Position Comparison

Function

Position comparison works by comparing the instantaneous position feedback with the value pre-saved in the data array and, once available, outputting a DO signal with pulse width settable or an ABZ/OCZ signal. Position comparison is applicable to high-speed motion axes as comparison actions are implemented by FPGA, removing the risk of software communication delay between processors.

Note

During position comparison, if any one of the comparison start point, end point, or comparison mode is modified, position comparison will be executed again.

The following table describes the specifications of position comparison output.

Specifications of Position Comparison Output		Function
Trigger output	Output terminal	DO or ABZ/OCZ signals.
	Logic	The effective level of DO is defined by the DO logic in group H04.
		The effective level of ABZ/OCZ output is defined by H18.06.
	Pulse width	The pulse output width is defined by H18.05.
	Delay compensation	Defined by H18.14 and used to compensate for hardware output delay.
Comparison source	Motor encoder feedback	Supported
	Pulse feedback fully closed-loop (ABZ)	Supported
	Communication-type fully closed-loop	Supported
Comparison value	Number of comparison points	40 points, signed 32-bit integer
Comparison attribute	Attribute of comparison point	Defines the attribute of the comparison point.
		Defines the output terminal for comparison.

Related objects

When position comparison is enabled, you can assign FunOUT.25 (Position comparison) to any one of the DOs. The DO you select will be used to output the position comparison output signal. You can also use the ABZ/OCZ signal as the position comparison output terminal by setting H18.16.

Position comparison output parameters:

Parameter	Name	Description
H18: Position comparison output		
H18.00	Position comparison output selection	0: Disabled 1: Enabled (rising edge-triggered)
H18.01	Position comparison output feedback source	0: Motor encoder feedback 1: Fully closed-loop feedback

Parameter	Name	Description
H18: Position comparison output		
H18.02	Position comparison resolution[1]	Defines the number of pulses per revolution. For example, if H18.02 is set to 1, the number of pulses per revolution is 2^{23}. 0: 24-bit 1: 23-bit 2: 22-bit 3: 21-bit 4: 20-bit 5: 19-bit 6: 18-bit 7: 17-bit
H18.03	Position comparison mode	0: Individual comparison 1: Cyclic comparison 2: Fixed cyclic comparison
H18.04	Current position as zero	0: Disabled 1: Enabled (rising edge-triggered) Note: This function needs to be used when the comparison state is inactive, otherwise the comparison logic may malfunction.
H18.05	Position comparison output width	Defines the active pulse width of the DO when the comparison point is reached. The value range is 0.1 to 204.7 (in ms).
H18.06	Position comparison output ABZ polarity	bit0: OCZ output logic 0: Positive, output high level upon active logic 1: Negative, output low level upon active logic bit1: Z output logic 0: Positive, output high level upon active logic 1: Negative, output low level upon active logic bit2: A/B output logic 0: Positive, output high level upon active logic 1: Negative, output low level upon active logic
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	Current state of position comparison	0: No comparison; n: Waiting for the comparison point N
H18.10	Real-time position of position comparison	Displays the current comparison position value Value range: -2^{31} to $(2^{31} - 1)$
H18.12	Zero offset of position comparison	Defines the offset value after current position is taken as the zero point Value range: -2^{31} to $+2^{31} - 1$

Parameter	Name	Description
H18: Position comparison output		
H18.14	Position comparison output delay compensation	Comparison delay compensation time: -12 μs to +12 μs
H18.15	Fixed cyclic comparison	1–65535
H18.16	ABZ output function setting	bit0: OCZ output function 0: Frequency-division output 1: Position comparison bit1: Z port output function 0: Frequency-division output 1: Position comparison bit2: A/B port output function 0: Frequency-division output 1: Position comparison
H18.17	Number of fixed mode cycles	Range: 0 to 65535

Note

[1]: When the source of position comparison is full closed-loop feedback, it is only effective for Inovance encoders.

Parameter	Name	Description
H19: Target position parameters		
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	Bit 0: 1: Current position changes from "less than" to "more than" the comparison point; 0: None Bit 1: 1: Current position changes from "more than" to "less than" the comparison point; 0: None bit2 to bit6: N/A bit7: 1: DO1 output; 0: None bit8: 1: DO2 output; 0: None bit9: 1: DO3 output; 0: None bit10: 1: DO4 output; 0: None bit11: 1: DO5 output; 0: None bit12: 1: Frequency-division A output; 0: None bit13: 1: Frequency-division B output; 0: None bit14: 1: Frequency-division C output; 0: None bit15: 1: Frequency-division OCZ output; 0: None
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. Value range: Same as H19.02
...	...	...
H19.117	Target value of position comparison 40	Defines the target value of position comparison 40. Value range: -2^{31} to 2^{31} - 1
H19.119	Attribute value of position comparison 40	Defines the attribute value of position comparison 40. Value range: Same as H19.02

Function operation

1. Description

   Position comparison works by comparing the instantaneous position feedback with the value pre-saved in the data array and, once available, outputting a DO signal with pulse width settable for future use in subsequent motion control. Position comparison is applicable to high-speed motion axes as comparison actions are implemented by FPGA, removing the risk of software communication delay between processors.

   - Position comparison switch

     When the value of H18.00 (Position comparison switch) changes from 0 to 1, position comparison starts and the value of H18.09 (Current state of position comparison) is updated to the start point of position comparison. When the value of H18.00 changes to 0, position comparison stops and the current comparison state will be cleared.

- Position comparison resolution
  The comparison resolution defines the number of pulses per revolution. Given the maximum and minimum limits on the target position (defined by group H19), you can reset the resolution when data overflow occurs on the comparison value. For example, when H18.02 is set to 7, the maximum value of the target position is 2^{31} - 1, and the motor rotates (2^{31} - 1)/2^{17} turns. When the SV680-INT works with a linear motor (DDL), H18.02 (position comparison output resolution) is ineffective.

Note

The target position in group H19 is only related to the set resolution.

- Individual comparison mode
  In the individual comparison mode, when comparison of the end point is done, the comparison function is switched off automatically and the current comparison value is cleared. Position comparison can be enabled again only when the position comparison switch is switched on again.

  The real-time position feedback in the individual comparison mode is an absolute value, which means it is an accumulative value based on preceding comparison points, which cannot be cleared automatically.
- Cyclic comparison
  In the cyclic comparison mode, position comparison will not be switched off when the comparison end point is reached, and current position comparison value will be reset as the start point for position comparison. After comparison of each point is done, the real-time position feedback (H18.10) will be cleared and counted again for cyclic comparison. 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 counted again for comparison with the new target.
- Fixed cyclic comparison
  In fixed cyclic comparison mode, the comparison process works in the same way as the cyclic comparison mode. The number of cycles is defined by H18.15. After the set number of cycles are done executing, comparison will be disabled automatically.
- Position comparison output width

When the position comparison conditions are fulfilled, the servo drive outputs DO active level signal. The width of the active signal can be set in H18.05 (value range: 1 to 2047 x 0.1 ms). 1 to 2047 × 0.1 ms.

When position comparison DO 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 output width of DO.

- Target value of position comparison
  There are 40 target values for position comparison. The target value and attribute value of position comparison must be updated to parameters in group H19 in advance.

Note

Set the target position properly. overflow comparison (H18.10) is not supported in the position comparison mode.

- Start point for comparison
  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
  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
  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).

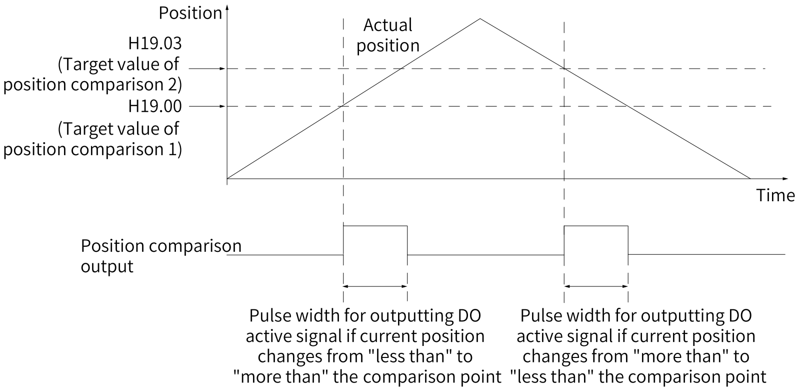
Note

Check whether zero offset needs to be set before enabling position comparison output. Otherwise, comparison error may occur.

---

2. Function operation

- When the position feedback of the encoder passes the target position comparison points, the output width of the output terminal is defined by H18.05 (Position comparison output width).

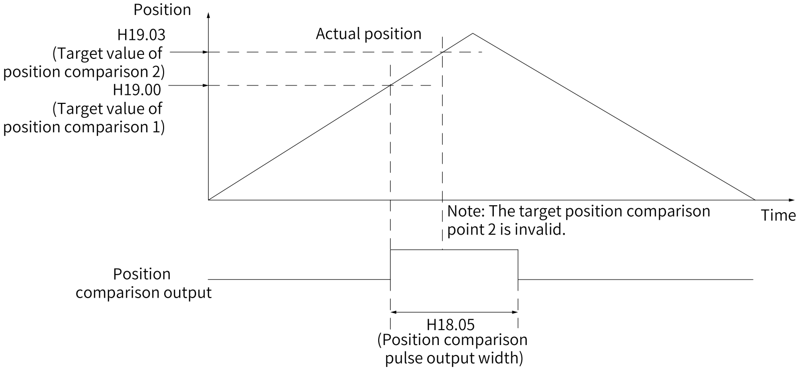


When the attribute of the comparison point is set to "bit0 = 1" (Output DO active signal if current position changes from "less than" to "more than" the comparison point), the DO outputs the position comparison signal when the axis passes the target position comparison point with position changing from "less than" to "more than" the comparison point position.

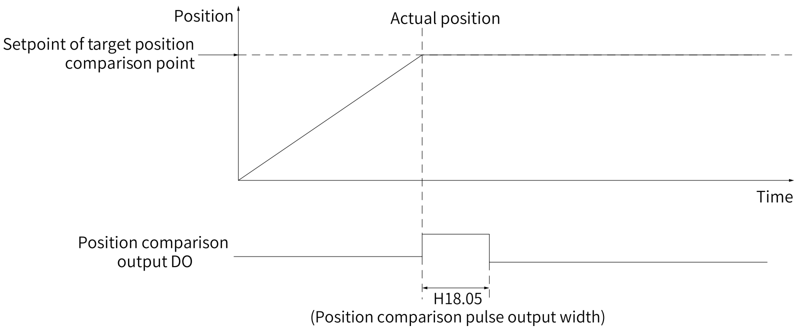
When the attribute of the comparison point is set to "bit1 = 1" (Output DO active signal if current position changing from "more than" to "less than" the comparison point), the DO outputs the position comparison signal when the axis passes the target position comparison point with position changing from "more than" to "less than" the comparison point position.

When the attribute of the comparison point is set to "bit0/bit1 = 1" (Output DO active signal in both situations), the DO outputs the position comparison signal when the position feedback passes the target position comparison point.

- When multiple position comparison values are set, no comparison will be performed once the position comparison output terminal is active. Therefore, ensure the operating time between two position comparison points is larger than the pulse output width.
  As shown in the following figure, comparison is not performed when the position changing from "more than" to "less than" the comparison point position. This is because the operating time between the two comparison points is lower than the pulse output width.



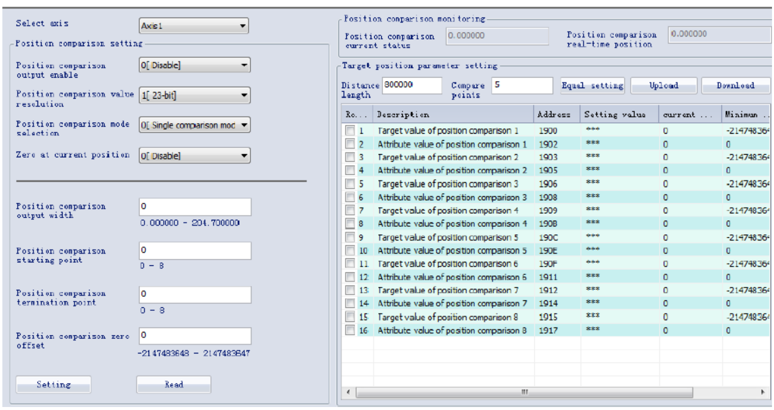
- Only one pulse will be outputted when the stop position is the same with the target value of position comparison. See the following figure.



3. Interface of the software tool

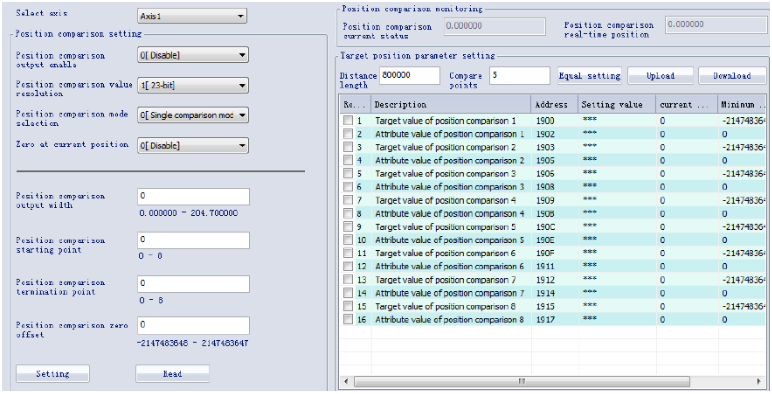
- Individual comparison mode

  a. Set H18.03 (Position comparison mode) to 0 (Individual position comparison).



b. **Target position parameter setting**: **Distance length** (total operating distance) and **Compare points**

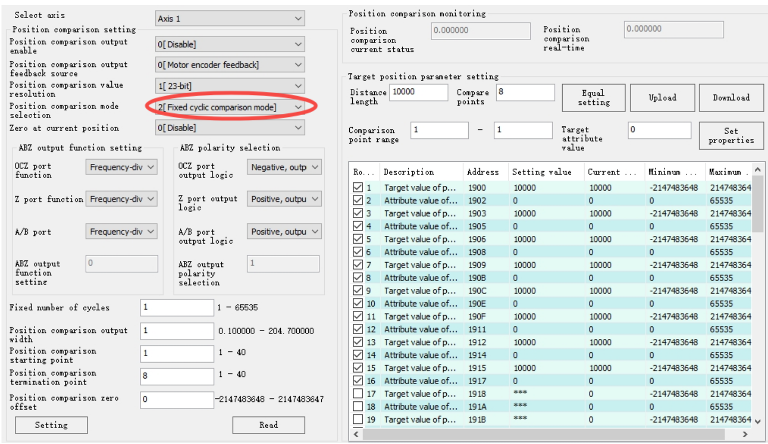
c. After clicking **Equal setting**, the target value of the first point is updated to "**Distance length** x 1/**Compare points**", the target value of the second point is updated to "**Distance length** x 2/**Compare points**", and the target value of the Nth point is updated to "**Distance length** x N/**Compare points**".



When H18.00 (Position comparison output selection) changes from 0 to 1 (Enable rising edge-triggered), H18.09 (Current state of position comparison) changes from 0 to 1 and the first target position value will be compared. When H18.10 (Real-time position feedback) reaches the value of the first target position, H18.09 changes from 1 to 2, and so on.

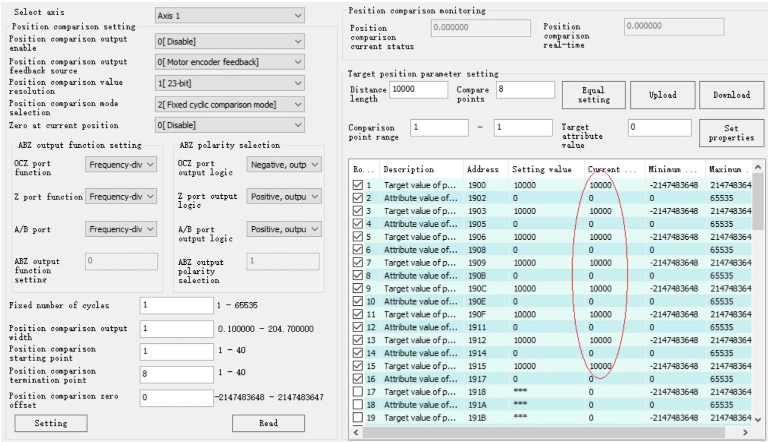
- Cyclic comparison mode/Fixed cyclic comparison mode

a. Set **Position comparison mode selection** to **1 (Cyclic comparison mode)**.



b. **Target position parameter setting**: **Distance length** (distance between two adjacent points) and **Compare points** (points to be compared cyclically)

c. After clicking **Equal setting**, the target values of the 1st point to the Nth point are updated to equal interval distance values.



When H18.00 (Position comparison output selection) changes from 0 to 1 (Enable rising edge-triggered), H18.09 (Current state of position comparison) changes from 0 to 1 and the first target position value will be compared. When H18.10 (Real-time position feedback) reaches the value of the first target position, H18.09 changes from 1 to 2, and so on.

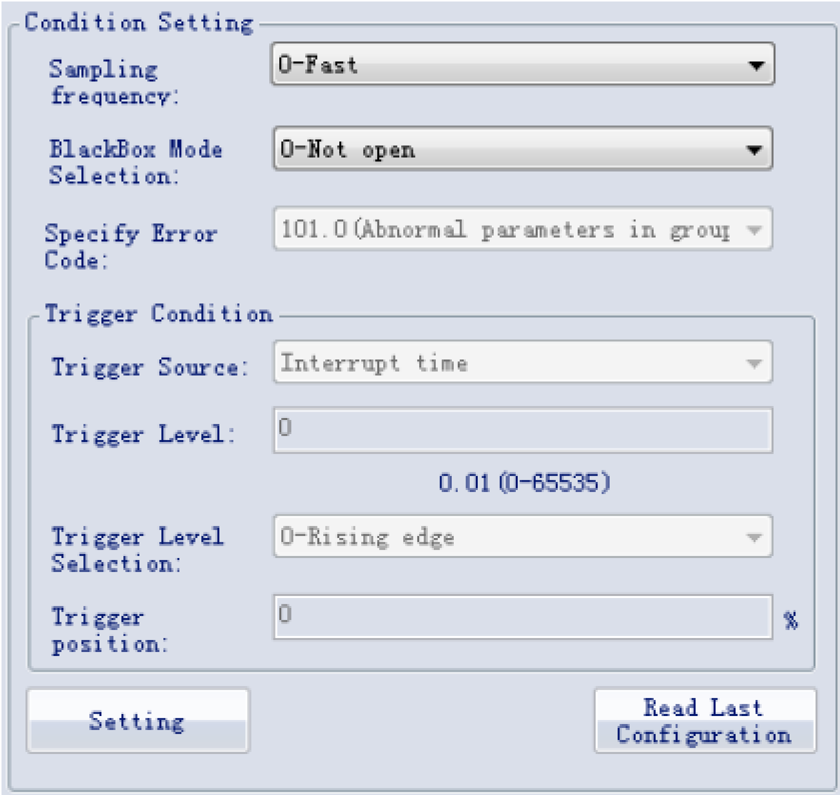
6.11 Black Box

Function

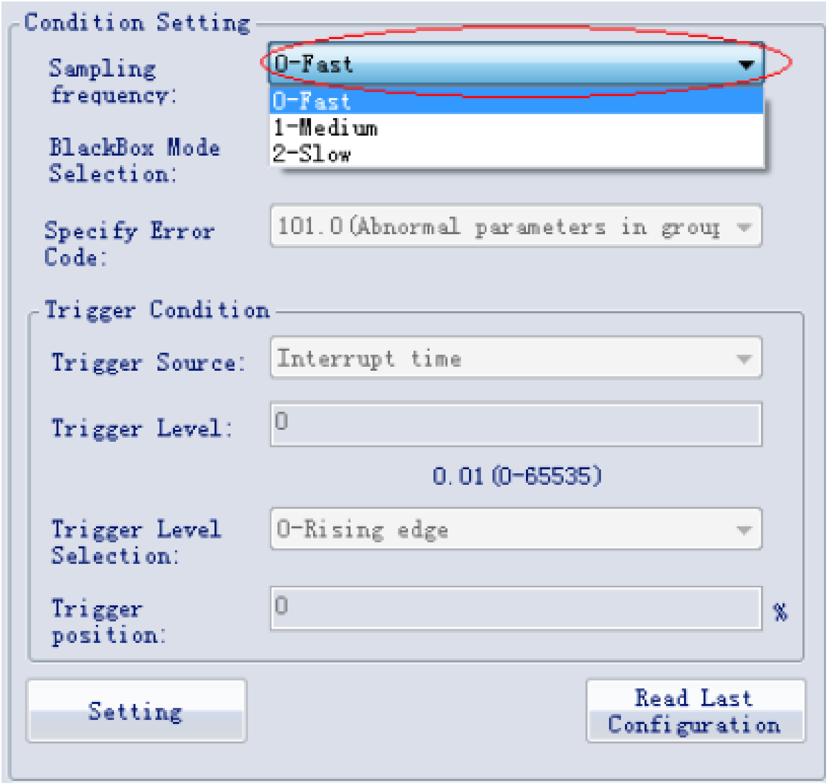
The black box function is used to capture and save the data generated upon occurrence of faults or under designated conditions. Such data can be read and uploaded by users through the software tool to facilitate troubleshooting. You can set black box channels through H32.45 to specifically analyze different types of issues. For example, in the real-time target speed (60FF)/electrical angle channel, real-time target absolute position (607A) is acquired when H32.45=0, and the electrical angle is acquired when H32.45=1.

The black box is enabled by default in the SV680-INT. It is triggered upon occurrence of a fault or a sampling frequency of 16k. The black box function will be turned off automatically after it is being triggered, or turned on automatically upon fault reset or power cycling.

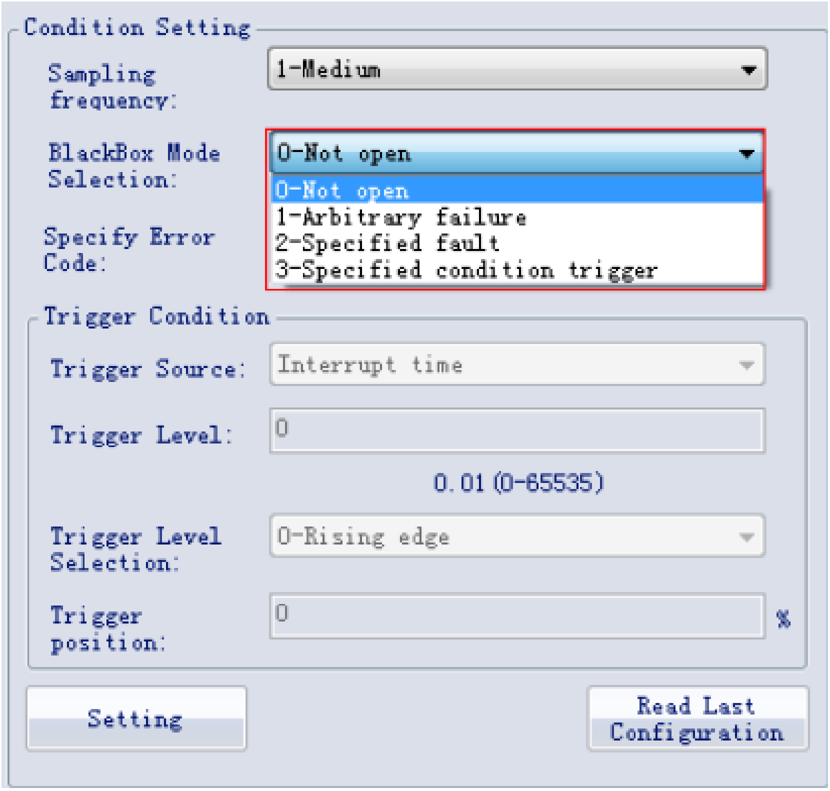
Triggering the black box



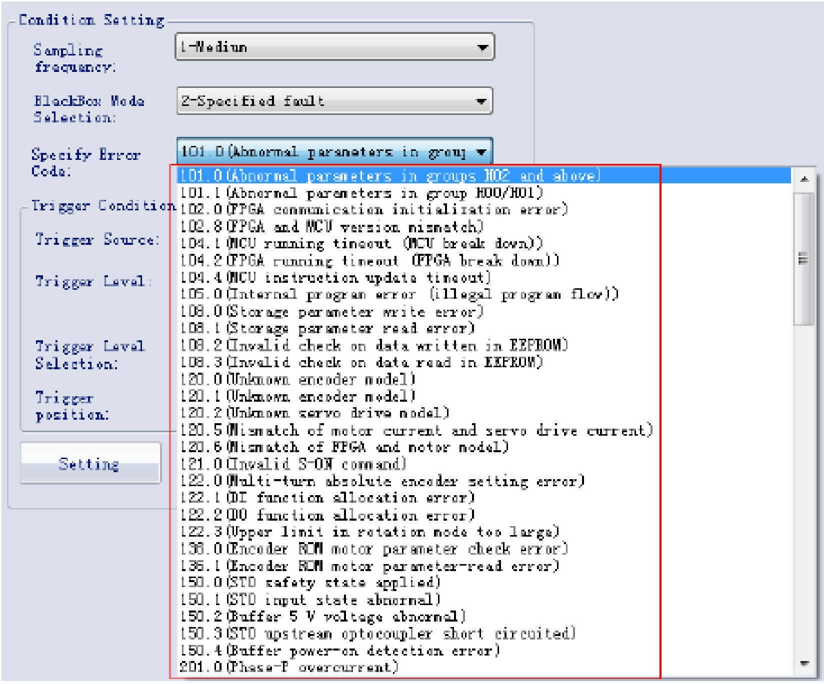
1. Sampling frequency of SV680P-INT: including three sampling frequencies, namely 16k (Fast), 8k (Medium), and 1k (Slow).
   Sampling frequency of SV680N-INT: including three sampling frequencies, namely 16k (Fast), 4k (Medium), and 0.5k (Slow).



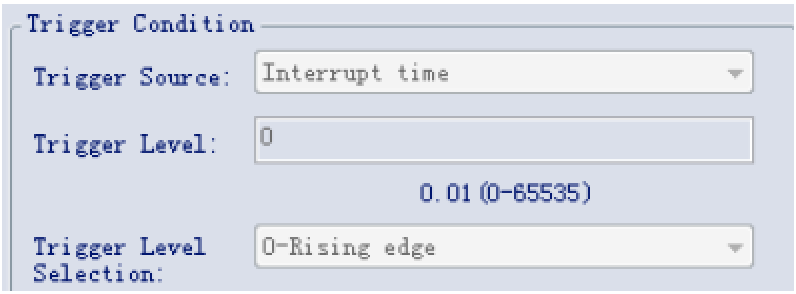
2. Black box mode selection: including three modes, namely Arbitrary failure, Specified fault, and Specified condition trigger.



3. Select designated fault in the combo box, as shown below.



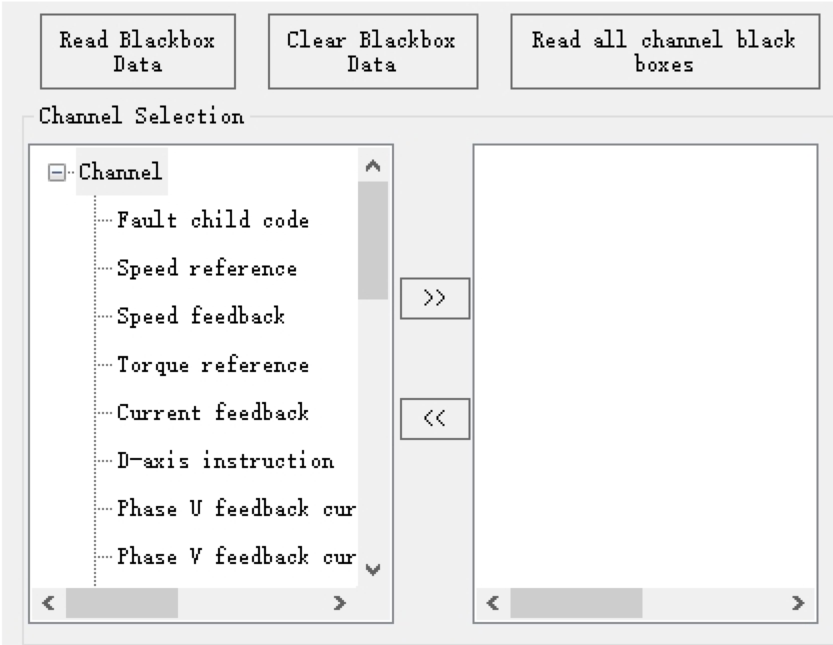
4. The Trigger Condition includes Trigger Source, Trigger Level, and Trigger Level Selection, as shown below.



5. Trigger position is used to set the position of the trigger time in the total sampling time, which is set to 75% by default.
6. After the black box is set, click Setting to download configuration parameters to the servo drive.

Reading black box data

You can select the black box channels (4 channels at most) by clicking >> or <<, or read data of all the channels by clicking Read all, then click Save to save the waveform files.



6.12 Touch Probe

Function

The touch probe function is the same as the position latch function. Position feedback sources include motor position and full closed-loop feedback. This feature latches the position information (in reference unit) when an DI signal or Z signal changes.

The drive offers 2 touch probes to record position values corresponding to the rising edge and falling edge of each touch probe signal, which means 4 position values can be latched simultaneously.

When a DI is used to trigger the touch probe, the relation between the DI logic and the touch probe edge is shown in the following table. Note that the probe is only available for high speed DI.

Table 6–4 Description of bit3 of H0A.40

Bit3 of H0A.40	Touch Probe Edge	DI logic	DI switch
0	Rising Edge	NO	OFF→ON
		NC	ON→OFF
	Falling Edge	NO	ON→OFF
		NC	OFF→ON
1	Rising Edge	NO/NC	OFF→ON
	Falling Edge	NO/NC	ON→OFF

When a DI is used to trigger the touch probe, you can set the filter window of the touch probe signal through H0A.19 and H0A.20.

The DI touch probe supports hardware action delay compensation to compensate for the precision loss incurred by ON/OFF delay of the DI. Related parameters are shown in the following table.

Parameter		Description
H0A.40	bit1	Touch probe rising edge compensation: 1: Enabled, 0: Disabled
	bit2	Touch probe falling edge compensation: 1: Enabled, 0: Disabled
H0A.53		DI probe DI on compensation time (DI switch off→on)
H0A.54		DI probe DI off compensation time (DI switch on→off)

To shorten the hardware delay to about 7 μs, it is recommended to set the touch probe latch through the ON-edge of the DI.

There are three Z touch probe triggers: motor Z signal, frequency-division output Z signal, and fully closed-loop Z signal, as shown in the following table.

Feedback Source	Parameter	Description
Motor encoder	H05.41.bit2 = 0, motor Z signal	The Z touch probe is triggered by the motor Z signal.
	H05.41.bit2 = 1, frequency-division output Z signal	The Z touch probe is triggered by the frequency-division output Z signal, including the multi-turn Z signal.
Fully closed-loop feedback	H0F.25 = 0, motor Z signal	When there is no Z signal input in the pulse-type fully closed-loop mode, you can trigger the touch probe through the motor Z signal to latch external position feedback.
	H0F.25 = 1, fully closed-loop Z signal	When there is Z signal input in the pulse-type fully closed-loop mode, you can trigger the touch probe latch function through the fully closed-loop Z signal.

Related objects

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
60B8h	60B8h	Touch probe function	0x0 to 0xFFFF	0x0	-	Real-time
60B9h	60B9h	Touch probe status	0x0 to 0xFFFF	0x0	-	Unchangeable
60BAh	60BAh	Touch probe 1 positive edge position value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
60BBh	60BBh	Touch probe 1 negative edge position value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
60BCh	60BCh	Touch probe 2 positive edge position value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
60BDh	60BDh	Touch probe 2 negative edge position value	-2147483648 to 2147483647	0	Reference unit	Unchangeable
60D5h	60D5h	Touch probe 1 positive edge counter	0x0 to 0xFFFF	0x0	-	Unchangeable
60D6h	60D6h	Touch probe 1 negative edge counter	0x0 to 0xFFFF	0x0	-	Unchangeable
60D7h	60D7h	Touch probe 2 positive edge counter	0x0 to 0xFFFF	0x0	-	Unchangeable
60D8h	60D8h	Touch probe 2 negative edge counter	0x0 to 0xFFFF	0x0	-	Unchangeable

Steps

Example:

Use DI5 to trigger the touch probe. Background: touch probe 1 positive edge, continuous latching

Observe the following steps:

1. Set the function of DI5 (H03.14 = 38). Set the DI5 logic to NO (H03.11 = 0).
2. Set the touch probe function in 60B8h.

   ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
60B8h	60B8h	Touch probe function	0x0 to 0xFFFF	0x0	-	Real-time

Assignment of each bit of the touch probe function (60B8h) is shown in the following table.

<table>
<tr><th>bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Touch probe 1 function selection
0: Probe 1 disabled
1: Probe 1 enabled</td><td rowspan="6">Bit0 to bit5: settings related to 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 absolute encoders, 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: Latching at positive edge disabled
1: Latching at positive edge enabled</td></tr>
<tr><td>5</td><td>Touch probe 1 negative edge
0: Latching at negative edge disabled
1: Latching at negative edge enabled</td></tr>
<tr><td>6–7</td><td>N/A</td><td>-</td></tr>
<tr><td>8</td><td>Touch probe 2 function selection
0: Probe 2 disabled
1: Probe 2 enabled</td><td rowspan="6">Bit8 to bit13: settings related to 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: Latching at positive edge disabled
1: Latching at positive edge enabled</td></tr>
<tr><td>13</td><td>Touch probe 2 negative edge
0: Latching at negative edge disabled
1: Latching at negative edge enabled</td></tr>
<tr><td>14–15</td><td>N/A</td><td>-</td></tr>
</table>

Set 60B8h to 0x0013 in this example.

3. Read the touch probe status in 60B9h.
   ☆ Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode
60B9h	60B9h	Touch probe status	0x0 to 0xFFFF	0x0	-	Unchangeable

Assignment of each bit of 60B9h is shown in the following table.

<table>
<tr><th>bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Touch probe 1 function selection
0: Probe 1 disabled
1: Probe 1 enabled</td><td rowspan="3">Bit0 to bit2: Status of probe 1</td></tr>
<tr><td>1</td><td>Touch probe 1 positive edge value
0: No positive edge value latched
1: 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>3–5</td><td>N/A</td><td>-</td></tr>
<tr><td>6–7</td><td>When the function of probe 1 is selected as continuous sampling, the total number of times the probe is triggered</td><td>When the function of probe 1 is selected as continuous sampling, the total number of times (0–3) the probe is triggered</td></tr>
<tr><td>8</td><td>Probe 2 enable:
0: Probe 2 disabled
1: Probe 2 enabled</td><td rowspan="3">Bit8 to bit10: Status of probe 2</td></tr>
<tr><td>9</td><td>Touch probe 2 positive edge value
0: No positive edge value latched
1: 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>11–13</td><td>N/A</td><td>-</td></tr>
<tr><td>14–15</td><td>When the function of probe 2 is selected as continuous sampling, the total number of times the probe is triggered</td><td>When the function of probe 2 is selected as continuous sampling, the total number of times (0–3) the probe is triggered</td></tr>
</table>

In this example, you can read bit1 of 60B9h to check whether the touch probe 1 positive edge value is latched.

4. Read latch position of touch probe
   The four position values of the touch probe are recorded in 60BAh to 60BDh.

In this example, if the function of position latch at positive edge of touch probe 1 is executed, you can read the position value in 60BAh (Touch probe 1 positive edge, reference unit). The latching count can be read in 60D5h.

Illustration

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.

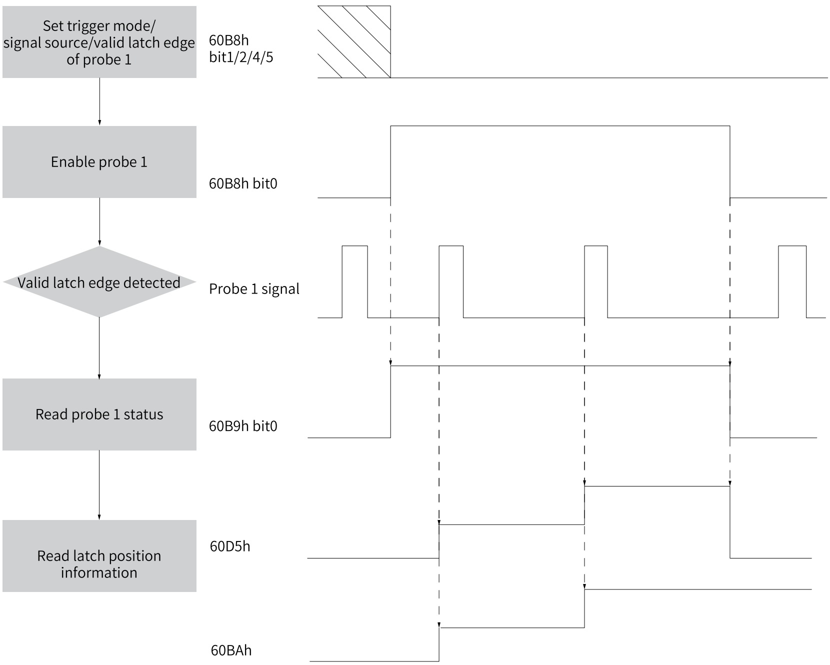


Figure 6-6 Procedure for use of the touch probe

6.13 SEMI F47 Voltage Drop

Description

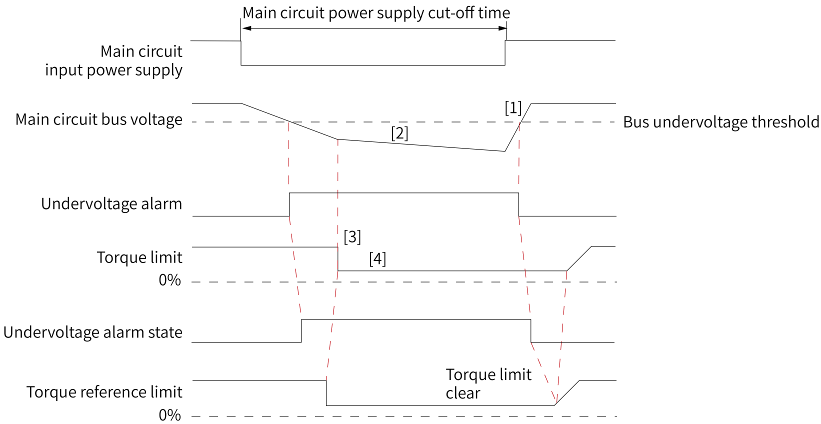
When the DC voltage of the main circuit of the drive is lower than the undervoltage threshold due to instantaneous power failure or temporary low power supply voltage of the main circuit, E971.0 is reported and the output current is limited. The alarm can be masked by setting bit 1 of H0A.88.

With combination of this function and H0A.84 (instantaneous power outage holding time), the drive can continue to run when the power supply voltage decreases, and it will not stop because of alarm.

Description

This function can be executed by the instruction issued by the host controller or the servo drive. You can choose through H0A.81 (enable voltage drop protection).

- **When executed by the host controller (H0A.81 = 1)**
  After receiving the warning of undervoltage E971.0, the host controller limits the torque, and removes torque limit after receiving E971.0 warning release signal.



Note

- [1]: After the main circuit power supply is restored, the bus voltage of the main circuit rises.
- [2]: By limiting the output torque, you can reduce the bus voltage of the main circuit gently.
- [3]: Torque limiting starts.
- [4]: Limit torque after an undervoltage warning is received.

  - When H07.07 = 0:
    For SV680P-INT: the forward torque limit is H07.09 and the negative torque limit is H07.10;

    For SV680N-INT: the forward torque limit is the minimum value of 60E0h and 6072h and the negative torque limit is the minimum value of 60E1h and 6072h.

  - When H07.07 is set to 1, the torque reference limit is determined by the logic of the external DI signal.
    For SV680P-INT: The positive torque limit is selected between H07.09 (Positive internal torque limit) and H07.11 (Positive external torque limit). The negative

torque limit is selected between H07.10 (Negative internal torque limit) and H07.12 (Negative external torque limit).

For SV680N-INT: The positive torque limit is selected between min {60E0h,6072h} and H07.11. The negative torque limit is selected between min {60E1h,6072h} and H07.12.

- When H07.07=2, you select AI1 or AI2 as the torque limit input source for T-LMT through H07.08.
- When H07.07 = 3:
  If DI-PCL (Forward External Torque Limit) is ineffective, the forward limit is determined by AI input. If DI-PCL (Forward External Torque Limit) is effective, the forward limit is determined by the smaller one between H07.11 and the torque corresponding to AI input voltage.

  If DI-NCL (Reverse External Torque Limit) is ineffective, the reverse limit is determined by AI input. If DI-NCL (Reverse External Torque Limit) is effective, the reverse limit is determined by the smaller one between H07.12 and the torque corresponding to AI input voltage.

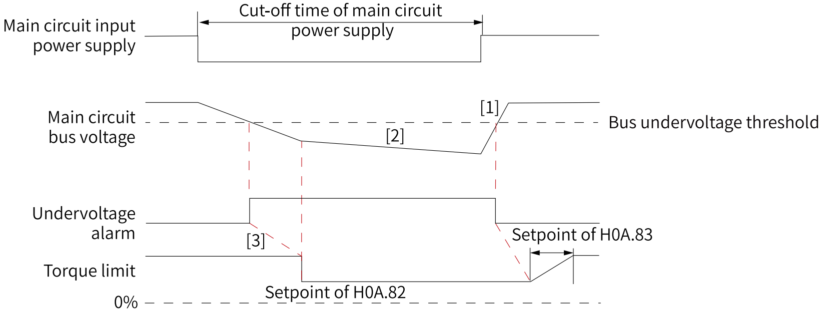
- When H07.07 = 4:
  For SV680P-INT:

  - If DI-PCL (Forward External Torque Limit) is ineffective, the forward limit is determined by H07.09. If DI-PCL is effective, the forward limit is determined by AI input voltage.
  - If DI-NCL (Reverse External Torque Limit) is ineffective, the reverse limit is determined by H07.10. If DI-NCL is effective, the reverse limit is determined by AI input voltage.

  For SV680N-INT:

  - If DI-PCL is ineffective, the forward limit is determined by min{60E0h,6072h}. If DI-PCL is effective, the forward limit is determined by AI input voltage.
  - If DI-NCL is ineffective, the reverse limit is determined by min{60E1h,6072h}. If DI-NCL is effective, the reverse limit is determined by AI input voltage.

- **When executed by the drive (H0A.81 = 2)**
  According to the undervoltage E971.0 warning, apply torque limit inside the servo drive; After receiving the undervoltage warning release signal, the torque limit value is controlled in the servo drive according to the set time.



Note

- [1]: After the main circuit power supply is restored, the bus voltage of the main circuit rises.
- [2]: By limiting the output torque, you can reduce the bus voltage of the main circuit gently.
- [3]: Torque limiting starts.

- **The E971.0 undervoltage warning is not detected (H0A.81 = 0)**
  Voltage drop does not trigger E971. 0 alarm, but E410.0.

Related parameters

Parameter	Communi cation Address	Name	Value	Default	Unit	Change Mode
H0A.81	200A-52h	Voltage drop protection enable	0: No operation 1: Host controller executes torque limit 2: Servo executes torque limit	0	-	At stop
H0A.82	200A-53h	Voltage drop torque limit	0.0% to 100.0%	50.0	%	Real-time
H0A.83	200A-54h	Torque limit cancel time	0 ms–1000 ms	100	ms	Real-time
H0A.84	200A-55h	Instantaneous power failure holding time	20 ms–50000 ms	1000	ms	Real-time

Note

- This function is suitable for instantaneous power outage with the voltage and time specified by SEMI F47. If the voltage and time beyond this range, a standby power supply is needed.
- When the power supply of the main circuit is restored, use the torque limit of the host controller or servo drive to set the torque, so as to avoid the output torque being greater than the commanded acceleration torque.
- When used on vertical axes, do not limit the torque below the holding torque.
- This function is to limit the torque within the capacity of the powered off servo drive, and is not applicable to all load conditions or operating conditions. The parameter to be set may vary with the actual device.
- After you set H0A.84, the time from disconnecting the power supply to stopping the motor power will become longer. You can power off the motor immediately through the input and output of servo ON input signal.

6.14 Accuracy Compensation

6.14.1Function

Accuracy compensation is only for DDL and DDR motors.

Precision electromechanical applications (such as silicon crystal/semiconductor/TP industry) usually require high absolute precision control. However, due to the inherent errors of the direct drive (such as parallelism/flatness/concentricity of motor installation, thermal deformation of materials, design tolerance, and so on), encoder errors (such as design tolerance of the scale, uneven scale marks, thermal deformation of the scale, insufficient parallelism/concentricity of the scale and reader), and motor wear errors caused by long-term operation, the actual position of the motor is different from that fed back by the encoder. In practical applications, the servo drive can only control the motor position based on the position information fed back by the encoder. If the fed back information is inaccurate, it is impossible to achieve accurate absolute precision control of the direct drive motor.

As a response, the SV680-INT come with a compensation feature for motor physical precision. The schematic diagram is as shown in *"Figure 6–7 " on page 386* .

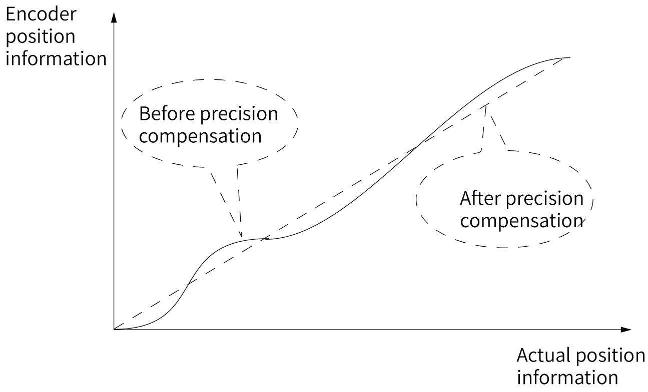


Figure 6-7 Accuracy compensation

The basic principle is as follows: An accuracy error compensation table is obtained by means of external high-precision ranging/angle measuring devices, and the current position is compensated in real time according to the accuracy compensation error table in the application stage, to obtain the corrected position information.

The accuracy compensation function of SV680-INT has different applications for different encoder types and motor types.

No.	Application
1	For DDL motor equipped with QEP counting encoder
2	For DDL motor equipped with Inovance incremental encoder
3	For DDL motor equipped with Biss-C absolute encoder
4	For DDR motor equipped with QEP counting encoder
5	For DDR motor equipped with Inovance incremental encoder
6	For DDR motor equipped with Inovance absolute encoder

All application modes involve two stages: accuracy compensation table acquisition and real-time accuracy compensation. The SV680-INT provides a software tool to help you with that.

The following is an example of DDL with a QEP encoder (the same applies to DDL with an Inovance communication incremental encoder):

Preparation

1. Acquire the accuracy compensation data table, as shown in *"Figure 6–8 " on page 387*. Linear motor ①, encoder ②, drive ③, controller ④, computer ⑤, laser interferometer and lens ⑥ are involved.

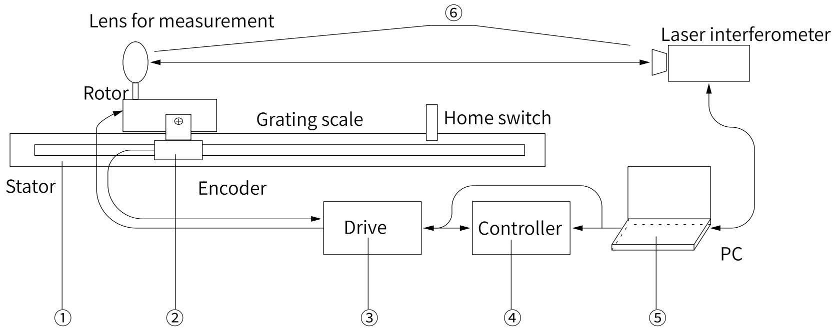


Figure 6-8 Schematic diagram of acquisition of accuracy compensation table

2. Apply accuracy compensation control, as shown in *"Figure 6–9 " on page 387* . Encoder ①, linear motor ②, drive ③ and controller ④ are involved.

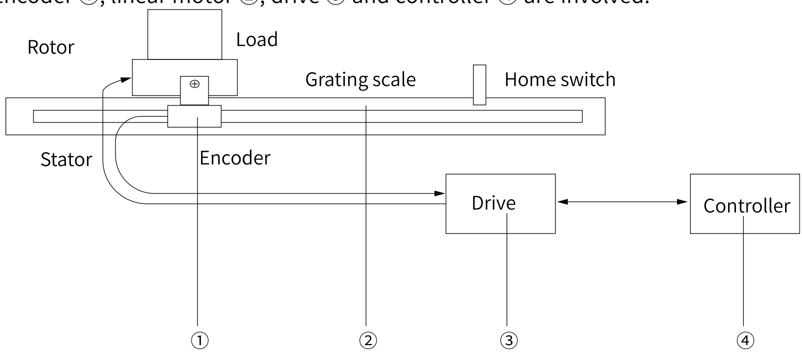


Figure 6-9 Schematic diagram of accuracy compensation of linear motor

Note

That basically also applies to DDR, except that you need to use an angle measuring laser interferometer rather than a laser ranging interferometer.

Table making (acquisition of accuracy compensation table)

- At this stage, the user obtains the accuracy compensation table. See the following schematic diagram *"Figure 6–10 " on page 388* and flow chart *"Figure 6–11 " on page 388* .

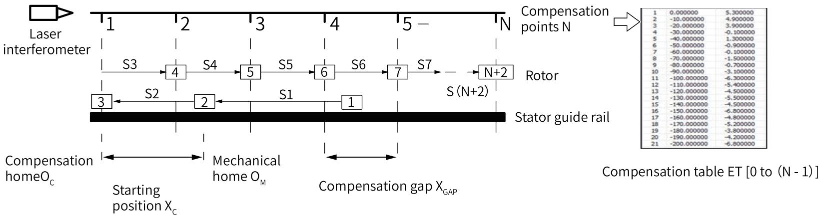


Figure 6-10 Schematic diagram of acquisition of accuracy compensation table

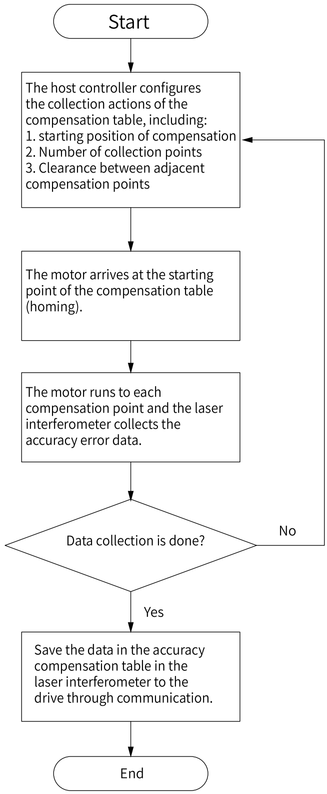
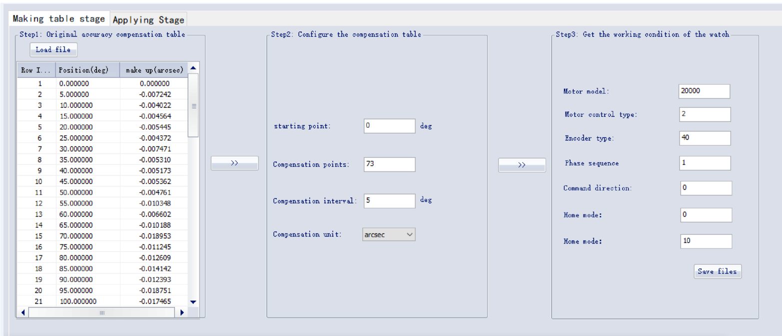


Figure 6-11 Flow chart of acquisition of accuracy compensation table

The steps are as follows:

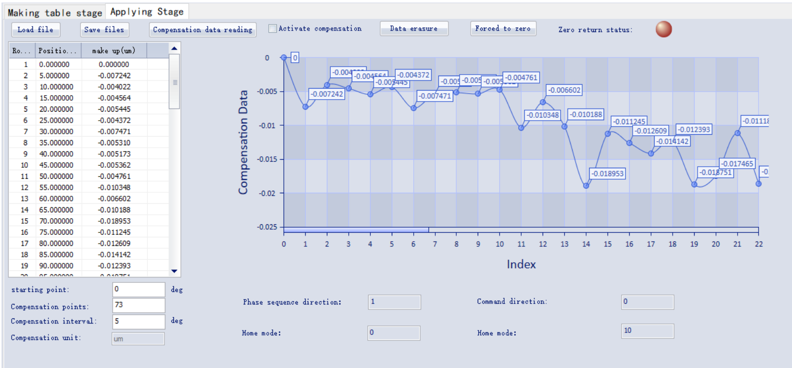
- S1: The controller (or PR module accuracy compensation control in InoDriverShop) controls the linear motor for homing, from any power-on position back to the mechanical origin O $_M$;

- S2: The controller runs the linear motor from the mechanical origin O_M to compensation origin O_C (that is, the base point of the compensation coordinate system). The moving distance is the starting position X_{OCOM} of the compensation point;
- S3: The laser interferometer performs base point calibration at compensation origin O_C, and obtains compensation error of the first compensation point. After that, the controller runs the linear motor according to compensation interval X_{GAP} to the next compensation point to obtain the position.
- S4–S(N+2): The laser interferometer obtains the compensation error data of the current compensation point. After that, the controller runs the linear motor according to compensation interval X_{GAP} to the position. This process continues until the desired number of compensation points N are obtained and a compensation table ET[0–(N-1)] is formed.
- S(N+3): Open InoDriverShop and connect the drive. Go to **Accuracy Compensation** -> **Making Table Stage** and operate according to the following figure to preprocess the accuracy compensation error table obtained by the laser interferometer.

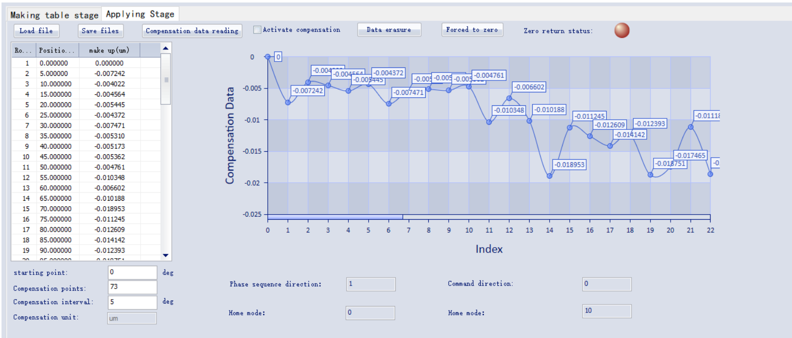


Application (drive receives and enables the accuracy compensation table)

- S1: Open InoDriverShop and connect the drive. Go to **Accuracy Compensation** -> **Application Stage** and operate according to the following figure to send the preprocessed accuracy compensation data to the drive and enable accuracy compensation.



Functions of other keys on this interface are as follows:



- S2: After the driver receives the accuracy compensation table an E941.0 error is reported. The table becomes effective after power-off. After power-on again, and angle auto-tuning and homing are completed, accuracy compensation is enabled. When the motor mover is pushed within the effective compensation travel range, you can see that the line number index of the loaded file jumps accordingly, indicating that accuracy compensation is effective.

Ro...	Positio...	make up(um)
1	0.000000	0.000000
2	5.000000	-0.007242
3	10.000000	-0.004022
4	15.000000	-0.004564
5	20.000000	-0.005445
6	25.000000	-0.004372
7	30.000000	-0.007471
8	35.000000	-0.005310
9	40.000000	-0.005173
10	45.000000	-0.005362
11	50.000000	-0.004761
12	55.000000	-0.010348
13	60.000000	-0.006602
14	65.000000	-0.010188
15	70.000000	-0.018953
16	75.000000	-0.011245
17	80.000000	-0.012609
18	85.000000	-0.014142
19	90.000000	-0.012393

Applications of other encoders and motors

Table 6–5 DDL with BISS-C absolute encoder

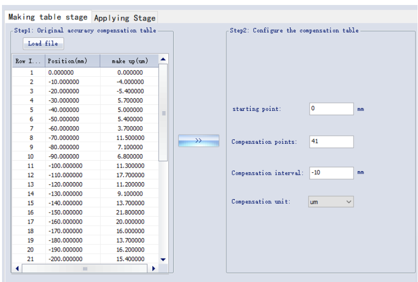
<table>
<tr><th colspan="2">Compared with DDL with QEP encoder</th></tr>
<tr><td>Preparation</td><td>Same.</td></tr>
<tr><td>Table making</td><td>● Homing is not required:
● The starting position is the absolute position value of the starting point of the laser interferometer.

</td></tr>
<tr><td>Application</td><td>The drive obtains the accuracy compensation table, which takes effect directly after restart, without homing.</td></tr>
</table>

Table 6–6 DDR with QEP encoder or Inovance communication incremental encoder

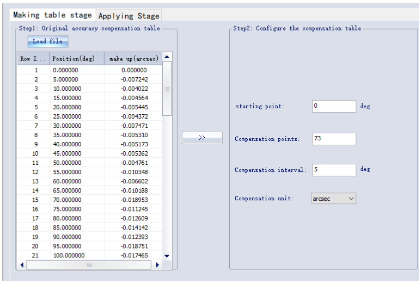
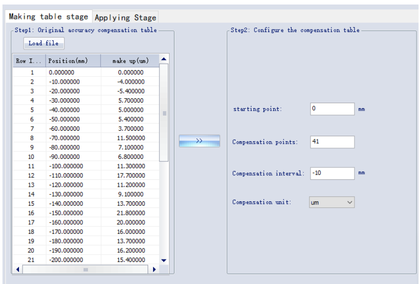
Compared with DDL with QEP encoder	
Preparation	The laser interferometer is changed from ranging to angle measuring.
Table making	The units become deg and arcsec, and the rest are the same. 
Application	Same.

Table 6–7 DDR with Inovance absolute encoder

Compared with DDL with QEP encoder	
Preparation	The laser interferometer is changed from ranging to angle measuring.
Table making	Homing is not required: The starting position is the absolute position value of the starting point of the laser interferometer. The units become deg and arcsec, and the rest are the same. 
Application	Same.

Note

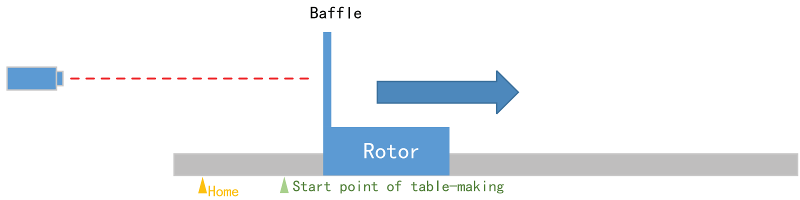
- The accuracy compensation function of the SV680-INT has the same accuracy compensation effect for frequency division output.
- In DDR application mode, to avoid logic confusion, the maximum angle corresponding to the number of compensation points must not exceed 360° (that is, correction point count x correction interval < = 360°).

6.14.2Application Cases

This case provides a setting mode. The specific parameters should be adjusted according to the actual accuracy requirements.

Case 1

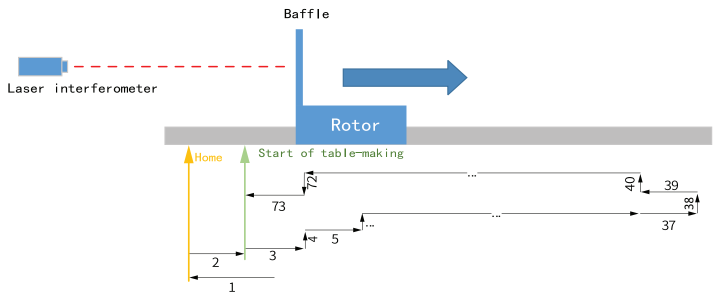
Suppose there is a linear motor, whose mover has an effective travel of 1m. It comes with a pulse quadrature encoder,with a resolution of 0.1 μm/pulse. The home is a limit switch near the left limit position. The direction from left to right is the positive direction. The start point of table making is 10cm away from the home in the positive direction. You must make a table every 5cm from the table making position.



Home offset calculation 10cm = 100000μm = 100000μm ÷ （0.1μm ÷ pulse） = 1000000pulse

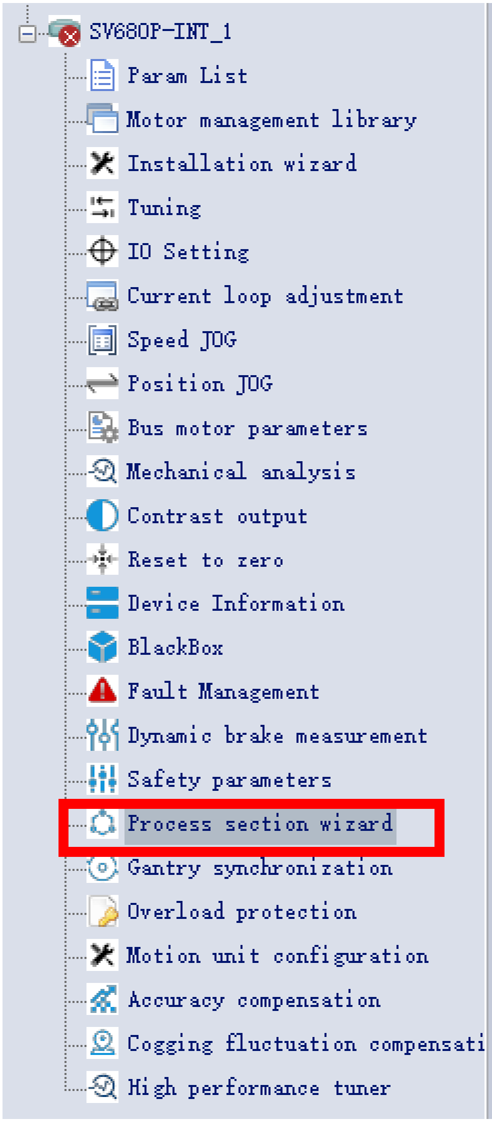
Table making segments: (1m-0.1 m) ÷ 0.05 m = 18 segments

Single-segment operation increment calculation: 5 cm = 50000 μm = 50000 μm ÷ (0.1 μm ÷ pulse) = 500000pulse

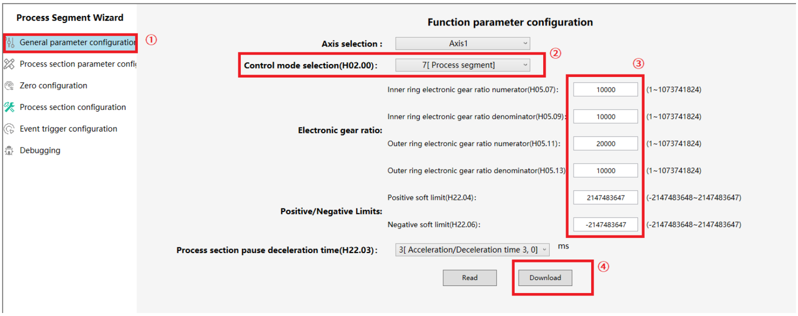


Steps of accuracy compensation table making setting

1. Complete the operation through the process segment mode.

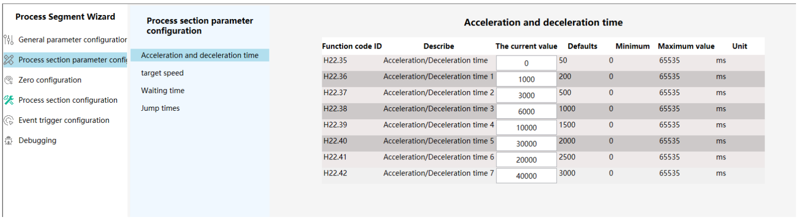


2. Set basic parameters.

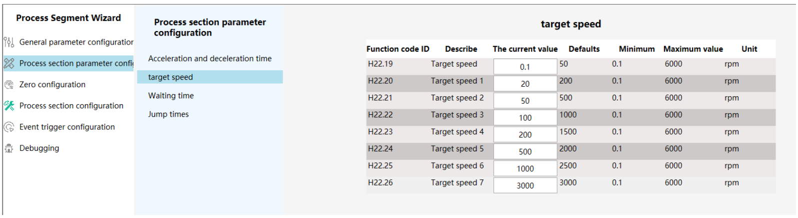


3. Set process segment parameters.

a. Keep the default settings in **Acc./dec. Time** and **Target Speed**, and go to the settings in **Jump Count**.

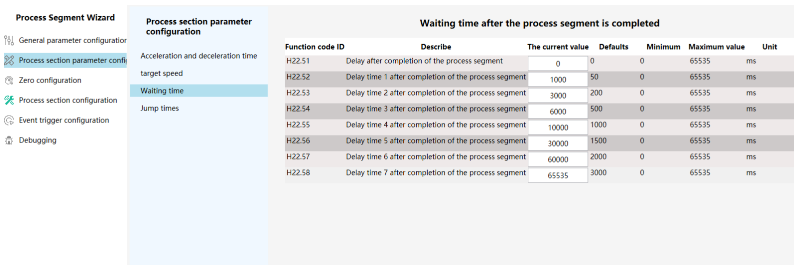


Function code ID	Describe	The current value	Defaults	Minimum	Maximum value	Unit
H22.35	Acceleration/Deceleration time	0	50	0	65535	ms
H22.36	Acceleration/Deceleration time 1	1000	200	0	65535	ms
H22.37	Acceleration/Deceleration time 2	3000	500	0	65535	ms
H22.38	Acceleration/Deceleration time 3	6000	1000	0	65535	ms
H22.39	Acceleration/Deceleration time 4	10000	1500	0	65535	ms
H22.40	Acceleration/Deceleration time 5	30000	2000	0	65535	ms
H22.41	Acceleration/Deceleration time 6	20000	2500	0	65535	ms
H22.42	Acceleration/Deceleration time 7	40000	3000	0	65535	ms



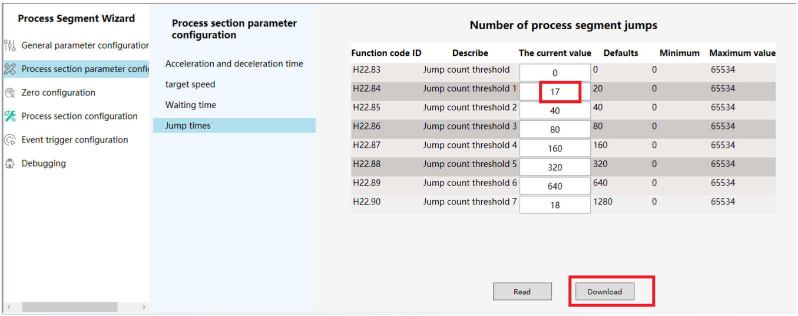
Function code ID	Describe	The current value	Defaults	Minimum	Maximum value	Unit
H22.19	Target speed	0.1	50	0.1	6000	rpm
H22.20	Target speed 1	20	200	0.1	6000	rpm
H22.21	Target speed 2	50	500	0.1	6000	rpm
H22.22	Target speed 3	100	1000	0.1	6000	rpm
H22.23	Target speed 4	200	1500	0.1	6000	rpm
H22.24	Target speed 5	500	2000	0.1	6000	rpm
H22.25	Target speed 6	1000	2500	0.1	6000	rpm
H22.26	Target speed 7	3000	3000	0.1	6000	rpm

b. The waiting time can be modified. You can set the waiting time for a single segment to 10s.

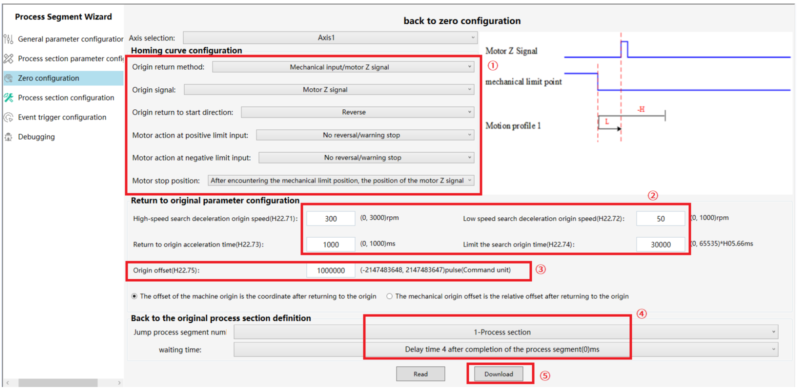


Function code ID	Describe	The current value	Defaults	Minimum	Maximum value	Unit
H22.51	Delay after completion of the process segment	0	0	0	65535	ms
H22.52	Delay time 1 after completion of the process segment	1000	50	0	65535	ms
H22.53	Delay time 2 after completion of the process segment	3000	200	0	65535	ms
H22.54	Delay time 3 after completion of the process segment	6000	500	0	65535	ms
H22.55	Delay time 4 after completion of the process segment	10000	1000	0	65535	ms
H22.56	Delay time 5 after completion of the process segment	30000	1500	0	65535	ms
H22.57	Delay time 6 after completion of the process segment	60000	2000	0	65535	ms
H22.58	Delay time 7 after completion of the process segment	65535	3000	0	65535	ms

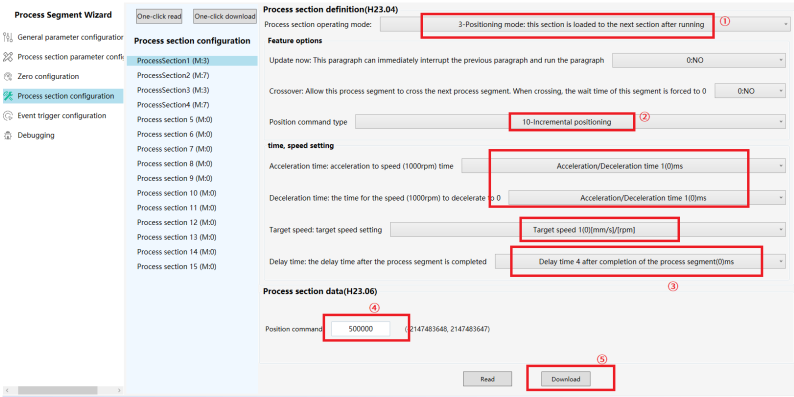
c. The number of segments is 18, and the last jump is also counted, so the jump count should be set to 17. When the parameters are modified, click **Download**.



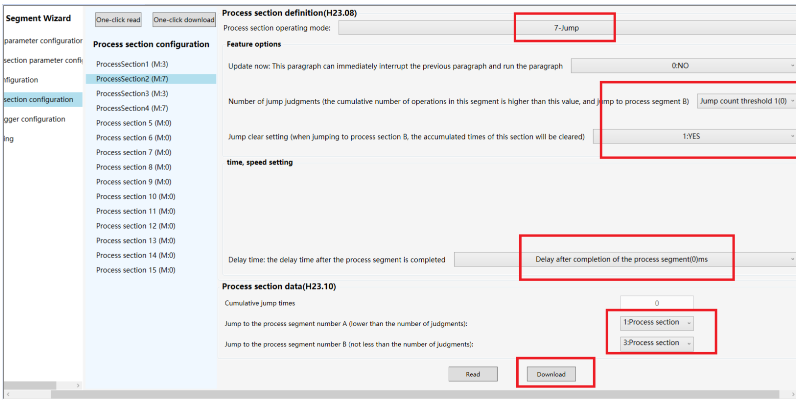
4. Configure the homing parameters. Because the left limit switch is the home, you need to configure the reverse search limit switch and homing speed, set the homing offset to 1000000 (the home offset calculated above), the jump process segment to process segment 1, and delay waiting time to 10s. Download the parameters. Note: The waiting position here is the first meter ???point of the laser interferometer.



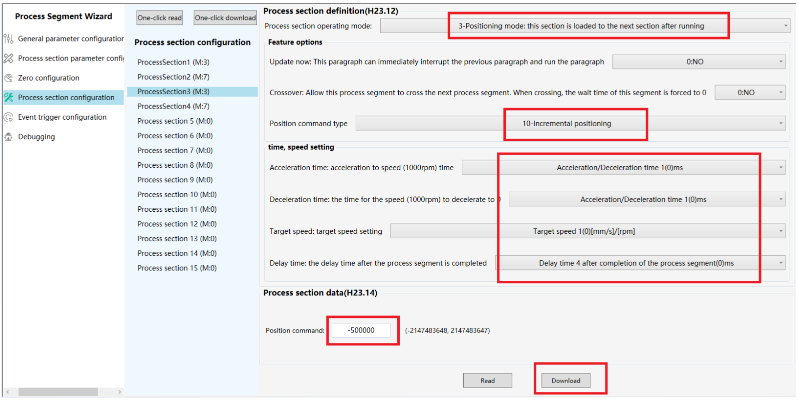
5. Configure the process segment parameters.
   a. Select Mode 3 for process segment 1, select incremental mode for position command, set target speed, set waiting time to 10s, and set position command to 50000pulse (single-segment operation increment calculated above). Click **Download**.



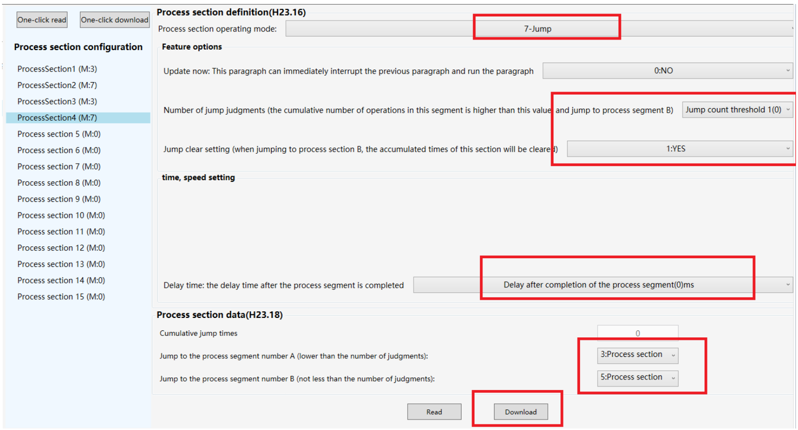
b. Set process segment 2 to mode 7 jump. Set jump evaluation count to 17. Set **Clear jump** to "YES". Set the jump delay time to 0 ms. Set **Jump to process segment A** to process segment 1 and **Jump to process segment B** to process segment 3. Click **Download**.



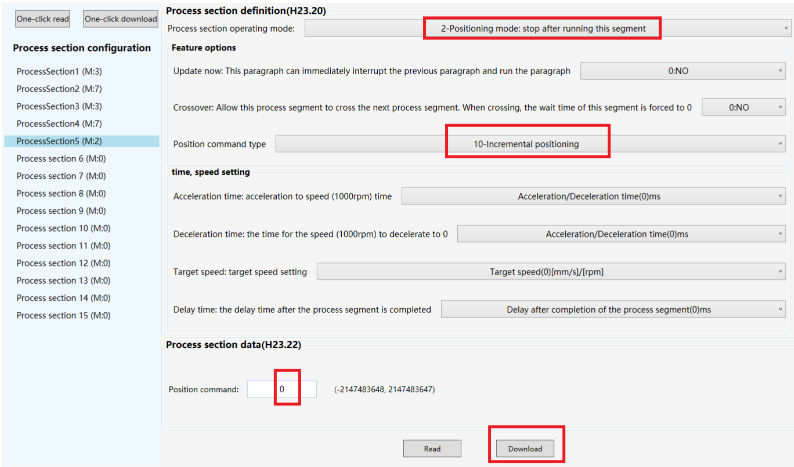
c. Set process segment 3 according to process segment 1, except that the position command is set to-500000.



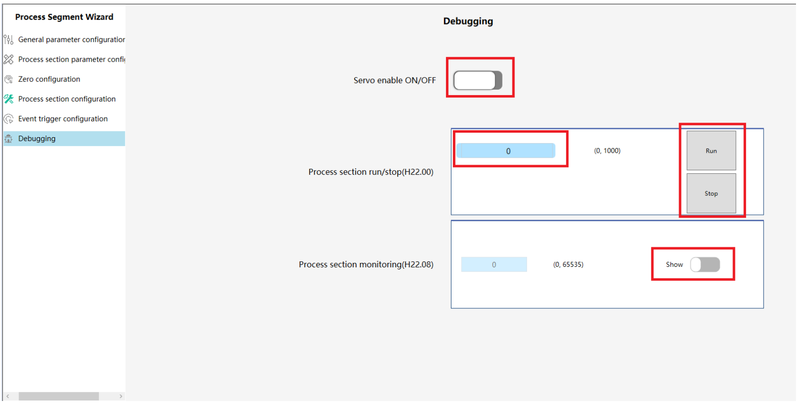
d. Process segment 4 is set as follows. Note that the jump condition is not the same as process segment 2.



e. Process segment 5 is set to **positioning mode: stop at current segment??**?, the position type is incremental positioning, and the command is 0. Click **Download**.

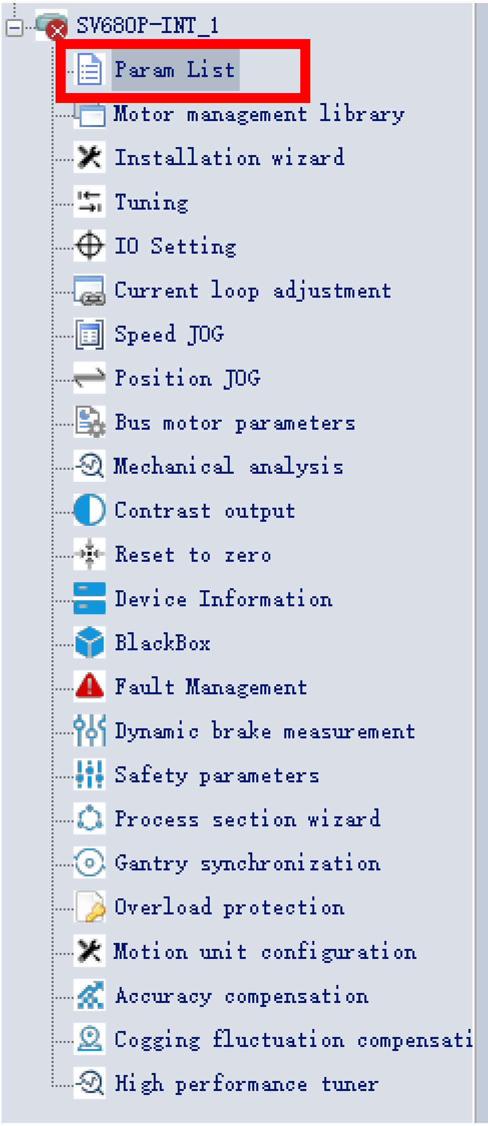


6. Commissioning

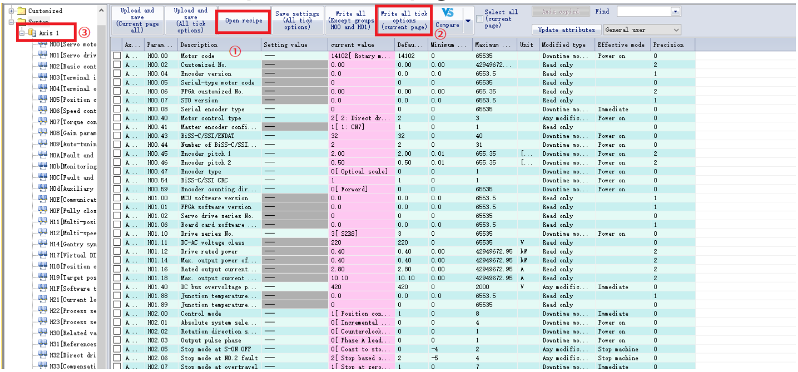


Steps for setting accuracy compensation table making

1. Click **Parameter List**.

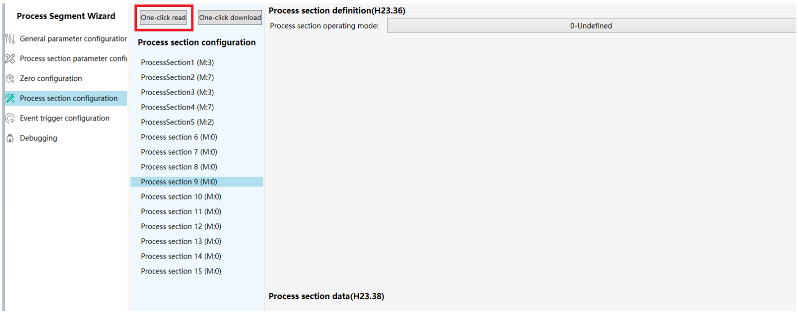

SV680P-INT_1
Param List
Motor management library
Installation wizard
Tuning
IO Setting
Current loop adjustment
Speed JOG
Position JOG
Bus motor parameters
Mechanical analysis
Contrast output
Reset to zero
Device Information
BlackBox
Fault Management
Dynamic brake measurement
Safety parameters
Process section wizard
Gantry synchronization
Overload protection
Motion unit configuration
Accuracy compensation
Cogging fluctuation compensati
High performance tuner

2. Click **Open recipe** and select the parameter recipe below. Click **Axis 1** on the left, and click **Write all tick options (current page)**.



Parameters are provided as follows. All parameters can be used for commissioning directly after being downloaded into the drive.

3. Enter the **Process Segment** page and click **One-click read** to add all parameters.



4. Carry out your testing.

SV680-INT precision compensation table-making process segment case 1.inoparam

Case 2

Suppose there is a linear motor, whose mover has an effective travel of 1m. It comes with a BISSC absolute encoder, with a resolution of 0.1 μm/pulse. There is no home. The direction from left to right is the positive direction. The start point of table making is 1000000 away from the absolute position, and the remaining length is 0.9 m. You must make a table every 5cm from the table making position.

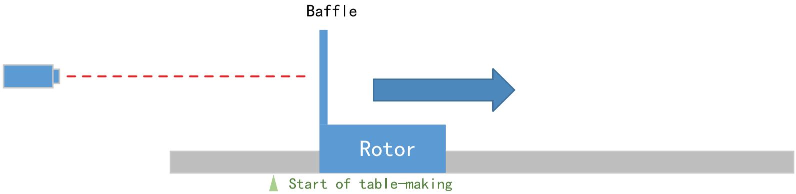
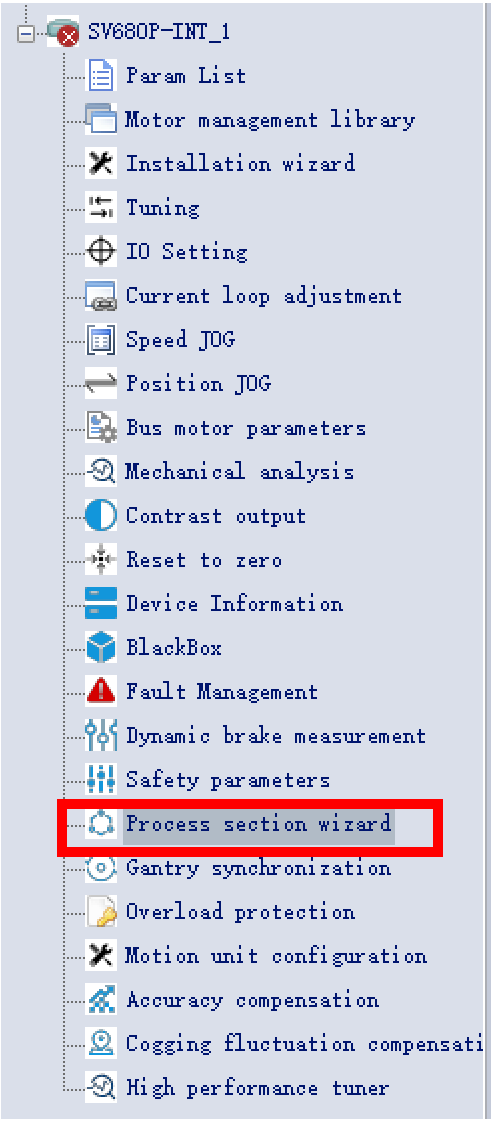


Table making segmentation: 0.9 m ÷ 0.05 m = 18 segments

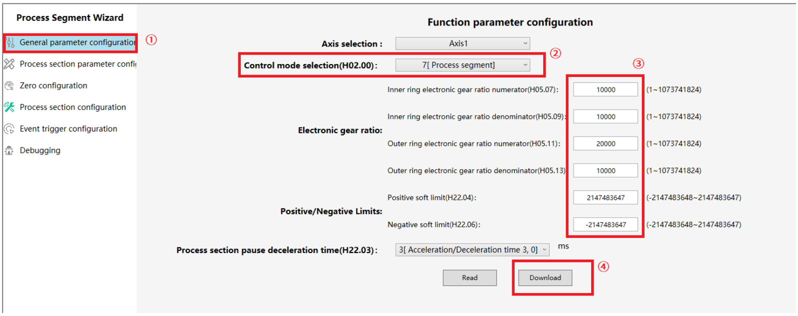
Calculation of single-segment operation increment: 5cm = 50000μm = 50000μm ÷ （0.1μm ÷ pulse） = 500000pulse

Steps of accuracy compensation table making setting

1. Complete the operation through the process segment mode.

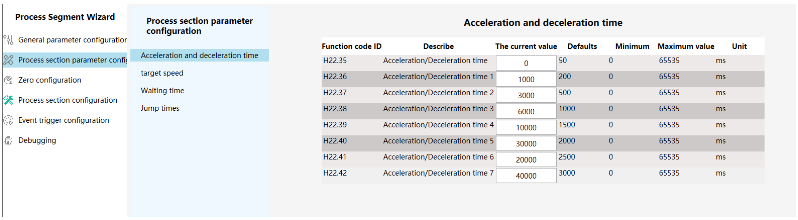


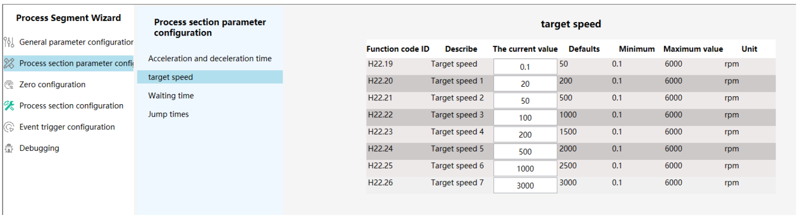
2. Set basic parameters.



3. Set process segment parameters.

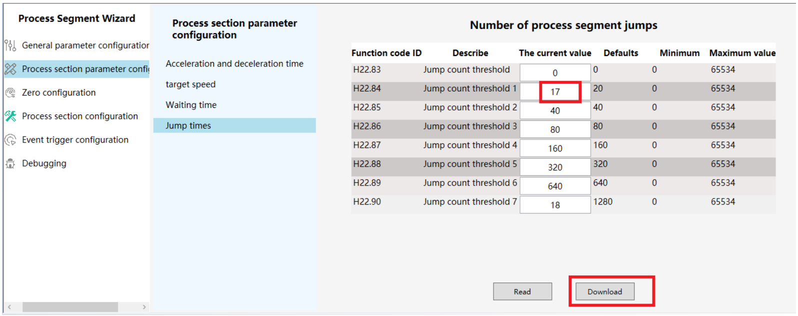
a. Keep the default settings in **Acc./dec. Time** and **Target Speed**, and go to the settings in **Jump Count**.





b. The waiting time can be modified. You can set the waiting time for a single segment to 10s.

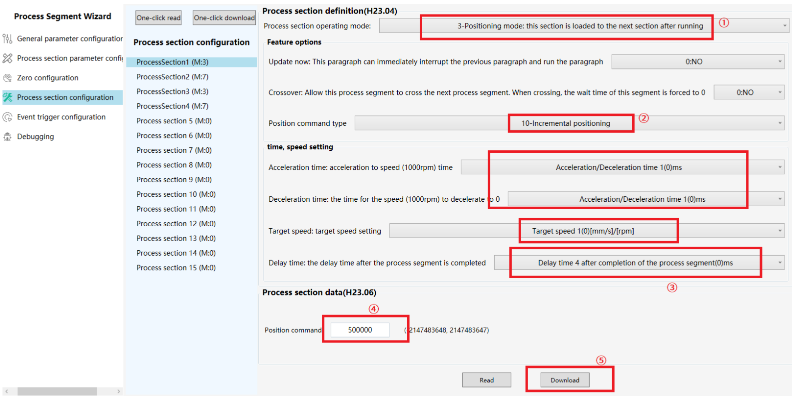
c. The number of segments is 18, and the last jump is also counted, so the jump count should be set to 17. When the parameters are modified, click **Download**.



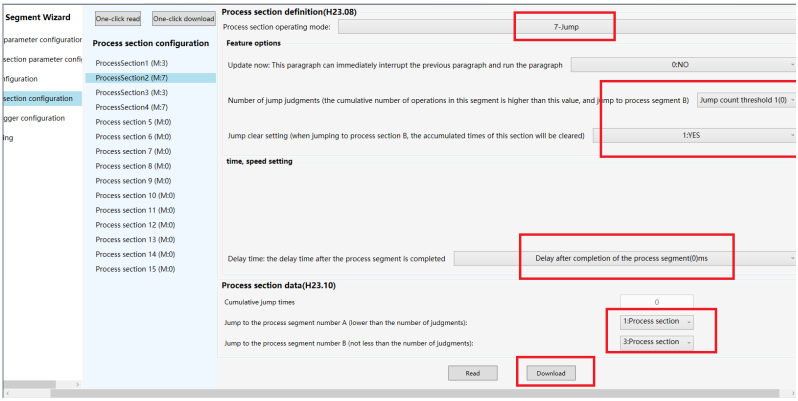
4. Configure the process segment parameters.

   Configure process segments 1 to 5 by using the preceding configured parameters.

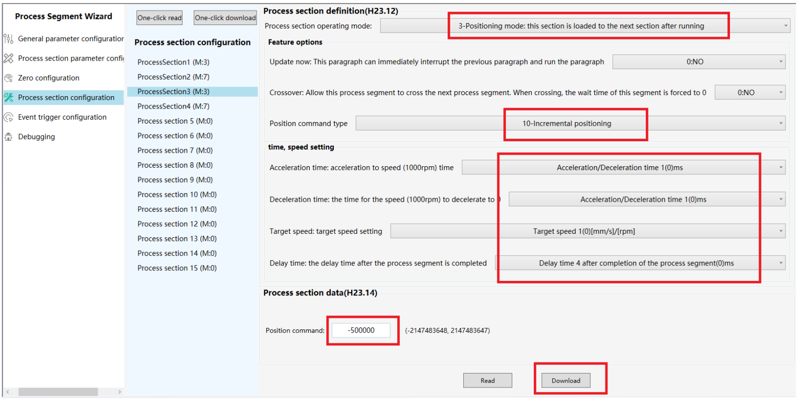
   a. Select Mode 3 for process segment 1, select incremental mode for position command, set target speed, set waiting time to 10s, and set position command to 50000pulse (single-segment operation increment calculated above). Click **Download**.



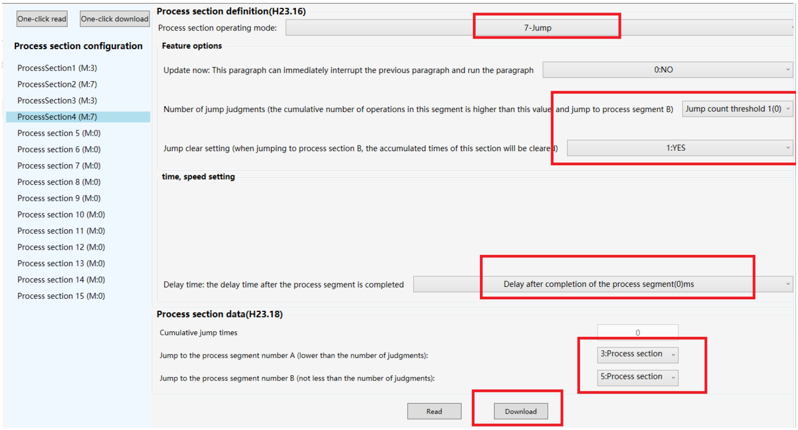
   b. Set process segment 2 to mode 7 jump. Set jump evaluation count to 17. Set **Clear jump** to "YES". Set the jump delay time to 0 ms. Set **Jump to process segment A** to process segment 1 and **Jump to process segment B** to process segment 3. Click **Download**.



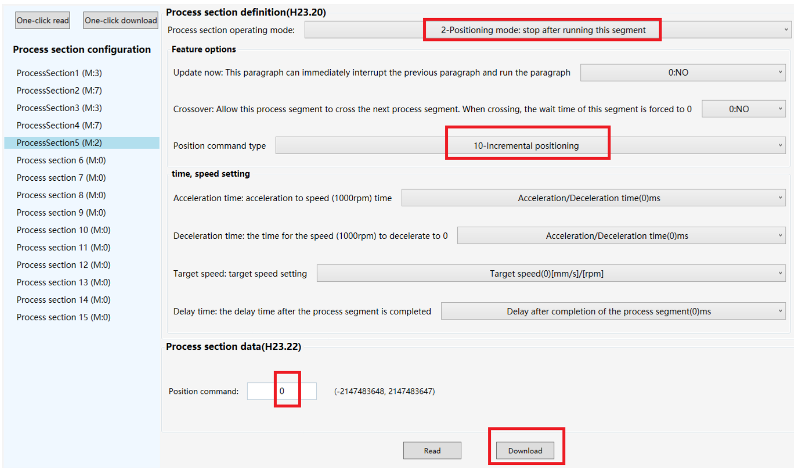
c. Set process segment 3 according to process segment 1, except that the position command is set to-500000.



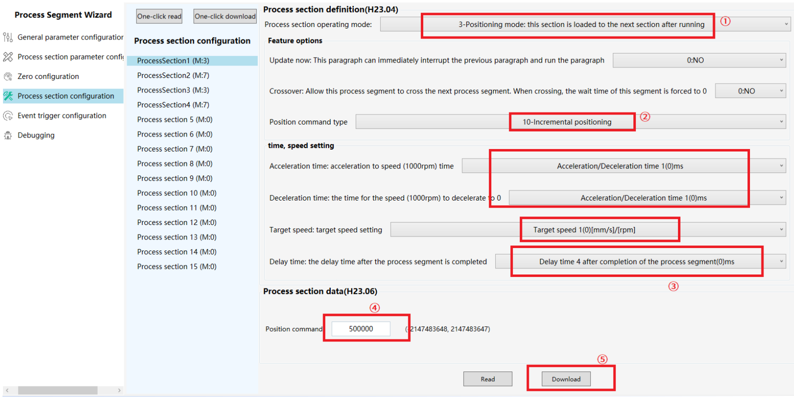
d. Process segment 4 is set as follows. Note that the jump condition is not the same as process segment 2.



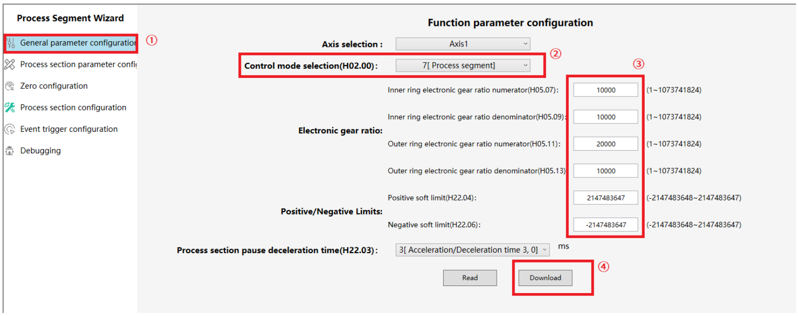
e. Process segment 5 is set to **positioning mode: stop at current segment???**, the position type is incremental positioning, and the command is 0. Click **Download**.



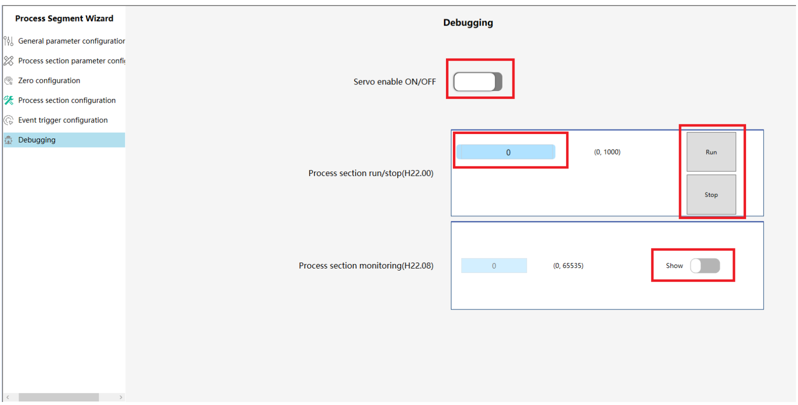
f. Configure process segment 6.



g. Configure process segment 7.

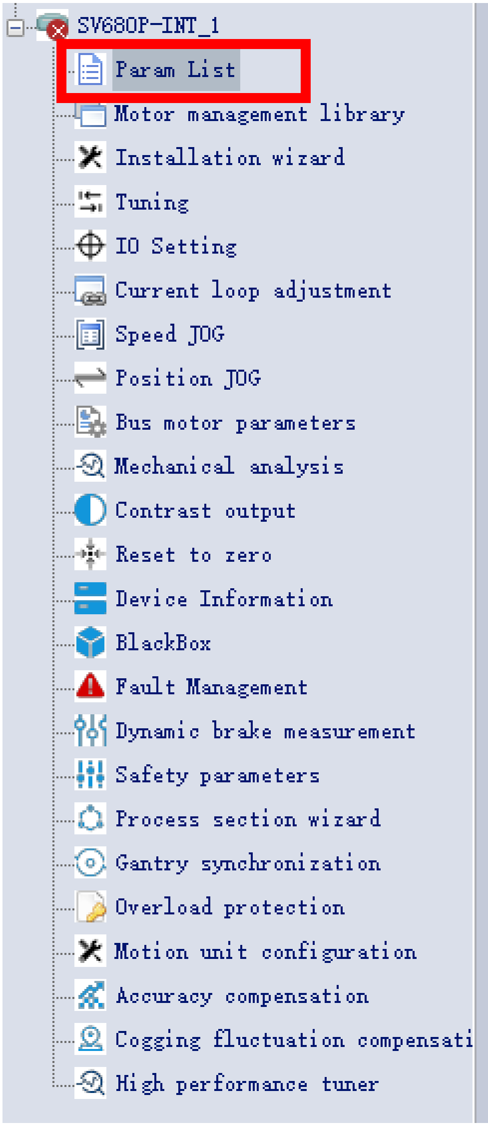


5. Carry out your testing.

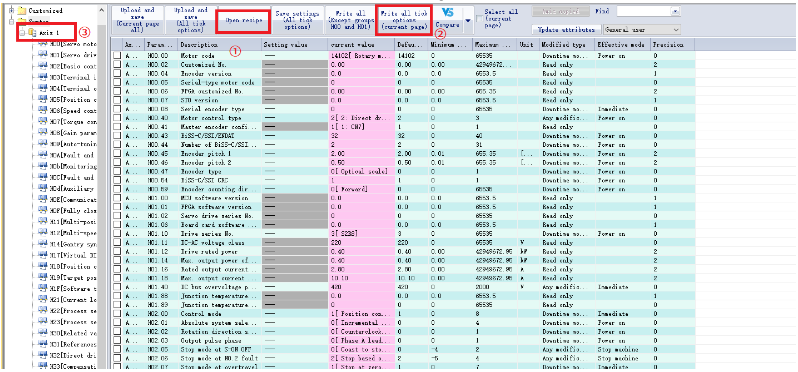


Steps for setting accuracy compensation table making

1. Click the parameter list.


SV680P-INT_1
Param List
Motor management library
Installation wizard
Tuning
IO Setting
Current loop adjustment
Speed JOG
Position JOG
Bus motor parameters
Mechanical analysis
Contrast output
Reset to zero
Device Information
BlackBox
Fault Management
Dynamic brake measurement
Safety parameters
Process section wizard
Gantry synchronization
Overload protection
Motion unit configuration
Accuracy compensation
Cogging fluctuation compensati
High performance tuner

2. Click **Open recipe** and select the parameter recipe below. Click **Axis 1** on the left, and click **Write all tick options (current page)**.

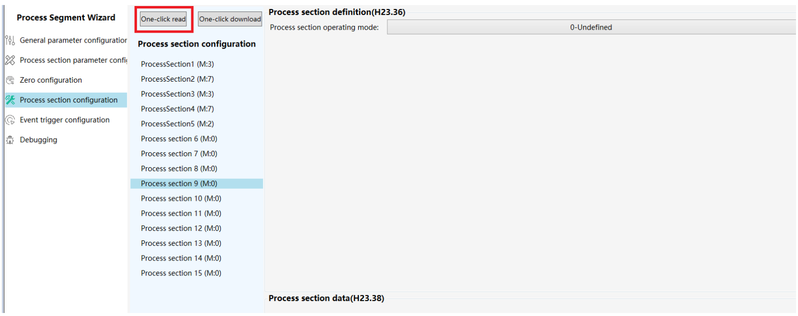


Parameters are provided as follows. All parameters can be used for commissioning directly after being downloaded into the drive.

3. Enter the **Process Segment** page and click **One-click read** to add all parameters.

SV680-INT precision compensation table-making process segment case 1.inoparam

4. Carry out your testing.



6.15 Gantry Synchronization

6.15.1Gantry Synchronization

In the industrial production field, gantry synchronization is widely applied to high-end technology devices. The gantry structure provides a stable motion platform for high-precision and highly-coordinated motion. Gantry synchronization enables high-response co-ordinated control.

6.15.2Wiring

As shown in "Figure 6–12 " on page 411 , X1 axis is connected to X1 drive, X2 axis is connected to X2 drive, beam axis is connected to Y drive, and X1 communicates with X2 through an RS485 bus. The motor and drive models of X1 axis and X2 axis should be consistent.

X1 axis is the master axis, which receives the control signal from the host controller. Gantry synchronization obtains the encoder feedback of the paired axis through RS485 and use the information for internal loop compensation calculation.

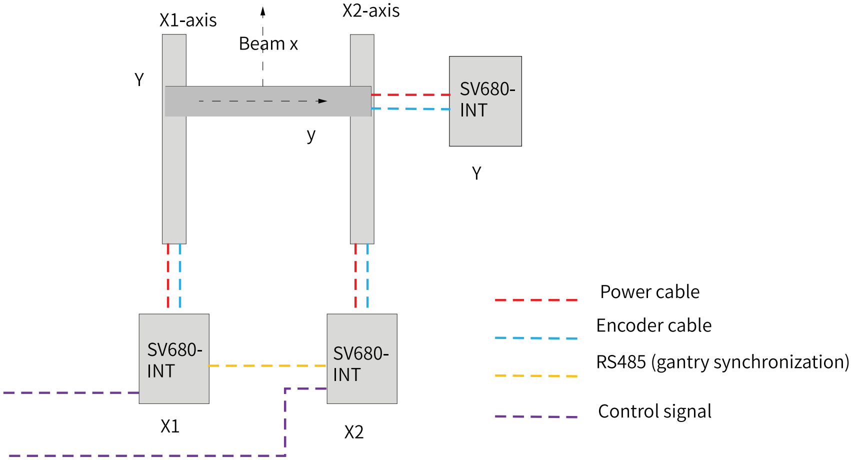
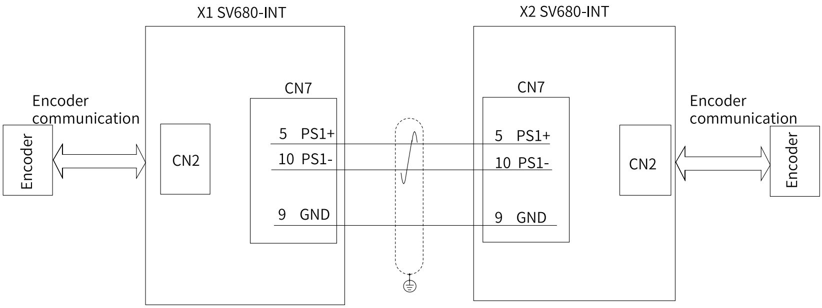


Figure 6-12 Wiring of gantry synchronization

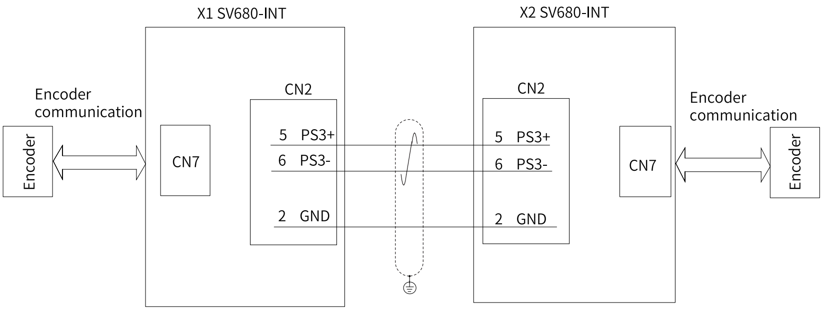
When the SV680-INT is equipped with a direct drive or third-party motor, the default interface of the main encoder is CN7. When it is equipped with an Inovance servo motor, the main encoder is connected to CN2 by default. You can switch it by setting H32.01=1 (the default value of H32.01 is 0).

The gantry communication interface is opposite to the main encoder interface, that is, when the main encoder is connected to CN2, gantry communication must be connected to CN7, and vice versa.

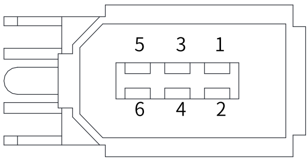
- When the main encoder is connected to CN2, the pins required for gantry communication are as follows:



- When the main encoder is connected to CN7, the pins required for gantry communication are as follows:



Pin assignment of CN2 and CN7 for gantry communication:



Encoder signal terminal CN2

Figure 6-13 CN2 terminal pin layout

Table 6–8 Pin definitions of the CN2 terminal

Pin No.	Pin Assignment	Pin Description
1	5 V	5 V power supply
2	GND	5V power ground
3	PS4+/CLK+	1. PS± signal of the second encoder; 2. CLK± signal of the communication-type encoder
4	PS4-/CLK-	

Pin No.	Pin Assignment	Pin Description
5	PS3+/DATA+	1. PS± signal of the first encoder; 2. DATA± signal of the communication-type encoder; 3. Gantry synchronization signal
6	PS3-/DATA-	
Enclosure	PE	Shield

CN7

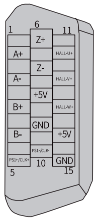


Figure 6-14 CN7 terminal pin layout

Pin No.	Terminal Definition	Description	Pin No.	Terminal Definition	Description
1	A+	Encoder pulse phase A±	9	GND	Power supply reference ground
2	A–		10	PS1-/DATA-	1. PS- signal of the first encoder; 2. DATA- signal of the communication-type encoder; 3. Gantry synchronization signal
3	B+	Encoder pulse phase B±	11	HALL_U+	Hall signal U
4	B–		12	HALL_V+	Hall signal V
5	PS1+/DATA+	1. PS+ signal of the first encoder; 2. DATA+ signal of the communication-type encoder; 3. Gantry synchronization signal	13	HALL_W+	Hall signal W

Pin No.	Terminal Definition	Description	Pin No.	Terminal Definition	Description
6	Z+	Encoder pulse phase Z±	14	PS2+/CLK+	1. PS± signal of the second encoder; 2. CLK± signal of the communication-type encoder
7	Z-		15	PS2-/CLK-	
8	+5 V	Encoder 5 V power supply (load current lower than 200 mA)	Enclosure	PE	Shield

6.15.3Gantry Commissioning Schemes

Gantry structure types and gantry synchronization control scheme

Table 6–9 Gantry structure types

Structure type	Description
Stiff gantry	The two axes are connected by a rigid beam frame, which does not allow large gantry synchronization deviation. Large deviation will cause "stuck axis".
Flexible gantry	The two axes are connected by a flexible beam frame, which allows certain synchronization deviation between the two axes.
Virtual gantry	Two axes are independent of each other, and not connect by any beam frame. Gantry synchronization deviation is allowed between them. Runout axis control is supported.

The SV680-INT provides the following *"Table 6–10 Gantry synchronization control scheme" on page 415*two gantry control schemes applied to different gantry structures.

Table 6–10 Gantry synchronization control scheme

Gantry synchronization control scheme	Description	Scope
Scheme 1	The master axis receives external position commands, and the master and slave axes perform position command following control respectively. In addition, the slave axis performs synchronization deviation elimination control to keep alignment with the master axis.	Stiff gantry Flexible gantry Virtual gantry
Scheme 2[1]	The master axis receives external position commands and performs position command following control. The slave axis performs synchronization deviation elimination control to keep alignment with the master axis. The slave axis can receive position commands, which are used for differential control of two axes to make the two axes run in opposite directions.	Only for stiff gantries

Note

[1]: The display value of master axis H0b.17 (6064) of gantry scheme 2 is (master axis position feedback + slave axis position feedback) ÷ 2, and the display value of slave axis H0b.17 (6064) is (master axis position feedback - slave axis position feedback) ÷ 2.

Application restrictions

The application of SV680-INT gantry synchronization control has the following constraints.

No.	Requirements	Principles
1	Motor models and specifications must be consistent.	In principle, differentiated gantry axis control structure is not supported.
2	Encoder models and specifications must be consistent.	
3	A Hall sensor is required.	
4	Drive models and specifications must be consistent.	

Commissioning precautions

1. Different from single-axis servo commissioning, you must ensure that the key parameters of two axes are consistent during the commissioning, otherwise malfunctions may occur. The following is a list of parameters that must be consistent between two axes. When you need to change the parameter of one axis, make sure the change is propagated to the paired axis. For details, see chapter 7 "Motion Control" on page 448. *"Table 6–11 Parameter settings" on page 416*

Table 6–11 Parameter settings

Precautions	Parameter Type	Corresponding parameter
Parameters	Motor and encoder	Parameters in group H00
	Drive	Parameters in group H01
	Basic function	Control mode: H02.00 Absolute system selection: H02.01 Stop mode: H02.05–H02.08, H02.17–H02.18 DB action delay: H02.20 Electronic gear ratio: H05.02, H05.07, H05.09, H05.11, H05.13, 6091h Brake parameters: H02.09 to H02.12, H02.16 Ramp stop: 6084h, 6085h
	Command limit	Speed limit: H07.17, H06.08, H06.09 Torque limit: H07.07, H07.09–H07.12
	Gain	Loop gain: H08.00, H08.01, H08.02, H08.62 Loop feedforward: H08.18, H08.19, H08.20, H08.21
	Filter	Position command filter: H05.04, H05.06, H05.70 Speed feedforward smoothing filter: H06.13 Torque command low pass filter H07.05, H07.06, H07.37, H07.38, H07.36 Speed measurement method and speed feedback filter: H08.25, H08.22, H08.23

2. Unlike single-axis servo commissioning, the ease-of-use functions can not be used. That is internally restricted by the drive. The following is a description of support for the ease-of-use functions after opening the gantry synchronization function. See *"Table 6–12 Scheme 1 Support for ease-of-use functions" on page 417 "Table 6–13 Scheme 2 Support for ease-of-use functions" on page 418*.

Table 6–12 Scheme 1 Support for ease-of-use functions

<table>
<tr><th>No.</th><th>Unsupported Function</th><th>Supported by Master Axis</th><th>Axis Setting Consistency</th><th>Supported by Slave Axis</th></tr>
<tr><td>1</td><td><Standard rigidity table> adjustment H09.00 = 1</td><td rowspan="6">1, 2 [3, 4, 5, 6 are not supported]</td><td rowspan="6">Consistent with the master axis</td><td rowspan="6">1, 2 [3, 4, 5, 6 are not supported]</td></tr>
<tr><td>2</td><td>Positioning mode adjustment H09.00 = 2</td></tr>
<tr><td>3</td><td><Interpolation mode + Online inertia auto-tuning> adjustment H09.00 = 3</td></tr>
<tr><td>4</td><td><Normal mode + Online inertia auto-tuning> adjustment H09.00 = 4</td></tr>
<tr><td>5</td><td>Stune5 mode adjustment H09.00 = 5</td></tr>
<tr><td>6</td><td>Stune6 mode adjustment H09.00 = 6</td></tr>
<tr><td>7</td><td>Speed feedforward control</td><td>Supported</td><td>Consistent with the master axis</td><td>Supported</td></tr>
<tr><td>8</td><td>Speed feedforward source</td><td>H05.19=2, 3 are not supported</td><td>-</td><td>H05.19=2, 3 are not supported</td></tr>
<tr><td>9</td><td>Torque feedforward control</td><td>Supported</td><td>Consistent with the master axis</td><td>Supported</td></tr>
<tr><td>10</td><td>Torque feedforward source</td><td>H06.11= 2 is not supported</td><td>-</td><td>H06.11= 2 is not supported</td></tr>
<tr><td>11</td><td>PDFF control</td><td>Supported</td><td>Consistent with the master axis</td><td>Supported</td></tr>
<tr><td>12</td><td>Gain Switchover</td><td>Not recommended</td><td>-</td><td>Not recommended</td></tr>
<tr><td>13</td><td>Model control</td><td>Supported</td><td>Consistent with the master axis</td><td>Supported</td></tr>
<tr><td>14</td><td>QFC control</td><td>Supported</td><td>Consistent with the master axis</td><td>Supported</td></tr>
<tr><td>15</td><td>Speed Observer</td><td>Supported</td><td>Consistent with the master axis</td><td>Supported</td></tr>
<tr><td>16</td><td>Disturbance observer</td><td>Supported</td><td>Recommended to be consistent</td><td>Supported</td></tr>
<tr><td>17</td><td>Cogging torque ripple compensation</td><td>Supported</td><td>Not required</td><td>Supported</td></tr>
<tr><td>18</td><td>Encoder scale spacing ripple suppression</td><td>Supported</td><td>Not required</td><td>Supported</td></tr>
<tr><td>19</td><td>Adaptive notch</td><td>Supported</td><td>Recommended to be consistent</td><td>Supported</td></tr>
<tr><td>20</td><td>Online Inertia Auto-tuning</td><td>Not supported</td><td>-</td><td>Not supported</td></tr>
<tr><td>21</td><td>Offline Inertia Auto-tuning</td><td>Not supported</td><td>Both axes are recommended to be (a-1) ÷ 2 after single axis auto-tuning is completed</td><td>Not supported</td></tr>
</table>

No.	Unsupported Function	Supported by Master Axis	Axis Setting Consistency	Supported by Slave Axis
22	Gravity compensation	Supported	Not required	Supported
23	Friction Compensation	Supported	Not required	Supported
24	End low-frequency resonance suppression 1	Supported	Consistent with the master axis	Supported
25	End low-frequency resonance suppression 2/ 3	Supported	Consistent with the master axis	Supported
26	Field weakening	Supported	Consistent with the master axis	Supported

Table 6–13 Scheme 2 Support for ease-of-use functions

<table>
<tr><th>No.</th><th>Description</th><th>Supported by Master Axis</th><th>Supported by Slave Axis</th></tr>
<tr><td>1</td><td><Standard rigidity table> adjustment H09.00 = 1</td><td rowspan="6">Supported</td><td rowspan="6">Not supported (only H09.00 = 0 is supported)</td></tr>
<tr><td>2</td><td>Positioning mode adjustment H09.00 = 2</td></tr>
<tr><td>3</td><td><Interpolation mode + Online inertia auto-tuning> adjustment H09.00 = 3</td></tr>
<tr><td>4</td><td><Normal mode + Online inertia auto-tuning> adjustment H09.00 = 4</td></tr>
<tr><td>5</td><td>Stune5 mode adjustment H09.00 = 5</td></tr>
<tr><td>6</td><td>Stune6 mode adjustment H09.00 = 6</td></tr>
<tr><td>7</td><td>Speed feedforward control</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>8</td><td>Torque feedforward control</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>9</td><td>PDFF control</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>10</td><td>Gain Switchover</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>11</td><td>Model control</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>12</td><td>QFC control</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>13</td><td>Speed Observer</td><td>Not supported</td><td>Not supported</td></tr>
<tr><td>14</td><td>Disturbance observer</td><td>Not supported</td><td>Not supported</td></tr>
<tr><td>15</td><td>Cogging torque ripple compensation</td><td>Not supported</td><td>Not supported</td></tr>
<tr><td>16</td><td>Encoder scale spacing ripple suppression</td><td>Not supported</td><td>Not supported</td></tr>
<tr><td>17</td><td>Adaptive notch</td><td>Supported</td><td>Supported</td></tr>
<tr><td>18</td><td>Online Inertia Auto-tuning</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>19</td><td>Offline Inertia Auto-tuning</td><td>Supported</td><td>Not supported</td></tr>
<tr><td>20</td><td>Gravity compensation</td><td>Supported</td><td>Supported</td></tr>
<tr><td>21</td><td>Friction Compensation</td><td>Not supported</td><td>Not supported</td></tr>
</table>

No.	Description	Supported by Master Axis	Supported by Slave Axis
22	End low-frequency resonance suppression 1	Supported	Not supported
23	End low-frequency resonance suppression 2/3	Supported	Not supported
24	Field weakening	Not supported	Not supported

6.15.4Gantry Commissioning Process

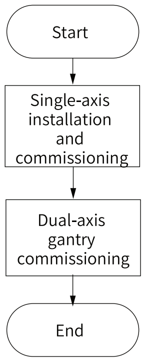


Figure 6-15 Flow chart

6.15.5Single-axis Installation and Commissioning

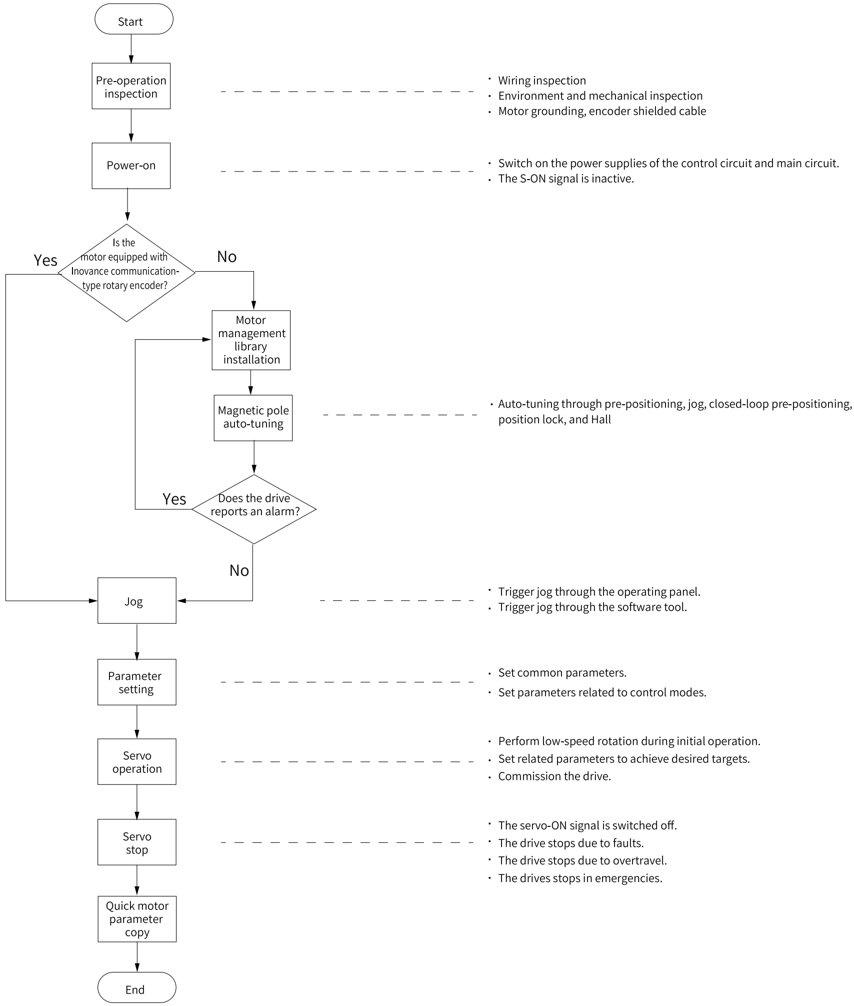


Figure 6-16 Commissioning flowchart of the drive

Perform installation and commissioning of the master/slave axis according to the flow chart, and make sure that the two axes can run smoothly.

6.15.6 Commissioning of 2-axis Gantry

The commissioning process varies with different gantry synchronization control schemes.

Caution

Before initial commissioning under gantry scheme 2, it is recommended to set the gain parameters of axis circuit control (H08.00, H08.02) to 0 and the integral time constant (H08.01) to 512. After setting H09.00 to 1 during commissioning, increase the stiffness level of slave axis (H09.01) gradually from 0. If the stiffness is too high, runaway may occur.

6.15.6.1 Commissioning Process of Gantry Sync Control Scheme 1

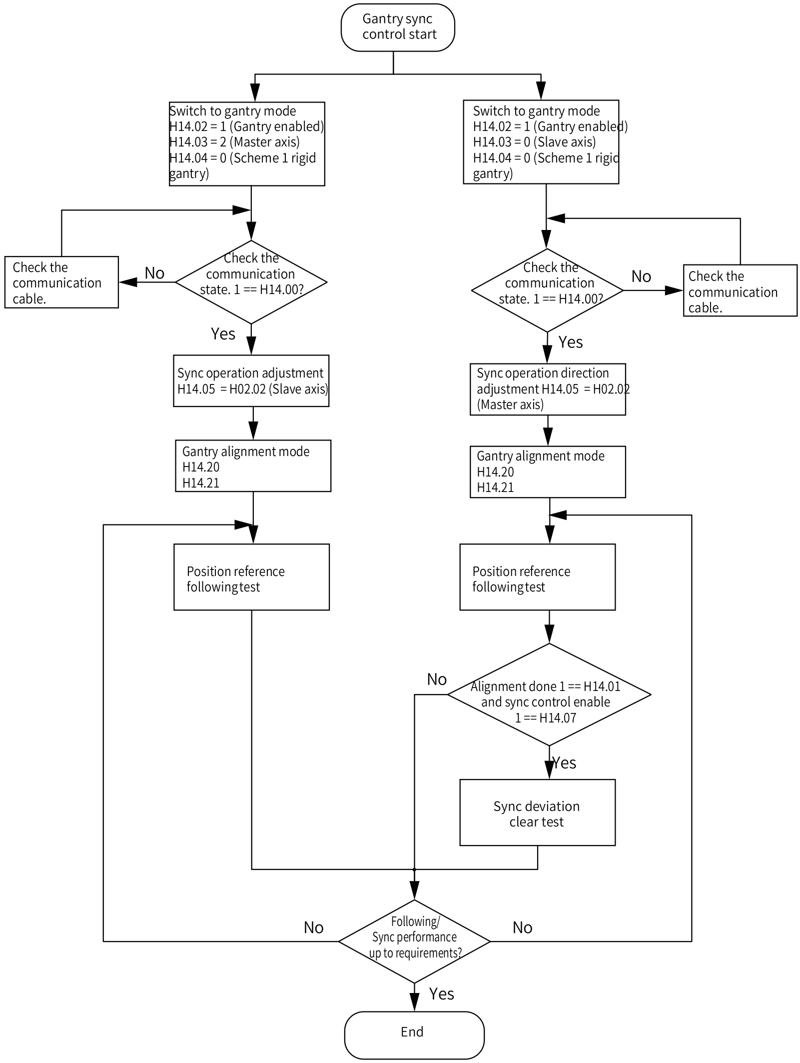


Figure 6-17 Commissioning process of gantry sync control scheme 1

Gantry sync direction

The setting of single-axis running direction has been completed through single-axis installation and commissioning. See *"6.15.5 Single-axis Installation and Commissioning" on page 420*. Now you need to complete the direction setting of communication data between two axes of gantry to ensure the directions of gantry synchronization control data of both axes are the same. The setting rule can be simplified as: H14.05 (master axis) = H02.02 (slave axis), H14.05 (slave axis) = H02.02 (master axis).

Gantry alignment

Before gantry synchronization function and position deviation alarm function can take effect, gantry alignment must be completed. Gantry alignment is configured according to H14.21. When two axes are aligned and both are in run state, the slave axis can carry out synchronization deviation elimination control and move to the alignment position with the master axis, and the alarm monitoring of excessive synchronization deviation takes effect at this time.

If H14.20 is set to 1, before the gantry meets the alignment condition, the position after both axes are powered on is the zero point.

- For scenarios where photoelectric sensors are used only on a single axis, the alignment is as follows:
  - **Align against the position where both axes are powered on**: Set H14.20 to 1 for both axes. Both axes are synchronized against the position of two axes where they are powered on. When there is deviation after the two axes are powered on, the slave axis will run after the first enabling to eliminate the deviation between the two axes. This mode has no gantry alignment DO and can be used in combination with other alignment modes. H14.01 and its corresponding DO will not be set to 1 only when this condition is met.
  - **Align against the position where both axes are enabled**: Set H14.21 to 3 for both axes. Both axes are synchronized against the position of two axes where both axes are in Run state. The gantry alignment state is exited after both axes are disabled.
  - **Torque oblique alignment:** Set H14.21 to 2 for both axes. Set the H14.26 to **DI enabled** or **Enabled when both axes are in Run state**. Relevant parameters are H14.26–H14.33.
- For scenarios where photoelectric sensors are used on both axes, the alignment is as follows:
  - **For a non-absolute encoder**: Set H14.21 to 0 for both axes. Align against the home of both axes. Or set H14.71 to 1, and set the offset with H14.72. The offset can be identified by H14.25. See Homing Alignment (H14.21=0).
  - **For an absolute encoder**: not supported.

The gantry alignment mode (H14.21) is described below.

1. **Homing alignment (H14.21=0)**

   Description

   During gantry homing, limit switches (photoelectric and hard limit) of master and slave axes are responded.

- Rigid gantry: Support all the originally supported homing modes. the homing path of the master axis is the same as the original planned path. For rigid gantry homing trajectory, see *"4.3 Homing" on page 301* and *"3.8.6 Homing Operation" on page 152*
- Flexible gantry: Only the following homing modes are supported. For flexible gantry homing trajectory, see *"9.4 Flexible Gantry Homing Trajectory" on page 684*
  - 402 homing: -2,-1, 1, 2, 7, 11, 23, 24, 25, 26, 27, 28, 29, 30 (SV680N-INT)
  - Local homing: 0, 1, 8, 9, 12, 13 (SV680P-INT)

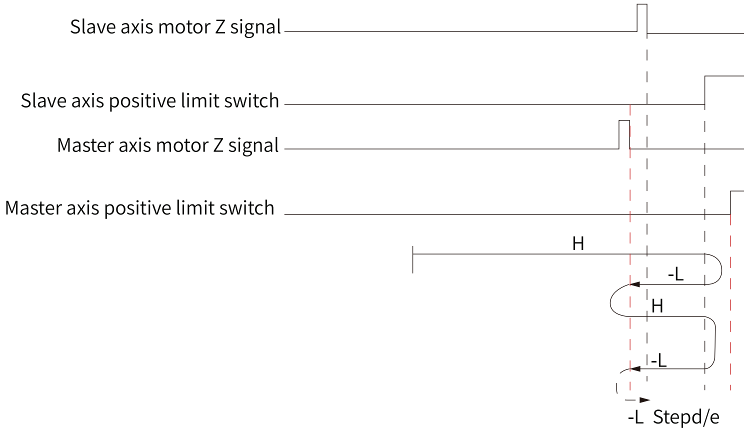
Note

If a homing mode other than the above-mentioned ones is set, starting homing will trigger E601.4 (gantry homing mode error).

- Homing steps for flexible gantry
  Flexible gantry limit or home switch must be installed on both axes, and the operation steps are as follows.

  a. Flexible gantry homing starts. If both axes are not aligned, auto torque alignment is turned on (H14.18), and the homing path is executed after the alignment is completed, otherwise, homing is directly executed.
  b. When both axes move at the same time, the home of the master axis is searched for first. At this time, the path planning is consistent with the original planned path. After the master axis home is found, the axis moves in reverse direction at high speed until encountering the deceleration point or limit. Then it moves backward and searches for the home of the slave axis.
  c. After the home of the slave axis is found, the two axes move to the home of the master axis. If gantry homing positioning is not enabled for the slave axis (H14.71 is 0), the homing is completed. If it is enabled, and if the gantry deviation compensation value of the slave axis (H14.72) is zero, step d is executed, and if it is not zero, step e is executed.
  d. The slave axis moves to its home position.
  e. The slave axis moves to the corresponding position according to the set deviation (H14.72 = Slave home position – Master home position).

  Take SV680-INT -2 homing trajectory 1 as an example, and the path is as follows:



- Torque alignment and deviation auto-tuning of gantry homing
  - Torque alignment
    For the flexible gantry, enable the torque pre-alignment before homing (H14.18 = 1). After homing is triggered, the slave axis automatically carry out torque pre-alignment. After that, H14.18 is reset to start normal homing operation.
  - Deviation auto-tuning
    - For the flexible gantry, enable homing deviation torque alignment auto-tuning for both axes (H14.25 is 1 and H14.71 is 0). After flexible gantry homing is completed, the slave axis automatically performs torque alignment. After that, the home deviation value is auto-tuned, the gantry deviation compensation value (H14.72) is written, and H14.25 is reset.
    - For the flexible gantry, enable homing deviation position auto-tuning for both axes (H14.25 is 2 and H14.71 is 0). After flexible gantry homing is completed, the home deviation value is auto-tuned, the gantry deviation compensation value (H14.72) is written, and H14.25 is reset.

2. **Torque alignment (H14.21=2)**

Gantry torque alignment:

The master axis keeps stationary, and the slave axis moves back and forth after torque is limited. The alignment reference is obtained through dichotomy according to the limit position of the back and forth movement.

Steps:

a. Set H14.21 to 2. The master axis remains stationary, and the slave axis moves back and forth after torque is limited.

b. Gantry torque alignment enable should be set according to H14.26 of the master axis. If H14.26 is set to direct enable, you must enable the drive first, and then set H14.26=1 before torque alignment enabling can take effect.

c. Alignment torque, alignment times and alignment speed of gantry torque can be through H14.27 to H14.33 of the slave axis.

- H14.27 sets the maximum torque command, which is recommended to be set as large as the mechanical structure allows. The torque command is the resultant force of friction force and mechanical coupling elastic force at constant speed during measurement.
- H14.28 sets the number of forward and reverse rotations. It is recommended to perform multiple measurements to ensure the accuracy of the result.
- H14.29 sets the alignment speed.
- H14.31 sets the alignment acceleration time, which should not be set too large, so that the motor is in a uniform speed section during zero speed evaluation.
- H14.32 is the motor zero speed evaluation threshold, which is used to evaluate the mechanical limit to reach the current torque command during the alignment process. It must be greater than the speed ripple value when the drive is enabled and both axes stay stationary.

3. **Enable alignment (H14.21=3)**
   The enabling signal is the alignment reference for both axes. When H14.21 is set to 3, every time both axes are re-enabled, their position where they enter the state is taken as the alignment reference.

4. **DI alignment (H14.21=4)**
   The gantry establishes or cancels alignment reference through the DI signal of the master axis. When parameter H14.21 is set to DI alignment, the gantry alignment reference is based on the position of two axes when the master axis receives a DI signal. The gantry axes can cancel the alignment reference by another DI signal.

5. **Power-on initial alignment (H14.20=1)**
   The alignment reference is the position where both axes are powered on. After H14.20 is set to 1, the alignment reference is the position where both axes are powered on. When there is deviation after the two axes are powered on, the slave axis will eliminate the deviation after the first enabling. Exit the alignment reference when the alignment state of H14.21 is met.

Alarm of large gantry synchronization deviation

To prevent machinery failures due to the asynchronization between axis positions or torques, two alarm modes: one for large position deviation and the other for large torque deviation, are provided.

- You can set H14.47=1 to enable the alarm for large gantry position deviation, and set H14.45 and H14.44 to configure the deviation threshold and how long the threshold can be exceeds. When the position deviation between the master and slave axes exceeds the threshold and lasts for a certain period of time, the axes raise an alarm on the large gantry position deviation.
- You can set H14.50=1 to enable the alarm for large gantry torque deviation, and set H14.48 and H14.49 to configure the deviation threshold and how long the threshold can be exceeds. When the master/slave torque deviation exceeds the threshold and lasts for a certain period of time, the axes raise an alarm for the large torque deviation.

Gantry sync deviation elimination

Gantry synchronization is in the master-slave mode, and synchronization deviation elimination control master axis compensation is not effective. It is only set by H14.07 of the slave axis to **enabled by default** or **by DI** (59), with which setting the slave axis follows the master axis. See the following for details.

- When the gantry alignment flag is 1, after the two axes enter enabled state from disabled state, the slave axis moves to align with the master axis. When both axes are enabled, and the gantry alignment flag bit changes from 0 to 1, the slave axis moves to align with the master axis. The alignment velocity and acceleration are H14.13 and H14.14.
- By adjusting the synchronization deviation elimination gain H14.08–H14.11, the synchronization deviation can be eliminated to ensure the synchronization of two axes.

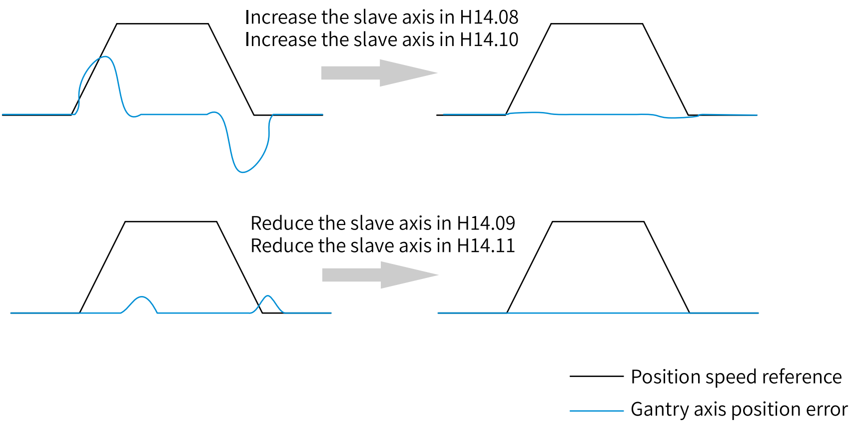


Figure 6-18 Curve change before and after commissioning

6.15.6.2 Commissioning Process of Gantry Sync Control Scheme 2

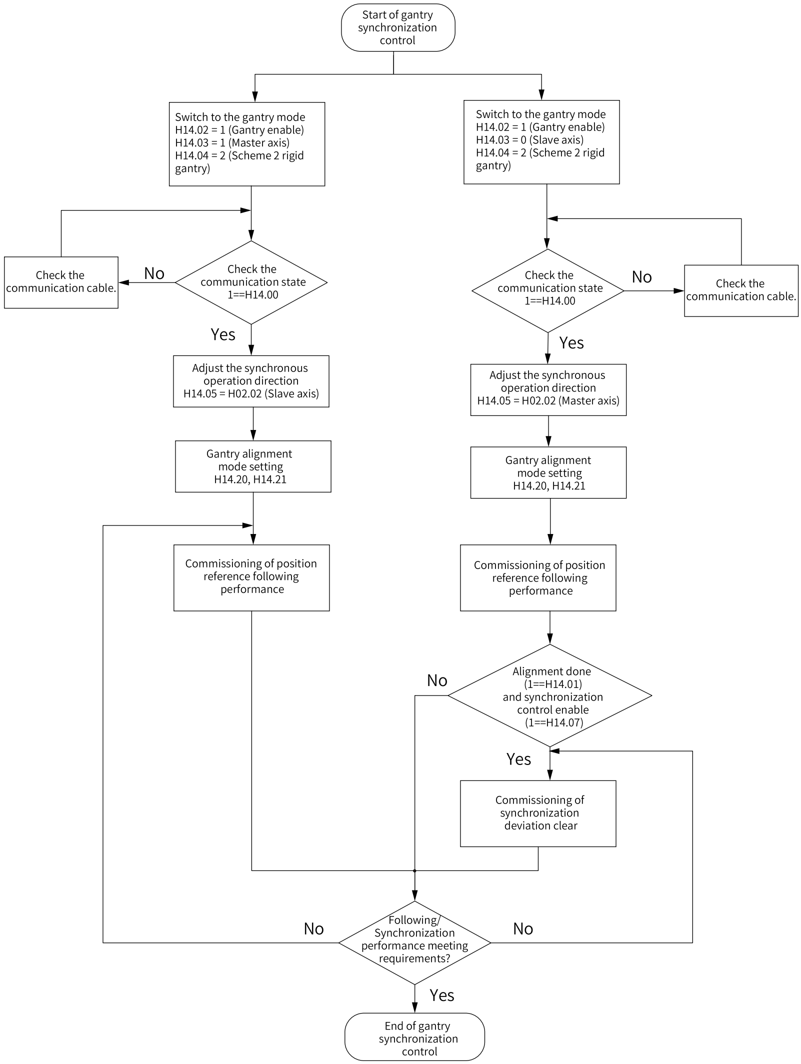


Figure 6-19 Commissioning Process of Gantry Sync Control Scheme 2

Gantry sync direction

For details, see section *" Gantry sync direction" on page 422*.

Gantry alignment

For details, see section *" Gantry alignment" on page 423*.

Note

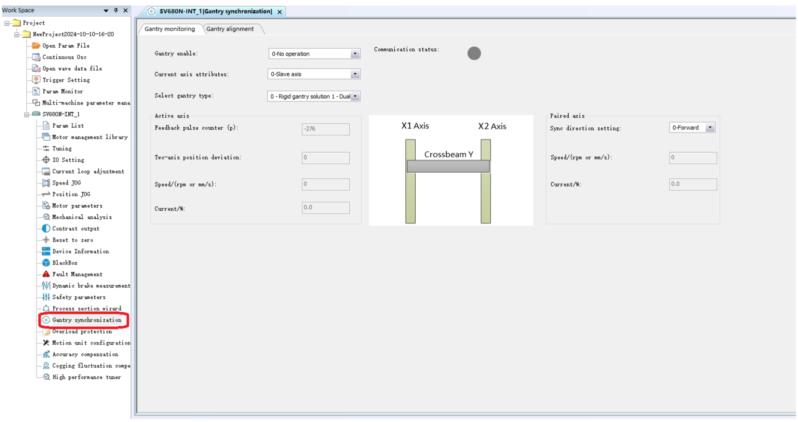
- Torque alignment mode (including torque oblique alignment mode) is not supported.
- Flexible gantry 2-axis homing alignment mode is not supported.

Gantry sync deviation elimination

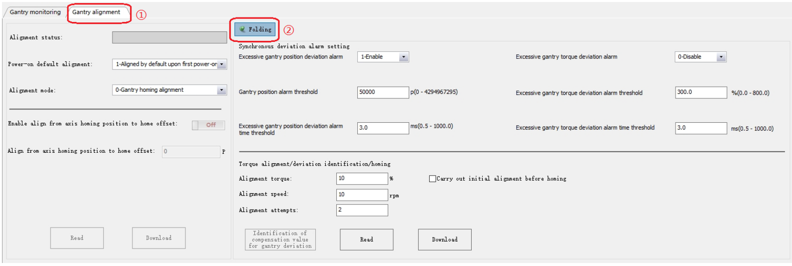
Scheme 2 is effected by slave axis control, that is, synchronization deviation is eliminated through the slave axis following the master axis. Different from scheme 1, synchronization deviation control takes effect by default, and takes effect by setting H08.00–H08.02. When H08.00=H08.02=0 and H08.01=512, sync deviation elimination control is disabled.

Commissioning the host controller gantry

1. Click **Gantry Synchronization** in the workspace. Enable the gantry function, configure the gantry axis property, and select the gantry control type. Observe the communication state to ensure that the communication function of the gantry is active and monitor the state of the active axis and paired axis.



2. In the gantry alignment interface, select the alignment mode (homing alignment, torque alignment, enable alignment, or DI alignment), and set the torque alignment/deviation identification/homing pre-alignment parameters setting (alignment torque, alignment speed, and alignment attempts). You can also change settings for synchronization position deviation and torque deviation alarm.


Gantry monitoring
Gantry alignment
①
Folding
②
Alignment status:
Power-on default alignment:
1-Aligned by default upon first power-on
Alignment mode:
0-Gantry homing alignment
Enable align from axis homing position to home offset:
Off
Align from axis homing position to home offset:
0
P
Read
Download
Synchronous deviation alarm setting
Excessive gantry position deviation alarm
1-Enable
Excessive gantry torque deviation alarm
0-Disable
Gantry position alarm threshold
50000
p(0 - 4294967295)
Excessive gantry torque deviation alarm threshold
300.0
%(0.0 - 800.0)
Excessive gantry position deviation alarm time threshold
3.0
ms(0.5 - 1000.0)
Excessive gantry torque deviation alarm time threshold
3.0
ms(0.5 - 1000.0)
Torque alignment/deviation identification/homing
Alignment torque:
10
%
Carry out initial alignment before homing
Alignment speed:
10
rpm
Alignment attempts:
2
Identification of compensation value for gantry deviation
Read
Download

7 STO

7.1 General

7.1.1 Terms and Abbreviations

Terms and Abbreviations	Description
Cat.	Safety category It includes B, 1, 2, 3, and 4.
CCF	Common cause failure
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
HFT	Hardware fault tolerance
PFH_D	Probability of a dangerous Failure per Hour
PL	Performance Level
SC	Systematic capability
SIL	Safety integrity level
T_1	Test interval
DI	Digital inputs
DO	Digital output
PCB	Printed circuit board
MCU	Micro computer unit
FPGA	Field programmable gate array
MTTFd	Mean time to dangerous failure
STO	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. If the motor is running when STO function is activated, it coasts to 0 RPM.

7.1.2 Safety Standards

Standards compliance

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

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

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

Safety standard	Reference
Functional safety	IEC 61508: 2010 ISO 13849-1: 2015 ISO 13849-2: 2012 IEC 62061: 2021 EN 61508: 2010 EN ISO 13849-1: 2015 EN ISO 13849-2: 2012 EN IEC 62061: 2021 IEC 60204-1: 2016 (in extracts) EN 60204-1: 2018 (in extracts)
EMC	IEC 61800-5-2: 2016 IEC 61800-3: 2017 IEC 61326-3-1: 2017 IEC 61000-6-7: 2014 EN 61800-5-2: 2017 EN IEC 61800-3: 2018 EN 61326-3-1: 2017 EN 61000-6-7:2015
LVD	IEC 61800-5-1:2007/AMD1:2016 EN 61800-5-1:2007/A1:2017

- Safety data

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

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

λ_{DD} means the failure rate of dangerous failure but can be diagnosed by the diagnosis subsystem.

λ_{DU} means the failure rate of dangerous failure and can’t be diagnosed by the diagnosis subsystem.

Note

- See ISO13849-2: 2012 for failure modes of devices.
- Failure sharing of different failure modes of each device.
- See SN29500 for failure rate of each device.

7.1.3 Precautions for Use

General safety precautions

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

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

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

Table 7–1 Warnings, Cautions and Notes

Icon	Indication	Description	Consequences in case of disregard
Example  General hazards  Special hazards Electric shock	DANGER	Danger	Indicates that failure to comply with the notice can result in death or severe personal injury.
	WARNINGS	Warning	Indicates that failure to comply with the notice may result in death or severe personal injury.
	CAUTION	Caution	Indicates that failure to comply with the notice may result in minor or moderate personal injury or equipment damage.
	STOP	Inhibited	Indicates that failure to comply with the notice can result in equipment or environmental damage.

Caution

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

It is the responsibility of the machine builder/OEM/system integrator to make sure that the essential health and safety function requirements specified in the Machinery Directive are met. The manufacturer or its authorized distributor is obliged to conduct a hazard analysis before placing a product on the market, take appropriate measures to reduce/eliminate the related hazards and ensure proper components are selected.

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

Use the safety function STO after comprehending all the instructions. Incorrect use of safety functions or use of safety functions that are not sufficient to meet the safety requirements of the site may result in personal injury.

Safety measures

Carefully read and observe the following important precautions when using safety functions:

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

Note

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

Risk Assessment

- When using the safety functions, perform risk assessment on the servo system in advance. Make sure that the safety integrity level of the standards is met.

- The following residual risks can be present even when the safety functions operate. Therefore, safety must always be given consideration during risk assessment.
- If external forces (such as gravitational force with a vertical axis) are applied when the safety functions are operating, the motor will rotate due to the action of these external forces. Therefore, you must use a separate mechanical brake to secure the motor.

Note

In the case of failure of multiple IGBTs, no matter whether the STO function is enabled, the servo drive can generate an alignment torque. This torque can cause the motor shaft to rotate within a range of up to 180/number of motor pole pairs (for a synchronous reluctance motor, the range is 180/2 x number of motor pole pairs).

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

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

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

Common residual risks

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

- Keep the required clearance/creepage distance depending on voltage you use.

Residual risks in each function

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

Note

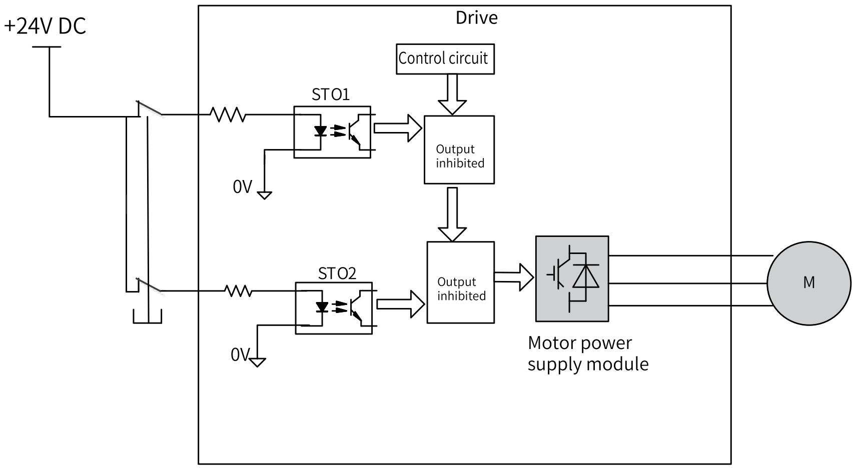
Perform STO function diagnosis at least once every three months. Run the STO function once to check whether the motor stops.

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

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

7.2 Safety Function

7.2.1 Overview



The motor torque off function is achieved by disconnection of the motor power supply module output and motor power supply current.

Figure 7-1 Schematics of the STO function

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

Remember to power off and on the drive every three months or trigger STO by disconnecting the 24 V input of CN6, so that STO can be reset periodically.

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

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

See the following table for the STO function.

STO1 input	STO2 Input	PWM signal
H	H	Normal
L	H	Inhibited
H	L	Inhibited
L	L	Inhibited

STO (safe torque)	
Assignment	Cuts off the power of the motor.
Description	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. If the motor is running when STO function is activated, it coasts to stop.
Safety state	Disables the PWM gating signal of the drive.
Operation mode	High demand mode or continuous mode

7.2.2 Use and Monitoring of STO Function

Functions

The keypad displays the STO function state and fault information.

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

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

Fault code	Fault code name	Cause	Cause	Solution
E150.0	STO safety state applied	The STO input protection applies (safety state).	One or two 24 V inputs are disconnected simultaneously, triggering the STO function.	There is no need to take any corrective actions. After the STO terminal is back to normal, clear the fault using the fault reset function. Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected. Replace the servo drive.
E150.1	STO input state exception	The single-channel input of STO is ineffective.	1. The STO input power supply is abnormal.	Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected.
			2. The STO input resistor is abnormal.	Replace the servo drive.
			3. The STO fails.	Replace the servo drive.
E150.2	Buffer 5 V voltage detection exception	The MCU monitors the 5 V power supply of the PWM Buffer to detect whether overvoltage or undervoltage occurs. If the voltage is abnormal, this fault code will be displayed.	The 5 V voltage supplied to the STOBuffer is abnormal due to undervoltage or overvoltage.	Replace the servo drive.
E150.3	STO input circuit hardware diagnosis failure	Short circuit occurs in the optocoupler in the upstream hardware circuit of STO. The drive displays E150.3.	Direct connection occurs on the upstream optocoupler of STO1 or STO2.	Replace the servo drive.
E150.4	STO activated	An error occurs on the PWM buffer integrated circuit during initialization detection upon power-on (the PWM signal cannot be blocked). The drive displays E150.4.	STOBuffer power-on detection error	Replace the servo drive.
E150.5	STO input signal interference	The STO signal is being disturbed, and the noise filtering condition defined by H0A.73 is not met.	The STO terminal is in poor contact or the external 24 V input voltage is unstable, which may lead to malfunction of STO.	Replace the 24 V power supply to ensure the STO terminal input voltage is stable.

Note

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

EDM signal DO output

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

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

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

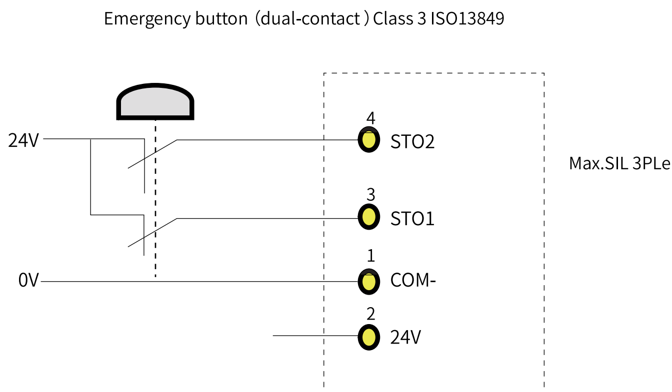
Note

The DO output of this EDM is only a monitoring signal that detects whether the safety function is triggered. It is not a safety signal output.

The EDM state of the STO output integrated by the drive can only be outputted through the non-safety DO of the servo, instead of the DO on the safety module.

Example

Example 1:



7.2.3 Fault Reset

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

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

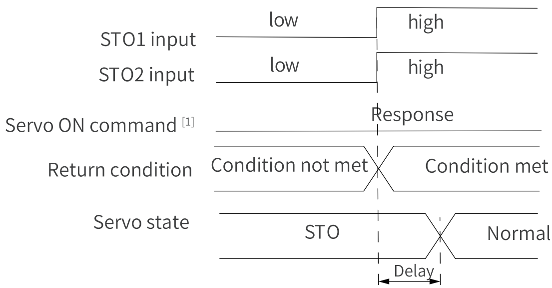


Figure 7-2 Return condition of external STO request state

Note

[1]: The servo ON command is used to enable the servo drive. It is not the internal enable state of the drive.

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

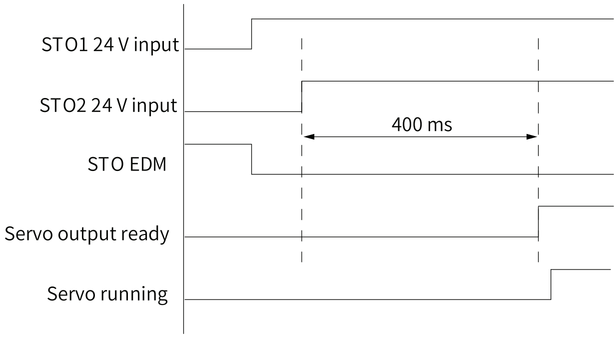
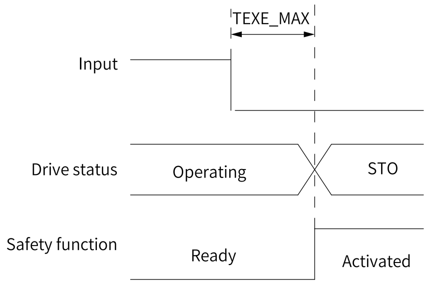


Figure 7-3 Servo drive reset sequence diagram

7.2.4 Safety Function Response Time

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

If either or both of them are at low level simultaneously, the PWM signal will be blocked in the next 30 ms [1].



Note

[1]: The typical response time is 30 ms. The maximum response time is 100 ms.

7.3 Acceptance

Basic requirements

- Technical staff must be trained to understand the requirements and principles of designing and operating safety-related systems.

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

Commissioning Checklist

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

  The acceptance test must be performed:

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

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

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

- Checklist of integrated STO functions

Step	Action	Result
1	Ensure that the drive runs and stops freely during commissioning.	
2	Stop the drive (if running), switch the input power supply off and isolate the drive from the power line by a disconnector.	
3	Check the STO circuit connections against the circuit diagram.	
4	Check that the shield of the STO input cable is grounded to the drive frame.	
5	Close the disconnector and switch the power supply on.	

Step	Action	Result
5.1	Test the STO signal #1 when the motor is stopped: Set STO1 and STO2 to H. Send a stop command to the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal #1 and send a start command to the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
5.2	Set STO1 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
5.3	Test the STO signal #2 when the motor is stopped: Set STO1 and STO2 to H. Send a stop command to the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal #2 and give a start command for the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
5.4	Set STO2 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
6.1	Test the STO channel 1 when the motor is running: Set STO1 and STO2 to H. Start the drive and ensure the motor is running. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 1. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
6.2	Set STO1 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
6.3	Test the STO channel 2 when the motor is running: Set STO1 and STO2 to H. Start the drive and ensure the motor is running. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 2. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	

Step	Action	Result
6.4	Set STO2 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
7	Document and sign the acceptance test report which verifies that the safety function is safe and acceptable for operation.	

Special requirements

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

Note

There are two ways to perform STO diagnosis:

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

You can use either of them.

7.4 Troubleshooting

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

Error code	Cause	Corrective Action
E150.1	1. STO input power supply is abnormal.	Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected.
	2. STO input resistor is abnormal.	Replace the servo drive.
	3. STO is ineffective.	Replace the servo drive.
E150.2	The 5 V voltage supplied to the STO Buffer is abnormal due to undervoltage or overvoltage.	Replace the servo drive.
E150.3	Direct connection occurs on the upstream optocoupler of STO1 or STO2.	Replace the servo drive.

Error code	Cause	Corrective Action
E150.4	STO buffer power-on detection abnormal	Replace the servo drive.
E150.5	Poor contact of the STO terminal or unstable external 24V input voltage may lead to STO misoperation or malfunction.	Replace the 24V power supply.

8 Troubleshooting

8.1 Fault Reset

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

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

Note

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

Operating procedure:

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

Note

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

☆Related function No.:

Start Process	Fault	Cause	Troubleshooting
FunIN.2	ALM-RST	Fault/alarm reset signal	The servo drive may, depending on the alarm type, continue running after reset. When FunIN.2 is assigned to a low-speed DI, the effective level change of this DI must be kept for more than 3 ms. Otherwise, fault reset will be inactive. Do not assign FunIN.2 to a high-speed DI. Otherwise, fault/alarm reset will be inactive. • Inactive: Not resetting the fault/alarm • Active: Resetting the fault/alarm

8.2 Handling of Faults and Alarms [P]

8.2.1 List of Fault Codes

No. 1 non-resettable faults:

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

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
E101	E101.0	Abnormal parameters in groups H02 and above	No.1	No
	E101.1	Parameter error in group H00/H01	No.1	No
	E101.2	Address error in read/write operation after the number of parameters changes	No.1	No
	E101.9	Parameter attribute initialization check error	No.1	No
E102	E102.0	FPGA communication establishment error	No.1	No
	E102.1	FPGA initialization start error	No.1	No
	E102.8	FPGA and MCU software version mismatch	No.1	No
E104	E104.1	MCU running timeout (MCU break down)	No.1	No
	E104.2	FPGA running timeout (FPGA break down)	No.1	No
	E104.4	MCU command update timeout	No.1	No

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
E120	E120.0	Unknown encoder model	No.1	No
	E120.1	Unknown motor model	No.1	No
	E120.2	Unknown drive model	No.1	No
	E120.5	Motor and drive current mismatch	No.1	No
	E120.6	FPGA and motor model mismatch	No.1	No
	E120.7	Model check error	No.1	No
	E120.8	Junction temperature parameter check error	No.1	No
E136	E136.0	Encoder ROM motor parameter check error	No.1	No
	E136.1	Encoder ROM motor parameter read error	No.1	No
	E136.9	Dimension parameter Initialization error	No.1	No
E138	E138.0	Accuracy compensation data error	No.1	No
	E138.1	Cogging ripple compensation data check failure	No.1	No
	E138.2	Gantry sync compensation data check failure	No.1	No
	E138.3	Overload compensation data check failure	No.1	No
E140	E140.1	MCU key calculation failed	No.1	No
	E140.4	Signature verification failed	No.1	No
E201	E201.0	Phase-P overcurrent	No.1	No
	E201.1	Phase-U overcurrent	No.1	No
	E201.2	Phase-V overcurrent	No.1	No
	E201.4	Phase-N overcurrent	No.1	No
E210	E210.0	Output short-circuited to ground	No.1	No
E234	E234.0	Runaway (protection scheme 1)	No.1	No
	E234.1	Runaway (protection scheme 2)	No.1	No
E308	E308.0	Pulse encoder phase A wire breakage	No.1	No
	E308.1	Pulse encoder phase B wire breakage	No.1	No
	E308.2	Pulse encoder phase Z wire breakage	No.1	No
E603	E603.0	Gantry communication CRC failure	No.1	No
	E603.1	Gantry communication timeout	No.1	No
	E603.2	Drive failed to establish communication for a long time	No.1	No
E606	E606.0	Gantry torque alignment timeout	No.1	No
E619	E619.0	Absolute accuracy compensation parameter setting error	No.1	No
	E619.1	Absolute accuracy compensation overflow	No.1	No

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
E720	E720.0	Wrong encoder interface	No.1	No
E740	E740.0	Absolute encoder communication timeout	No.1	No
	E740.2	Absolute encoder error	No.1	No
	E740.3	Absolute encoder single-turn calculation error	No.1	No
	E740.6	Encoder write error	No.1	No
	E740.8	BISSC register communication failure	No.1	No
	E740.9	Encoder data transmit delay too long	No.1	No
E755	E755.0	Nikon encoder communication fault	No.1	No
E765	E765.0	Nikon encoder over-temperature or overspeed	No.1	No
E770	E770.6	Fully closed-loop 2nd encoder initialization communication error	No.1	No
	E770.7	Fully closed-loop Inovance 2nd encoder communication error	No.1	No
E771	E771.0	Communication handshake failed between the interpolator and drive	No.1	No
EA33	EA33.0	Encoder read/write check error	No.1	No
	EA33.1	Fully closed-loop Inovance 2nd encoder data read/write error	No.1	No
EA34	EA34.0	Abnormal Hall state	No.1	No
	EA34.1	Dynamic Hall auto-tuning error	No.1	No
	EA34.2	Static Hall auto-tuning error	No.1	No
EEE0	EEE0.0	Gantry paired axis error	No.1	No

No. 1 resettable faults:

Table 8–2 List of No. 1 resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
E126	E126.0	Process segment number error	No.1	Yes
	E126.1	Internal operation mode error of the process segment	No.1	Yes
	E126.2	Position reference type error in process segment position mode	No.1	Yes
E150	E150.0	STO safety state applied	No.1	Yes
	E150.1	STO input state abnormal	No.1	Yes
	E150.2	Buffer 5 V supply error	No.1	Yes
	E150.3	STO input circuit hardware diagnosis failure	No.1	Yes
	E150.4	PWM Buffer hardware diagnosis failure	No.1	Yes
	E150.5	STO input signal interference	No.1	Yes
E208	E208.2	Encoder communication timeout	No.1	Yes
	E208.4	FPGA current loop operation timeout	No.1	Yes
E320	E320.0	Discharge fault	No.1	Yes
	E320.1	External braking resistor surface temperature too high	No.1	Yes
E321	E321.0	Dynamic brake resistor overload	No.1	Yes
E400	E400.0	Main circuit overvoltage	No.1	Yes
E410	E410.0	Main circuit undervoltage	No.1	Yes
	E410.1	Main circuit de-energized	No.1	Yes
E500	E500.0	Motor overspeed	No.1	Yes
	E500.1	Speed feedback overflow	No.1	Yes
	E500.2	FPGA position feedback pulse overspeed	No.1	Yes
E602	E602.0	Locked-rotor	No.1	Yes
	E602.1	Angle auto-tuning overtravel	No.1	Yes
	E602.2	U/V/W phase sequence reversed	No.1	Yes
	E602.3	Large encoder jitter during angle auto-tuning	No.1	Yes
	E602.4	Auto-tuning failed. Auto-tuning timeout.	No.1	Yes
	E602.5	Angle auto-tuning failed. Z signal not found.	No.1	Yes
	E602.6	Angle auto-tuning does not converge	No.1	Yes

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
E604	E604.0	Inconsistent settings of two gantry axes	No.1	Yes
	E604.1	Gantry not set to position mode	No.1	Yes
	E604.2	Gantry is running on an unsupported feature	No.1	Yes
E605	E605.0	Speed too fast upon S-ON	No.1	Yes
E612	E612.0	Rotor locked during phase sequence auto-tuning	No.1	Yes
	E612.1	Overtravel occurred during phase sequence auto-tuning	No.1	Yes
	E612.3	Large encoder jitter during phase sequence auto-tuning	No.1	Yes
	E612.4	Phase sequence auto-tuning failed. Auto-tuning timeout.	No.1	Yes
E620	E620.0	Motor overload	No.1	Yes
	E620.1	Overload current limit mode, motor overloaded	No.1	Yes
E621	E621.0	Overload current limiting torque attained	No.1	Yes
E630	E630.0	Motor stall over-temperature protection	No.1	Yes
E631	E631.1	24 V power supply or brake not connected	No.1	Yes
	E631.2	P-MOS open circuit	No.1	Yes
	E631.3	N-MOS disconnection	No.1	Yes
E640	E640.0	High IGBT junction overtemperature	No.1	Yes
	E640.1	Flywheel diode overtemperature	No.1	Yes
E650	E650.0	Heatsink overtemperature	No.1	Yes
E660	E660.0	Motor overtemperature	No.1	Yes
E770	E770.0	Fully-closed loop input phase A wire breakage	No.1	Yes
	E770.1	Fully-closed loop input phase B wire breakage	No.1	Yes
	E770.2	Fully-closed loop input phase Z wire breakage	No.1	Yes
	E770.3	BISS/SSI/ENDAT communication protocol timeout	No.1	Yes
	E770.8	Full closed-loop encoder data transmit delay is too large	No.1	Yes
E939	E939.0	Motor power cables disconnected	No.1	Yes
EB00	EB00.0	Excessive position deviation	No.1	Yes

No. 2 resettable faults

Table 8–3 List of No. 2 resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
E122	E122.0	Multi-turn absolute encoder setting error	No.2	Yes
	E122.1	Different DIs allocated with the same function	No.2	Yes
	E122.2	DO function allocation error	No.2	Yes
	E122.3	Upper limit in the rotation mode too high	No.2	Yes
	E122.4	VDI function allocation error	No.2	Yes
	E122.5	DI and VDI assigned with the same function	No.2	Yes
	E122.6	Absolute function setting fault of 2nd encoder	No.2	Yes
	E122.7	Fully closed-loop parameter setting error	No.2	Yes
	E122.8	Interpolator version mismatch	No.2	Yes
E420	E420.0	Main circuit phase loss	No.2	Yes
E661	E661.0	STune failure	No.2	Yes
E662	E662.0	ETune failure	No.2	Yes
E664	E664.0	Resonance too strong	No.2	Yes
E731	E731.0	Encoder multi-turn data lost	No.2	Yes
	E731.1	Inovance second encoder multi-turn data lost	No.2	Yes
E733	E733.0	Encoder multi-turn counting error	No.2	Yes
	E733.1	Inovance second encoder multi-turn data lost	No.2	Yes
E735	E735.0	Encoder multi-turn counting overflow	No.2	Yes
E760	E760.0	Encoder over-temperature	No.2	Yes
E994	E994.0	Station numbers conflict	No.2	Yes
EB00	EB00.1	Position deviation overflow	No.2	Yes
EB01	EB01.0	Position reference increment too large	No.2	Yes
	EB01.1	Individual position reference increment too large	No.2	Yes
	EB01.2	Position reference increment too large continuously	No.2	Yes
	EB01.3	Reference overflow	No.2	Yes
EB02	EB02.0	Position deviation too large in fully closed-loop mode	No.2	Yes
	EB02.1	Fully closed-loop position deviation overflow	No.2	Yes

Fault Code	Fault subcode	Fault Name	Fault level	Resettable
EB03	EB03.0	Electronic gear ratio beyond the limit - H05.02	No.2	Yes
	EB03.1	Electronic gear ratio beyond the limit - Electronic gear ratio 1	No.2	Yes
	EB03.2	Electronic gear ratio beyond the limit -Electronic gear ratio 2	No.2	Yes
EB04	EB04.0	Large gantry position deviation	No.2	Yes
	EB04.1	Gantry position deviation overrun	No.2	Yes
ED02	ED02.0	Modbus communication timeout	No.2	Yes
ED03	ED03.0	CANLink communication failure	No.2	Yes
ED04	ED04.0	CANopen communication timeout	No.2	Yes
ED05	ED05.0	CANopen communication initialized	No.2	Yes
ED08	ED08.0	CANopen bus PDO transmission length error	No.2	Yes
ED11	ED11.0	CANopen sync period error too large	No.2	Yes
EE09	EE09.0	Software position limit setting error	No.2	Yes
	EE09.1	Home setting error	No.2	Yes
	EE09.2	Gear ratio beyond the limit	No.2	Yes

8.2.2 List of Alarm Codes

Alarm

Table 8–4 List of alarm codes

Warning code	Alarm subcode	Name	Fault level	Resettable
E108	E108.0	Storage parameter write error	No.3	Yes
	E108.1	Storage parameter read error	No.3	Yes
	E108.2	Invalid check on data written in EEPROM	No.3	Yes
	E108.3	Invalid check on data read in EEPROM	No.3	Yes
	E108.4	Single data is stored too many times	No.3	Yes
E110	E110.0	Frequency-division pulse output setting error	No.3	Yes
E120	E120.3	The motor and drive do not match in the power	No.3	Yes
E121	E121.0	Invalid S-ON command	No.3	Yes
E126	E126.3	PR process segment write parameter out of limit	No.3	Yes
E510	E510.0	Frequency division pulse output overspeed	No.3	Yes
E600	E600.0	Inertia auto-tuning failure	No.3	Yes

Warning code	Alarm subcode	Name	Fault level	Resettable
E601	E601.0	Homing alarm	No.3	Yes
	E601.1	Homing switch error	No.3	Yes
	E601.2	Homing mode setting error	No.3	Yes
	E601.4	Gantry homing mode setting error	No.3	Yes
E602	E602.9	Angle auto-tuning not done for incremental encoder motor	No.3	Yes
E607	E607.0	Large gantry torque deviation	No.3	Yes
E608	E608.0	Master-to-slave parameter setting error	No.3	Yes
E609	E609.0	Data save timeout	No.3	Yes
	E609.1	Data save overflow	No.3	Yes
	E609.2	Failed to save data	No.3	Yes
	E609.3	Failed to erase data	No.3	Yes
E621	E621.1	Overload current limiting torque attained	No.3	Yes
E631	E631.4	P-MOS disconnection	No.3	Yes
	E631.5	N-MOS disconnection	No.3	Yes
E730	E730.0	Encoder battery alarm	No.3	Yes
	E730.1	Inovance 2nd encoder battery voltage low	No.3	Yes
E831	E831.1	AI1 zero offset too large	No.3	Yes
	E831.2	AI2 zero offset too large	No.3	Yes
E834	E834.1	AI1 overvoltage	No.3	Yes
	E834.2	AI2 overvoltage	No.3	Yes
E900	E900.0	DI emergency braking	No.3	Yes
E902	E902.0	DI/VDI setting invalid	No.3	Yes
	E902.1	DO/VDO setting invalid	No.3	Yes
	E902.2	Torque reach setting invalid	No.3	Yes
E909	E909.0	Motor overload	No.3	Yes
E910	E910.0	Control circuit overvoltage	No.3	Yes
E920	E920.0	Braking resistor overload	No.3	Yes
E921	E921.0	Dynamic brake resistor overload alarm	No.3	Yes
E922	E922.0	Resistance of the external braking resistor too small	No.3	Yes
E924	E924.0	Regenerative transistor over-temperature	No.3	Yes
E940	E940.0	Change of controlled motor is detected. It is recommended to restore factory settings before use	No.3	Yes
E941	E941.0	Modified parameters activated at next power-on	No.3	No
E942	E942.0	Parameter storage too frequent	No.3	Yes

Warning code	Alarm subcode	Name	Fault level	Resettable
E950	E950.0	Positive limit switch alarm	No.3	Yes
E952	E952.0	Negative limit switch alarm	No.3	Yes
E954	E954.0	Position reference overflow	No.3	Yes
E956	E956.0	Forward position reference overtravel in process segment position mode	No.3	Yes
E958	E958.0	Reverse position reference overtravel in process segment position mode	No.3	Yes
E971	E971.0	Undervoltage alarm for voltage drop protection	No.3	Yes
E980	E980.0	Frequency division output overflow	No.3	Yes
E990	E990.0	Pulse input overspeed alarm	No.3	Yes
E991	E991.1	SIGN pulse connection error	No.3	Yes
EA34	EA34.9	Hall is not configured	No.3	Yes
EA41	EA41.0	Torque fluctuation compensation failure	No.3	Yes

8.2.3 Description of Fault Codes

8.2.3.1 Solutions to Faults

- E101.0: Abnormal parameters in groups H02 and above
  Description:

  The total number of parameters changes, which generally occurs after software update. Setpoints of parameters in groups H02 and above exceed the limit, which generally occurs after software update.

Cause	Troubleshooting	Solution
1. The actual value of the parameter exceeds the upper/lower limit of the parameter.	Read H0b.90 and H0b.91 and obtain the abnormal parameter group number.	Rectify the wrong values. Restore default settings.
2. The voltage of the control circuit power supply drops instantaneously.	Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. Measure whether the input voltage of the control circuit cable on the non-drive side is within the following range: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: 10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: -10% to +10% (342 V to 484 V)	Restore system parameters to default settings (H02.31 = 1) and write parameters again. Increase the power supply capacity or replace with a power supply of higher capacity. Restore system parameters to default settings (H02.31 = 1), and write parameters again.
3. Instantaneous power failure occurs when saving parameters.	Check whether instantaneous power failure occurs when saving parameters.	Power on the system again, restore system parameters to default settings (H02.31 = 1), and write parameters again.
4. The number of write operations within a certain period of time exceeds the limit.	Check whether instantaneous power failure occurs when saving parameters. Check whether parameters are updated frequently through the host controller.	If the servo drive is faulty, replace the servo drive. Change the parameter writing method and write parameters again. Power on the system again, restore system parameters to default settings (H02.31 = 1), and write parameters again.
5. The software is updated.	Check whether parameter values in group H02 and above exceed the upper/ lower limit due to software update.	Reset the servo drive model and servo motor model, and restore system parameters to default settings (H02.31 = 1).
6. The servo drive is faulty.	If the fault persists though parameters are restored to default settings and the servo drive is powered off and on repeatedly, the servo drive is faulty.	Replace the servo drive.

- E101.1: parameter error in group H00/H01
  Description:

  The total number of parameters changes, which generally occurs after software update. Setpoints of parameters in groups H00 or H01 exceed the limit, which generally occurs after software update.

Cause	Troubleshooting	Solution
The servo drive detects whether parameter values in groups H00 and H01 exceed the upper/lower limit during initialization upon power-on. If yes, the keypad displays E101.1. Motor parameters in group H00 are read from the encoder. Servo drive parameters in group H01 are mapped based on the servo drive model defined by H01.10.	Read H0b.90 and H0b.91 and obtain the abnormal parameter group number. Check groups H00 and H01 to find the parameter whose value exceeds the limit. Confirm whether this parameter range is abnormal.	Replace the motor or drive.

- E101.2: Address error in read/write operation after the number of parameters changes
  Description:

  Address error in read/write operation after the number of parameters changes.

Cause	Troubleshooting	Solution
The total number of parameters changes after software update, leading to address error in read/write operation.	Read H0b.90 and H0b.91 and obtain the abnormal parameter group number.	Rectify the wrong values. Restore default settings.

- E101.9: Parameter attribute initialization check error
  Description:

  Parameter attribute initialization check error.

Cause	Troubleshooting	Solution
Parameter attribute initialization check error	Check whether H0A.99 has been written.	Restore factory settings. If the problems persists after several power cycles, replace the drive.

- E102.0: FPGA communication establishment error
  Description:

  The communication between MCU and FPGA cannot be established.

Cause	Troubleshooting	Solution
The communication between MCU and FPGA cannot be established.	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E102.1: FPGA initialization start error
  Description:

  FPGA failed.

Cause	Troubleshooting	Solution
FPGA cannot start.	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E102.8: FPGA and MCU software version mismatch
  Description:

  FPGA and MCU version mismatch.

Cause	Troubleshooting	Solution
The software versions of MCU and FPGA are inconsistent.	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. Update the FPGA or MCU software.

- E104.1: MCU running timeout (MCU break down)
  Description:

  The access to MCU times out.

Cause	Troubleshooting	Solution
1.FPGA failure 2. FPGA and HOST communication handshaking error 3. Access timeout occurs between HOST and the coprocessor	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E104.2: FPGA running timeout (FPGA break down)
  Description:

  The MCU torque interrupt scheduling time is abnormal. This fault is reported only during commissioning.

Cause	Troubleshooting	Solution
1.FPGA failure 2. FPGA and MCU communication handshaking error	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E104.4: MCU command update timeout
  Description:

  Take the moment when interrupt starts as the starting time, if the time when commands are written to MCU is larger than the time when position and speed regulators are started by FPGA, an alarm will be reported.

Cause	Troubleshooting	Solution
The system reports that the encoder communication time is set improperly or the command calculation time is too long.	The fault persists after the servo drive is powered off and on repeatedly.	Hide the unnecessary functions. Replace the servo drive.

- E120.0: Unknown encoder model
  Description:

  The servo drive detects the encoder model during initialization upon power-on. If the encoder model does not comply with the requirement, E120.0 occurs.

Cause	Troubleshooting	Solution
1. The product (motor or servo drive) code does not exist.	Read the nameplates of the servo drive and motor to check whether SV680P series servo drive and 26-bit servo motor are used. Meanwhile, check whether H00.00 (motor code) is set to 14102. Check the servo drive code (H01.02) to see whether this servo drive code exists.	If the motor code is unknown, set H00.00 to 14102 when the SV680 series servo drive and 23-bit servo motor are used. If the drive code is unknown, check it against the nameplate of the drive. If the drive model is incorrect, contact our technicians.
2. The power rating of the motor does not match that of the servo drive.	Check whether the servo drive code (H01.02) matches the serial-type motor code (H00.05).	Replace the unmatched products.

- E120.1: Unknown motor model
  Description:

  The servo drive detects the motor model defined by H00.00 during initialization upon power-on. If the motor model does not exist, E120.1 occurs.

Cause	Troubleshooting	Solution
The motor model defined by H00.00 is abnormal	Check whether the value of H00.00 matches the data on the nameplate of the used motor.	Rectify the value of H00.00.

- E120.2: Unknown drive model
  Description:

  The servo drive detects the servo drive model defined by H01.10 during initialization upon power-on. If the servo drive model does not exist, E120.2 occurs.

Cause	Troubleshooting	Solution
H01.10 is incorrect	Check the value of H01.10.	Replace the servo drive.

- E120.5: Motor and drive current mismatch
  Description:

  The rated output of the servo drive is far higher than the rated current of the motor. You must use a servo drive of lower rated output or a motor with higher rated current.

Cause	Troubleshooting	Solution
The internal scale value is abnormal.	Check whether the servo drive model is correct. If the set current sampling coefficient is too large, calculation overflow will occur.	Replace the servo drive.

- E120.6: FPGA and motor model mismatch
  Description:

  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.

Cause	Troubleshooting	Solution
FPGA software version and H00.00 mismatch	Check whether the FPGA software version (H01.01) supports the motor model set by H00.00.	Update the FPGA software to support the motor model or replace the motor.

- E120.7: Model check error
  Description:

  The servo drive model parameter cannot be identified.

Cause	Troubleshooting	Solution
Model parameter CRC check failed	Check that the model parameter is present.	Write the model parameter again.

- E120.8: Junction temperature parameter check error
  Description:

  The junction temperature parameter is identified incorrectly.

Cause	Troubleshooting	Solution
Junction temperature parameter CRC check failed	Check that the junction temperature parameter is present.	Rewrite the junction temperature parameter.

- E122.0: Multi-turn absolute encoder setting error
  Description:

  The motor does not match the absolute position mode or the motor code is set improperly.

Cause	Troubleshooting	Solution
The motor does not match the absolute position mode or the motor code is set incorrectly.	Check the motor nameplate to see whether the motor is configured with a multi-turn absolute encoder. Check whether H00.00 (motor code) is set properly.	Reset H00.00 (motor code) according to the motor nameplate or use a suitable motor.

- E122.1: Different DIs assigned with the same function
  Description:

  1. The same function is assigned to different DIs. 2. The DI function No. exceeds the maximum number allowed for DI functions.

Cause	Troubleshooting	Solution
1. The same function is allocated to different DIs.	Check whether parameters in groups H03 (H03.02, H03.04...H03.20) and H17 (H17.00, H17.02...H17.30) are assigned with the same non-zero DI function No.	Assign different DI function numbers to parameters in groups H03 or H17, and then restart the control circuit to activate the assignment, or switch off the S-ON signal and send a "RESET" signal to activate the assignment.
2. The DI function No. exceeds the maximum number allowed for DI functions.	Check whether the MCU program is updated.	Restore system parameters to default values (H02.31 = 1) and restart the servo drive.

- E122.2: Different DOs assigned with the same function
  Description:

  The DO function No. exceeds the maximum number allowed for DO functions

Cause	Troubleshooting	Solution
The DO function No. exceeds the maximum number allowed for DO functions	Check whether DO function numbers defined by H04.00 and H04.02 are abnormal.	Set the correct DO function No.

- E122.3: Upper limit in the rotation mode invalid
  Description:

  The upper limit (reference range) of the mechanical single-turn position exceeds 2^{31} in the absolute position rotation mode.

Cause	Troubleshooting	Solution
The upper limit (reference range) of the mechanical single-turn position exceeds 2^{31} in the absolute position rotation mode.	Check the setting of the mechanical gear ratio, the upper limit of mechanical single-turn position and the electronic gear ratio when the servo drive runs in the absolute 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}.

- E122.4: Different VDIs assigned with the same function
  Description:

  The same function is assigned to different VDIs. The VDI function No. exceeds the maximum number allowed for VDI functions.

Cause	Troubleshooting	Solution
1. The same function is assigned to different VDIs	Check whether parameters in groups H03 (H03.02, H03.04...H03.20) and H17 (H17.00, H17.02...H17.30) are assigned with the same non-zero DI function No.	Assign different DI function numbers to parameters in groups H03 or H17, and then restart the control circuit to activate the assignment, or switch off the S-ON signal and send a "RESET" signal to activate the assignment.
2. The VDI function No. exceeds the maximum number allowed for VDI functions.	Check whether the MCU program is updated.	Restore system parameters to default values (H02.31 = 1) and restart the servo drive.

- E122.5: DI and VDI assigned with the same function
  Description:

  The same function is assigned to different VDIs. The VDI function No. exceeds the maximum number allowed for VDI functions.

Cause	Troubleshooting	Solution
Two or more DIs and VDIs are assigned with the same function No.	Check whether DI function numbers set in groups H03 and H17 are repetitive.	Change any repetitive number.

- E122.6: Absolute function setting fault of the 2nd encoder
  Description:

  The motor does not match the absolute mode.

Cause	Troubleshooting	Solution
The motor does not match the absolute mode.	Check the motor nameplate to see whether the motor is configured with a multi-turn absolute encoder.	Set H0F.02 to 0.

- E122.7: Fully closed-loop parameter setting error
  Description:

  In fully closed-loop applications, the inner loop is set to rotation mode.

Cause	Troubleshooting	Solution
When H0F.00 is not 0, set H02.01 to 2 (absolute position rotation mode)	Check the value of H02.01 if fully closed-loop is used.	Set the value of H02.01 to 2 if fully closed-loop is used.

- E122.8: Interpolator version mismatch
  Description:

  Interpolator version mismatch.

Cause	Troubleshooting	Solution
The T2 interpolator does not match the motor.	Check whether H00.50 is consistent with H00.51, and they are not 65535.	Check whether the interpolator is misused. For the alarm caused by replacing the interpolator, write the corresponding factory parameters and into the interpolator.

- E126.0: Process segment number error
  Description:

  Process segment number error

Cause	Troubleshooting	Solution
The process segment number is not 1000 or any other value from 0 to 15 in the process segment mode.	Check whether the value of H22.00 exceeds the specified range of process segment number (0–15 or 1000).	Write 0...15 to H22.00 in the technology segment mode.

- E126.1: Process segment internal operation mode error

Description:

Internal operation mode error of the process segment

Cause	Troubleshooting	Solution
The technology segment operation mode is not 0, 1, 2, 3, 7, or 8.	Check whether the values of bit0 to bit3 of the parameter defined by the process segment at fault are 0, 1, 2, 3, 7, and 8.	Set the technology segment operation mode to 0, 1, 2, 3, 7, and 8 in the technology segment mode.

- E126.2: Position reference type error in process segment position mode
  Description:

  Position reference type error in process segment position mode

Cause	Troubleshooting	Solution
The position reference type in the process segment position mode is not 00 (absolute reference) or 10 (incremental mode).	Check whether the value of bit6 or bit7 of the parameter defined by the process segment at fault is 00 or 10.	Set the position reference type in the process segment position mode to 00 (absolute reference) or 10 (incremental reference).

- E136.0: Encoder ROM motor parameter check error
  Description:

  When reading parameters in the encoder ROM, the servo drive detects that no parameters are saved there or parameter values are inconsistent with the setpoints.

Cause	Troubleshooting	Solution
1. The servo Servo drive model does not match the motor model.	View the servo drive and servo motor nameplates to check whether the SV680 series servo drive and servo motor are used.	Replace the servo drive and motor.
2. A parameter check error occurs or no parameter is saved in the ROM of the serial incremental encoder.	Check whether the encoder cable provided by Inovance is used. For cable specifications, see "Matching Cables". The cable must be connected securely without scratching, breaking or poor contact on both ends. Measure signals PS+, PS-, +5V and GND on both ends of the encoder cable and observe whether signals at both ends are consistent. For signal pin assignment, see the section related to wiring.	Use the encoder cable provided by Inovance. Ensure motor terminals are connected securely and servo drive screws are tightened properly. Use a new encoder cable if necessary. Route encoder cables and power cables (RST, UVW) through different routes.
3. The servo drive is faulty.	The fault persists after the servo drive is restarted.	Replace the servo drive.

- E136.1: Encoder ROM motor parameter read error
  Description:

  The encoder cable is not connected properly. A communication error occurs on the encoder due to interference.

Cause	Troubleshooting	Solution
1. The encoder cable connections are incorrect or loosened.	Check the wiring of the encoder. Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder.	Connect the encoder cables according to the correct wiring diagram. Re-connect encoder cables and ensure encoder terminals are connected securely.
2. The servo drive is faulty.	The fault persists after the servo drive is restarted.	Replace the servo drive.
3. Encoder communication is interfered with.	Check whether E136.1 occurs occasionally.	Install a magnetic ring. Route the power cable and communication cable separately.

- E136.9: Dimension parameter Initialization error
  Description:

Dimension parameter Initialization error

Cause	Troubleshooting	Solution
Encoder read-write error causes 32-bit dimensional compatibility initialization error.	Check whether H32.50 is set to enable compatibility.	If the encoder communication error still occurs after you disable compatibility, takes measures accordingly. If power-on is normal after you disable compatibility. turn on the alarm and contact the technical support personnel of Inovance.

- E138.0: Accuracy compensation data error
  Description:

  Accuracy compensation data error

Cause	Troubleshooting	Solution
1. Check failed because accuracy compensation data is lost. 2. FLASH hardware failure.	Read the drive compensation data from the commissioning software and observe whether the data is normal.	Compensate again through the commissioning software and power off to restart. If the alarm remains, contact the manufacturer.

- E138.1: Cogging ripple compensation data check failure
  Description:

  Cogging ripple compensation data check failure

Cause	Troubleshooting	Solution
1. Check failed because cogging ripple compensation data is lost. 2. FLASH hardware failure.	Read data through InoDriverShop.	Compensate again through the commissioning software and power off to restart. If the alarm remains, contact the manufacturer.

- E138.2: Gantry sync compensation data check failure
  Description:

  Gantry sync compensation data check failure

Cause	Troubleshooting	Solution
1. Check failed because gantry synchronization compensation data is lost. 2. FLASH hardware failure.	Read data through InoDriverShop.	Compensate again through the commissioning software and power off to restart. If the alarm remains, contact the manufacturer.

- E138.3: Overload compensation data check failure

Description:

Overload compensation data check failure

Cause	Troubleshooting	Solution
1. Check failed because overload compensation data is lost. 2. FLASH hardware failure.	Read data through InoDriverShop.	Compensate again through the commissioning software and power off to restart. If the alarm remains, contact the manufacturer.

- E140.1: MCU key calculation failed
  Description:

  The version of the encryption chip is incorrect.

Cause	Troubleshooting	Solution
Communication failure between MCU and the encryption chip	Check whether the error persists after restart.	Ask the manufacturer to flash the encryption software.

- E140.4: Signature verification failed
  Description:

  Signature verification of the encryption chip failed.

Cause	Troubleshooting	Solution
Encryption software is not flashed	Check whether the error persists after restart.	Ask the manufacturer to flash the encryption software.

- E150.0: STO safety state applied
  Description:

  The STO input protection applies (safety state).

Cause	Troubleshooting	Solution
STO is triggered because either or both of two 24 V inputs are disconnected.	Check whether the STO function is activated. Check whether the STO power supply is normal. The fault persists after preceding causes are rectified.	It does not affect normal operation. After the STO terminal is back to normal, clear the fault using the fault reset function. Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected. Replace the servo drive.

- E150.1: STO input state abnormal
  Description:

The single-channel input of STO is ineffective.

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

- E150.2: Buffer 5 V supply error
  Description:

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

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

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

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

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

- E150.4: PWM buffer hardware diagnosis failure
  Description:

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

Cause	Troubleshooting	Solution
STO buffer power-on detection abnormal	The fault persists and the keypad displays E150.4 after restart.	Replace the servo drive.

- E150.5: STO input signal interference
  Description:

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

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

- E201.0: Phase-P overcurrent
  Description:

  An excessively high current flows through the positive pole of the DC-AC circuit.

Cause	Troubleshooting	Solution
1. Gains are set improperly, leading to motor oscillation.	Check whether vibration or sharp noise occurs during start and operation of the motor, or view "Current feedback" in the software tool.	The motor parameters are set improperly, modify the motor parameters. The current loop parameters are set improperly, re-adjust the current loop parameters. Improper speed loop parameters cause vibration. Servo drive operates improperly. Replace it.
2. The encoder cable is aged or corroded, or connected incorrectly or loosely.	Check whether the encoder cable provided by Inovance is used. Check whether the cable is aging, corroded, or connected loosely. Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.17h (Electrical angle) changes as motor shaft rotates.	Re-solder, tighten or replace the encoder cable.

Cause	Troubleshooting	Solution
3. The servo drive is faulty.	Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.17 (Electrical angle) changes as motor shaft rotates. Disconnect the motor cable but the fault persists after the servo drive is powered off and on again. Check whether resistance of the external braking resistor is too small or the braking resistor is short-circuited (between terminals P ⊕ , C).	Use an external braking resistor of matching resistance. Perform wiring again. Replace the servo drive.
4. Overcurrent occurs on the braking resistor.	Check whether resistance of the external braking resistor is too small or the braking resistor is short-circuited (between terminals P, C).	Use a braking resistor of matching resistance. Perform wiring again.

- E201.1: Phase-U overcurrent

  Description:

  A current higher than the threshold is collected in the phase-U current.

Cause	Troubleshooting	Solution
1. Motor cables are in poor contact.	Check whether the servo drive power cables and motor cables on the U, V, and W sides of the servo drive are loose.	Tighten the cables that are loose or disconnected.
2. The motor cables are grounded.	After confirming the drive power cables and motor cables are connected properly, measure whether the insulation resistance between the drive U/V/W side and the PE cable is at MΩ level.	Replace the motor in case of poor insulation.

Cause	Troubleshooting	Solution
3. U/V/W cables of the motor are short-circuited.	Disconnect motor cables and check whether short circuit occurs among motor U/V/W cables and whether burrs exist in the wiring.	Connect the motor cables correctly.
4. The motor is damaged.	Disconnect the motor cables and measure whether the resistance among UVW phases of motor cables is balanced.	Replace the motor if the resistance is unbalanced.

- E201.2: Phase-V overcurrent
  Description:

  A current higher than the threshold is collected in the phase-V current.

Cause	Troubleshooting	Solution
1. Motor cables are in poor contact.	Check whether the servo drive power cables and motor cables on the U, V, and W sides of the servo drive are loose.	Tighten the cables that are loose or disconnected.
2. The motor cables are grounded.	After confirming the drive power cables and motor cables are connected properly, measure whether the insulation resistance between the drive U/V/W side and the PE cable is at MΩ level.	Replace the motor in case of poor insulation.
3. U/V/W cables of the motor are short-circuited.	Disconnect motor cables and check whether short circuit occurs among motor U/V/W cables and whether burrs exist in the wiring.	Connect the motor cables correctly.
4. The motor is damaged.	Disconnect the motor cables and measure whether the resistance among UVW phases of motor cables is balanced.	Replace the motor if the resistance is unbalanced.

- E201.4: Phase-N overcurrent
  Description:

  An excessively high current flows through the negative pole of the DC-AC circuit.

Cause	Troubleshooting	Solution
1. Gains are set improperly, leading to motor oscillation.	Check whether vibration or sharp noise occurs during start and operation of the motor, or view "Current feedback" in the software tool.	Adjust the gains.
2. The encoder cable is aged or corroded, or connected incorrectly or loosely.	Check whether the encoder cable provided by Inovance is used and whether the cable is aging, corroded, or connected loosely.	Re-solder, tighten or replace the encoder cable.
3. Overcurrent occurs on the braking resistor.	Check whether resistance of the external braking resistor is too small or the braking resistor is short-circuited (between terminals P ⊕ , C).	Use a braking resistor of matching resistance. Perform wiring again.
4. Overcurrent is caused by the superposition of the braking current and phase current.	Check if the drive accelerates abruptly during braking. Check if the voltage feedback exceeds the release threshold through the Inovance drive commissioning platform, and if the torque command increases abruptly.	Increase the acceleration/ deceleration time.
5. The servo drive is faulty.	Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.17 (Electrical angle) changes as motor shaft rotates. Disconnect the motor cable but the fault persists after the servo drive is powered off and on again.	Replace the servo drive.

- E208.2: Encoder communication timeout
  Description:

  The FPGA detected a communication timeout with the encoder.

Cause	Troubleshooting	Solution
The servo drive fails to receive the data fed back by the encoder in three consecutive cycles.	Check whether H00.00 (Motor code) is set properly. Check whether the encoder cable is connected incorrectly, damaged, interfered with, or too long. Check whether the encoder version (H00.04) is set properly. It may be set to 0 or 65535 incorrectly. (You only need to check the version in the case of an Inovance encoder.) Check whether the encoder is faulty (see H0B.28 for details). 5. Check bit12 of H0b.30.	Modify the motor model according to the nameplate or use a suitable motor. Replace the cable or take additional anti-interference measures. If the cable is too long, you can change the value of H01.60. Perform a power cycle to read the version again. Use H0D.20 or perform a power cycle to check whether the fault persists. 5. The servo drive operates improperly. Replace it.

- E208.4: FPGA current loop operation timeout
  Description:

  The operating time of the current loop exceeds the interval threshold.

Cause	Troubleshooting	Solution
FPGA operation timeout	Internal fault code H0b.45 = 4208: Current loop operation timeout	Disable some unnecessary functions, such as notch and speed observer, to reduce the operating load of the current loop. Modify the value of H01.60, which may lead to slow response and noise of the motor.

- E210.0: Output short-circuited to ground
  Description:

  An abnormal motor phase current or bus voltage is detected during power-on self-testing. 1. The DC bus voltage exceeds the discharge threshold. 2. The phase U current of size C/D/E models is greater than 1/4 of H01.07. 3. Overcurrent occurs on phase-P and phase-N of servo drives in SIZE A and B.

Cause	Troubleshooting	Solution
1. The servo drive power cables (U/V/W) are short-circuited to ground.	Disconnect the motor cables and measure whether the servo drive power cables (U/V/W) are short-circuited to ground (PE).	Connect the cables again or replace the servo drive power cables.
2. The motor is short-circuited to ground.	After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive U/V/W side and the PE cable is at MΩ level.	Replace the motor.
3. The servo drive is faulty.	Disconnect the power cables from the servo drive, but the fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.
4. The motor speed is too high during grounding detection.	Check whether the motor is in the generating status during power-on.	Reduce the motor speed to less than 10 rpm.
5. Control circuit bus voltage is greater than the discharge threshold.	Check whether the bus voltage is higher than the bus discharge threshold (H01.41) when the fault is logged.	Set the discharge threshold correctly.

- E234.0: Runaway (protection scheme 1)
  Description:

  The torque reference direction is opposite to the speed feedback direction in the torque control mode. The speed feedback direction is in reverse to the speed reference direction in the position or speed control mode.

Cause	Troubleshooting	Solution
1. The UVW cables are connected incorrectly.	Check whether the servo drive power cables are connected in the correct sequence at both ends.	Connect the UVW cables according to the correct sequence.
2. The interference signal causes an error in the initial phase detection of the motor mover 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.

Cause	Troubleshooting	Solution
3. The encoder model is wrong or the encoder is wired improperly.	View the servo drive and servo motor nameplates to check whether the devices used are Inovance SV680N series servo drive and 23-bit servo motor.	Replace with a mutually-matching servo drive and servo motor. For use of of SV680N series servo drive and 26-bit servo motor, set H00.00 to 14102. Check the motor model, encoder type, and encoder cable connection again.
4. The encoder cable is aged or corroded, or connected incorrectly or loosely.	Check whether the encoder cable provided by Inovance is used and whether the cable is aging, corroded, or connected loosely. Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.10 (Electrical angle) changes as motor shaft rotates.	Re-solder, tighten or replace the encoder cable.
5. The gravity load in vertical axis applications is too large.	Check whether the load of the vertical shaft is too large. Adjust brake parameters H02.09...H02.12 and check whether the fault is cleared.	Reduce the load of the vertical axis, increase the stiffness level, or hide this fault without affecting the safety performance and normal use.
6. Improper parameter settings lead to excessive vibration.	The stiffness level is set to an excessively high value, leading to excessive vibration.	Set a proper stiffness level to avoid excessive vibration.

- E234.1: Runaway (protection scheme 2)
  Description:

  The torque reference direction is opposite to the speed feedback direction in the torque control mode. The speed feedback direction is in reverse to the speed reference direction in the position or speed control mode.

Cause	Troubleshooting	Solution
1. The motor output is limited due to torque limit or current saturation.	Check whether the motor is operating beyond its capacity or torque is limited.	Relax the torque limit, reduce acceleration/ deceleration and operation speed, or use a motor with matching capacity.
2. Host controller command direction is incorrect or position increment is too large.	Check whether 607Ah and 6064h are aligned in the host controller program. Check whether the command of the host controller changes abnormally. Check whether the electronic gear ratio of the servo drive is set to an excessively large value.	Align 607Ah and 6064h. Set a proper electronic gear ratio.
3: Collision	Check whether a collision occurs. Check whether the commands of the host controller are properly planned and whether the trajectory overlap that of any other mechanism.	Optimize the command planning of the host controller, increase the safety distance between mechanisms and increase the zero-speed stop safe distance for DB-less models.
4. The working conditions triggered the runaway alarm.	Check whether there is a waveform consistent with the runaway conditions. Check whether the load of the vertical shaft is too heavy and check whether the torque is limited in the non-torque mode.	If the load of the vertical shaft is too heavy and the brake is not applied in a timely manner, adjust the brake parameters H02.09 to H02.12 or increase the stiffness. Release the runaway threshold and set proper parameters to avoid excessive vibration. Ensure to take additional protection measures to mask runaway alarms, such as torque limit or changing the No. 2 fault to DB stop or coast to stop.

Cause	Troubleshooting	Solution
5. Electrical angle error.	Check whether the UVW phase sequence is correct. Check whether the encoder cable and power cable belong to the same motor. Check whether the electrical angle is auto-tuned. Check whether Hall is installed correctly. Check whether there is any deviation between the electrical angle and absolute position feedback of the same physical position before and after runaway or after a period of operation.	Connect the cables correctly. Perform angle auto-tuning again. Install the Hall sensor correctly. Perform electrical angle auto-tuning for several times and power on to check the electrical angle.
6. Power cable and encoder cable failure, motor and drive damage	Inspect the power cable and encoder cable for aging and corrosion, loose joints, and broken wire cores. Check the encoder cable for shield failure, reading head contamination, and power cable interference. Check whether the motor and drive components are damaged.	Re-solder, tighten or replace the power cable or encoder cable. Replace the motor and drive.

- E308.0: Pulse encoder phase A wire breakage
  Description:

  Pulse encoder phase A wire breakage

Cause	Troubleshooting	Solution
1. Phase A of the encoder is wired improperly. 2. The motor is set to a model with a pulse encoder.	Check the wiring of the encoder. Check whether the motor code H00.00 is set correctly and matches the connected encoder.	Reconnect the encoder and power off and restart. Check whether the motor code H00.00 is set correctly and matches the connected encoder.

- E308.1: Pulse encoder phase B wire breakage
  Description:

  Pulse encoder phase B wire breakage

Cause	Troubleshooting	Solution
1. Phase B of the encoder is wired improperly.	Check the wiring of the encoder.	Reconnect the encoder and power off and restart.

- E308.2: Pulse encoder phase Z wire breakage

Description:

Pulse encoder phase Z wire breakage

Cause	Troubleshooting	Solution
1. Phase Z of the encoder is wired improperly. 2. The connected encoder does not have phase Z.	Check the wiring. Check the encoder manual.	Connect the encoder again. Re-install the motor and select an AB two-phase encoder on the encoder configuration page.

- E320.0: Braking resistor overload
  Description:

  The braking resistor is overloaded.

Cause	Troubleshooting	Solution
The accumulative heat of the braking resistor exceeds the maximum thermal capacity of the braking resistor.	Check whether the value of H0b.67 exceeds 100%.	Check if large discharge current is present due to high bus voltage. Ensure that the motor cannot be driven reversely. Replace the servo drive.

Caution

In applications where the motor drives a vertical axis or is driven by the load, set H0A.12 to 0 to hide the runaway fault.

- E320.1: External braking resistor surface temperature too high
  Description:

  The accumulative heat of the built-in braking resistor is too great.

Cause	Troubleshooting	Solution
The accumulative heat of the built-in braking resistor is too great.	Cut off the power and check the braking resistor for over-temperature.	Check if large discharge current is present due to high bus voltage. Ensure that the motor cannot be driven reversely. Replace the servo drive.

- E321.0: Dynamic brake resistor overload
  Description:

  The dynamic braking resistor is overloaded.

Cause	Troubleshooting	Solution
The accumulative heat of exceed braking resistor exceeds the maximum thermal capacity of the resistor.	Check whether the value of H0b.98 exceeds 100%.	Ensure that the motor cannot be driven reversely in the dynamic braking state.

- E400.0: Main circuit overvoltage
  Description:

  The DC bus voltage between P ⊕ and N ⊖ exceeds the overvoltage threshold. 220 V servo drive: Normal value 310 V Overvoltage threshold 420 V. 380 V servo drive: Normal value 540 V Overvoltage threshold 760 V.

Cause	Troubleshooting	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 input voltage of the main circuit cables on the drive side (RST) 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 drive: Valid 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 range.
2. The power supply is unstable or affected by lightning.	Check whether the power supply is unstable, affected by lightning, or complies with the preceding range.	Connect a surge protection device (SPD) and switch on the power supplies of the control circuit and the main circuit. If the fault persists, replace the servo drive.

Cause	Troubleshooting	Solution
3. The braking resistor fails.	If the built-in braking resistor is used (H02.25 = 0), check whether terminals P ⊕ and D are jumpered. If yes, measure the resistance between terminals C and D to ensure that the resistor works normally. If an external braking resistor is used (H02.25 = 1 or 2), measure the resistance of the external braking resistor connected between terminals P⊕ and C.	If the resistance is "∞" (infinite), the braking resistor is disconnected internally. If you use a built-in braking resistor with insufficient discharge capability, use an external braking resistor (H02.25 = 1 or 2) instead and remove the jumper between terminals P⊕ and D. The resistance of the external braking resistor can be equal to or smaller than the built-in one and the power must not be smaller than the built-in one. If you use an external braking resistor which is damaged or has insufficient power, replace it with a new one with larger power and connect the new one between terminals P ⊕ and C. Set H02.26 (Power of external braking resistor) and H02.27 (Resistance of external braking resistor) to values consistent with the specifications of the external braking resistor used.
4. The resistance of the external braking resistor is too large, resulting in insufficient energy absorption during braking.	Measure the resistance of the external braking resistor connected between terminals P ⊕ and C. Compare the measured value with the recommended value.	Connect a new external braking resistor with recommended resistance between terminals P ⊕ and C. Set H02.26 (Power of external braking resistor) and H02.27 (Resistance of external braking resistor) to values consistent with the specifications of the external braking resistor used.

Cause	Troubleshooting	Solution
5. The motor is in abrupt acceleration/deceleration status and the maximum braking energy exceeds the energy absorption value.	Confirm the acceleration/ deceleration time during running and measure the DC bus voltage between P ⊕ and N to check whether the voltage exceeds the fault threshold during deceleration.	After confirming the input voltage of the main circuit is within the specified range, increase the acceleration/ deceleration time if the operating conditions allow.
6. The bus voltage sampling value deviates greatly from the measured value.	Check whether H0b.26 (Bus voltage) is within the following range: 220 V servo drive: H0b.26 ＞ 420 V 380 V servo drive: H0b.26 ＞ 760 V Measure whether the DC bus voltage N between P ⊕ and N ⊖ is normal and less than the value of H0b.26.	Contact Inovance for technical support.
7. The servo drive is faulty.	The fault persists after the main circuit is powered off and on repeatedly.	Replace the servo drive.

- E410.0: Main circuit undervoltage

  Description:

  The DC bus voltage between P ⊕ and N ⊖ is lower than the undervoltage threshold. 220 V servo drive: Normal value: 310 V Undervoltage threshold: 200 V (180 V for S5R5 models) 380 V servo drive: Normal value 540 V Overvoltage threshold 380 V.

Cause	Troubleshooting	Solution
1. The power supply of the main circuit is unstable or power failure occurs. 2. Instantaneous power failure occurs.	Check the specifications of the input power supply. Measure whether the input voltages of the main circuit on the non-drive side and the drive side (RST) are within the following range: 220 V servo drive: Valid value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) All the three phases need to be measured.	Increase the capacity of the power supply.
3. The power voltage drops during running.	Monitor the power supply voltage and check whether the main circuit power supply is applied to other devices, resulting in insufficient power capacity and voltage drop.	Increase the capacity of the power supply.

Cause	Troubleshooting	Solution
4. A three-phase servo drive is connected to a single-phase power supply, leading to phase loss.	Check the wiring of the main circuit.	Replace the cables and connect the main circuit cables properly.
5. The servo drive is faulty.	Check whether H0b.26 (Bus voltage) is within the following range: 220 V drive: H0b.26 ＞ 200 V 380 V servo drive: H0b.26＜ 380 V. The fault persists after the main circuit (RST) is powered off and on repeatedly.	Replace the servo drive.

- E410.1: Main circuit de-energized
  Description:

  Phase loss occurs on the three-phase servo drive.

Cause	Troubleshooting	Solution
The power supply is disconnected during operation.	Check the power input specifications of the servo drive and measure whether the input voltage at the power supply side of the main circuit cables and R/S/T on the drive side is within the following range: 220 V servo drive: Valid value: 220 V to 240 V Allowable deviation: –10% to +10% 380 V drive: Valid value: 380 V to 440 V Allowable deviation: –10% to +10% All the three phases need to be measured. Monitor the power supply voltage and check whether the main circuit power supply is applied to other devices, resulting in insufficient power capacity and voltage drop. Check whether H0b.26 (Bus voltage) complies with the following specifications: 220 V servo drive: H0b.26＜200V. 380 V drive: H0b.26＜ 380 V. The fault persists after the main circuit is powered off and on repeatedly. 4. Check the wiring of the main circuit.	Increase the capacity of the power supply. Replace the servo drive. Replace the cables and connect the main circuit cables (RST/L1L2L3) properly.

- E420.0: Main circuit phase loss
  Description:

  Drive three-phase input phase abnormal.

Cause	Troubleshooting	Solution
1. The three-phase input cables are connected improperly.	Check whether RST cables on the drive side and non-drive side are in good condition and connected properly.	Replace the cables and connect the main circuit cables properly.
2. A single-phase power supply is used for a three-phase servo drive 3. The three-phase power supply is imbalanced or the voltages of the three phases are too low.	Check the specifications of the power supply 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 drive: Valid value: 380 V to 4240 V Allowable deviation: –10% to +10% (342 V to 484 V) All the three phases need to be measured.	Servo drives of 0.75 kW (H01.10 = 5) can be supplied by single-phase power supplies. If the input voltage complies with the specifications, set H0A.00 (power input phase loss protection) to 2 (inhibit phase loss faults and alarms). If input voltage is outside the specified range, replace or adjust the power supply.

- E500.0: motor overspeed
  Description:

  The actual feedback speed of the motor exceeds the overspeed threshold.

Cause	Troubleshooting	Solution
1. The UVW phase sequence of the motor is incorrect.	Check whether the servo drive power cables are connected in the correct sequence at both ends.	Connect the UVW cables according to the correct sequence.
2. H0A.08 is set improperly.	Check whether the overspeed threshold is lower than the maximum speed. Overspeed threshold = 1.2 x Maximum motor speed (H0A.08 = 0) Overspeed threshold = H0A.08 (H0A.08 ≠ 0, and H0A.08 < 1.2 x Maximum motor speed)	Re-set the overspeed threshold according to the mechanical requirements.

Cause	Troubleshooting	Solution
3. The input reference exceeds the overspeed threshold.	Check whether the motor speed corresponding to the input reference exceeds the overspeed threshold. In CSP mode, check the gear ratio 6091.01h/6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). In HM mode, check the gear ratio 6091.01h/ 6091.02h, and determine 6099.01h and 6099.02h. In speed control mode, view the gear ratio 6091-01h/ 6091-02h, and the values of 60FFh (Target velocity), 2006-H06.06 to 2006-H06.09, and 607Fh (Max profile velocity). In torque control mode, view the value of H07.17 (Speed limit source) and the corresponding speed limit value.	CSP: Decrease the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. PP: Decrease the value 6081h or increase the acceleration/ deceleration ramp (6083h, 6084h). HM: Decrease 6099.01h and 6099.02h or increase the acceleration/ deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions. Speed control mode: Decrease the target velocity, speed limit, and gear ratio. In PV mode, increase the speed ramp (6083h and 6084h). In CSV mode, the host controller should cover the speed ramp. In the torque control mode, set the speed limit to a value lower than the overspeed threshold.
4. The motor speed overshoots.	When H0A.08 = 0, check whether the speed feedback exceeds 1.2 times the maximum motor speed (H00.15). When the value of H0A.08 is not 0, check whether the speed feedback exceeds the setpoint of H0A.08.	Adjust the gain or mechanical running conditions.
5. The servo drive is faulty.	The fault persists after the servo drive is powered off and on again.	Replace the servo drive.

Cause	Troubleshooting	Solution
6: Encoder data error	Check whether there is interference, whether encoder type selection is incorrect, or whether encoder parameter settings are incorrect.	Take interference shielding measures, such as magnetic rings and shielding cables. Check whether the encoder type is selected correctly. If not, replace the encoder type correctly. Set the encoder parameters properly according to encoder manual.
7. The selected motor type is incorrect.	Check whether the type of the motor is set improperly. For example, the linear motor is set to a rotary motor or the rotary motor is set to a linear motor.	Replace the actual motor with the correct type or change the value of H00.00 to the correct motor type.

- E500.1: Speed feedback overflow
  Description:

  The FPGA speed measurement overflows.

Cause	Troubleshooting	Solution
1. FPGA internal speed overflows.	Check whether the servo drive power cables are connected in the correct sequence at both ends.	Connect the UVW cables according to the correct sequence.
2. The motor speed overshoots.	Check whether the speed feedback exceeds the overspeed threshold by using Inovance servo commissioning software. Overspeed threshold: 16384 rpm for a rotary motor, 8192 rpm for a DDR motor, and 16384 mm/s for a linear motor.	Adjust the gain or mechanical running conditions.

Cause	Troubleshooting	Solution
3: Encoder data error	Check whether there is interference, whether encoder type selection is incorrect, or whether encoder parameter settings are incorrect.	Take interference shielding measures, such as magnetic rings and shielding cables. Check whether the encoder type is selected correctly. If not, replace the encoder type correctly. Set the encoder parameters properly according to encoder manual.
4. The selected motor type is incorrect.	Check whether the type of the motor is set improperly. For example, the linear motor is set to a rotary motor or the rotary motor is set to a linear motor.	Replace the actual motor with the correct type or change the value of H00.00 to the correct motor type.

- E500.2: FPGA position feedback pulse overspeed
  Description:

  The MCU has detected that the position feedback increment from the FPGA is too large.

Cause	Troubleshooting	Solution
1. The MCU has detected that the position feedback increment from the FPGA is too large.	Check whether the value of H0B.17 changes abruptly.	Modify the value of H0A.70 (Overspeed threshold), which is 0 by default. Use the maximum speed of the motor as the threshold for large feedback increment.
2: Encoder data error	Check whether there is interference, whether encoder type selection is incorrect, or whether encoder parameter settings are incorrect.	Take interference shielding measures, such as magnetic rings and shielding cables. Check whether the encoder type is selected correctly. If not, replace the encoder type correctly. Set the encoder parameters properly according to encoder manual.
3. The selected motor type is incorrect.	Check whether the type of the motor is set improperly. For example, the linear motor is set to a rotary motor or the rotary motor is set to a linear motor.	Replace the actual motor with the correct type or change the value of H00.00 to the correct motor type.

- E602.0: Angle auto-tuning failure
  Description:

Unusual jitter occurs on the encoder feedback during angle auto-tuning.

Cause	Troubleshooting	Solution
1. Locked-rotor occurred in mechanical equipment. 2. The data fed back by the encoder is abnormal. 3. U, V and W power cables are incorrectly connected or disconnected. 4. The drive/motor is faulty.	Stop the motor and push it to check whether locked-rotor occurred. Push the motor and observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement? Check the wiring. Use a multimeter to check wire breakage. If none of the above solves the problem, contact the manufacturer.	If yes, eliminate the problem and perform angle auto-tuning (phase sequence auto-tuning) again. If you determine that the feedback data of the encoder is abnormal, replace the encoder and perform angle auto-tuning (phase sequence auto-tuning) again. If any improper connection is found, reconnect the cables perform angle auto-tuning (phase sequence auto-tuning) again. If none of the above solves the problem, contact the manufacturer.

- E602.1: Angle auto-tuning overtravel
  Description:

  Angle auto-tuning overtravel

Cause	Troubleshooting	Solution
The moving distance during angle auto-tuning is too large. 1. The setting of auto-tuning parameters does not match the load characteristics, and large impact occurred during auto-tuning, resulting in an overtravel alarm. 2. The data fed back by the encoder is abnormal. A false alarm is raised.	Check whether the displacement is really too large, and whether overtravel is caused by the setting of auto-tuning parameters. Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is the feedback operation continuous? Is the observed displacement consistent with the actual displacement?	If the movement during auto-tuning is too large, the overtravel can be avoided by manually reducing the current rising slope (H32.21 closed-loop pre-positioning method) (H32.31 position locking method) or the maximum auto-tuning current (H32.20 closed-loop pre-positioning method) (H32.30 position locking method). If the encoder feedback data is abnormal, replace the encoder, and then identify the angle/phase sequence again.

- E602.2: U/V/W phase sequence reversed
  Description:

  A wrong U/V/W phase sequence is detected during angle auto-tuning.

Cause	Troubleshooting	Solution
The system indicates the UVW wiring is wrong to avoid the motor from losing control.	Check U/V/W wiring through phase sequence auto-tuning.	After phase sequence is corrected, perform angle auto-tuning again. Exchange cables of any two phases and perform angle auto-tuning again.

- E602.3: Large encoder jitter during angle auto-tuning
  Description:

  Large encoder jitter during angle auto-tuning

Cause	Troubleshooting	Solution
Encoder feedback data has large jitter.	Check whether the encoder jitters abnormally at standstill.	Check the wiring of the encoder. Check for external electromagnetic interference. Install a magnetic ring and use shielded cables as necessary. Manually increase H32.14/ H32.16 (inching angle auto-tuning) and H32.34/H32.36 (position locking angle auto-tuning).

- E602.4: Auto-tuning failed. Auto-tuning timeout.
  Description:

  Auto-tuning failed. Auto-tuning timeout.

Cause	Troubleshooting	Solution
If the angle auto-tuning process is not completed in 30 seconds, a timeout alarm is raised. Due to external disturbance (such as vibration of other parts on the bench), the completion condition of angle auto-tuning cannot be met. The feedback data of the encoder is subjected to poor characteristics, interference or anomaly, and the completion condition of angle auto-tuning cannot be met.	Check for vibrating parts on the bench. Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement? Is there abnormal jitter during standby?	Check whether the encoder cable shield is connected properly. If the encoder data is abnormal, replace the encoder, and then auto-tune the angle/phase sequence again. Adjust the angle auto-tuning parameters properly and reduce the completion conditions of angle auto-tuning. For example, you can increase the operation/ standstill evaluation threshold of angle auto-tuning as appropriate.

- E602.5: Angle auto-tuning failed. Z signal not found.
  Description:

  Angle auto-tuning failed. Z signal not found.

Cause	Troubleshooting	Solution
The encoder configuration is incorrect. The connected motor encoder has no Z signal. The Z signal polarity is set incorrectly. The data fed back by the encoder is abnormal. No Z signal is present.	Check whether the encoder has a Z signal. Check if the polarity of the Z signal is configured correctly. Check bit 13 of H00.26. Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement?	Check the wiring of the encoder. Ensure the shielded cables are effectively connected. Check the polarity configuration of Z signal. If the encoder data is abnormal, replace the encoder and then identify the angle again.

- E602.6: Angle auto-tuning does not converge
  Description:

  Angle auto-tuning does not converge

Cause	Troubleshooting	Solution
1. External disturbance (such as vibration of other parts on the bench) is present. 2. Parameters are set incorrectly.	Check for vibrating parts on the bench. Check whether the angle gain is set too large.	Check for external electromagnetic interference. Install a magnetic ring and use shielded cables as necessary. For the position lock method, you can reduce the angle gain (H32.37) manually. For the jog method, you can manually reduce the operation evaluation threshold (H32.13/H32.15) or increase the standstill evaluation threshold (H32.14/H32.16).

- E603.0: Gantry communication CRC failure
  Description:

  Gantry communication CRC failure

Cause	Troubleshooting	Solution
Gantry communication keeps abnormal.	Check the gantry wiring and electromagnetic environment.	Check the gantry wiring and electromagnetic environment.

- E603.1: Gantry communication timeout
  Description:

  Gantry communication timeout

Cause	Troubleshooting	Solution
The gantry communication signal is abnormal or the gantry cable is in poor contact.	Check the gantry wiring and electromagnetic environment. Check whether H14.02 is 1.	Check the gantry wiring and electromagnetic environment.

Note

Alarm EE15.0 is raised if communication is disconnected from the slave axis.

- E603.2: Drive failed to establish communication for a long time
  Description:

  Drive failed to establish communication for a long time

Cause	Troubleshooting	Solution
Gantry communication is disconnected or communication has not been established for a long time.	Check the gantry wiring and electromagnetic environment. Check whether H14.02 is 1.	Check the gantry wiring and electromagnetic environment.

- E604.0: Inconsistent settings of two gantry axes
  Description:

  Inconsistent settings of two gantry axes

Cause	Troubleshooting	Solution
The parameter settings of both axes of the gantry are inconsistent.	Check parameter settings.	Correct the settings.

- E604.1: Gantry not set to position mode
  Description:

  Gantry not set to position mode

Cause	Troubleshooting	Solution
When gantry is enabled, the drive does not run in the position mode.	When gantry is enabled, check whether the drive runs in the position mode.	Switch the drive to the position mode (H02.00).

- E604.2: Gantry is running on an unsupported feature
  Description:

  Gantry is running on an unsupported feature

Cause	Troubleshooting	Solution
Gantry is running on an unsupported feature.	Check whether the gantry configuration parameters meet the requirements of the current control scheme. For example: Rigid gantry control scheme 2 does not support "torque alignment mode", "homing torque pre-alignment" and "gantry alignment deviation compensation value auto-tuning".	Check whether the gantry configuration parameters meet the requirements of the current control scheme and make corrections accordingly.

- E605.0: Motor speed too high upon S-ON
  Description:

  The motor speed exceeds the rated speed when the servo drive in size A/B is switched on.

Cause	Troubleshooting	Solution
The motor speed exceeds the rated speed when the servo drive is switched on.	Check if the drive is enabled when the motor has been driven.	Switch on the drive when the motor is standstill.

- E606.0: Gantry torque alignment timeout
  Description:

  Gantry torque alignment timeout

Cause	Troubleshooting	Solution
Gantry torque alignment times out.	Check whether the alignment time exceeds the alarm threshold set by H14.30.	Increase the alarm threshold to see if the relevant parameters are set properly.

- E612.0: Rotor locked during phase sequence auto-tuning
  Description:

  Rotor locked during phase sequence auto-tuning

Cause	Troubleshooting	Solution
1. Locked-rotor occurred in mechanical equipment. 2. The data fed back by the encoder is abnormal. 3. U, V and W power cables are incorrectly connected or disconnected. 4. The drive/motor is faulty.	Stop the motor and push it to check whether locked-rotor occurred. Push the motor and observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement? Check the wiring. Use a multimeter to check wire breakage. If none of the above solves the problem, contact the manufacturer.	If yes, eliminate the problem and perform angle auto-tuning (phase sequence auto-tuning) again. If you determine that the feedback data of the encoder is abnormal, replace the encoder and perform angle auto-tuning (phase sequence auto-tuning) again. If any improper connection is found, reconnect the cables perform angle auto-tuning (phase sequence auto-tuning) again. If none of the above solves the problem, contact the manufacturer.

- E612.1: Overtravel occurred during phase sequence auto-tuning
  Description:

  Overtravel occurred during phase sequence auto-tuning

Cause	Troubleshooting	Solution
The moving distance during phase sequence auto-tuning is too large. 1. The setting of auto-tuning parameters does not match the load characteristics, and large impact occurred during auto-tuning, resulting in an overtravel alarm. 2. The data fed back by the encoder is abnormal. A false alarm is raised.	Check whether the displacement is really too large, and whether overtravel is caused by the setting of auto-tuning parameters. Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is the feedback operation continuous? Is the observed displacement consistent with the actual displacement?	If the movement during auto-tuning is too large, you can manually reduce the current rising slope (H32.21). If the encoder feedback data is abnormal, replace the encoder, and then identify the angle/phase sequence again.

- E612.3: Large encoder jitter during phase sequence auto-tuning
  Description:

  Large encoder jitter during phase sequence auto-tuning

Cause	Troubleshooting	Solution
Encoder feedback data has large jitter.	Check whether the encoder jitters abnormally at standstill.	Check the wiring of the encoder. Check for external electromagnetic interference. Install a magnetic ring and use shielded cables as necessary. Manually increase H32.24/ H32.25.

- E612.4: Phase sequence auto-tuning failed. Auto-tuning timeout.
  Description:

  Phase sequence auto-tuning failed. Auto-tuning timeout.

Cause	Troubleshooting	Solution
If the phase sequence auto-tuning process is not completed in 30 seconds, a timeout alarm is raised. 1. Due to external disturbance (such as vibration of other parts on the bench), the completion condition of angle auto-tuning cannot be met. 2. The feedback data of the encoder is subjected to poor characteristics, interference or anomaly, and the completion condition of angle auto-tuning cannot be met.	Check for vibrating parts on the bench. Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement? Is there abnormal jitter during standby?	Check whether the encoder cable shield is connected properly. If the encoder data is abnormal, replace the encoder, and then auto-tune the phase sequence again. Adjust the phase sequence auto-tuning parameters properly and reduce the completion conditions of the auto-tuning. For example, you can increase the operation/standstill evaluation threshold as appropriate.

- E619.0: Absolute accuracy compensation parameter setting error
  Description:

  Accuracy compensation parameter setting error

Cause	Troubleshooting	Solution
1. The accuracy compensation interval(H33.64) is set to 0. 2. Inovance communication encoder DDL: 1. The distance from the mechanical home to the correction home exceeds the upper limit of the encoder (encoder unit: 23^{34}). 2. The length of correction exceeds the upper limit of the encoder (2^{34}). 3: Homing mode record error. The value of H33.70 is not in {-2, -1, 1, 2, 4, 6, 17, 18, 24, 28, 33, 34}.	Check whether H33.64 is set to 0. Check whether the distance between the mechanical home and the correction home (start position) exceeds the limit (encoder unit: 2^{34}). Check whether the value of H33.70 is in {-2, -1, 1, 2, 4, 6, 17, 18, 24, 28, 33, 34}.	Set the correct compensation interval. Set the distance between the mechanical home and the correction home properly. Set H33.70 correctly.

- E619.1: Absolute accuracy compensation overflow
  Description:

  1. The input quadrature pulse frequency (quadruple) is greater than 1/(H33.74 x 25 ns). 2. The number of compensated pulses at a time is greater than 1.

Cause	Troubleshooting	Solution
The input quadrature pulse frequency (quadruple) is greater than 1/(H33.74 x 25 ns). 2. The number of compensated pulses at a time is greater than 1.	Check the motor speed at the alarm time. Check the compensation table to see if there is a length greater than 1 index interval.	Reduce motor speed. Load the correct error compensation table.

- E620.0: Motor overload

  Description:

  The accumulative heat of the motor reaches the fault threshold.

Cause	Troubleshooting	Solution
1. The motor and encoder cables are connected incorrectly or in poor contact.	Check the wiring between the servo drive, servo motor and the 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. When customized cables are used, prepare and connect the customized cables according to the wiring instructions.
2. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	Check the overload characteristics of the servo drive or servo motor. Check whether the average load rate (H0b.12) of the servo drive keeps exceeding 100.0%.	Use a servo drive of higher capacity and a matching servo motor. 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. View the value of H08.15 (Load moment of inertia ratio). Confirm the individual operation cycle when the servo motor operates cyclically.	Increase the acceleration/ deceleration time during single-cycle running.
4. The gain adjustment is improper or the stiffness is too high.	Check whether the motor vibrates and generates unusual noise during operation.	Readjust the gain.

Cause	Troubleshooting	Solution
5. The servo drive model or motor model is set improperly.	Check the motor model (H00.00) and drive model (H01.10) stored in the bus encoder.	Check the servo drive nameplate and set the servo drive model (H01.10) and motor model properly according to section "Servo Drive Model and Nameplate" in SV680P Series Servo Drive Hardware Guide.
6. The motor is stalled due to mechanical factors, resulting in overload during operation.	Check the reference and motor speed (H0b.00) through the software tool or keypad. References in the position control mode: H0b.13 (Input position reference counter). References in the speed control mode: H0b.01 (Speed reference). References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
7. The servo drive is faulty.	The fault persists after the 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.

- E620.1: Overload current limit mode, motor overloaded
  Description:

  Overload current limit mode, motor overloaded

Cause	Troubleshooting	Solution
1. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque. 2. Acceleration/deceleration is too frequent or the load inertia is too large. 3. The motor and encoder cables are connected incorrectly or in poor contact. 4. The gain adjustment is improper or the stiffness is too high. 5. The motor is stalled due to mechanical factors, resulting in overload during operation. 6. The servo drive is faulty.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load rate (H0b.12) keeps exceeding 100.0%.	Replace with a servo drive of higher capacity and a matching servo motor, or reduce the load and increase the acceleration/ deceleration time.

- E621.0: Overload current limiting torque attained
  Description:

  Overload current limiting torque attained

Cause	Troubleshooting	Solution
1. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque. 2. Acceleration/deceleration is too frequent or the load inertia is too large. 3. The motor and encoder cables are connected incorrectly or in poor contact. 4. The gain adjustment is improper or the stiffness is too high. 5. The motor is stalled due to mechanical factors, resulting in overload during operation. 6. The servo drive is faulty.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load rate (H0b.12) keeps exceeding 100.0%. Detect whether the value of H3278 is set too high.	Replace with a servo drive of higher capacity and a matching servo motor. Reduce the load and increase the acceleration/ deceleration time.

- E630.0: motor rotor locked over-temperature
  Description:

The actual motor speed is lower than 10rpm but the torque reference reaches the limit, and such status lasts for the time defined by H0A.32.

Cause	Troubleshooting	Solution
1. U/V/W output phase loss, wire breakage 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 wiring diagram or replace the cables.
2. The motor parameters (especially the number of pole pairs) are set improperly, or motor angle auto-tuning is not performed, or motor power is greater than drive power.	View parameters in group H00 to check whether the number of pole pairs are set properly. Perform angle auto-tuning on the motor several times and check whether the value of H00.28 is consistent during angle auto-tuning. Check whether the motor and drive match in the power.	Modify motor parameter values or replace the drive.
3. The communication commands are being disturbed.	Check whether jitter occurs on the commands sent from the host controller and whether EtherCAT communication is being disturbed.	Check whether the communication line between the host controller and the servo drive is being disturbed.
4. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. References in the position control mode: H0b.13 (Input position reference counter). References in the speed control mode: H0b.01 (Speed reference). References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode. Check the current feedback (torque reference) waveform.	Check whether any mechanical part gets stuck or eccentric.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E631.1: 24 V or brake not connected
  Description:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
The brake or the 24 power supply is not connected when the internal brake feature is used. 2. DO or VDO configuration 9: Brake function, and the function is not enabled by H04.24.	Check whether 24 V power supply or the brake is not connected when H02.16 is set to 1. 2. DO or VDO configuration 9: Brake function, and H04.24 = 0.	If you use the internal brake, connect the brake cable and 24 power supply. If you use a DO brake, set H0E-10 to 1.

- E631.2: P-MOS open circuit
  Description:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, P-MOS open circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	Replace the servo drive. Turn off the brake switch H02.16.

- E631.3: N-MOS open circuit
  Description:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, N-MOS open circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	Replace the servo drive. Turn off the brake switch H02.16.

- E640.0: IGBT over-temperature
  Description:

  The IGBT temperature reaches the fault threshold defined by H0A.18.

Cause	Troubleshooting	Solution
1. The ambient temperature is too high. 2. The servo drive is restarted repeatedly to reset the overload fault.	Measure the ambient temperature and view the fault records (set H0b.33 and view H0b.34) to check whether an overload fault/ alarm is reported (E620.0, E630.0, E650.0, E909.0, E920.0, E922.0).	Improve the cooling conditions of the servo drive to lower down the ambient temperature. Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacities 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 works properly during operation.	Replace the servo drive.
4. The servo drive is installed in a wrong direction and the clearance between servo drives is 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 fault persists even though the servo drive is restarted five minutes after power-off.	Replace the servo drive.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E640.1: Flywheel diode overtemperature
  Description:

  The temperature of the flywheel diode reaches the fault threshold defined by H0A.18.

Cause	Troubleshooting	Solution
1. The ambient temperature is too high. 2. The servo drive is restarted repeatedly to reset the overload fault.	Measure the ambient temperature and view the fault records (set H0b.33 and view H0b.34) to check whether an overload fault/ alarm is reported (E620.0, E630.0, E650.0, E909.0, E920.0, E922.0).	Improve the cooling conditions of the servo drive to lower down the ambient temperature. Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacities 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 works properly during operation.	Replace the servo drive.
4. The servo drive is installed in a wrong direction and the clearance between servo drives is 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 fault persists even though the servo drive is restarted five minutes after power-off.	Replace the servo drive.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E650.0: Heatsink overtemperature
  Description:

  The temperature of the servo drive power module is higher than the overtemperature threshold.

Cause	Troubleshooting	Solution
1. The ambient temperature is too high. 2. The servo drive is restarted repeatedly to reset the overload fault.	Measure the ambient temperature and view the fault records (set H0b.33 and view H0b.34) to check whether an overload fault/ alarm is reported (E620.0, E630.0, E650.0, E909.0, E920.0, E922.0).	Improve the cooling conditions of the servo drive to lower down the ambient temperature. Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacities 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 works properly during operation.	Replace the servo drive.
4. The servo drive is installed in a wrong direction and the clearance between servo drives is 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 fault persists even though the servo drive is restarted five minutes after power-off.	Replace the servo drive.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E660.0: Motor overtemperature
  Description:

  The temperature of the air-cooled motor is too high. Or PTC was turned on by mistake through H00.26.

Cause	Troubleshooting	Solution
The temperature of the air-cooled motor is too high. Or PTC was turned on by mistake through H00.26.	Measure whether the temperature of the air-cooled motor is too high. Check whether PTC is enabled on the drive, but the motor has no PTC hardware. Or check whether PTC is connected properly. For an Inovance motor, the temperature threshold is 130°C. For a third-party motor, measure the PTC resistance and determine the motor temperature based on the resistance specifications.	Cool the motor down. Check whether PTC is enabled on the drive, but the motor has no PTC hardware. Or check whether PTC is connected properly.

- E661.0: STune failure
  Description:

  During STune operation, the gain drops to the lower limit. Position loop gain < 5 Speed loop gain < 5 Model loop gain < 10

Cause	Troubleshooting	Solution
During STune operation, the gain drops to the lower limit. Position loop gain < 5 Speed loop gain < 5 Model loop gain < 10	Check if vibration resonance is properly suppressed in the system. The torque vibration amplitude exceeds the setpoint of H09.11.	Set the notch manually. Modify the electronic gear ratio to improve the command resolution, or increase the command filter time constant or in the parameter configuration interface. Check whether the current of the machine fluctuates periodically. Set H09.58 to 1 to clear resonance suppression parameters, and perform STune again.

- E662.0: ETune failure
  Description:

  Check whether resonance that occurred during ETune operation cannot be suppressed.

Cause	Troubleshooting	Solution
Check whether resonance that occurred during ETune operation cannot be suppressed.	Check whether there is abnormal noise or torque fluctuation during operation.	Set the notch manually when vibration cannot be suppressed automatically. Modify the electronic gear ratio to improve the command resolution, increase the command filter time constant or in the parameter configuration interface. Increase the value of H09.11 as appropriate. Check whether the current of the machine fluctuates periodically. Check whether the positioning threshold is too low. Increase the reference acceleration/deceleration time.

- E664.0: Resonance too strong
  Description:

  Resonance occurs on the servo system and the torque fluctuation amplitude is higher than the value of H09.54.

Cause	Troubleshooting	Solution
Resonance occurs on the servo system and the torque fluctuation amplitude is higher than the value of H09.54.	Check whether there is abnormal noise or torque fluctuation during operation.	Check whether the inertia ratio or loop gain parameters are set properly. Check whether resonance parameters are set properly. Increase the value of H09.54 or set H09.54 to 0 to disable this function.

- E720.0: Wrong encoder interface
  Description:

  The drive does not support the selected encoder interface.

Cause	Troubleshooting	Solution
The drive does not support the selected encoder interface.	Check whether H32.01 and H0F.06 are set properly. If the gantry function is turned on, check whether the gantry function conflicts with the master encoder or full closed-loop encoder setting.	Check whether the signal cable required by the current encoder interface scheme exceeds the upper limit of a single interface. Modify H32.01 and H0F.01.

- E731.0: Encoder multi-turn data lost

  Description:

  Encoder multi-turn data lost

Cause	Troubleshooting	Solution
1. The battery of the first encoder is not connected during power-off.	Check whether the battery is connected during power-off.	Set H0d.20 to 1 to clear the fault.
2. The battery voltage of the first encoder is lower than 2.9 V.	Measure the battery voltage.	Use a new battery with the matching voltage.
3. The first encoder is interfered with by a strong magnetic field.	Check whether the encoder is in a strong magnetic field.	Remove the magnetic field and set H0d.20 to 1 to clear the error.

- E731.1: Inovance second encoder multi-turn data lost

  Description:

  Inovance second encoder multi-turn data lost

Cause	Troubleshooting	Solution
1. The battery of the Inovance second encoder is not connected during power-off.	Check whether the battery is connected during power-off.	Set H0d.20 to 1 to clear the fault.
2. The Inovance second encoder battery voltage is lower than 2.9 V.	Measure the battery voltage.	Use a new battery with the matching voltage.
3. The Inovance second encoder is interfered with by a strong magnetic field.	Check whether the encoder is in a strong magnetic field.	Remove the magnetic field and set H0d.20 to 1 to clear the error.

- E733.0: Encoder multi-turn counting error

  Description:

  An encoder multi-turn counting error occurs.

Cause	Troubleshooting	Solution
The encoder is faulty.	Set H0d.20 to 2 to clear the fault, but E733.0 persists after restart.	Replace the motor.

- E733.1: Inovance 2nd encoder multi-turn counting error.
  Description:

  Inovance 2nd encoder multi-turn counting error

Cause	Troubleshooting	Solution
Inovance 2nd encoder error	Set H0d.20 to 3 to clear the fault, but E733.1 persists after restart.	Replace the motor.

- E735.0: Encoder multi-turn counting overflow
  Description:

  A multi-turn counting overflow occurs on the absolute encoder.

Cause	Troubleshooting	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 linear mode (H02.01 = 1).	Set H0d.20 to 2 to power on again. Perform homing if necessary.

- E740.0: Absolute encoder communication timeout
  Description:

  Communication timeout occurs on the absolute encoder.

Cause	Troubleshooting	Solution
The communication between the servo drive and the encoder times out.	Check the wiring of the encoder and power on the servo drive again.	Check whether the encoder version (H00.04) is set properly. Check whether the servo drive software version (H01.00). Check the wiring of the encoder. Replace the servo motor.

- E740.2: Absolute encoder error
  Description:

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

Cause	Troubleshooting	Solution
An error occurs on the communication between the servo drive and the encoder.	Check whether the value of H0b.28 is not 0.	Check whether H00-00 (motor SN) is set properly. Check whether encoder cables are connected properly. Check whether the servo drive and motor are grounded properly. You can wind a magnetic ring on the encoder cable to reduce interference.

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

  Internal fault of the encoder.

Cause	Troubleshooting	Solution
An internal fault occurs on the encoder.	Check whether bit7 of H0b.28 is set to 1.	Check whether the encoder version (H00-04) is proper. Check whether encoder cables are in proper condition. Replace the motor.

- E740.6: Encoder data write error
  Cause:

  The attempt to write the encoder data fails.

Cause	Troubleshooting	Solution
An error occurs when writing the position offset after angle auto-tuning.	Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates the original encoder cable is damaged. Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change.	Use a new encoder cable. If the fault persists after the encoder cable is replaced, the encoder may be faulty. In this case, replace the servo motor.

- E740.8: BISSC register communication failure
  Description:

  Non-real-time communication: encoder communication timeout, stop bit error, CRC error, data field error.

Cause	Troubleshooting	Solution
1. The BISSC read head is loose, and the distance between the head and the scale does not meet the installation requirements. 2. BISSC scale is contaminated. 3. The encoder read head is damaged.	Check the head for abnormal illumination of the indicator. Check whether the indicator is lit when the head is at a certain position.	Reinstall the read head. Replace the scale. Replace the read head.

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

  Description:

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

Cause	Troubleshooting	Solution
1. The value of H01.59 is set too large. 2. Too many encoder data bits.	Power off and restart the drive.	Decrease the value of H01.59. Use an encoder with fewer data bits.

- E755.0: Nikon encoder communication fault

  Description:

  Nikon encoder communication failure.

Cause	Troubleshooting	Solution
Nikon encoder communication error	Perform a power cycle to check if the error is still reported.	Manually reset the encoder error through H0d-21. If the error remains, check the encoder and its wiring.

- E760.0: Encoder overtemperature

  Description:

  The temperature of the absolute encoder is too high.

Cause	Troubleshooting	Solution
The temperature of the absolute encoder is too high.	Measure the encoder temperature or the motor temperature, which must not exceed 120°C. Note that you are measuring the temperature of the housing, which is is 20°C to 40°C lower than the internal temperature.	Switch off the S-ON signal to wait for the encoder to cool down.

- E765.0: 3rd party encoder over-temperature or overspeed

  Description:

Encoder over-temperature or overspeed

Cause	Troubleshooting	Solution
Motor overtemperature or overspeed.	Check if the ambient temperature or the average load rate is too high (over 140°C). Check the motor for overspeed.	Switch off the S-ON signal to wait for the encoder to cool down.

- E770.0: Fully-closed loop input phase A wire breakage
  Description:

  Fully-closed loop phase A input differential voltage wire breakage

Cause	Troubleshooting	Solution
Fully-closed loop phase A input differential voltage wire breakage	Measure the phase AB differential voltage to check if it is below 2.5 V.	Adjust the fully-closed loop phase A input voltage.

- E770.1: Fully-closed loop input phase B wire breakage
  Description:

  Fully-closed loop phase B input differential voltage wire breakage

Cause	Troubleshooting	Solution
Fully-closed loop phase B input differential voltage wire breakage	Measure the phase B differential voltage to check if it is below 2.5 V.	Adjust the fully-closed loop phase B input voltage.

- E770.2: Fully-closed loop input phase Z wire breakage
  Description:

  Fully-closed loop phase Z input differential voltage wire breakage

Cause	Troubleshooting	Solution
Fully-closed loop phase Z input differential voltage wire breakage	Measure the phase Z differential voltage to check if it is below 2.5 V.	Adjust the fully-closed loop phase Z input voltage.

- E770.3: fully closed-loop external loop encoder communication timeout
  Description:

  Fully closed-loop external loop encoder communication timeout.

Cause	Troubleshooting	Solution
Fully closed-loop external loop encoder communication timeout.	Check the wiring.	Check the wiring.

- E770.6: Fully-closed loop Inovance 2nd encoder initialization communication error
  Description:

The Inovance second encoder failed to initialize.

Cause	Troubleshooting	Solution
1. The encoder cable connections are incorrect or loosened.	Check the wiring of the encoder. Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder.	Connect the encoder cables according to the correct wiring diagram. Re-connect encoder cables and ensure encoder terminals are connected securely.
2. The servo drive is faulty.	The fault persists after the servo drive is restarted.	Replace the servo drive.

- E770.7: Fully closed-loop 2nd encoder communication error
  Description:

  Second encoder communication failed.

Cause	Troubleshooting	Solution
1. The encoder is wired improperly. 2. The encoder cable connections become loose. 3. The encoder Z signal is interfered with. 4. The encoder is faulty. 5. Check whether H0F.29–H0F.33 are set correctly.	Check encoder wiring. Check for strong vibration, which loosens the encoder cable and even damages the encoder. Use a new encoder cable. If the fault disappears, the original encoder cable is damaged. Check whether ambient devices are generating interference and whether multiple interference sources are present in the cabinet. Make servo drive stay in "Rdy" status and rotate motor shaft counterclockwise (CCW) manually and observer whether H0b.17 (electrical angle) increases/decreases smoothly. Turning one circle corresponds to five 0–360° (for Z series motors). For X series motors, turning one circle corresponds to four 0–360°. If H0b.17 changes abnormally during motor rotating, the encoder is faulty. If no alarm is reported during motor shaft rotating but an alarm is reported during servo drive running, interference may exist. Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change. Check the encoder manual to see if H0F.29–H0F.33 are set to the correct values.	Connect the cables again according to the correct wiring diagram. Connect the cables again and ensure encoder terminals are connected securely. It is recommended to use the cables provided by Inovance. If a customized cable is used, check whether this cable is a shielded twisted pair cable that complies with the specifications. Route the motor cables and encoder cables through different routes. Ensure the servo motor and servo drive are grounded properly. Check whether the connectors at both ends of the encoder are in good contact and whether any pin retracts. Use a new encoder cable. If the fault persists after encoder cables are replaced, the encoder may be faulty. In this case, replace the servo motor. Check the encoder manual to see if H0F.29–H0F.33 are set to the correct values.

- E770.8: Full closed-loop encoder data transmit delay is too large

  Description:

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

Cause	Troubleshooting	Solution
1. The value of H01.59 is set too large. 2. Too many encoder data bits.	Power off and restart the drive.	Decrease the value of H01.59. Use an encoder with fewer data bits.

- E771.0: Communication handshake failure between interpolator and drive
  Description:

  Communication handshake failed between the interpolator and drive

Cause	Troubleshooting	Solution
Communication between T2 interpolator and motor is abnormal during power-on initialization.	Check whether power cycling is not performed after parameters are written to the interpolator. Check the wiring between the interpolator and motor.	Power off and on again. Check the wiring. If the alarm remains after several power cycling, replace the motor.

- E939.0: Motor power cable disconnected
  Description:

  At least one phase of the motor is disconnected.

Cause	Troubleshooting	Solution
1. One or two phases of the motor power cable are disconnected. 2. The actual current loop gain is set improperly.	Check the wiring of U/V/W power cables. The power cable is not disconnected. The current feedback and torque reference follow are abnormal. Perform inductive resistance auto-tuning and current loop auto-tuning again.	Check if the power cable are disconnected or in poor contact. Re-connect the power cable. Replace the servo motor. Perform inductive resistance auto-tuning and current loop auto-tuning again.

- E994.0: Station number conflict
  Description:

  CANlink station number conflict.

Cause	Troubleshooting	Solution
CANlink station number conflict.	Check the setpoint of H0E.00.	Rectify the value of H0E.00.

- EA33.0: Encoder read/write check error
  Description:

  Internal parameters of the encoder are abnormal.

Cause	Troubleshooting	Solution
1. The serial incremental encoder cable is disconnected or loose.	Check the wiring.	Check whether the encoder cables are connected incorrectly, disconnected, or in poor contact. If the motor cables and encoder cables are bundled together, separate them.
2. An error occurs when reading/writing the serial incremental encoder parameters.	If the fault persists after the servo drive is powered off and on repeatedly, the encoder is faulty.	Replace the servo motor.

- EA33.1: Fully closed-loop Inovance 2nd encoder data read/write error
  Description:

  Internal parameters of the encoder are abnormal.

Cause	Troubleshooting	Solution
1. The serial incremental encoder cable is disconnected or loose.	Check the wiring.	Check whether the encoder cables are connected incorrectly, disconnected, or in poor contact. If the motor cables and encoder cables are bundled together, separate them.
2. An error occurs when reading/writing the serial incremental encoder parameters.	If the fault persists after the servo drive is powered off and on repeatedly, the encoder is faulty.	Replace the servo motor.

- EA34.0: Abnormal Hall state
  Description:

  Hall state fault.

Cause	Troubleshooting	Solution
Hall signal output is all high or all low.	Check the wiring of the Hall sensor. Collect the states of the Hall sensor with the oscilloscope in InoDriverShop. Push the motor, and observe whether there is 0 or 7 in the states.	Check the U, V and W wiring of the Hall sensor. If the alarm persists after several power cycling, the Hall sensor must be faulty and you must replace it. Check whether the encoder shield is connected properly. If a phase of the Hall sensor is connected incorrectly, you can adjust the level active state of a single phase through H32.55.

- EA34.1: Dynamic Hall auto-tuning error
  Description:

  Dynamic Hall auto-tuning error

Cause	Troubleshooting	Solution
Anomaly was found during electrical angle evaluation.	Check whether the motor can move normally. Check whether the Hall signal output corresponds to the electrical angle change. Check whether the motor is equipped with a Hall sensor. Check the wiring of the Hall sensor.	Ensure that the motor can move on one side regardless of the limit. If the motor parameters are normal, but one Hall signal change does not correspond to a 60° electrical angle approximately after several tests, the Hall signal output must be abnormal and you must replace the Hall sensor. Check whether the motor is equipped with a Hall sensor. Check the wiring of the Hall sensor.

- EA34.2: Static Hall auto-tuning error
  Description:

  Static Hall auto-tuning error

Cause	Troubleshooting	Solution
Failed to enable static Hall auto-tuning.	Check whether the motor is connected to an incremental encoder. Check whether H32.62 is 1 when H0A.13 is set to 6.	Only motors with an incremental encoder support static Hall auto-tuning. If not, perform dynamic Hall auto-tuning again.

- EB00.0: Position deviation too large
  Description:

  The position deviation in the position control mode is larger than the setpoint of 6065h (Threshold of excessive position deviation).

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive U/V/W cables or the encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.
3. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or 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 is not 0 but the motor speed is 0 in the corresponding mode.	Rectify the mechanical-related problem.
4. The servo drive gain is too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: H08.00...H08.02 2nd gain set: H08.03...H08.05	Adjust the gain values manually or perform gain auto-tuning.
5. The position reference increment is too large.	Position control mode: In CSP mode, check the gear ratio 6091.01h/6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). In HM mode, check the gear ratio 6091.01h/ 6091.02h, and determine 6099.01h and 6099.02h.	CSP: Decrease the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. PP: Decrease the value 6081h or increase the acceleration/ deceleration ramp (6083h, 6084h). HM: Decrease 6099.01h and 6099.02h or increase the acceleration/ deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions.

Cause	Troubleshooting	Solution
6. The value of 6065h is insufficient for the operating conditions.	Check the value of 6065h.	Increase the setpoint of 6065h.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB00.1: Position deviation overflow
  Description:

  The position deviation is too large.

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive U/V/W cables or the encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.
3. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. References in the position control mode: H0b.13 (Input position reference counter). References in the speed control mode: H0b.01 (Speed reference). References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.

Cause	Troubleshooting	Solution
4. The servo drive gain is too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: H08.00...H08.02 2nd gain set: H08.03...H08.05	Adjust the gain values manually or perform gain auto-tuning.
5. The position reference increment is too large.	Position control mode: In CSP mode, check the gear ratio 6091.01h/6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). In HM mode, check the gear ratio 6091.01h/ 6091.02h, and determine 6099.01h and 6099.02h.	CSP: Decrease the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. PP: Decrease the value 6081h or increase the acceleration/ deceleration ramp (6083h, 6084h). HM: Decrease 6099.01h and 6099.02h or increase the acceleration/ deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions.
6. The value of 6065h is insufficient for the operating conditions.	Check the value of 6065h.	Increase the setpoint of 6065h.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB01.0: Position reference increment too large
  Description:

  Position reference increment too large

Cause	Troubleshooting	Solution
The pulse reference increment exceeds the excessive reference threshold three times consecutively.	Check whether the baud rate of pulse reference input exceeds H0A.09.	Increase the value of H0A.09. Reduce the baud rate of pulse input.

- EB01.1: Individual position reference increment too large
  Description:

  The target position increment is too large.

Cause	Troubleshooting	Solution
The target position increment is too large.	Check the variation between two adjacent target positions using the software tool.	Check whether the maximum speed of the motor fulfills the application requirement. If yes, reduce the target position reference increment, which is to lower the profile reference speed. If not, replace the servo motor. Before switching the mode or enabling the servo drive, check whether the target position is aligned with current position feedback. The communication sequence of the host controller is abnormal, leading to slave data error. Check the communication sequence of the host controller.

- EB01.2: Position reference increment too large continuously
  Description:

  The target position increment is too large continuously.

Cause	Troubleshooting	Solution
The target position increment is too large continuously.	Check the variation between two adjacent target positions using the software tool.	Check whether the maximum speed of the motor fulfills the application requirement. If yes, reduce the target position reference increment, which is to lower the profile reference speed. If not, replace the servo motor. Before switching the mode or enabling the servo drive, check whether the target position is aligned with current position feedback. The communication sequence of the host controller is abnormal, leading to slave data error. Check the communication sequence of the host controller.

- EB01.3: Command overflow
  Description:

  The target position is still in the process of transmission when the servo limit or software position limit signal is activated and the 32-bit upper/lower limit is reached.

Cause	Troubleshooting	Solution
The target position is still in the process of transmission when the servo limit or software position limit signal is activated and the 32-bit upper/lower limit is reached.	Check whether the host controller continues sending commands after overtravel alarm is reported by the servo drive.	Detect the servo limit signal (bit0 and bit1 of 60FDh is recommended) through the host controller. Stop sending limit direction commands when an active servo limit signal is detected by the host controller.

- EB02.0: Position deviation exceeding threshold in fully closed-loop
  Description:

  The absolute value of position deviation in fully closed-loop mode exceeds the value of H0F.08 (Excessive position deviation threshold in fully closed-loop mode).

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive U/V/W cables or the internal/ external encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.

Cause	Troubleshooting	Solution
3. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. References in the position control mode: H0b.13 (Input position reference counter). References in the speed control mode: H0b.01 (Speed reference). References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
4. The servo drive gain is too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: H08.00...H08.02 2nd gain set: H08.03...H08.05	Adjust the gain values manually or use gain auto-tuning.
5. The input pulse frequency is high.	When the position reference source is pulse reference, check whether the input pulse frequency is too high or whether the acceleration/deceleration time is set to 0 or an excessively low value.	Reduce the position reference frequency or the electronic gear ratio. When the host controller is used to output position pulses, you can set the acceleration time in the host controller. If the acceleration/deceleration time cannot be set in the host controller, increase the values of H05.04 and H05.06.
6. The value of H0F.08 is insufficient for the operating conditions.	Check the value of H0F.08.	Increase the setpoint of H0F.08.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB02.1: Fully closed-loop position deviation overflow
  Description:

  The absolute value of the fully closed-loop position deviation is greater than 2^{31}.

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The drive U/V/W cables or the encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.
3. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. References in the position control mode: H0b.13 (Input position reference counter). References in the speed control mode: H0b.01 (Speed reference). References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
4. The servo drive gain is too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: H08.00...H08.02 2nd gain set: H08.03...H08.05	Adjust the gain values manually or use gain auto-tuning.

Cause	Troubleshooting	Solution
5. The position reference increment is too large.	Position control mode: In IP/ CSP mode, check the gear ratio 6091.01h/6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). In HM mode, check the gear ratio 6091.01h/ 6091.02h, and determine 6099.01h and 6099.02h.	IP/CSP: Decreases the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. PP: Decreases the value of 6081h or decreases the acceleration/deceleration ramp (6083h, 6084h). HM: Decreases 6099.01h and 6099.02h or decreases the acceleration/deceleration ramp (609Ah). Reduce the gear ratio as needed.
6. The value of H0F.08 is insufficient for the operating conditions.	Check the value of 6065h.	Increase the setpoint of 6065h.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB03.0: Electronic gear ratio beyond the limit-H05.02
  Description:

  The electronic gear ratio exceeds the limit: (0.001–4000 x Encoder resolution/ 10000).

Cause	Troubleshooting	Solution
The electronic gear ratio converted by converted exceeds the maximum gear ratio or is less than the minimum gear ratio.	Check if the electronic gear ratio is within the range of 0.001–4000 x Encoder resolution/10000.	Change the value of H05.02.

- EB03.1: Electronic gear ratio beyond the limit-Electronic gear ratio 1
  Description:

  The electronic gear ratio exceeds the limit: (0.001–4000 x Encoder resolution/ 10000).

Cause	Troubleshooting	Solution
Electronic gear ratio 1 exceeds the maximum gear ratio or is less than the minimum gear ratio.	Check if the electronic gear ratio is within the range of 0.001–4000 × Encoder resolution/10000.	Change the values of H05.07/H05.09.

- EB03.2: Electronic gear ratio beyond the limit-Electronic gear ratio 2
  Description:

  Electronic gear ratio 2 exceeds the limit: (0.001–4000 x Encoder resolution/10000).

Cause	Troubleshooting	Solution
Electronic gear ratio 2 exceeds the maximum gear ratio or is less than the minimum gear ratio.	Check if the group 2 electronic gear ratio is within the range of 0.001–4000 × Encoder resolution/10000.	Change the values of H05.11/H05.13.

- EB04.0: Large gantry position deviation
  Description:

  Large gantry position deviation

Cause	Troubleshooting	Solution
1. Large gantry position deviation. 2. The gantry position deviation is too large after mechanical homing enabling is off.	Check whether the gantry position deviation exceeds the threshold set in H14.45, or is related to any instrument or device.	Increase the value of H14.45.

- EB04.1: Gantry position deviation overrun
  Description:

  Gantry position deviation overrun

Cause	Troubleshooting	Solution
The deviation of two gantry axes exceeds the internal 32-bit data.	Check whether the gantry alignment mode is suitable. Check whether the position command of the two axes are the same and whether the mechanical structure is abnormal.	Check whether the gantry alignment mode is suitable. Check whether the position command of the two axes are the same and whether the mechanical structure is abnormal.

- ED02.0: Modbus communication timeout
  Description:

  Modbus communication timeout

Cause	Troubleshooting	Solution
Modbus communication timeout	Increase the value of H0E.83.	Determine the Modbus access cycle by frame grab.

- ED03.0: CANLink communication failure
  Description:

  The master is offline.

Cause	Troubleshooting	Solution
The master is offline.	Increase the heartbeat threshold of the master station. Check the wiring.	Capture frames to ensure that the master station is online.

- ED04.0: CANopen communication timeout
  Description:

  The slave reaches the time configured by the consumer or the node guarding time.

Cause	Troubleshooting	Solution
The slave reaches the time configured by the consumer or the node guarding time.	Check whether the heartbeat frame cycle of the host controller is normal by frame grab.	Check whether all CAN nodes are online, or check the CANopen configuration, reset the node or communication.

- ED05.0: CANopen communication initialized
  Description:

  After the motor is enabled, errors such as slave offline, heartbeat abnormal, load ratio too high, data frame loss, and false master reset occurred when NMT changes to the initialization state.

Cause	Troubleshooting	Solution
After the motor is enabled, errors such as slave offline, heartbeat abnormal, load ratio too high, data frame loss, and false master reset occurred when NMT changes to the initialization state.	Check whether the reset frame is received during operation by capturing frames.	Reset the NMT node. When changing the NMT, disable the output stage. Use shielded cables to prevent interference. Ground the servo drive properly. Ensure the load rate is proper. If asynchronous transmission is configured, ensure the suppression time is set properly. Ensure no false reset frame is triggered by the host controller. Ensure the termination resistor is installed.

- ED08.0: CANopen bus PDO transmission length error
  Description:

The length of the content transmitted by PDO is inconsistent with the configured mapping length.

Cause	Troubleshooting	Solution
The length of the content transmitted by PDO is inconsistent with the configured mapping length.	Check whether the PDO transmission length is consistent with the configuration by capturing frames.	Re-configure the PDO and reset the node or communication.

- ED11.0: CANopen sync period error too large
  Description:

  The SYNC period error exceeds the setpoint

Cause	Troubleshooting	Solution
The SYNC period error exceeds the setpoint	Collect the synchronization signal using the software tool and calculate whether the cycle is higher than the fault threshold.	Check the settings of 60C2.01h and 60C2.02h and ensure the synchronization period is set properly. Ensure the synchronization period of the host controller is set correctly and consistent with the setting of 60C2h. Check the wiring between the slave and the master.

- EE09.0: Software position limit setting error
  Description:

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

Cause	Troubleshooting	Solution
The lower limit of the software position limit is equal to or larger than the upper limit.	Check the values of 607D.01h and 607D.02h.	Reset the values and ensure the former is smaller than the latter.

- EE09.1: Home setting error
  Description:

  The home offset exceeds the upper/lower limit.

Cause	Troubleshooting	Solution
1. The home offset is beyond the software limits, which are H0A.41 and H0A.43 (607C and 607D).	The home offset is outside the software position limit when the encoder works in the incremental mode, absolute linear mode, and single-turn absolute mode.	Set the home offset to a value within the software position limit.
2. The home offset is beyond the upper/lower limit in the rotation mode.	The home offset is outside 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/lower limit.

- EE09.2: Gear ratio beyond the limit
  Description:

  The electronic gear ratio exceeds the limit: (0.001, 4000 x Encoder resolution/ 10000).

Cause	Troubleshooting	Solution
The set electronic gear ratio exceeds the preceding range.	The gear ratio 6091.01h/ 6091.02h exceeds the preceding range.	Set the gear ratio within the required range.

- EEE0.0: gantry paired axis error
  Description:

  Gantry paired axis error

Cause	Troubleshooting	Solution
Gantry paired axis error	Check whether the gantry paired axis.	Eliminate the fault.

8.2.3.2 Internal Faults

When any one of the following fault occurs, contact Inovance for technical support.

- E111.0: Internal parameter error
- E602.0: Angle auto-tuning failure
- E220.0: Phase sequence incorrect
- EA40.0: Parameter auto-tuning failure

8.2.4 Description of Alarm Codes

- E108.0: Parameter write error
  Cause:

  Parameter values cannot be written to EEPROM.

Cause	Troubleshooting	Solution
An error occurs during parameter-writing.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.1: Parameter read error
  Cause:

  Parameter values cannot be read from EEPROM.

Cause	Troubleshooting	Solution
The parameter-read operation is abnormal, and the system indicates an EEPROM read failure.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.2: EEPROM write check error
  Cause:

  The check on the data written in EEPROM failed.

Cause	Troubleshooting	Solution
An error occurs during parameter-writing.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.3: EEPROM read check error
  Cause:

  The check on the data read in EEPROM failed.

Cause	Troubleshooting	Solution
An error occurs during parameter-reading.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.4: Single data stored too many times
  Cause:

  Single data is stored too frequently.

Cause	Troubleshooting	Solution
That may damage EEPROM over time.	Check H0b.90 and H0b.91. H0b.90 shows the parameter in question or object dictionaries (in hexadecimal). If H0b.91=15, H0b.90 shows internal variables of software. Check "Func Test 1" through the oscilloscope channel. Be sure to display it in hexadecimal. This channel displays the address that EEPROM is storing. Check the storage count through the oscilloscope channel "Func Test 2".	If the alarm is caused by manually modifying a certain parameter or object dictionary, there will be no frequent storage of a certain data during operation, and you can reset the fault. Check the abnormal parameter through H0b. 90 or oscilloscope channel, and find out the cause. For example, if the host controller program frequently writes parameters through SDO, you can modify the program to stop it or set H0E.01 to 0 (Do not access EEPROM when writing parameters or object dictionaries).

- E110.0: Frequency-division pulse output setting error
  Cause:

  The frequency-division output setpoint (H05.17) exceeds the encoder resolution.

Cause	Troubleshooting	Solution
The number of frequency divisions (quadrupled) exceeds the motor revolutions	Check the setpoint of H05.17.	Adjust the value of H05.17 on the basis of the motor revolutions.

- E120.3: The motor and drive do not match in the power
  Cause:

  the motor and drive do not match in the rated power.

Cause	Troubleshooting	Solution
The rated current/voltage of the motor is higher than that of the drive.	Check whether the rated motor current/voltage is larger than that of the drive.	Replace the motor or drive.

- E121.0: Invalid S-ON command
  Cause:

  A redundant S-ON signal is sent when some auxiliary functions are used.

Cause	Troubleshooting	Solution
The external S-ON signal is active when servo drive is enabled internally.	Check whether the following auxiliary functions are used: Check whether DI functions (H0d.02, H0d.03, and H0d.12) are used and whether FunIN.1 (S-ON signal) is active.	Deactivate the DI assigned with FunIN.1 (both hardware DI and virtual DI).

- E126.3: PR process segment write parameter out of limit
  Cause:

  PR process segment write parameter out of limit.

Cause	Troubleshooting	Solution
In the process segment mode, the written value exceeds the upper limit of the parameter.	Check the upper and lower limits of the parameter.	In the process segment mode, the written value exceeds the upper limit of the parameter.

- E510.0: Frequency division output overspeed
  Cause:

  The output pulse frequency exceeds the frequency upper limit allowed by the hardware (4 MHz) when pulse output is used (H05.38 = 0 or 1 or 2).

Cause	Troubleshooting	Solution
The MCU detects excessive pulse increment fed back by FPGA.	When H05.38 is set to 0 (Encoder frequency-division output), check whether the output pulse frequency corresponding to the motor speed upon fault exceeds the limit. Output pulse frequency (Hz) = Motor speed (rpm)/60 x H05.17.	Decrease the value of H05.17 (encoder frequency-division pulses) to allow the output pulse frequency, within the speed range required by the machine, to drop below the frequency upper limit allowed by the hardware.
	The input pulse frequency exceeds 2 MHz or interference exists in the pulse input pins when H05.38 is set to 1 (Reference pulse synchronous output). • High-speed pulse input pins:open-collector input terminals: PULLHI, PULSE+, PULSE-, SIGN+, SIGN-; single-phase maximum pulse frequency: 200 kpps. • High-speed pulse input pins: differential input terminals: HPULSE+, HPULSE-, HSIGN+, HSIGN-; single-phase maximum pulse frequency: 8 Mpps.	Decrease the input pulse frequency to a value within the frequency upper limit allowed by hardware. **Note:** In this case, if you do not modify the electronic gear ratio, the motor speed will decrease. If the input pulse frequency is high but is still within the frequency upper limit allowed by the hardware, take anti-interference measures (use STP cable for pulse input and set pin filter parameter H0A.24 or H0A.30). This is to prevent false alarms caused by interference pulses superimposed to actual pulse references.

- E600.0: Inertia auto-tuning failure
  Cause:

  Vibration cannot be suppressed. You can set notch parameters (H09.12...H09.23) manually to suppress vibration.

  The auto-tuned values fluctuate dramatically. Increase the maximum operating speed, reduce the acceleration/deceleration time, and shorten the stroke of the lead screw during ETune operation.

  Mechanical couplings of the load are loose or eccentric. Rectify the mechanical faults.

  An alarm occurs during auto-tuning and causes interruption. Rectify the fault causes and perform inertia auto-tuning again.

The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/deceleration time to ensure the motor current is unsaturated.

The position following-up is too poor. That is, the maximum speed of the motor is less than the speed setpoint of the inertia auto-tuning. Ensure that the speed setpoint is less than the maximum speed of the motor.

Cause	Troubleshooting	Solution
Continuous vibration occurs during auto-tuning. The auto-tuned values fluctuate dramatically. Mechanical couplings of the load are loose or eccentric. An alarm occurs during auto-tuning and causes interruption. The vibration cannot be suppressed if the load carries a large inertia. In this case, increase the acceleration/deceleration time first to ensure the motor current is unsaturated. The position following-up is too poor. That is, the maximum speed of the motor is less than the speed setpoint of the inertia auto-tuning.	1. Perform internal inspection to check whether the torque jitters upon stop (not FFT). Check whether three times more than the last auto-tuned value for variation less than 2.5 times; 0.5 times more than last auto-tuned value for variation above 5 times.	Rectify the fault and perform inertia auto-tuning again. For vibration that cannot be suppressed, enable vibration suppression. Ensure mechanical couplings are connected securely. During ETune operation, increase the maximum operating speed, reduce the acceleration/deceleration time, and shorten the stroke of the lead screw during ETune operation. Ensure that the speed setpoint is less than the maximum speed of the motor.

- E601.0: Homing alarm
  Cause:

  Homing time exceeds the setpoint.

Cause	Troubleshooting	Solution
1. The home switch is faulty.	There is only high-speed searching but no low-speed searching during homing. After high-speed searching, low-speed searching in the reverse direction applies.	If a hardware DI is used, check whether the corresponding DI function is allocated to a certain DI in group 2003h and check the wiring of this DI. Change the DI logic manually and observe the value of H0B.03 (monitored DI status) to monitor whether the servo drive receives corresponding DI level changes. If the home signal is Z signal but it cannot be found, check the condition of the Z signal.
2. The homing time limit is too short.	Check whether the value of H05.35h (Time limit for homing) is too small.	Increase the value of H05.35.
3. The speed in high-speed searching for the home switch signal is too low.	Check the distance between the start position of homing and the home switch. Then check whether the setpoint of 6099.01h (Speed in high-speed searching for the home switch signal) is too low, resulting in a long homing process.	Increase the value of 6099.01h.

- E601.1: Homing switch error
  Cause:

  The homing switch is set improperly.

Cause	Troubleshooting	Solution
The home switch is set improperly.	Check whether the limit signals at both sides are activated. Check whether the limit signal and the deceleration point signal/home signal are both activated. Check whether the positive and negative position limits are activated successively.	Set the position of the physical switch properly.

- E601.2: Homing mode setting error
  Cause:

  The homing method value is too large.

Cause	Troubleshooting	Solution
The homing method value is too large.	Check the homing method value (object dictionary 6098h).	Change the value of 6098h.

- E601.4: Gantry homing mode setting error
  Cause:

  Gantry homing mode setting error.

Cause	Troubleshooting	Solution
You have set a wrong homing mode for the gantry through H05.31.	Check the setting.	Change the setting.

- E602.9: Angle auto-tuning not done for incremental encoder motor
  Cause:

  Angle auto-tuning is not performed for the incremental encoder motor.

Cause	Troubleshooting	Solution
Angle auto-tuning is not performed for the incremental encoder, and corresponding alarm is enabled.	Check whether bit1 of H32.04 is set.	1. The alarm is automatically reset after the angle auto-tuning is completed. 2. If you do not need this alarm, reset bit1 of H32.04.

- E607.0: Large gantry torque deviation
  Cause:

  Gantry torque deviation is too large.

Cause	Troubleshooting	Solution
Large gantry torque deviation	Gantry torque deviation is too large.	Check the wiring of the gantry.

- E608.0: Master-to-slave parameter setting error
  Cause:

  Master-to-slave parameter setting error.

Cause	Troubleshooting	Solution
Master-to-slave parameter setting error	The parameter value exceeds the limit or the communication between drives is poor.	Check the setpoint of H14.03.

- E609.0: Data save timeout

Cause:

Wire breakage occurred when the software was downloading data.

Cause	Troubleshooting	Solution
Wire breakage occurred when the software was downloading data.	Check that the drive is connected to the software.	Download the data again.

- E609.1: Data save overflow

  Cause:

  Wire breakage occurred when the software was downloading data.

Cause	Troubleshooting	Solution
Wire breakage occurred when the software was downloading data.	Check that the drive is connected to the software.	Download the data again.

- E609.2: Failed to save data

  Cause:

  Failed to save data.

Cause	Troubleshooting	Solution
The FLASH memory chip or the interface between MCU and FLASH failed.	Power on multiple times and download data again.	If the problems persists, replace the drive.

- E609.3: Failed to erase data

  Cause:

  Failed to erase data.

Cause	Troubleshooting	Solution
The FLASH memory chip or the interface between MCU and FLASH failed.	Power on multiple times and download data again.	If the problems persists, replace the drive.

- E621.1: Overload current limiting torque attained

  Cause:

  Overload current limiting torque attained.

Cause	Troubleshooting	Solution
The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	• Confirm the overload characteristics of the servo drive or motor. • Check whether the average load rate (H0b.12) keeps exceeding 100.0%. • Detect whether the value of H32.77 is set too high.	• Replace with a servo drive of higher capacity and a matching servo motor. • Reduce the load and increase the acceleration/ deceleration time.
Acceleration/deceleration is too frequent or the load inertia is too large.		
The motor and encoder cables are connected incorrectly or in poor contact.		
The gain adjustment is improper or the stiffness is too high.		
The motor is stalled due to mechanical factors, resulting in overload during operation.		
The servo drive is faulty.		

- E631.4: P-MOS short circuit
  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, the P-MOS short circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	Replace the servo drive. Turn off the brake switch H02.16.

- E631.5: N-MOS short circuit
  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, the N-MOS short circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	Replace the servo drive. Turn off the brake switch H02.16.

- E730.0: Encoder battery alarm
  Cause:

  The voltage of the absolute encoder battery is lower than 3.0 V.

Cause	Troubleshooting	Solution
The voltage of the absolute encoder battery is lower than 3.0 V.	Measure the battery voltage.	Use a new battery with the matching voltage.

Note

E731.0 and E733.0 can trigger E730.0. See E731.0 and E733.0 for other solutions.

- E730.1: Inovance 2nd encoder battery voltage low
  Cause:

  Inovance 2nd encoder battery voltage is lower than 3.0 V.

Cause	Troubleshooting	Solution
Inovance 2nd encoder battery voltage is too low.	Measure the battery voltage.	Use a new battery with the matching voltage.

- E831.1: AI1 zero offset too large
  Cause:

  The zero drift of AI1 exceeds 500 mV.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI1 input filter time.
2. The servo drive is faulty.	Disconnect AI1 and measure whether the actual terminal voltage exceeds 0.5 V.	If not, replace the servo drive.

- E831.2: AI2 zero offset too large
  Cause:

  The zero drift of AI2 exceeds 500 mV.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI2 input filter time.
2. The servo drive is faulty.	Disconnect AI2 and measure whether the actual terminal voltage exceeds 0.5 V.	If not, replace the servo drive.

- E834.1: AI1 overvoltage
  Cause:

  AI1 input voltage is greater than 11.5 V.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI1 input filter time.
2. The input voltage is too high.	Measure whether the actual terminal voltage exceeds 11.5 V.	Adjust the input voltage to a value lower than 11.5 V.

- E834.2: AI2 overvoltage
  Cause:

  AI2 input voltage is greater than 11.5 V.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI2 input filter time.
2. The input voltage is too high.	Measure whether the actual terminal voltage exceeds 11.5 V.	Adjust the input voltage to a value lower than 11.5 V.

- E900.0: DI emergency braking
  Cause:

  The logic of the DI terminal (including the hardware DI and virtual DI) allocated with DI function 34 (FunIN.34) is effective.

Cause	Troubleshooting	Solution
The DI function 34 (EmergencyStop) is triggered.	Check whether the logic of the DI allocated with DI function 34 (FunIN.34: Emergency stop) is valid.	Check the operation mode and clear the active DI braking signal without affecting the safety performance.

- E902.0: Invalid DI/VDI setting
  Description:

  DI function parameters are set to invalid values.

Cause	Troubleshooting	Solution
DI/VDI function parameters are set to invalid values.	Check whether DI function configure parameters in H03 and H17 are set to invalid values.	Set DI/VDI function parameters to valid values.

- E902.1: Invalid DO/VDO setting
  Description:

  DO/VDO function parameters are set to invalid values.

Cause	Troubleshooting	Solution
DO or VDO function selections are invalid.	Check whether DO function configure parameters in H04 and H17 are set to invalid values.	Set DO/VDO function parameters to valid values.

- E902.2: Invalid setting for torque reach

  Cause:

  The DO parameters set for torque reach in the torque control mode are invalid.

Cause	Troubleshooting	Solution
The DO parameters set for torque reach in the torque control mode are invalid.	Check whether the value of H07.22 is lower than or equal to the value of H07.23 (unit: 0.1%).	Set H07.22 to a value higher than that of H07.23.

- E909.0: Motor overload alarm

  Cause:

  The accumulative heat of the motor reaches 90% of the fault threshold.

Cause	Troubleshooting	Solution
1. The motor cables and encoder cable are connected improperly or in poor contact.	Check the wiring among the servo drive, servo motor and the encoder according to the correct wiring diagram.	Connect the cables according to the wiring diagram. It is recommended to use the cables provided by Inovance. When customized cables are used, prepare and connect the customized cables according to the wiring instructions.
2. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load rate (H0b.12) keeps exceeding 100.0%.	Use a servo drive of higher capacity and a matching servo motor. Reduce the load and increase the acceleration/deceleration time.
3. Acceleration/Deceleration is too frequent or the load inertia is too large.	Check the mechanical inertia ratio or perform inertia auto-tuning. View the value of H08.15 (load moment of inertia ratio). Confirm the individual operation cycle when the servo motor operates cyclically.	Increase the acceleration/deceleration time.

Cause	Troubleshooting	Solution
4. Gains are improper or the stiffness level is too high.	Check whether the motor vibrates and generates unusual noise during operation.	Readjust the gain.
5. The servo drive model or motor model is set improperly.	View the model of the motor equipped with a serial-type encoder in H00.05 and the servo drive model in H01.10.	Read the servo drive nameplate and set the servo drive model (H01.10) and motor model properly.
6. The motor is stalled due to mechanical factors, resulting in overload during operation.	Check the running reference and motor speed (H0b.00) through Inovance servo commissioning software or keypad: • References in the position control mode: H0b.13 (Input position reference counter) • References in the speed control mode: H0b.01 (Speed reference) • References in the torque control mode: H0b.02 (Internal torque reference) Check whether the reference value is not 0 or is very large but the motor speed is 0 RPM in the corresponding mode.	Rectify the mechanical-related problem.
7. The servo drive is faulty.	Power off and on the servo drive.	Replace the servo drive.

- E910.0: Control circuit overvoltage

  Cause:

  The voltage of the control circuit exceeds the overvoltage threshold.

Cause	Troubleshooting	Solution
Overvoltage occurred on the control circuit of the drive.	Measure whether the input voltage in the control circuit cable is within the following range: 220 V servo drive: Value range: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Value range: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V) Check whether control circuit cables are connected properly and whether the voltage of control circuit cables (L1C, L2C) is within the specified range.	Re-connect or replace the cables.

- E920.0: Braking resistor overload

  Cause:

  The accumulative heat of the braking resistor exceeds the set value.

Cause	Troubleshooting	Solution
1. The external braking resistor is connected improperly or disconnected.	Remove the external braking resistor and measure whether its resistance is "∞" (infinite). Measure whether the resistance between terminals P⊕ and C is "∞" (infinite).	Replace with a new external braking resistor. If the resistance measured is the same as the nominal value, connect the external braking resistor between terminals P ⊕ and C.
		Connect the external braking resistor between terminals P ⊕ and C with a proper cable.
2. The jumper between terminals P ⊕ and D is shorted or disconnected when the built-in braking resistor is used.	Measure whether resistance between P ⊕ and D is "∞" (infinite).	Ensure terminals P ⊕ and D are jumpered.

<table>
<tr><th>Cause</th><th>Troubleshooting</th><th>Solution</th></tr>
<tr><td>3. H02.25 (Braking resistor type) is set improperly when an external braking resistor is used.</td><td rowspan="3">• Check the setpoint of H02.25.
• Check whether the resistance of the external braking resistor connected between P ⊕ and C is too large by comparing it with the value listed in Table "Specifications of the braking resistor".
• Check whether the value of H02.27 is larger than the resistance of the external braking resistor between terminals P ⊕ and C.</td><td>Set H02.25 correctly.
H02.25 = 1 (external, naturally ventilated)
H02.25 = 2 (external, forced-air cooling)</td></tr>
<tr><td>4. The resistance of the external braking resistor is too large.</td><td>Select a braking resistor with suitable resistance.</td></tr>
<tr><td>5. The setpoint of H02.27 (Resistance of external braking resistor) is higher than the resistance of the external braking resistor used.</td><td>Set H02.27 according to the resistance of the external braking resistor used.</td></tr>
<tr><td>6. The input voltage of the main circuit is beyond the specified range.</td><td>Check whether the input voltage of the main circuit cable on the drive side is within the following range:
• 220 V servo drive:Value range: 220 V to 240 VAllowable deviation: –10% to +10% (198 V to 264 V)
• 380 V servo drive:Value range: 380 V to 440 VAllowable deviation: –10% to +10% (342 V to 484 V)</td><td>Replace or adjust the power supply according to the specified range.</td></tr>
</table>

Cause	Troubleshooting	Solution
7. The load moment of inertia ratio is too large.	Perform moment of inertia auto-tuning according to section "Inertia auto-tuning" in SV680N Series Servo Drive Function Guide or calculate the total mechanical inertia based on mechanical parameters. Check whether the actual load inertia ratio exceeds 30.	• Select an external braking resistor with large capacity and set H02.26 to a value consistent with the actual power. • Select a larger servo drive. • Reduce the load if allowed. • Increase the acceleration/deceleration time if allowed. • Increase the motor operation cycle if allowed.
8. The motor speed is excessively high and deceleration is not done within the set time. The motor is in the continuous deceleration status during cyclic operation.	View the motor speed curve in cycle running and check whether the motor is in deceleration status for a long period.	
9. The capacity of the servo drive or the braking resistor is insufficient.	View the motor's single cycle speed curve and calculate whether maximum braking energy can be absorbed completely.	
10. The servo drive is faulty.	-	Replace the servo drive.

- E921.0: Dynamic brake resistor overload alarm
  Cause:

  The dynamic braking resistor is close to overload.

Cause	Troubleshooting	Solution
The accumulative heat of the dynamic braking resistor is close to the maximum thermal capacity of the resistor.	Check whether the value of H0b.98 exceeds 70%.	Ensure that the motor cannot be driven reversely in the dynamic braking state.

- E922.0: Resistance of the external braking resistor too small
  Cause:

  The value of H02.27 (resistance of external braking resistor) is lower than the value of H02.21 (permissible min. resistance of external braking resistor).

Cause	Troubleshooting	Solution
When an external braking resistor is used (H02.25 = 1 or 2), the resistance of this resistor is lower than the minimum resistance allowed by the servo drive.	Measure whether the resistance of the external braking resistor between terminals P ⊕ and C is lower than the value of H02.21 (Permissible minimum resistance of braking resistor).	• If yes, replace with an external braking resistor that matches the drive, set H02.27 to a value consistent with the resistance of this resistor, and connect this resistor between terminals P ⊕ and C. • If not, set H02.27 to a value consistent with the resistance of the external braking resistor used.

- E924.0: Regenerative transistor overtemperature
  Cause:

  The estimated temperature of the regenerative transistor is higher than H0A.18 (IGBT overtemperature threshold).

Cause	Troubleshooting	Solution
1. The junction temperature of the regenerative transistor is too high. 2. The regenerative transistor will be turned off automatically after overload occurs.	The regenerative transistor temperature exceeds the threshold defined by H0A.49.	Control the number of times the discharge conduit is activated by, for example, increasing acceleration/ deceleration time, reducing gain, and using a drive with higher specifications.

- E940.0: Change of controlled motor is detected. It is recommended to restore factory settings before use
  Cause:

  Change of controlled motor is detected. It is recommended to restore factory settings before use

Cause	Troubleshooting	Solution
It is detected that the control type of the controlled motor has changed (for example, changing from rotary servo motor control to linear motor control). To ensure the normal functions and thresholds of the drive, it is recommended to restore the factory settings before use. The alarm is raised only once.	Check whether the value of H00.00 is changed.	It is recommended to restore the factory settings before use when any change is made in the controlled motor. You can also maintain the original parameter settings.

- E941.0: Parameter modifications activated at next power-on
  Cause:

  When the parameter effective mode of the drive is set to "Re-power-on", after the parameter value is changed, the servo drive prompts the user to power on again.

Cause	Troubleshooting	Solution
The parameters modified are those whose "Effective time" is "Next power-on".	Check whether parameters you modified are those whose "Effective Time" is "Next power-on".	Power off and on the servo drive again.

- E942.0: Parameter saved frequently
  Cause:

  The number of parameters modified at a time exceeds 700.

Cause	Troubleshooting	Solution
Too many parameters are modified and saved to EEPROM at a brief interval.	Check whether parameters are modified through the host controller at a brief interval.	Check the operation mode. For parameters that need not be saved to EEPROM, set H0E.01 to the correct value before the host controller perform write operation.

- E950.0: Forward overtravel alarm
  Cause:

  The logic of the DI allocated with FunIN.14: P-OT (positive limit switch) is valid.

Cause	Troubleshooting	Solution
1. The logic of the DI assigned with FunIN.14 (P-OT function 14, positive limit switch) is effective.	• Check whether a certain DI in group H03 is assigned with FunIN.14. • Check whether the logic of DI corresponding to the bit of H0b.03 (Monitored DI status) is effective.	Check the running mode. On the prerequisite of safety, send a reverse command or rotate the motor to deactivate the logic of the DI terminal allocated with DI function 14.
2. The servo position feedback reaches the positive software position limit.	Check whether the position feedback (H0b.17) is close to the value of H0A.41. Check whether the software position limit is set in H0A.40.	Ensure the servo drive references are proper, allowing the load travel range to be within the software position limit.

- E952.0: Reverse overtravel alarm
  Cause:

  The logic of the DI allocated with FunIN.15: N-OT (negative limit switch) is valid.

Cause	Troubleshooting	Solution
1. The logic of the DI assigned with FunIN.15 is effective.	• Check whether a certain DI in group H03 is assigned with FunIN.15. • Check whether the logic of DI corresponding to the bit of H0b.03 (Monitored DI status) is effective.	Check the operation mode. On the prerequisite of ensuring safety, send a forward run command or rotate the motor to deactivate the logic of DI assigned with FunIN.15.
2. The servo position feedback reaches the negative software position limit.	Check whether the position feedback (H0b.17) is close to the value of H0A.43. Check whether the software position limit is set in H0A.40.	Ensure the servo drive references are proper, allowing the load travel range to be within the software position limit.

- E954.0: Position command overflow

  Cause:

  Position reference overflow.

Cause	Troubleshooting	Solution
in PR mode, the position command is beyond the limit.	1. Check the position command. 2. Check the limit value.	Change the value of the position command and the limit.

- E956.0: Forward position reference overtravel in process segment position mode

  Cause:

  Forward position reference overtravel occurs in the process segment position mode.

Cause	Troubleshooting	Solution
Forward position reference overtravel occurs in the process segment position mode.	E956.0 occurs when the position reference exceeds the value of H22.04 when the motor runs forwardly in the process segment position mode.	Reduce the position reference to a value lower than the setpoint of H22.04.

- E958.0: Reverse position reference overtravel in process segment position mode

  Cause:

  Reverse direction position reference overtravel occurs in the process segment position mode.

Cause	Troubleshooting	Solution
Reverse direction position reference overtravel occurs in the process segment position mode.	E958.0 occurs when the position reference is less than the value of H22.06 when the motor runs reversely in the process segment position mode.	Increase the position reference to a value greater than the setpoint of H22.06.

- E971.0: Undervoltage alarm for voltage drop protection
  Cause:

  The bus voltage is lower than the undervoltage threshold.

  This alarm can be masked by setting bit1 of H0A.88 to 1.

Cause	Troubleshooting	Solution
The bus voltage is lower than the undervoltage threshold.	Check the bus voltage. This alarm can be masked by setting bit1 of H0A.88 to 1.	Check the power supply.

- E980.0: Frequency division output overflow
  Cause:

  Frequency division output overflow.

Cause	Troubleshooting	Solution
The frequency division output is too large. Calculation overflows.	Check if an E510.0 alarm has occurred and set H05.17 to a proper value so that E510.0 disappears.	Set H05.17 to a proper value or reduce the maximum operating speed.

- E990.0: Pulse input overspeed alarm
  Cause:

  Pulse input overspeed alarm.

Cause	Troubleshooting	Solution
The pulse position command input exceeds the maximum rotational speed for a period exceeding the time threshold of large pulse position command increment.	Check if the input pulse frequency is too high.	Reduce the frequency below 4M.

- E991.0: SIGN pulse connection error
  Cause:

  If 24V is connected to SIGN+, 0V is connected to SIGN-, and the current limiting resistor is not connected, that will lead to large current between SIGN+ and SIGN-, which generates large voltage on the measuring resistor, triggering an alarm.

Cause	Troubleshooting	Solution
Pulse SIGN input voltage is too high.	Check wiring of SIGN+ and SIGN-. There must be a current limiting resistor. Check if the 24V power supply voltage exceeds the specified value. Measure if the voltage between SIGN+ and SIGN- exceeds or is close to 24V.	Check wiring of SIGN+ and SIGN-. There must be a current limiting resistor. Check the power supply voltage for SIGN+ and SIGN-. If the voltage is too high, use a power supply within 24V.

- EA34.9: Hall is not configured

  Cause:

  Hall is not configured.

Cause	Troubleshooting	Solution
H00.26 is configured when dynamic Hall auto-tuning is enabled.	When H0A.13 = 6, check whether bit3 of H00.26 is set to 1. For a non-Hall sensor (bit3 of H00.26 is set to 0), check whether H0A.13 is set to 6 incorrectly.	For a Hall-enabled motor, you need to perform Hall auto-tuning (H0A.13=6) and set bit3 of H00.26 to 1. For a non-Hall motor, Hall auto-tuning is unavailable (H0A.13 cannot be set to 6).

- EA41.0: Torque ripple compensation failure

  Cause:

  Torque ripple compensation failure.

Cause	Troubleshooting	Solution
Auto-tuning torque fluctuation compensation failure	Check whether homing is not performed during cogging torque ripple auto-tuning of the incremental encoder. Confirm whether emergency stop or external fault interruption occurs during cogging torque ripple auto-tuning. Torque ripple compensation auto-tuning failed. Please try again.	Perform homing during cogging torque ripple auto-tuning of the incremental encoder. Avoid emergency stop or external fault interruption during cogging torque ripple auto-tuning. Torque ripple compensation auto-tuning failed. Please try again.

8.3 Handling of Faults and Alarms [N]

8.3.1 List of Fault Codes

No. 1 non-resettable faults:

Table 8–5 List of No. 1 non-resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E101	E101.0	Abnormal parameters in groups H02 and above	No.1	No	0x6320	0x01010101
	E101.1	Parameter error in group H00/H01	No.1	No	0x6320	0x11010101
	E101.2	Address error in read/ write operation after the number of parameters changes	No.1	No	0x6320	0x21010101
	E101.9	Parameter attribute initialization check error	No.1	No	0x6320	0x91010101
E102	E102.0	FPGA communication initialization error	No.1	No	0x7500	0x01020102
	E102.1	FPGA initialization not completed	No.1	No	0x7500	0x11020102
	E102.8	FPGA and MCU software version mismatch	No.1	No	0x7500	0x81020102
E104	E104.1	MCU running timeout (MCU break down)	No.1	No	0x7500	0x11040104
	E104.2	FPGA running timeout (FPGA break down)	No.1	No	0x7500	0x21040104
	E104.4	MCU command update timeout	No.1	No	0x7500	0x41040104
E120	E120.0	Unknown encoder model	No.1	No	0x7122	0x01200120
	E120.1	Unknown motor model	No.1	No	0x7122	0x11200120
	E120.2	Unknown drive model	No.1	No	0x7122	0x21200120
	E120.5	Motor and drive current mismatch	No.1	No	0x7122	0x51200120
	E120.6	FPGA and motor model mismatch	No.1	No	0x7122	0x61200120
	E120.7	Model check error	No.1	No	0x0120	0x71200120
	E120.8	Junction temperature parameter check error	No.1	No	0x0120	0x81200120

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E136	E136.0	Encoder ROM motor parameter check error	No.1	No	0x7305	0x01360136
	E136.1	Encoder ROM motor parameter read error	No.1	No	0x7305	0x11360136
	E136.9	Dimension parameter Initialization error	No.1	No	0x7305	0x91360136
E138	E138.0	Accuracy compensation data error	No.1	No	0x0138	0x01380138
	E138.1	Cogging ripple compensation data check failure	No.1	No	0x0138	0x11380138
	E138.2	Gantry sync compensation data check failure	No.1	No	0x0138	0x21380138
	E138.3	Overload compensation data check failure	No.1	No	0x0138	0x31380138
E140	E140.0	Encryption chip check fault	No.1	No	0x0140	0x01400140
	E140.2	Wrong encryption chip version	No.1	No	0x0140	0x21400140
	E140.3	Encrypted chip damaged	No.1	No	0x0140	0x31400140
E201	E201.0	Phase-P overcurrent	No.1	No	0x2312	0x02010201
	E201.1	Phase-U overcurrent	No.1	No	0x2312	0x12010201
	E201.2	Phase-V overcurrent	No.1	No	0x2312	0x22010201
	E201.4	Phase-N overcurrent	No.1	No	0x2312	0x42010201
E210	E210.0	Output short-circuited to ground	No.1	No	0x2330	0x02100210
E234	E234.0	Runaway (protection scheme 1)	No.1	No	0x0234	0x02340234
	E234.1	Runaway (protection scheme 2)	No.1	No	0x0234	0x12340234
E308	E308.0	Pulse encoder phase A wire breakage	No.1	No	0x0308	0x03080308
	E308.1	Pulse encoder phase B wire breakage	No.1	No	0x0308	0x13080308
	E308.2	Pulse encoder phase Z wire breakage	No.1	No	0x0308	0x23080308
E603	E603.0	Gantry communication CRC failure	No.1	No	0x0603	0x06030603
	E603.1	Gantry communication timeout	No.1	No	0x0603	0x16030603
	E603.2	Drive failed to establish communication for a long time	No.1	No	0x0603	0x26030603

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E606	E606.0	Gantry torque alignment timeout	No.1	No	0x0606	0x06060606
E619	E619.0	Absolute accuracy compensation parameter setting error	No.1	No	0x0619	0x06190619
	E619.1	Absolute accuracy compensation overflow	No.1	No	0x0619	0x16190619
E720	E720.0	Wrong encoder interface	No.1	No	0x0720	0x07200720
E740	E740.0	Absolute encoder communication timeout	No.1	No	0x7305	0x07400740
	E740.2	Absolute encoder error	No.1	No	0x7305	0x27400740
	E740.3	Absolute encoder single-turn calculation error	No.1	No	0x7305	0x37400740
	E740.6	Encoder write error	No.1	No	0x7305	0x67400740
	E740.8	BISSC register communication failure	No.1	No	0x7305	0x87400740
	E740.9	Encoder data transmit delay too long	No.1	No	0x7305	0x97400740
E755	E755.0	Nikon encoder communication fault	No.1	No	0x0FFF	0x07550755
E765	E765.0	Nikon encoder over-temperature or overspeed	No.1	No	0x0765	0x07650765
E770	E770.6	Fully closed-loop 2nd encoder initialization communication error	No.1	No	0x7305	0x67700770
	E770.7	Fully closed-loop Inovance 2nd encoder communication error	No.1	No	0x7305	0x77700770
E771	E771.0	Communication handshake failed between the interpolator and drive	No.1	No	0x0771	0x07710771
EA33	EA33.0	Encoder read/write check error	No.1	No	0x7305	0x0A330A33
	EA33.1	Fully closed-loop Inovance 2nd encoder data read/write error	No.1	No	0x7305	0X1A330A33
EA34	EA34.0	Abnormal Hall state	No.1	No	0x0A34	0x0A340A34
	EA34.1	Dynamic Hall auto-tuning error	No.1	No	0x0A34	0x1A340A34
	EA34.2	Static Hall auto-tuning error	No.1	No	0x0A34	0x2A340A34
EE12	EE12.0	EtherCAT initialization failure	No.1	No	0x0E12	0x0E120E12
EE16	EE16.0	MCU and ESC communication error	No.1	No	0x0E16	0xEE160E16
EEE0	EEE0.0	Gantry paired axis error	No.1	No	0x0EE0	0x0EE00EE0

No. 1 resettable faults:

Table 8–6 List of No. 1 resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E126	E126.0	Process segment number error	No.1	Yes	0x0126	0x01260126
	E126.1	Internal operation mode error of the process segment	No.1	Yes	0x0126	0x11260126
	E126.2	Position reference type error in process segment position mode	No.1	Yes	0x0126	0x21260126
E150	E150.0	STO safety state applied	No.1	Yes	0x0150	0x01500150
	E150.1	STO input state abnormal	No.1	Yes	0x0150	0x11500150
	E150.2	Buffer 5 V supply error	No.1	Yes	0x0150	0x21500150
	E150.3	STO input circuit hardware diagnosis failure	No.1	Yes	0x0150	0x31500150
	E150.4	PWM Buffer hardware diagnosis failure	No.1	Yes	0x0150	0x41500150
	E150.5	STO input signal interference	No.1	Yes	0x0150	0x51500150
E208	E208.2	Encoder communication timeout	No.1	Yes	0x0208	0x22080208
	E208.4	FPGA current loop operation timeout	No.1	Yes	0x0208	0x42080208
E320	E320.0	Braking resistor overload	No.1	Yes	0x0320	0x03200320
	E320.1	External braking resistor surface temperature too high	No.1	Yes	0x0320	0x13200320
E321	E321.0	Dynamic brake resistor overload	No.1	Yes	0x0321	0x03210321
E400	E400.0	Main circuit overvoltage	No.1	Yes	0x3210	0x04000400
E410	E410.0	Main circuit undervoltage	No.1	Yes	0x3220	0x04100410
	E410.1	Main circuit de-energized	No.1	Yes	0x0410	0x14100410
E500	E500.0	Motor overspeed	No.1	Yes	0x8400	0x05000500
	E500.1	Speed feedback overflow	No.1	Yes	0x8400	0x15000500
	E500.2	FPGA position feedback pulse overspeed	No.1	Yes	0x0500	0x25000500

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E602	E602.0	Angle auto-tuning failure	No.1	Yes	0x0602	0x06020602
	E602.1	Angle auto-tuning overtravel	No.1	Yes	0x0602	0x16020602
	E602.2	U/V/W phase sequence reversed	No.1	Yes	0x0602	0x26020602
	E602.3	Large encoder jitter during angle auto-tuning	No.1	Yes	0x0602	0x36020602
	E602.4	Auto-tuning failed. Auto-tuning timeout.	No.1	Yes	0x0602	0x46020602
	E602.5	Angle auto-tuning failed. Z signal not found.	No.1	Yes	0x0602	0x56020602
	E602.6	Angle auto-tuning does not converge	No.1	Yes	0x0602	0x66020602
E604	E604.0	Inconsistent settings of two gantry axes	No.1	Yes	0x0604	0x06040604
	E604.1	Gantry not set to position mode	No.1	Yes	0x0604	0x16040604
	E604.2	Gantry is running on an unsupported feature	No.1	Yes	0x0604	0x26040604
E605	E605.0	Speed too fast upon S-ON	No.1	Yes	0x0605	0x06050605
E612	E612.0	Rotor locked during phase sequence auto-tuning	No.1	Yes	0x0612	0x06120612
	E612.1	Overtravel occurred during phase sequence auto-tuning	No.1	Yes	0x0612	0x16120612
	E612.3	Large encoder jitter during phase sequence auto-tuning	No.1	Yes	0x0612	0x36120612
	E612.4	Phase sequence auto-tuning failed. Auto-tuning timeout.	No.1	Yes	0x0612	0x46120612
E620	E620.0	Motor overload	No.1	Yes	0x3230	0x06200620
	E620.1	Overload current limit mode, motor overloaded	No.1	Yes	0x3230	0x16200620
E621	E621.0	Overload current limiting torque attained	No.1	Yes	0x0621	0x06210621
E630	E630.0	Motor stall over-temperature protection	No.1	Yes	0x7121	0x06300630
E631	E631.1	24 V power supply or brake not connected	No.1	Yes	0x0631	0x16310631
	E631.2	P-MOS open circuit	No.1	Yes	0x0631	0x26310631
	E631.3	N-MOS disconnection	No.1	Yes	0x0631	0x36310631

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E640	E640.0	High IGBT junction overtemperature	No.1	Yes	0x4210	0x06400640
	E640.1	Flywheel diode overtemperature	No.1	Yes	0x0640	0x16400640
E650	E650.0	Heatsink overtemperature	No.1	Yes	0x4210	0x06500650
E660	E660.0	Motor overtemperature	No.1	Yes	0x4210	0x06600660
E770	E770.0	Fully-closed input phase A wire breakage	No.1	Yes	0x7305	0x07700770
	E770.1	Fully-closed input phase B wire breakage	No.1	Yes	0x7305	0x17700770
	E770.2	Fully-closed input phase Z wire breakage	No.1	Yes	0x7305	0x27700770
	E770.3	BISS/SSI/ENDAT communication protocol timeout	No.1	Yes	0x7305	0x37700770
	E770.8	Full closed-loop encoder data transmit delay is too large	No.1	Yes	0x7305	0x87700770
E939	E939.0	Motor power cables disconnected	No.1	Yes	0x0939	0x09390939
EB00	EB00.0	Excessive position deviation	No.1	Yes	0x8611	0x0B000B00

No. 2 resettable faults

Table 8–7 List of No. 2 resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E122	E122.0	Multi-turn absolute encoder setting error	No.2	Yes	0x6320	0x01220122
	E122.1	Different DIs allocated with the same function	No.2	Yes	0x6320	0x11220122
	E122.2	DO function allocation error	No.2	Yes	0x0122	0x21220122
	E122.3	Upper limit in the rotation mode too high	No.2	Yes	0x6320	0x31220122
	E122.4	VDI function allocation error	No.2	Yes	0x0122	0x41220122
	E122.5	DI and VDI assigned with the same function	No.2	Yes	0x0122	0x51220122
	E122.6	Absolute function setting fault of 2nd encoder	No.2	Yes	0x6320	0x61220122
	E122.7	Fully closed-loop parameter setting error	No.2	Yes	0x6320	0x71220122
	E122.8	Interpolator version mismatch	No.2	Yes	0x6320	0x81220122
E420	E420.0	Main circuit phase loss	No.2	Yes	0x3130	0x04200420
E661	E661.0	STune failure	No.2	Yes	0x4210	0x06610661
E662	E662.0	ETune failure	No.2	Yes	0x0662	0x06620662
E664	E664.0	Resonance too strong	No.2	Yes	0x0664	0x06640664
E731	E731.0	Encoder multi-turn data lost	No.2	Yes	0x7305	0x07310731
	E731.1	Inovance second encoder multi-turn data lost	No.2	Yes	0x7305	0x17310731
E733	E733.0	Encoder multi-turn counting error	No.2	Yes	0x7305	0x07330733
	E733.1	Inovance 2nd encoder multi-turn counting error	No.2	Yes	0x7305	0x17330733
E735	E735.0	Encoder multi-turn counting overflow	No.2	Yes	0x7305	0x07350735
E760	E760.0	Encoder over-temperature	No.2	Yes	0x4210	0x07600760
EB00	EB00.1	Position deviation overflow	No.2	Yes	0x8611	0x1B000B00

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
EB01	EB01.1	Individual position reference increment too large	No.2	Yes	0x6320	0x1B010B01
	EB01.2	Position reference increment too large continuously	No.2	Yes	0x6320	0x2B010B01
	EB01.3	Reference overflow	No.2	Yes	0x6320	0x3B010B01
EB02	EB02.0	Position deviation too large in fully closed-loop mode	No.2	Yes	0x8611	0x0B020B02
	EB02.1	Fully closed-loop position deviation overflow	No.2	Yes	0x8611	0x1B020B02
EB03	EB03.0	Electronic gear ratio beyond the limit - H05.02	No.2	Yes	0x0B03	0x0B030B03
	EB03.1	Electronic gear ratio beyond the limit - Electronic gear ratio 1	No.2	Yes	0x0B03	0x1B030B03
	EB03.2	Electronic gear ratio beyond the limit -Electronic gear ratio 2	No.2	Yes	0x0B03	0x2B030B03
EB04	EB04.0	Large gantry position deviation	No.2	Yes	0x0B04	0x0B040B04
	EB04.1	Gantry position deviation overrun	No.2	Yes	0x0B04	0x1B040B04
ED02	ED02.0	Modbus communication timeout	No.2	Yes	0x0D02	0x0D020D02
EE08	EE08.0	Synchronization signal loss	No.2	Yes	0x0E08	0x0E080E08
	EE08.1	Status switchover error	No.2	Yes	0x0E08	0x1E080E08
	EE08.3	Network cable connected improperly	No.2	Yes	0x0E08	0x3E080E08
	EE08.4	Data frame loss protection error	No.2	Yes	0x0E08	0x4E080E08
	EE08.5	Data frame transfer error	No.2	Yes	0x0E08	0x5E080E08
	EE08.6	Data update timeout	No.2	Yes	0x0E08	0x6E080E08
EE09	EE09.0	Software position limit setting error	No.2	Yes	0x6320	0x0E090E09
	EE09.1	Home setting error	No.2	Yes	0x6320	0x1E090E09
	EE09.2	Gear ratio beyond the limit	No.2	Yes	0x6320	0x2E090E09
	EE09.3	No synchronization signal	No.2	Yes	0x6320	0x3E090E09
	EE09.5	PDO mapping beyond the limit	No.2	Yes	0x6320	0x5E090E09

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
EE10	EE10.0	Protection against MailBox setting error	No.2	Yes	0x0E10	0x0E100E10
	EE10.1	SM2 setting error	No.2	Yes	0x0E10	0x1E100E10
	EE10.2	SM3 setting error	No.2	Yes	0x0E10	0x2E100E10
	EE10.3	PDO watchdog setting error	No.2	Yes	0x0E10	0x3E100E10
	EE10.4	Protection against incomplete PLL	No.2	Yes	0x0E10	0x4E100E10
	EE10.5	PHY setting error	No.2	Yes	0x0E10	0x5E100E10
EE11	EE11.0	ESI check error	No.2	Yes	0x5530	0x0E110E11
	EE11.1	EEPROM bus read failure	No.2	Yes	0x5530	0x1E110E11
	EE11.2	EEPROM update failure	No.2	Yes	0x5530	0x2E110E11
	EE11.3	ESI and drive mismatch	No.2	Yes	0x5530	0x3E110E11
EE13	EE13.0	EtherCAT sync period setting error	No.2	Yes	0x6320	0x0E130E13
EE15	EE15.0	Large EtherCAT sync period error	No.2	Yes	0x0E15	0x0E150E15

8.3.2 List of Alarm Codes

Table 8–8 List of alarm codes

Warning code	Alarm subcode	Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E108	E108.0	Storage parameter write error	No.3	Yes	0x5530	0x01080108
	E108.1	Storage parameter read error	No.3	Yes	0x5530	0x11080108
	E108.2	Invalid check on data written in EEPROM	No.3	Yes	0x5530	0x21080108
	E108.3	Invalid check on data read in EEPROM	No.3	Yes	0x5530	0x31080108
	E108.4	Single data is stored too many times	No.3	Yes	0x0108	0x41080108
E110	E110.0	Frequency-division pulse output setting error	No.3	Yes	0x0110	0x01100110
E120	E120.3	The motor and drive do not match in the power	No.3	Yes	0x7122	0x31200120
E121	E121.0	Invalid S-ON command	No.3	Yes	0x0121	0x01210121
E126	E126.3	PR process segment write parameter out of limit	No.3	Yes	0x0126	0x31260126
E510	E510.0	Frequency division pulse output overspeed	No.3	Yes	0x0510	0x05100510

Warning code	Alarm subcode	Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E600	E600.0	Inertia auto-tuning failure	No.3	Yes	0x0600	0x06000600
E601	E601.0	Homing alarm	No.3	Yes	0x0601	0x06010601
	E601.1	Homing switch error	No.3	Yes	0x0601	0x16010601
	E601.2	Homing mode setting error	No.3	Yes	0x6320	0x26010601
	E601.4	Gantry homing mode setting error	No.3	Yes	0x0601	0x46010601
E602	E602.9	Angle auto-tuning not done for incremental encoder motor	No.3	Yes	0x0602	0x96020602
E607	E607.0	Large gantry torque deviation	No.3	Yes	0x0607	0x06070607
E608	E608.0	Master-to-slave parameter setting error	No.3	Yes	0x0608	0x06080608
E609	E609.0	Data save timeout	No.3	Yes	0x0609	0x06090609
	E609.1	Data save overflow	No.3	Yes	0x0609	0x16090609
	E609.2	Failed to save data	No.3	Yes	0x0609	0x26090609
	E609.3	Failed to erase data	No.3	Yes	0x0609	0x36090609
E621	E621.1	Overload current limiting torque attained	No.3	Yes	0x0621	0x16210621
E631	E631.4	P-MOS disconnection	No.3	Yes	0x0631	0x46310631
	E631.5	N-MOS disconnection	No.3	Yes	0x0631	0x56310631
E730	E730.0	Encoder battery alarm	No.3	Yes	0x7305	0x07300730
	E730.1	Inovance 2nd encoder battery voltage low	No.3	Yes	0x0730	0x17300730
E831	E831.1	AI1 zero offset too large	No.3	Yes	0x0831	0x18310831
	E831.2	AI2 zero offset too large	No.3	Yes	0x0831	0x28310831
E834	E834.1	AI1 overvoltage	No.3	Yes	0x0834	0x18340834
	E834.2	AI2 overvoltage	No.3	Yes	0x0834	0x28340834
E900	E900.0	DI emergency braking	No.3	Yes	0x0900	0x09000900
E902	E902.0	DI setting invalid	No.3	Yes	0x6320	0x09020902
	E902.1	DO setting invalid	No.3	Yes	0x0902	0x19020902
	E902.2	Torque reach setting invalid	No.3	Yes	0x0902	0x29020902
E909	E909.0	Motor overload	No.3	Yes	0x3230	0x09090909
E910	E910.0	Control circuit overvoltage	No.3	Yes	0x3210	0x09100910
E920	E920.0	Braking resistor overload	No.3	Yes	0x3210	0x09200920
E921	E921.0	Dynamic brake resistor overload alarm	No.3	Yes	0x3210	0x09210921
E922	E922.0	Resistance of the external braking resistor too small	No.3	Yes	0x6320	0x09220922

Warning code	Alarm subcode	Name	Fault level	Resettable	Error code	Auxiliary Code (203Fh)
E924	E924.0	Regenerative transistor over-temperature	No.3	Yes	0x3230	0x09240924
E940	E940.0	Change of controlled motor is detected. It is recommended to restore factory settings before use	No.3	Yes	0x0940	0x09400940
E941	E941.0	Modified parameters activated at next power-on	No.3	No	0x6320	0x09410941
E942	E942.0	Parameter storage too frequent	No.3	Yes	0x7600	0x09420942
E950	E950.0	Positive limit switch alarm	No.3	Yes	0x5443	0x09500950
E952	E952.0	Negative limit switch alarm	No.3	Yes	0x5444	0x09520952
E954	E954.0	Position reference overflow	No.3	Yes	0x0954	0x09540954
E956	E956.0	Forward position reference overtravel in process segment position mode	No.3	Yes	0x0956	0x09560956
E958	E958.0	Reverse position reference overtravel in process segment position mode	No.3	Yes	0x0958	0x09580958
E971	E971.0	Undervoltage alarm for voltage drop protection	No.3	Yes	0x3210	0x09710971
E980	E980.0	Frequency division output overflow	No.3	Yes	0x0980	0x09800980
EA34	EA34.9	Hall is not configured	No.3	Yes	0x0A34	0x9A340A34
EA41	EA41.0	Torque fluctuation compensation failure	No.3	Yes	0x0A41	0x0A410A41

8.3.3 Description of Fault Codes

8.3.3.1 Solutions to Faults

- E101.0: Abnormal parameters in groups H02 and above
  Cause:

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

  Values of parameters in groups H02 and above exceed the limit, which generally occurs after software update.

Cause	Troubleshooting	Solution
1. The actual value of the parameter exceeds the upper/lower limit of the parameter.	Read H0b.90 and H0b.91 and obtain the abnormal parameter group number.	1. Rectify the wrong value. 2. Restore default settings.
2. The voltage of the control circuit power supply drops instantaneously.	1. Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. 2. Measure whether the input voltage of the control circuit cable on the non-drive side is within the following range: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: 10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: -10% to +10% (342 V to 484 V)	1. Restore default settings (H02.31 = 1), and write parameters again. 2. Enlarge the power capacity or replace with a power supply of higher capacity, restore default settings (H02.31 = 1) and write parameters again.
3. Instantaneous power failure occurs during parameter saving.	Check whether instantaneous power failure occurs when saving parameters.	Power on the system again, restore system parameters to default settings (H02.31 = 1), and write parameters again.
4. The number of write operations within a certain period of time exceeds the limit.	1. Check whether instantaneous power failure occurs during parameter storage. 2. Check whether parameters are updated frequently through the host controller.	1. If the servo drive is faulty, replace the servo drive. 2. Change the way of writing and write parameters again. 3. Power on the system again, restore system parameters to default settings (H02.31 = 1), and write parameters again.
5. The software is updated.	Check whether parameter values in group H02 and above exceed the upper/ lower limit due to software update.	Reset the servo drive model and servo motor model, and restore system parameters to default settings (H02.31 = 1).
6. The servo drive is faulty.	If the fault persists though parameters are restored to default settings and the servo drive is powered off and on repeatedly, the servo drive is faulty.	Replace the servo drive.

- E101.1: parameter error in group H00/H01
  Cause:

The total number of parameters changes, which generally occurs after software update. Values of parameters in groups H00 or H01 exceed the limit, which generally occurs after software update.

Cause	Troubleshooting	Solution
The servo drive detects whether parameter values in groups H00 and H01 exceed the upper/lower limit during initialization upon power-on. If yes, the keypad displays E101.1. Motor parameters in group H00 are read from the encoder. Servo drive parameters in group H01 are mapped based on the servo drive model defined by H01.10.	Read H0b.90 and H0b.91 and obtain the abnormal parameter group number. Check groups H00 and H01 to find the parameter whose value exceeds the limit. Confirm whether this parameter range is abnormal.	Replace the motor or drive.

- E101.2: Address error in read/write operation after the number of parameters changes
  Cause:

  Address error in read/write operation after the number of parameters changes.

Cause	Troubleshooting	Solution
The total number of parameters changes after software update, leading to address error in read/write operation.	Read H0b.90 and H0b.91 and obtain the abnormal parameter group number.	1. Rectify the wrong value. 2. Restore default settings.

- E101.9: Parameter attribute initialization check error
  Cause:

  Parameter attribute initialization check error.

Cause	Troubleshooting	Solution
Parameter attribute initialization error	Check whether H0A.99 has been written.	Restore factory settings. If the problems persists after several power cycles, replace the drive.

- E102.0: FPGA communication initialization error
  Cause:

  FPGA and MCU version mismatch.

Cause	Troubleshooting	Solution
The communication between MCU and FPGA cannot be established.	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E102.1: FPGA initialization start error
  Cause:

  FPGA failed.

Cause	Troubleshooting	Solution
FPGA cannot start.	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E102.8: FPGA and MCU software version mismatch
  Cause:

  FPGA and MCU version mismatch.

Cause	Troubleshooting	Solution
The software versions of MCU and FPGA are inconsistent.	1. Check whether the MCU version (H01.00) is 9xx.x (the fourth digit displayed on the keypad is 9). 2. Check whether the FPGA version (H01.01) is 9xx.x (the fourth digit displayed on the keypad is 9).	Contact Inovance for technical support. Update the FPGA or MCU software.

- E104.1: MCU running timeout (MCU break down)
  Cause:

  The access to MCU times out.

Cause	Troubleshooting	Solution
1. FPGA failure.	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.
2. FPGA and HOST communication handshaking error.		
3. Access timeout occurs between HOST and the coprocessor.		

- E104.2: FPGA running timeout (FPGA break down)
  Cause:

  The MCU torque interrupt scheduling time is abnormal. This fault is reported only during commissioning.

Cause	Troubleshooting	Solution
1.FPGA failure. 2. FPGA and MCU communication handshaking error.	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- E104.4: MCU command update timeout
  Cause:

  Take the moment when interrupt starts as the starting time, if the time when commands are written to MCU is larger than the time when position and speed regulators are started by FPGA, an alarm will be reported.

Cause	Troubleshooting	Solution
The system reports that the encoder communication time is set improperly or the command calculation time is too long.	The fault persists after the servo drive is powered off and on repeatedly.	1. Hide the unnecessary functions. 2. Replace the servo drive.

- E120.0: Unknown encoder model
  Cause:

  The motor is incompatible with the encoder.

Cause	Troubleshooting	Solution
1. The product (motor or servo drive) code does not exist.	Read the nameplates of the servo drive and motor to check whether SV680N series servo drive and 26-bit servo motor are used. Meanwhile, check whether H00.00 (motor code) is set to 14102. Check the servo drive code (H01.02) to see whether this servo drive code exists.	If the motor code is unknown, set H00.00 to 14102 when the SV680N series servo drive and 23-bit servo motor are used. If the drive code is unknown, check it against the nameplate of the drive. If the drive model is incorrect, contact our technicians.
2. The power rating of the motor does not match that of the servo drive.	Check whether the servo drive code (H01.02) matches the serial-type motor code (H00.05).	Replace the unmatched products.

- E120.1: Unknown motor model
  Cause:

  The motor model does not exist.

Cause	Troubleshooting	Solution
The motor model defined by H00.00 is abnormal	Check whether the value of H00.00 matches the used motor.	Rectify the value of H00.00.

- E120.2: Unknown drive model
  Cause:

  The servo drive detects the servo drive model defined by H01.10 during initialization upon power-on. If the servo drive model does not exist, E120.2 occurs.

Cause	Troubleshooting	Solution
H01.10 is set incorrectly.	Check the value of H01.10.	Replace the servo drive.

- E120.5: Motor and drive current mismatch
  Cause:

  The rated output of the servo drive is far higher than the rated current of the motor. You must use a servo drive of lower rated output or a motor with higher rated current.

Cause	Troubleshooting	Solution
The internal scaling value is abnormal.	Check whether the servo drive model is correct. If the set current sampling coefficient is too large, calculation overflow will occur.	Replace the servo drive.

- E120.6: FPGA and motor model mismatch
  Cause:
  - The motor model is set improperly, causing mismatch and malfunction of the servo drive.
  - The motor model is set properly, but the motor encoder is not supported by the servo drive.

Cause	Troubleshooting	Solution
FPGA software version does not match the setting of H00.00.	Check whether the FPGA software version (H01.01) supports the motor model set by H00.00.	Update the FPGA software to support the motor model or replace the motor.

- E120.7: Model check error
  Cause:

  The servo drive model parameter cannot be identified.

Cause	Troubleshooting	Solution
Model parameter CRC check failed.	Check that the model parameter is present.	Write the model parameter again.

- E120.8: Junction temperature parameter check error
  Cause:

  The junction temperature parameter is identified incorrectly.

Cause	Troubleshooting	Solution
Junction temperature parameter CRC check failed.	Check that the junction temperature parameter is present.	Rewrite the junction temperature parameter.

- E122.0: Multi-turn absolute encoder setting error
  Cause:

  The motor does not match the absolute position mode or the motor code is set improperly.

Cause	Troubleshooting	Solution
The motor does not match in the absolute position mode or the motor SN is set improperly.	1. Check the motor nameplate to see whether the motor is configured with a multi-turn absolute encoder. 2. Check whether H00.00 (motor code) is set properly.	Reset H00.00 (motor code) according to the motor nameplate or use a suitable motor.

- E122.1: Different DIs assigned with the same function
  Cause:

  The same function is assigned to different DIs.

  The DI function No. exceeds the maximum number allowed for DI functions.

Cause	Troubleshooting	Solution
1. The same function is assigned to different DIs.	Check whether parameters in groups H03 (H03.02, H03.04...H03.20) and H17 (H17.00, H17.02...H17.30) are assigned with the same non-zero DI function No.	Assign different DI function numbers to parameters in groups H03 or H17, and then restart the control circuit to activate the assignment, or switch off the S-ON signal and send a "RESET" signal to activate the assignment.
2. The DI function No. exceeds the maximum setting number allowed for DI functions.	Check whether the MCU program is updated.	Restore system parameters to default values (H02.31 = 1) and restart the servo drive.

- E122.2: Different DOs assigned with the same function
  Cause:

  The DO function No. exceeds the maximum number allowed for DO functions.

Cause	Troubleshooting	Solution
The DO function No. exceeds the maximum number allowed for DO functions.	Check whether DO function numbers defined by H04.00 and H04.02 are abnormal.	Set the correct DO function No.

- E122.3: Upper limit in the rotation mode invalid
  Cause:

  The upper limit (reference range) of the mechanical single-turn position exceeds 2^{31} in the absolute position rotation mode.

Cause	Troubleshooting	Solution
The upper limit (reference range) of the mechanical single-turn position exceeds 2^{31} in the absolute position rotation mode.	Check the setting of the mechanical gear ratio, the upper limit of mechanical single-turn position and the electronic gear ratio when the servo drive runs in the absolute 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}.

- E122.4: Different VDIs assigned with the same function
  Cause:

  The same function is assigned to different VDIs. The VDI function No. exceeds the maximum number allowed for VDI functions.

Cause	Troubleshooting	Solution
1. The same function is assigned to different VDIs.	Check whether parameters in groups H03 (H03.02, H03.04...H03.20) and H17 (H17.00, H17.02...H17.30) are assigned with the same non-zero DI function No.	Assign different DI function numbers to parameters in groups H03 or H17, and then restart the control circuit to activate the assignment, or switch off the S-ON signal and send a "RESET" signal to activate the assignment.
2. The VDI function No. exceeds the maximum number allowed for VDI functions.	Check whether the MCU program is updated.	Restore system parameters to default values (H02.31 = 1) and restart the servo drive.

- E122.5: DI and VDI assigned with the same function
  Cause:

  The same function is assigned to different VDIs. The VDI function No. exceeds the maximum number allowed for VDI functions.

Cause	Troubleshooting	Solution
Two or more DIs and VDIs are assigned with the same function No.	Check whether DI function numbers set in groups H03 and H17 are repetitive.	Change any repetitive number.

- E122.6: Absolute function setting fault of the 2nd encoder
  Cause:

  The motor does not match the absolute mode.

Cause	Troubleshooting	Solution
The motor does not match the absolute mode.	Check the motor nameplate to see whether the motor is configured with a multi-turn absolute encoder.	Set H0F.02 to 0.

- E122.7: Fully closed-loop parameter setting error
  Cause:

  In fully closed-loop applications, the inner loop is set to rotation mode.

Cause	Troubleshooting	Solution
When H0F.00 is not 0, set H02.01 to 2 (absolute position rotation mode).	Check the value of H02.01 if fully closed-loop is used.	Set the value of H02.01 to 2 if fully closed-loop is used.

- E122.8: Interpolator version mismatch
  Cause:

  Interpolator version mismatch

Cause	Troubleshooting	Solution
The T2 interpolator does not match the motor.	Check whether H00.50 is consistent with H00.51, and they are not 65535.	1. Check whether the interpolator is misused. 2. For the alarm caused by replacing the interpolator, write the corresponding factory parameters into the interpolator.

- E126.0: Process segment number error
  Cause:

  The process segment number is not 1000 or any other value from 0 to 15 in the process segment mode.

Cause	Troubleshooting	Solution
The process segment number is not 1000 or any other value from 0 to 15 in the process segment mode.	Check whether the value of H22.00 exceeds the specified range of process segment number (0–15 or 1000).	Write 0...15 to H22.00 in the technology segment mode.

- E126.1: Process segment internal operation mode error
  Cause:

  The process segment operation mode is not 0, 1, 2, 3, 7, or 8.

Cause	Troubleshooting	Solution
The process segment operation mode is not 0, 1, 2, 3, 7, or 8.	Check whether the values of bit0 to bit3 of the parameter defined by the process segment at fault are 0, 1, 2, 3, 7, and 8.	Set the technology segment operation mode to 0, 1, 2, 3, 7, and 8 in the technology segment mode.

- E126.2: Position reference type error in process segment position mode
  Cause:

  The position reference type in the process segment position mode is not 00 (absolute reference) or 10 (incremental mode).

Cause	Troubleshooting	Solution
The position reference type in the process segment position mode is not 00 (absolute reference) or 10 (incremental mode).	Check whether the value of bit6 or bit7 of the parameter defined by the process segment at fault is 00 or 10.	Set the position reference type in the process segment position mode to 00 (absolute reference) or 10 (incremental reference).

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

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

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

- E136.0: Encoder ROM motor parameter check error
  Cause:

  When reading parameters in the encoder ROM, the servo drive detects that no parameters are saved there or parameter values are inconsistent with the setpoints.

Cause	Troubleshooting	Solution
1. The servo Servo drive model does not match the motor model.	View the servo drive and servo motor nameplates to check whether the SV680N series servo drive and servo motor are used.	Replace the servo drive and motor.
2. A parameter check error occurs or no parameter is saved in the ROM of the serial incremental encoder.	1. Check whether the encoder cable provided by Inovance is used. For cable specifications, see "Matching Cables". The cable must be connected securely without scratching, breaking or poor contact on both ends. 2. Measure signals PS+, PS-, +5V and GND on both ends of the encoder cable and observe whether signals at both ends are consistent. For signal pin assignment, see the section related to wiring.	1. Use the encoder cable provided by Inovance. Ensure motor terminals are connected securely and servo drive screws are tightened properly. Use a new encoder cable if necessary. 2. Route encoder cables and power cables (RST, UVW) through different routes.
3. The servo drive is faulty.	The fault persists after the servo drive is restarted.	Replace the servo drive.

- E136.1: Encoder ROM motor parameter read error
  Cause:

  The encoder cable is not connected properly.

  A communication error occurs on the encoder due to interference.

Cause	Troubleshooting	Solution
The encoder cable connections are incorrect or loosened.	Check the wiring of the encoder. Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder.	1. Connect the encoder cables according to the correct wiring diagram. 2. Re-connect encoder cables and ensure encoder terminals are connected securely.
The servo drive is faulty.	The fault persists after the servo drive is restarted.	Replace the servo drive.
Encoder communication is interfered with.	Check whether E136.1 occurs occasionally.	Install a magnetic ring. Route the power cable and communication cable separately.

- E136.9: Dimension parameter Initialization error
  Cause:

  Encoder read-write error causes 32-bit dimensional compatibility initialization error.

Cause	Troubleshooting	Solution
Encoder read-write error causes 32-bit dimensional compatibility initialization error.	Check whether H32.50 is set to enable compatibility.	1. If the encoder communication error still occurs after you disable compatibility, takes measures accordingly. 2. If power-on is normal after you disable compatibility. turn on the alarm and contact the technical support personnel of Inovance.

- E138.0: Accuracy compensation data error
  Cause:

  Check failed because accuracy compensation data is lost.

Cause	Troubleshooting	Solution
1. Check failed because accuracy compensation data is lost.	Read the drive compensation data from the commissioning software and observe whether the data is normal.	1. Compensate again through the commissioning software and power off to restart. 2. If the alarm remains, contact the manufacturer.
2. FLASH hardware failure.		

- E138.1: Cogging ripple compensation data check failure
  Cause:

  Check failed because cogging ripple compensation data is lost.

Cause	Troubleshooting	Solution
1. Check failed because cogging ripple compensation data is lost.	Read data through InoDriverShop.	1. Compensate again and power off to restart. 2. If the alarm remains, contact the manufacturer.
2. FLASH hardware failure.		

- E138.2: Gantry sync compensation data check failure
  Cause:

  Check failed because gantry synchronization compensation data is lost.

Cause	Troubleshooting	Solution
1. Check failed because gantry synchronization compensation data is lost.	Read data through InoDriverShop.	1. Compensate again and power off to restart. 2. If the alarm remains, contact the manufacturer.
2. FLASH hardware failure.		

- E138.3: Overload compensation data check failure
  Cause:

  Check failed because overload compensation data is lost.

Cause	Troubleshooting	Solution
1. Check failed because overload compensation data is lost.	Read data through InoDriverShop.	1. Compensate again and power off to restart. 2. If the alarm remains, contact the manufacturer.
2. FLASH hardware failure.		

- E140.0: encryption chip check error
  Cause:

  Encryption chip check failure

Cause	Troubleshooting	Solution
Encryption software is not flashed.	Check whether the error persists after restart.	Ask the manufacturer to flash the encryption software.

- E140.2: wrong encryption chip version
  Cause:

  The MCU failed to establish communication with the encryption chip.

Cause	Troubleshooting	Solution
Encryption software is not flashed.	Check whether the error persists after restart.	Ask the manufacturer to flash the encryption software.

- E140.3: Encryption chip damaged
  Cause:

  The MCU failed to establish communication with the encryption chip.

Cause	Troubleshooting	Solution
The MCU failed to establish communication with the encryption chip.	Check whether the error persists after restart.	Ask the manufacturer to flash the encryption software.

- E150.0: STO safety state applied
  Cause:

  The STO input protection applies (safety state).

Cause	Troubleshooting	Solution
STO is triggered because either or both of two 24 V inputs are disconnected.	1. Check whether the STO function is activated.	It does not affect normal operation. After the STO terminal is back to normal, clear the fault using the fault reset function.
	2. Check whether the STO power supply is normal.	Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected.
	3. The fault persists after preceding causes are rectified.	Replace the servo drive.

- E150.1: STO input state abnormal
  Cause:

  The single-channel input of STO is ineffective.

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

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

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

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

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

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

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

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

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

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

- E150.5: STO input signal interference
  Cause:

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

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

- E201.0: Phase-P overcurrent
  Cause:

  An excessively high current flows through the positive pole of the DC-AC circuit.

Cause	Troubleshooting	Solution
1. Gains are set improperly and the motor oscillates.	Check whether vibration or sharp noise occurs during start and operation of the motor, or view "Current feedback" in the software tool.	1. The motor parameters are set improperly, modify the motor parameters. 2. The current loop parameters are set improperly, re-adjust the current loop parameters. 3. Improper speed loop parameters cause vibration. 4. Servo drive operates improperly. Replace it.
2. The encoder cable is wired incorrectly, aging, corroded, or connected loosely.	Check whether the encoder cable provided by Inovance is used. Check whether the cable is aging, corroded, or connected loosely. Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.17h (Electrical angle) changes as motor shaft rotates.	Re-solder, tighten or replace the encoder cable.

Cause	Troubleshooting	Solution
3. The servo drive is faulty.	1. Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.17 (Electrical angle) changes as motor shaft rotates. 2. Disconnect the motor cable but the fault persists after the servo drive is powered off and on again. 3. Check whether resistance of the external braking resistor is too small or the braking resistor is short-circuited (between terminals P ⊕ , C).	1. Use an external braking resistor of matching resistance. Perform wiring again. 2. Replace the servo drive.
4. Overcurrent occurs on the external braking resistor.	Check whether resistance of the external braking resistor is too small or the braking resistor is short-circuited (between terminals P, C).	Use an external braking resistor of matching resistance. Perform wiring again.

- E201.1: Phase-U overcurrent
  Cause:

  A current higher than the threshold is collected in the phase-U current.

Cause	Troubleshooting	Solution
Motor cables are in poor contact. Motor cables are grounded. U/V/W cables of the motor are short-circuited.	Check whether the servo drive power cables and motor cables on the U, V, and W sides of the servo drive are loose. After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive U/V/W side and the PE cable is at MΩ level.	Tighten the cables that are loose or disconnected. Replace the motor in case of poor insulation.
4. The motor is damaged due to over-temperature.	Disconnect the motor cables and check whether short circuit occurs among U, V, and W phases and whether burrs exist in the wiring. Disconnect the motor cables and measure whether the resistance among U, V, and W phases of motor cables is balanced.	Connect the motor cables correctly. Replace the motor if the resistance is unbalanced.

- E201.2: Phase-V overcurrent
  Cause:

  A current higher than the threshold is collected in the phase-V current.

Cause	Troubleshooting	Solution
Motor cables are in poor contact. Motor cables are grounded. U/V/W cables of the motor are short-circuited.	Check whether the servo drive power cables and motor cables on the U, V, and W sides of the servo drive are loose. After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive U/V/W side and the PE cable is at MΩ level.	Tighten the cables that are loose or disconnected. Replace the motor in case of poor insulation.
4. The motor is damaged due to over-temperature.	Disconnect the motor cables and check whether short circuit occurs among U, V, and W phases and whether burrs exist in the wiring. Disconnect the motor cables and measure whether the resistance among U, V, and W phases of motor cables is balanced.	Connect the motor cables correctly. Replace the motor if the resistance is unbalanced.

- E201.4: Phase-N overcurrent

  Cause:

  An excessively high current flows through the negative pole of the DC-AC circuit.

Cause	Troubleshooting	Solution
1. Gains are set improperly and the motor oscillates.	Check whether vibration or sharp noise occurs during start and operation of the motor, or view "Current feedback" in the software tool.	Adjust the gains.
2. The encoder cable is wired incorrectly, aging, corroded, or connected loosely.	Check whether the encoder cable provided by Inovance is used and whether the cable is aging, corroded, or connected loosely.	Re-solder, tighten or replace the encoder cable.
3. Overcurrent occurs on the braking resistor.	Check whether resistance of the external braking resistor is too small or the braking resistor is short-circuited (between terminals P ⊕ , C).	Use a braking resistor of matching resistance. Perform wiring again.

Cause	Troubleshooting	Solution
4. Overcurrent is caused by the superposition of the braking current and phase current.	Check if the drive accelerates abruptly during braking. Check if the voltage feedback exceeds the release threshold through the Inovance drive commissioning platform, and if the torque command increases abruptly.	Increase the acceleration/ deceleration time.
5. The servo drive is faulty.	Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.17 (Electrical angle) changes as motor shaft rotates. Disconnect the motor cable but the fault persists after the servo drive is powered off and on again.	Replace the servo drive.

- E208.2: Encoder communication timeout

  Cause:

  The FPGA detected a communication timeout with the encoder.

Cause	Troubleshooting	Solution
The servo drive fails to receive the data fed back by the encoder in three consecutive cycles.	Check whether H00.00 (Motor code) is set properly. Check whether the encoder cable is connected incorrectly, damaged, interfered with, or too long. Check whether the encoder version (H00.04) is set properly. It may be set to 0 or 65535 incorrectly. (You only need to check the version in the case of an Inovance encoder.) 4. Check whether the encoder is faulty (see H0B.28 for details). Check bit12 of H0b.30.	Modify the motor model according to the nameplate or use a suitable motor. Replace the cable or take additional anti-interference measures. If the cable is too long, you can change the value of H01.60. Perform a power cycle to read the version again. Use H0D.20 or perform a power cycle to check whether the fault persists. The servo drive operates improperly. Replace it.

- E208.4: FPGA current loop calculation timeout

  Cause:

  The operating time of the current loop exceeds the interval threshold.

Cause	Troubleshooting	Solution
FPGA operation timeout.	Internal fault code H0b.45 = 4208: Current loop operation timeout	Disable some unnecessary functions, such as notch and speed observer, to reduce the operating load of the current loop. Modify the value of H01.60, which may lead to slow response and noise of the motor.

- E210.0: Output short-circuited to ground
  Cause:

  An abnormal motor phase current or bus voltage is detected during power-on self-testing.

  - The DC bus voltage exceeds the discharge threshold.
  - The phase U current of size C/D/E models is greater than 1/4 of H01.07.
  - Overcurrent occurs on phase-P and phase-N of servo drives in size A and B.

Cause	Troubleshooting	Solution
1. The servo drive power cables (U/V/W) are short-circuited to ground.	Disconnect the motor cables and measure whether the servo drive power cables (U/V/W) are short-circuited to ground (PE).	Connect the cables again or replace the servo drive power cables.
2. The motor is short-circuited to ground.	After confirming the servo drive power cables and motor cables are connected properly, measure whether the insulation resistance between the servo drive U/V/W side and the PE cable is at MΩ level.	Replace the motor.
3. The servo drive is faulty.	Disconnect the power cables from the servo drive, but the fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.
4. The motor speed is too high during phase-to-ground detection.	Check whether the motor is in the generating status during power-on.	Reduce the motor speed to less than 10 rpm.
5. Control circuit bus voltage is greater than the discharge threshold.	Check whether the bus voltage is higher than the bus discharge threshold (H01.41) when the fault is logged.	Set the discharge threshold correctly.

- E234.0: Runaway (protection scheme 1)

Cause:

The torque reference direction is opposite to the speed feedback direction in the torque control mode.

The speed feedback direction is in reverse to the speed reference direction in the position or speed control mode.

Cause	Troubleshooting	Solution
1. The UVW cables are connected incorrectly.	Check whether the servo drive power cables are connected in the correct sequence at both ends.	Connect the UVW cables according to the correct sequence.
2. The interference signal causes an error in the initial phase detection of the motor rotor 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.	View the servo drive and servo motor nameplates to check whether the devices used are Inovance SV680N-INT series servo drive and 26-bit servo motor.	Replace with a mutually-matching servo drive and servo motor. For use of SV680N-INT series servo drive and 26-bit servo motor, set H00.00 to 14102. Check the motor model, encoder type, and encoder cable connection again.
4. The encoder cable is wired incorrectly, aging, corroded, or connected loosely.	Check whether the encoder cable provided by Inovance is used and whether the cable is aging, corroded, or connected loosely. Switch off the S-ON signal and rotate the motor shaft manually. Check whether the value of H0b.10 (Electrical angle) changes as motor shaft rotates.	Re-solder, tighten or replace the encoder cable.
5. The gravity load in vertical axis applications is too heavy.	Check whether the load of the vertical shaft is too large. Adjust brake parameters H02.09...H02.12 and check whether the fault is cleared.	Reduce the load of the vertical axis, increase the stiffness level, or hide this fault without affecting the safety performance and normal use.
6. Improper parameter settings lead to excessive vibration.	The stiffness level is set to an excessively high value, leading to excessive vibration.	Set a proper stiffness level to avoid excessive vibration.

- E234.1: Runaway (protection scheme 2)
  Cause:

The torque reference direction is opposite to the speed feedback direction in the torque control mode. The speed feedback direction is in reverse to the speed reference direction in the position or speed control mode.

Troubleshooting

Cause	Troubleshooting	Solution
1. The motor output is limited due to torque limit or current saturation.	Check whether the motor is operating beyond its capacity or torque is limited.	Relax the torque limit, reduce acceleration/ deceleration and operation speed, or use a motor with matching capacity.
2. Host controller command direction is incorrect or position increment is too large.	Check whether 607Ah and 6064h are aligned in the host controller program. Check whether the command of the host controller changes abnormally. Check whether the electronic gear ratio of the servo drive is set to an excessively large value.	Align 607Ah and 6064h. Set a proper electronic gear ratio.
3: Collision.	Check whether a collision occurs. Check whether the commands of the host controller are properly planned and whether the trajectory overlap that of any other mechanism.	Optimize the command planning of the host controller, increase the safety distance between mechanisms and increase the zero-speed stop safe distance for DB-less models.
4. The working conditions triggered the runaway alarm.	Check whether there is a waveform consistent with the runaway conditions. Check whether the load of the vertical shaft is too heavy and check whether the torque is limited in the non-torque mode.	If the load of the vertical shaft is too heavy and the brake is not applied in a timely manner, adjust the brake parameters H02.09 to H02.12 or increase the stiffness. Release the runaway threshold and set proper parameters to avoid excessive vibration. Ensure to take additional protection measures to mask runaway alarms, such as torque limit or changing the No. 2 fault to DB stop or coast to stop.

Cause	Troubleshooting	Solution
5. Electrical angle error.	Check whether the UVW phase sequence is correct. Check whether the encoder cable and power cable belong to the same motor. Check whether the electrical angle is auto-tuned. Check whether Hall is installed correctly. Check whether there is any deviation between the electrical angle and absolute position feedback of the same physical position before and after runaway or after a period of operation.	Connect the cables correctly. Perform angle auto-tuning again. Install the Hall sensor correctly. Perform electrical angle auto-tuning for several times and power on to check the electrical angle.
6. Power cable and encoder cable failure, motor and drive damage	Inspect the power cable and encoder cable for aging and corrosion, loose joints, and broken wire cores. Check the encoder cable for shield failure, reading head contamination, and power cable interference. Check whether the motor and drive components are damaged.	Re-solder, tighten or replace the power cable or encoder cable. Replace the motor and drive.

- E308.0: Pulse encoder phase A wire breakage
  Cause:

  Pulse encoder phase A wire breakage.

Cause	Troubleshooting	Solution
1. Phase A of the encoder is wired improperly.	Check the wiring of the encoder.	Reconnect the encoder and power off and restart.
2. The motor is set to a model with a pulse encoder.	Check whether the motor code H00.00 is set correctly and matches the connected encoder.	Check whether the motor code H00.00 is set correctly and matches the connected encoder.

- E308.1: Pulse encoder phase B wire breakage
  Cause:

  Pulse encoder phase B wire breakage.

Cause	Troubleshooting	Solution
Phase B of the encoder is wired improperly.	Check the wiring of the encoder.	Reconnect the encoder and power off and restart.

- E308.2: Pulse encoder phase Z wire breakage

Cause:

Pulse encoder phase Z wire breakage.

Cause	Troubleshooting	Solution
1. Phase Z of the encoder is wired improperly.	Check the wiring.	Connect the encoder again.
2. The connected encoder does not have phase Z.	Check the encoder manual.	Re-install the motor and select an AB two-phase encoder on the encoder configuration page.

- E320.0: Braking resistor overload
  Cause:

  The braking resistor is overloaded.

Cause	Troubleshooting	Solution
The accumulative heat of the braking resistor exceeds the maximum thermal capacity of the braking resistor.	Check whether the value of H0b.67 exceeds 100%.	Check if large discharge current is present due to high bus voltage. Ensure that the motor cannot be driven reversely. Replace the servo drive.

Caution

In applications where the motor drives a vertical axis or is driven by the load, set H0A.12 to 0 to hide the runaway fault.

- E320.1: External braking resistor surface temperature too high
  Cause:

  The accumulative heat of the built-in braking resistor is too great.

Cause	Troubleshooting	Solution
The accumulative heat of the built-in braking resistor is too great.	Cut off the power and check the braking resistor for over-temperature.	Check if large discharge current is present due to high bus voltage. Ensure that the motor cannot be driven reversely. Replace the servo drive.

- E321.0: Dynamic brake resistor overload
  Cause:

  The dynamic braking resistor is overloaded.

Cause	Troubleshooting	Solution
The accumulative heat of exceed braking resistor exceeds the maximum thermal capacity of the resistor.	Check whether the value of H0b.98 exceeds 100%.	Ensure that the motor cannot be driven reversely in the dynamic braking state.

- E400.0: Main circuit overvoltage

  Cause:

  The DC bus voltage between P ⊕ and N ⊖ exceeds the overvoltage threshold.

  220 V servo drive: Normal value 310 V Overvoltage threshold 420 V.

  380 V servo drive: Normal value 540 V Overvoltage threshold 760 V.

Cause	Troubleshooting	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 (R S T) on the 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: Value range: 380 V–440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Replace or adjust the power supply according to the specified range.
2. The power supply is unstable or affected by lightning.	Check whether the power supply is unstable, affected by lightning, or complies with the preceding range.	Connect a surge protection device (SPD) and switch on the power supplies of the control circuit and the main circuit. If the fault persists, replace the servo drive.

Cause	Troubleshooting	Solution
3. The braking resistor fails.	If the built-in braking resistor is used (H02.25 = 0), check whether terminals P ⊕ and D are jumpered. If yes, measure the resistance between terminals C and D to ensure that the resistor works normally. If an external braking resistor is used (H02.25 = 1 or 2), measure the resistance of the external braking resistor connected between terminals P⊕ and C. For details, See table "Specifications of the braking resistor" in SV680N Series Servo Drive Commissioning Guide.	If the resistance is "∞" (infinite), the braking resistor is disconnected internally. If you use a built-in braking resistor with insufficient discharge capability, use an external braking resistor (H02.25 = 1 or 2) instead and remove the jumper between terminals P⊕ and D. The resistance of the external braking resistor can be equal to or smaller than the built-in one and the power must not be smaller than the built-in one. If you use an external braking resistor which is damaged or has insufficient power, replace it with a new one with larger power and connect the new one between terminals P ⊕ and C. Set H02.26 (Power of external braking resistor) and H02.27 (Resistance of external braking resistor) to values consistent with the specifications of the external braking resistor used.
4. The resistance of the external braking resistor is too large, resulting in insufficient energy absorption during braking.	Measure the resistance of the external braking resistor connected between terminals P ⊕ and C. Compare the measured value with the recommended value.	Connect a new external braking resistor with recommended resistance between terminals P ⊕ and C. Set H02.26 (Power of external braking resistor) and H02.27 (Resistance of external braking resistor) to values consistent with the specifications of the external braking resistor used.

Cause	Troubleshooting	Solution
5. The motor is in abrupt acceleration/deceleration status and the maximum braking energy exceeds the energy absorption value.	Confirm the acceleration/ deceleration time during running and measure the DC bus voltage between P ⊕ and N to check whether the voltage exceeds the fault threshold during deceleration.	After confirming the input voltage of the main circuit is within the specified range, increase the acceleration/ deceleration time if the operating conditions allow.
6. The bus voltage sampling value deviates greatly from the measured value.	Check whether H0b.26 (Bus voltage) is within the following range: 220 V servo drive: H0b.26 ＞ 420 V 380 V servo drive: H0b.26 ＞ 760 V Measure whether the DC bus voltage N between P ⊕ and N ⊖ is normal and less than the value of H0b.26.	Contact Inovance for technical support.
7. The servo drive is faulty.	The fault persists after the main circuit is powered off and on repeatedly.	Replace the servo drive.

- E410.0: Main circuit undervoltage
  Cause:

  The DC bus voltage between P ⊕ and N ⊖ is lower than the undervoltage threshold.

  220 V servo drive: Normal value: 310 V Undervoltage threshold: 200 V (180 V for S5R5 models)

  380 V servo drive: Normal value 540 V Overvoltage threshold 380 V.

Cause	Troubleshooting	Solution
1. The power supply of the main circuit is unstable or power failure occurs.	Check the power input specifications of the servo drive and measure whether the input voltage at the power supply side of the main circuit cables and R/S/T on the drive side is within the following range: 220 V servo drive: Value range: 220 V–240 V Allowable deviation: –10% to +10% (198 V to 264 V) Measure the voltages of all the three phases.	Increase the capacity of the power supply.
2. Instantaneous power failure occurs.		
3. The voltage of the power supply drops during operation.	Monitor the power supply voltage and check whether the main circuit power supply is applied to other devices, resulting in insufficient power capacity and voltage drop.	
4. A three-phase servo drive is connected to a single-phase power supply, leading to phase loss.	Check whether the main circuit is wired correctly and whether phase loss detection (H0A.00) is hidden.	Replace the cables and wire the power cables correctly Three-phase: RST.
5. The servo drive is faulty.	Check whether H0b.26 (Bus voltage) is within the following range: 220 V servo drive: H0b.26 < 200 V 380 V servo drive: H0b.26 < 380 V The fault persists after the main circuit is powered off and on repeatedly.	Replace the servo drive.

- E410.1: Main circuit de-energized
  Cause:

  Phase loss occurs on the three-phase servo drive.

Cause	Troubleshooting	Solution
The power supply is disconnected during operation..	Check the power input specifications of the servo drive and measure whether the input voltage at the power supply side of the main circuit cables and R/S/T on the drive side is within the following range: 220 V servo drive: Value range: 220 V–240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 to 440 V Allowable deviation: –10% to +10% (342 V to 484 V) Measure the voltages of all the three phases.	Increase the capacity of the power supply.
	Monitor the power supply voltage and check whether the main circuit power supply is applied to other devices, resulting in insufficient power capacity and voltage drop.	
	Check whether 200B.1Bh (Bus voltage) is within the following range: 200 V servo drive: H0b.26h < 200 V. 400 V servo drive: H0b.26h＜ 400 V. The fault persists after the main circuit is powered off and on repeatedly.	Replace the servo drive.
	Check the wiring of the main circuit.	Replace the cables and wire the power cables correctly Three-phase: RST /L1 L2 L3.

- E420.0: Main circuit phase loss

  Cause:

  Drive three-phase input phase abnormal.

Cause	Troubleshooting	Solution
1. The three-phase input cables are connected improperly.	Check whether RST cables on the drive side and non-drive side are in good condition and connected properly.	Replace the cables and connect the main circuit cables properly.
2. A single-phase power supply is used for a three-phase servo drive.	Check the specifications of the power supply and measure whether the voltage input to the main circuit is within the following range: 220 V servo drive: Value range: 220 V–240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 to 440 V Allowable deviation: –10% to +10% (342 V to 484 V) Measure the voltages of all the three phases.	Servo drives of 0.75 kW (H01.10 = 5) can be supplied by single-phase power supplies. If the input voltage complies with the specifications, set H0A.00 (power input phase loss protection) to 2 (inhibit phase loss faults and alarms). If input voltage is outside the specified range, replace or adjust the power supply.
3. The three-phase power supply is unbalanced or the voltages of the three phases are too low.		

- E500.0: motor overspeed

  Cause:

  The actual feedback speed of the motor exceeds the overspeed threshold.

Cause	Troubleshooting	Solution
1. The UVW phase sequence of the motor is incorrect.	Check whether the servo drive power cables are connected in the correct sequence at both ends.	Connect the UVW cables according to the correct sequence.
2. H0A.08 is set improperly.	Check whether the overspeed threshold is lower than the maximum speed. Overspeed threshold = 1.2 x Maximum motor speed (H0A.08 = 0) Overspeed threshold = H0A.08 (H0A.08 ≠ 0, and H0A.08 < 1.2 x Maximum motor speed)	Re-set the overspeed threshold according to the mechanical requirements.

Cause	Troubleshooting	Solution
3. The input reference exceeds the overspeed threshold.	Check whether the motor speed corresponding to the input reference exceeds the overspeed threshold. • Position control mode:In CSP mode, check the gear ratio 6091.01h/6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information.In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity).In HM mode, check the gear ratio 6091.01h/6091.02h, and determine 6099.01h and 6099.02h. • Speed control mode:Check the gear ratio (6091h), target velocity (60FFh), speed limits (H06.06 to H06.09), and the maximum profile velocity (607Fh). • Torque control mode:View the speed limit defined by H07.17 and check the corresponding speed limit.	• Position control mode:CSP: Decrease the position reference increment per synchronization period. The host controller should cover the position ramp when generating references.PP: Decrease the value 6081h or increase the acceleration/ deceleration ramp (6083h, 6084h).HM: Decrease 6099.01h and 6099.02h or increase the acceleration/ deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions. • Speed mode:Decrease the target velocity, speed limit, and gear ratio. In PV mode, increase the speed ramp (6083h and 6084h). In CSV mode, the host controller should cover 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 by using Inovance servo commissioning software.	Adjust the gain or mechanical running conditions.
5. The servo drive is faulty.	The fault persists after the servo drive is powered off and on again.	Replace the servo drive.

Cause	Troubleshooting	Solution
6. Encoder data error.	Check whether there is interference, whether encoder type selection is incorrect, or whether encoder parameter settings are incorrect.	• Take interference shielding measures, such as magnetic rings and shielding cables. • Check whether the encoder type is selected correctly. If not, replace the encoder type correctly. • Set the encoder parameters properly according to encoder manual.
7. The selected motor type is incorrect.	Check whether the type of the motor is set improperly. For example, the linear motor is set to a rotary motor or the rotary motor is set to a linear motor.	Replace the actual motor with the correct type or change the value of H00.00 to the correct motor type.

- E500.1: Speed feedback overflow

  Cause:

  The FPGA speed measurement overflows.

Cause	Troubleshooting	Solution
1. FPGA internal speed overflows.	Check whether the servo drive power cables are connected in the correct sequence at both ends.	Connect the UVW cables according to the correct sequence.
2. The motor speed overshoots.	Check whether the speed feedback exceeds the overspeed threshold by using Inovance servo commissioning software. Overspeed threshold: 16384 rpm for a rotary motor, 8192 rpm for a DDR motor, and 16384 mm/s for a linear motor.	Adjust the gain or mechanical running conditions.

Cause	Troubleshooting	Solution
3. Encoder data error.	Check whether there is interference, whether encoder type selection is incorrect, or whether encoder parameter settings are incorrect.	• Take interference shielding measures, such as magnetic rings and shielding cables. • Check whether the encoder type is selected correctly. If not, replace the encoder type correctly. • Set the encoder parameters properly according to encoder manual.
4. The selected motor type is incorrect.	Check whether the type of the motor is set improperly. For example, the linear motor is set to a rotary motor or the rotary motor is set to a linear motor.	Replace the actual motor with the correct type or change the value of H00.00 to the correct motor type.

- E500.2: FPGA position feedback pulse overspeed

  Cause:

  The MCU has detected that the position feedback increment from the FPGA is too large.

Cause	Troubleshooting	Solution
1. The MCU has detected that the position feedback increment from the FPGA is too large.	Check whether the value of H0b.17 changes abruptly.	Modify the value of H0A.70 (Overspeed threshold), which is 0 by default. Use the maximum speed of the motor as the threshold for large feedback increment.
2. Encoder data error.	Check whether there is interference, whether encoder type selection is incorrect, or whether encoder parameter settings are incorrect.	• Take interference shielding measures, such as magnetic rings and shielding cables. • Check whether the encoder type is selected correctly. If not, replace the encoder type correctly. • Set the encoder parameters properly according to encoder manual.
3. The selected motor type is incorrect.	Check whether the type of the motor is set improperly. For example, the linear motor is set to a rotary motor or the rotary motor is set to a linear motor.	Replace the actual motor with the correct type or change the value of H00.00 to the correct motor type.

- E602.0: Angle auto-tuning failure

  Cause:

  Unusual jitter occurs on the encoder feedback during angle auto-tuning.

Cause	Troubleshooting	Solution
1. Locked-rotor occurred in mechanical equipment.	Stop the motor and push it to check whether locked-rotor occurred.	If yes, eliminate the problem and perform angle auto-tuning (phase sequence auto-tuning) again.
2. The data fed back by the encoder is abnormal.	Push the motor and observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement?	If you determine that the feedback data of the encoder is abnormal, replace the encoder and perform angle auto-tuning (phase sequence auto-tuning) again.

Cause	Troubleshooting	Solution
3. U, V and W power cables are incorrectly connected or disconnected.	Check the wiring. Use a multimeter to check wire breakage.	If any improper connection is found, reconnect the cables perform angle auto-tuning (phase sequence auto-tuning) again.
4. The drive/motor is faulty.	If none of the above solves the problem, contact the manufacturer.	If none of the above solves the problem, contact the manufacturer.

- E602.1: Angle auto-tuning overtravel
  Cause:

  Angle auto-tuning overtravel.

Cause	Troubleshooting	Solution
The moving distance during angle auto-tuning is too large. 1. The setting of auto-tuning parameters does not match the load characteristics, and large impact occurred during auto-tuning, resulting in an overtravel alarm. 2. The data fed back by the encoder is abnormal. A false alarm is raised.	• Check whether the displacement is really too large, and whether overtravel is caused by the setting of auto-tuning parameters. • Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is the feedback operation continuous? Is the observed displacement consistent with the actual displacement?	• If the movement during auto-tuning is too large, the overtravel can be avoided by manually reducing the current rising slope (H32.21 closed-loop pre-positioning method) (H32.31 position locking method) or the maximum auto-tuning current (H32.20 closed-loop pre-positioning method) (H32.30 position locking method). • If the encoder feedback data is abnormal, replace the encoder, and then identify the angle/phase sequence again.

- E602.2: U/V/W phase sequence reversed
  Cause:

  A wrong U/V/W phase sequence is detected during angle auto-tuning.

Cause	Troubleshooting	Solution
The system indicates the UVW wiring is wrong to avoid the motor from losing control.	Check U/V/W wiring through phase sequence auto-tuning.	• After phase sequence is corrected, perform angle auto-tuning again. • Exchange cables of any two phases and perform angle auto-tuning again.

- E602.3: Large encoder jitter during angle auto-tuning
  Cause:

Large encoder jitter during angle auto-tuning

Cause	Troubleshooting	Solution
Encoder feedback data has large jitter.	Check whether the encoder jitters abnormally at standstill.	• Check the wiring of the encoder. • Check for external electromagnetic interference. Install a magnetic ring and use shielded cables as necessary. • Manually increase H32.14/ H32.16 (inching angle auto-tuning) and H32.34/H32.36 (position locking angle auto-tuning).

- E602.4: Auto-tuning failed. Auto-tuning timeout.
  Cause:

  Auto-tuning failed. Auto-tuning timeout.

Cause	Troubleshooting	Solution
If the angle auto-tuning process is not completed in 30 seconds, a timeout alarm is raised. 1. Due to external disturbance (such as vibration of other parts on the bench), the completion condition of angle auto-tuning cannot be met. 2. The feedback data of the encoder is subjected to poor characteristics, interference or anomaly, and the completion condition of angle auto-tuning cannot be met.	• Check for vibrating parts on the bench. • Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement? Is there abnormal jitter during standby?	• Check whether the encoder cable shield is connected properly. If the encoder data is abnormal, replace the encoder, and then auto-tune the angle/phase sequence again. • Adjust the angle auto-tuning parameters properly and reduce the completion conditions of angle auto-tuning. For example, you can increase the operation/standstill evaluation threshold of angle auto-tuning as appropriate.

- E602.5: Angle auto-tuning failed. Z signal not found.
  Cause:

  Angle auto-tuning failed. Z signal not found.

Cause	Troubleshooting	Solution
1. The encoder configuration is incorrect. The connected motor encoder has no Z signal.	Check whether the encoder has a Z signal.	Check the wiring of the encoder. Ensure the shielded cables are effectively connected. Check the polarity configuration of Z signal. If the encoder data is abnormal, replace the encoder and then identify the angle again.
2. The Z signal polarity is set incorrectly.	Check if the polarity of the Z signal is configured correctly. Check bit 13 of H00.26.	
3. The data fed back by the encoder is abnormal. No Z signal is present.	Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement?	

- E602.6: Angle auto-tuning does not converge
  Cause:

  Angle auto-tuning does not converge.

Cause	Troubleshooting	Solution
1. External disturbance (such as vibration of other parts on the bench) is present. 2. Parameters are set incorrectly.	Check for vibrating parts on the bench. Check whether the angle gain is set too large.	• Check for external electromagnetic interference. Install a magnetic ring and use shielded cables as necessary. • For the position lock method, you can reduce the angle gain (H32.37) manually. • For the jog method, you can manually reduce the operation evaluation threshold (H32.13/H32.15) or increase the standstill evaluation threshold (H32.14/H32.16).

- E603.0: Gantry communication CRC failure
  Cause:

  Gantry communication CRC failure.

Cause	Troubleshooting	Solution
Gantry communication keeps abnormal.	Check the gantry wiring and electromagnetic environment.	Check the gantry wiring and electromagnetic environment.

- E603.1: Gantry communication timeout
  Cause:

  Gantry communication timeout.

Cause	Troubleshooting	Solution
Gantry communication is disconnected or communication has not been established for a long time.	Check the gantry wiring and electromagnetic environment. Check whether H14.01 is 1.	Check the gantry wiring and electromagnetic environment.

Note

If the slave axis disconnects the communication between drives without communicating with the host controller, the alarm EE15.0 will be raised.

- E603.2: Drive failed to establish communication for a long time
  Cause:

  The drive failed to establish communication for a long time.

Cause	Troubleshooting	Solution
Gantry communication is disconnected or communication has not been established for a long time.	Check the gantry wiring and electromagnetic environment. Check whether H14.01 is 1.	Check the gantry wiring and electromagnetic environment.

- E604.0: Inconsistent settings of two gantry axes
  Cause:

  Inconsistent settings of two gantry axes.

Cause	Troubleshooting	Solution
Inconsistent parameter settings of two gantry axes.	Check parameter settings.	Correct the settings.

- E604.1: Gantry not set to position mode
  Cause:

  The gantry is not set to the position mode.

Cause	Troubleshooting	Solution
When gantry is enabled, the drive does not run in the position mode.	When gantry is enabled, check whether the drive runs in the position mode.	Switch the drive to the position mode.

- E604.2: Gantry is running on an unsupported feature
  Cause:

  The gantry is running on an unsupported feature.

Cause	Troubleshooting	Solution
Gantry is running on an unsupported feature.	Check whether the gantry configuration parameters meet the requirements of the current control scheme. For example: Rigid gantry control scheme 2 does not support "torque alignment mode", "homing torque pre-alignment" and "gantry alignment deviation compensation value auto-tuning".	Check whether the gantry configuration parameters meet the requirements of the current control scheme and make corrections accordingly.

- E605.0: Motor speed too high upon S-ON
  Cause:

  The motor speed exceeds the rated speed when the servo drive in size A/B is switched on.

Cause	Troubleshooting	Solution
The motor speed exceeds the rated speed when the servo drive is switched on.	Check if the drive is enabled when the motor has been driven.	Switch on the drive when the motor is standstill.

- E606.0: Gantry torque alignment timeout
  Cause:

  Gantry torque alignment times out.

Cause	Troubleshooting	Solution
Gantry torque alignment times out.	Check whether the alignment time exceeds the alarm threshold set by H14.30.	Increase the alarm threshold to see if the relevant parameters are set properly.

- E612.0: Rotor locked during phase sequence auto-tuning
  Cause:

  Locked-rotor occurred during phase sequence auto-tuning.

Cause	Troubleshooting	Solution
1. Locked-rotor occurred in mechanical equipment.	Stop the motor and push it to check whether locked-rotor occurred.	If yes, eliminate the problem and perform angle auto-tuning (phase sequence auto-tuning) again.
2. The data fed back by the encoder is abnormal.	Push the motor and observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement?	If you determine that the feedback data of the encoder is abnormal, replace the encoder and perform angle auto-tuning (phase sequence auto-tuning) again.
3. U, V and W power cables are incorrectly connected or disconnected.	Check the wiring. Use a multimeter to check wire breakage.	If any improper connection is found, reconnect the cables perform angle auto-tuning (phase sequence auto-tuning) again.
4. The drive/motor is faulty.	If none of the above solves the problem, contact the manufacturer.	If none of the above solves the problem, contact the manufacturer.

- E612.1: Overtravel occurred during phase sequence auto-tuning
  Cause:

  Overtravel occurred during phase sequence auto-tuning.

Cause	Troubleshooting	Solution
1. The setting of auto-tuning parameters does not match the load characteristics, and large impact occurred during auto-tuning, resulting in an overtravel alarm.	Check whether the displacement is really too large, and whether overtravel is caused by the setting of auto-tuning parameters.	If the movement during auto-tuning is too large, you can manually reduce the current rising slope (H32.21).
2. The data fed back by the encoder is abnormal. A false alarm is raised.	Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is the feedback operation continuous? Is the observed displacement consistent with the actual displacement?	If the encoder feedback data is abnormal, replace the encoder, and then identify the angle/phase sequence again.

- E612.3: Large encoder jitter during phase sequence auto-tuning
  Cause:

  Large encoder jitter during phase sequence auto-tuning.

Cause	Troubleshooting	Solution
Encoder feedback data has large jitter.	Check whether the encoder jitters abnormally at standstill.	Check the wiring of the encoder. Check for external electromagnetic interference. Install a magnetic ring and use shielded cables as necessary. Manually increase H32.24/ H32.25.

- E612.4: Phase sequence auto-tuning failed. Auto-tuning timeout.
  Cause:

  Phase sequence auto-tuning failed. Auto-tuning timeout.

Cause	Troubleshooting	Solution
1. If the phase sequence auto-tuning process is not completed in 30 seconds, a timeout alarm is raised. 2. Due to external disturbance (such as vibration of other parts on the bench), the completion condition of angle auto-tuning cannot be met. 3. The feedback data of the encoder is subjected to poor characteristics, interference or anomaly, and the completion condition of angle auto-tuning cannot be met.	Check for vibrating parts on the bench. Observe the encoder with the oscilloscope in InoDriverShop. You can determine whether the encoder feedback is abnormal by the following criteria: Is there feedback? Is the feedback data continuous? Is the observed displacement consistent with the actual displacement? Is there abnormal jitter during standby?	Check whether the encoder cable shield is connected properly. If the encoder data is abnormal, replace the encoder, and then auto-tune the phase sequence again. Adjust the phase sequence auto-tuning parameters properly and reduce the completion conditions of the auto-tuning. For example, you can increase the operation/standstill evaluation threshold as appropriate.

- E619.0: Absolute accuracy compensation parameter setting error
  Cause:

  The accuracy compensation interval is set to 0.

Cause	Troubleshooting	Solution
1. The accuracy compensation interval(H33.64) is set to 0. 2. Inovance communication encoder DDL: 1) The distance from the mechanical home to the correction home exceeds the upper limit of the encoder (encoder unit: 23^{34}). 2) The length of correction exceeds the upper limit of the encoder (2^{34}). 3. Homing mode record error. The value of H33.70 is not in {-2, -1, 1, 2, 4, 6, 17, 18, 24, 28, 33, 34}.	1. Check whether H33.64 is set to 0. 2. Check whether the distance between the mechanical home and the correction home (start position) exceeds the limit (encoder unit: 2^{34}). 3. Check whether the value of H33.70 is in {-2, -1, 1, 2, 4, 6, 17, 18, 24, 28, 33, 34}.	Set the correct compensation interval. Set the distance between the mechanical home and the correction home properly. Set H33.70 correctly.

- E619.1: Absolute accuracy compensation overflow
  Cause:

  1. The input quadrature pulse frequency (quadruple) is greater than 1/(H33.7 x 25 ns).

  2. The number of compensated pulses at a time is greater than 1.

Cause	Troubleshooting	Solution
1. The input quadrature pulse frequency (quadruple) is greater than 1/(H33.74 x 25 ns).	Check the motor speed at the alarm time.	Reduce motor speed.
2. The number of compensated pulses at a time is greater than 1.	Check the compensation table to see if there is a length greater than 1 index interval.	Load the correct error compensation table.

- E620.0: Motor overload

  Cause:

  The accumulative heat of the motor reaches the fault threshold.

Cause	Troubleshooting	Solution
1. The motor and encoder cables are connected improperly.	Check the wiring between the servo drive, servo motor and the 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. When customized cables are used, prepare and connect the customized cables according to the wiring instructions.
2. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	Check the overload characteristics of the servo drive or servo motor. Check whether the average load rate (H0b.12) of the servo drive keeps exceeding 100.0%.	Use a servo drive of higher capacity and a matching servo motor. Reduce the load and increase the acceleration/deceleration time.
3. The acceleration/ deceleration is too frequent or the load inertia is too large.	Calculate the mechanical inertia ratio or perform inertia auto-tuning. View the value of H08.00 (Load moment of inertia ratio). Confirm the individual operation cycle when the servo motor operates cyclically.	Increase the acceleration/ deceleration time during single-cycle running.
4. Gains are improper or the stiffness level is too high.	Check whether the motor vibrates and generates unusual noise during operation.	Readjust the gain.

Cause	Troubleshooting	Solution
5. The servo drive model or motor model is set improperly.	Check the motor model (H00.00) and drive model (H01.10) stored in the bus encoder.	Check the servo drive nameplate and set the servo drive model (H01.10) and motor model properly according to section "Servo Drive Model and Nameplate" in SV680-INT Series Servo Drive Hardware Guide.
6. The motor stalls due to mechanical factors, resulting in overload during operation.	Check the reference and motor speed (H0b.00) through the software tool or keypad. • References in the position control mode: H0b.13 (Input position reference counter) • References in the speed control mode: H0b.01 (Speed reference) • References in the torque control mode: H0b.02 (Internal torque reference) Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
7. The servo drive is faulty.	The fault persists after the 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.

- E620.1: Overload current limit mode, motor overloaded

  Cause:

  Overload current limit mode, motor overloaded.

Cause	Troubleshooting	Solution
1. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	• Confirm the overload characteristics of the servo drive or motor. • Check whether the average load rate (H0b.12) keeps exceeding 100.0%.	• Replace with a servo drive of higher capacity and a matching servo motor. • Reduce the load and increase the acceleration/ deceleration time.
2. The acceleration/ deceleration is too frequent or the load inertia is too large.		
3. The motor and encoder cables are connected improperly.		
4. Gains are improper or the stiffness level is too high.		
5. The motor stalls due to mechanical factors, resulting in overload during operation.		
6. The servo drive is faulty.		

- E621.0: Overload current limiting torque attained

  Cause:

  Overload current limiting torque is attained.

Cause	Troubleshooting	Solution
1. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load rate (H0b.12) keeps exceeding 100.0%.	• Replace with a servo drive of higher capacity and a matching servo motor. • Reduce the load and increase the acceleration/ deceleration time.
2. The acceleration/ deceleration is too frequent or the load inertia is too large.		
3. The motor and encoder cables are connected improperly.		
4. Gains are improper or the stiffness level is too high.		
5. The motor stalls due to mechanical factors, resulting in overload during operation.		
6. The servo drive is faulty.		

- E630.0: motor rotor locked over-temperature

Cause:

The actual motor speed is lower than 10rpm but the torque reference reaches the limit, and such status lasts for the time defined by H0A.32.

Cause	Troubleshooting	Solution
1. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	Perform motor trial run without load and check cable connections and the phase sequence.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The motor parameters (especially the number of pole pairs) are set improperly, or motor angle auto-tuning is not performed, or motor power is greater than drive power.	View parameters in group H00 to check whether the number of pole pairs are set properly. Perform angle auto-tuning on the motor several times and check whether the value of H00.28 is consistent during angle auto-tuning. Check whether the motor and drive match in the power.	Modify motor parameter values or replace the drive.
3. The communication commands are being disturbed.	Check whether jitter occurs on the commands sent from the host controller and whether EtherCAT communication is being disturbed.	Check whether the communication line between the host controller and the servo drive is being disturbed.
4. The motor is stalled due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. • References in the position control mode: H0b.13 (Input position reference counter) • References in the speed control mode: H0b.01 (Speed reference) • References in the torque control mode: H0b.02 (Internal torque reference) Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode. Check the current feedback (torque reference) waveform.	Check whether any mechanical part gets stuck or eccentric.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E631.1: 24 V or brake not connected
  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
The brake or the 24 power supply is not connected when the internal brake feature is used.	Check whether 24 V power supply or the brake is not connected when H02.16 is set to 1.	If you use the internal brake, connect the brake cable and 24 power supply.
2. DO or VDO configuration 9: Brake function, and the function is not enabled by H04.24.	2. DO or VDO configuration 9: Brake function, and H04.24 = 0.	If you use a DO brake, set H0E-10 to 1.

- E631.2: P-MOS open circuit
  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, P-MOS open circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	Replace the servo drive. Turn off the brake switch H02.16.

- E631.3: N-MOS open circuit
  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, N-MOS open circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	Replace the servo drive. Turn off the brake switch H02.16.

- E640.0: IGBT over-temperature
  Cause:

  The IGBT temperature reaches the fault threshold defined by H0A.18.

Cause	Troubleshooting	Solution
1. The ambient temperature is too high. 2. The servo drive is restarted repeatedly to reset the overload fault.	Measure the ambient temperature and view the fault records (set H0b.33 and view H0b.34) to check whether an overload fault/ alarm is reported (E620.0, E630.0, E650.0, E909.0, E920.0, E922.0).	Improve the cooling conditions of the servo drive to lower down the ambient temperature. Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacities 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 works properly during operation.	Replace the servo drive.
4. The servo drive is installed in a wrong direction and the clearance between servo drives is 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 fault persists even though the servo drive is restarted five minutes after power-off.	Replace the servo drive.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E640.1: Flywheel diode overtemperature
  Cause:

  The temperature of the flywheel diode reaches the fault threshold defined by H0A.18.

Cause	Troubleshooting	Solution
1. The ambient temperature is too high. 2. The servo drive is restarted repeatedly to reset the overload fault.	Measure the ambient temperature and view the fault records (set H0b.33 and view H0b.34) to check whether an overload fault/ alarm is reported (E620.0, E630.0, E650.0, E909.0, E920.0, E922.0).	Improve the cooling conditions of the servo drive to lower down the ambient temperature. Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacities 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 works properly during operation.	Replace the servo drive.
4. The servo drive is installed in a wrong direction and the clearance between servo drives is 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 fault persists even though the servo drive is restarted five minutes after power-off.	Replace the servo drive.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E650.0: Heatsink overtemperature
  Cause:

  The temperature of the servo drive power module is higher than the overtemperature threshold.

Cause	Troubleshooting	Solution
1. The ambient temperature is too high. 2. The servo drive is restarted repeatedly to reset the overload fault.	Measure the ambient temperature. View the fault log. (set H0b.33 and view H0b.34). Check whether an overload fault or alarm (E620.0, E630.0, E650.5, E909.0, E920.0, E922.0) occurs.	Improve the cooling conditions of the servo drive to lower down the ambient temperature. Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacities 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 works properly during operation.	Replace the servo drive.
4. The servo drive is installed in a wrong direction and the clearance between servo drives is 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 fault persists even though the servo drive is restarted five minutes after power-off.	Replace the servo drive.

Note

When the fault occurs, stop the servo drive for at least 30s before further operations.

- E660.0: Motor overtemperature
  Cause:
  - The temperature of the air-cooled motor is too high.
  - PTC was turned on by mistake through H00.26.

Cause	Troubleshooting	Solution
• The temperature of the air-cooled motor is too high. • PTC was turned on by mistake through H00.26.	Measure whether the temperature of the air-cooled motor is too high. Check whether PTC is enabled on the drive, but the motor has no PTC hardware. Or check whether PTC is connected properly. For an Inovance motor, the temperature threshold is 130°C. For a third-party motor, measure the PTC resistance and determine the motor temperature based on the resistance specifications.	• Cool the motor down. • Check whether PTC is enabled on the drive, but the motor has no PTC hardware. • Check whether PTC is connected properly.

- E661.0: STune failure

  Cause:

  During STune operation, the gain drops to the lower limit. Position loop gain < 5 Speed loop gain < 5 Model loop gain < 10.

Cause	Troubleshooting	Solution
During ETune operation, the gain drops to the lower limit: Position loop gain < 5 Speed loop gain < 5 Model loop gain < 10.	Check if vibration resonance is properly suppressed in the system. The torque vibration amplitude exceeds the setpoint of H09.11.	Set the notch manually. Modify the electronic gear ratio to improve the command resolution, or increase the command filter time constant or in the parameter configuration interface. Check whether the current of the machine fluctuates periodically. Set H09.58 to 1 to clear resonance suppression parameters, and perform STune again.

- E662.0: ETune failure

  Cause:

  Check whether resonance that occurred during ETune operation cannot be suppressed.

Cause	Troubleshooting	Solution
Check whether resonance that occurred during ETune operation cannot be suppressed.	Check whether there is abnormal noise or torque fluctuation during operation.	Set the notch manually when vibration cannot be suppressed automatically. Modify the electronic gear ratio to improve the command resolution, increase the command filter time constant or in the parameter configuration interface. Increase the value of H09.11 as appropriate. Check whether the current of the machine fluctuates periodically. Check whether the positioning threshold is too low. Increase the reference acceleration/deceleration time.

- E664.0: Resonance too strong
  Cause:

  Resonance occurs on the servo system and the torque fluctuation amplitude is higher than the value of H09.54.

Cause	Troubleshooting	Solution
Resonance occurs on the servo system and the torque fluctuation amplitude is higher than the value of H09.54.	Check whether there is abnormal noise or torque fluctuation during operation.	Check whether the inertia ratio or loop gain parameters are set properly. Check whether resonance parameters are set properly. Increase the value of H09.54 or set H09.54 to 0 to disable this function.

- E720.0: Wrong encoder interface
  Cause:

  The drive does not support the selected encoder interface.

Cause	Troubleshooting	Solution
The drive does not support the selected encoder interface.	Check whether H32.01 and H0F.06 are set properly. If the gantry function is turned on, check whether the gantry function conflicts with the master encoder or full closed-loop encoder setting.	Check whether the signal cable required by the current encoder interface scheme exceeds the upper limit of a single interface. Modify H32.01 and H0F.01.

- E731.0: Encoder multi-turn data lost

  Cause:

  Encoder multi-turn data is lost.

Cause	Troubleshooting	Solution
1. The battery of the first encoder is not connected during power-off.	Check whether the battery is connected during power-off.	Set H0d.20 to 1 to clear the fault.
2. The battery voltage of the first encoder is lower than 2.9 V.	Measure the battery voltage.	Use a new battery with the matching voltage.
3. The first encoder is interfered with by a strong magnetic field.	Check whether the encoder is in a strong magnetic field.	Remove the magnetic field and set H0d.20 to 1 to clear the error.

- E731.1: Inovance second encoder multi-turn data lost

  Cause:

  Inovance 2nd encoder multi-turn data is lost.

Cause	Troubleshooting	Solution
1. The battery of the Inovance second encoder is not connected during power-off.	Check whether the battery is connected during power-off.	Set H0d.20 to 1 to clear the fault.
2. The Inovance second encoder battery voltage is lower than 2.9 V.	Measure the battery voltage.	Use a new battery with the matching voltage.
3. The Inovance second encoder is interfered with by a strong magnetic field.	Check whether the encoder is in a strong magnetic field.	Remove the magnetic field and set H0d.20 to 1 to clear the error.

- E733.0: Encoder multi-turn counting error

  Cause:

  An encoder multi-turn counting error occurs.

Cause	Troubleshooting	Solution
The encoder is faulty.	Set H0d.20 to 2 to clear the fault, but E733.0 persists after restart.	Replace the motor.

- E733.1: Inovance 2nd encoder multi-turn counting error.
  Cause:

  Inovance second encoder multi-turn counting error

Cause	Troubleshooting	Solution
Inovance 2nd encoder error	Set H0d.20 to 3 to clear the fault, but E733.1 persists after restart.	Replace the motor.

- E735.0: Encoder multi-turn counting overflow
  Cause:

  A multi-turn counting overflow occurs on the absolute encoder.

Cause	Troubleshooting	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 linear mode (H02.01 = 1).	Set H0d.20 to 2 to power on again. Perform homing if necessary.

- E740.0: Absolute encoder communication timeout
  Cause:

  Communication timeout occurs on the absolute encoder.

Cause	Troubleshooting	Solution
The communication between the servo drive and the encoder times out.	Check the wiring of the encoder and power on the servo drive again.	Check whether the encoder version (H00.04) is set properly. Check whether the servo drive software version (H01.00). Check the encoder wiring. Replace the servo motor.

- E740.2: Absolute encoder error
  Cause:

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

Cause	Troubleshooting	Solution
An error occurs on the communication between the servo drive and the encoder.	Check whether the value of H0b.28 is not 0.	Check whether H00-00 (motor SN) is set properly. Check whether encoder cables are connected properly. Check whether the servo drive and motor are grounded properly. You can wind a magnetic ring on the encoder cable to reduce interference.

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

  Cause:

  Internal fault of the encoder.

Cause	Troubleshooting	Solution
Internal fault of the encoder.	Check whether bit7 of H0b.28 is set to 1.	Check whether the encoder version (H00-04) is proper. Check whether encoder cables are in proper condition. Replace the motor.

- E740.6: Encoder data write error

  Cause:

  The attempt to write the encoder data fails.

Cause	Troubleshooting	Solution
An error occurs when writing the position offset after angle auto-tuning.	Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates the original encoder cable is damaged. Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change.	Use a new encoder cable. If the fault persists after the encoder cable is replaced, the encoder may be faulty. In this case, replace the servo motor.

- E740.8: BISSC register communication failure

  Cause:

  Non-real-time communication: encoder communication timeout, stop bit error, CRC error, data field error.

Cause	Troubleshooting	Solution
1. The BISSC read head is loose, and the distance between the head and the scale does not meet the installation requirements.	Check the head for abnormal illumination of the indicator. Check whether the indicator is lit when the head is at a certain position.	Reinstall the read head. Replace the scale. Replace the read head.
2. BISSC scale is contaminated.		
3. The encoder read head is damaged.		

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

  Cause:

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

Cause	Troubleshooting	Solution
1. The value of H01.59 is set too large.	Power off and restart the drive.	Decrease the value of H01.59.
2. Too many encoder data bits.		Use an encoder with fewer data bits.

- E755.0: Nikon encoder communication fault

  Cause:

  Nikon encoder communication failure.

Cause	Troubleshooting	Solution
Nikon encoder communication error	Perform a power cycle to check if the error is still reported.	Manually reset the encoder error through H0d.21. If the error remains, check the encoder and its wiring.

- E760.0: Encoder overtemperature

  Cause:

  The temperature of the absolute encoder is too high.

Cause	Troubleshooting	Solution
The temperature of the absolute encoder is too high.	Measure the encoder temperature or the motor temperature, which must not exceed 120°C. Note that you are measuring the temperature of the housing, which is is 20°C to 40°C lower than the internal temperature.	Switch off the S-ON signal to wait for the encoder to cool down.

- E765.0: Nikon encoder over-temperature or overspeed

Cause	Troubleshooting	Solution
Motor overtemperature	Check if the ambient temperature or the average load rate is too high.	Switch off the S-ON signal to wait for the encoder to cool down.

- E770.0: Fully-closed input phase A wire breakage

  Cause:

  Fully-closed phase A input differential voltage wire breakage.

Cause	Troubleshooting	Solution
Fully-closed phase A input differential voltage wire breakage.	Measure the phase A differential voltage to check if it is below 2.5 V.	Adjust the fully-closed loop phase A input voltage.

- E770.1: Fully-closed input phase B wire breakage

  Cause:

  Fully-closed phase B input differential voltage wire breakage.

Cause	Troubleshooting	Solution
Fully-closed phase B input differential voltage wire breakage.	Measure the phase B differential voltage to check if it is below 2.5 V.	Adjust the fully-closed loop phase B input voltage.

- E770.2: Fully-closed input phase Z wire breakage

  Cause:

  Fully-closed phase Z input differential voltage wire breakage.

Cause	Troubleshooting	Solution
Fully-closed phase Z input differential voltage wire breakage	Measure the phase Z differential voltage to check if it is below 2.5 V.	Adjust the fully-closed loop phase Z input voltage.

- E770.3: BISS/SSI/ENDAT communication protocol timeout

  Cause:

  BISS/SSI/ENDAT fully closed-loop external loop encoder communication times out.

Cause	Troubleshooting	Solution
BISS/SSI/ENDAT fully closed-loop external loop encoder communication times out.	Check the wiring.	Check the wiring.

- E770.6: Fully closed-loop Inovance 2nd encoder initialization communication error

  Cause:

  The Inovance second encoder failed to initialize.

Cause	Troubleshooting	Solution
1. The encoder cable connections are incorrect or loosened.	Check the wiring of the encoder. Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder.	Connect the encoder cables according to the correct wiring diagram. Re-connect encoder cables and ensure encoder terminals are connected securely.
2. The servo drive is faulty.	The fault persists after the servo drive is restarted.	Replace the servo drive.

- E770.7: Fully closed-loop 2nd encoder communication error
  Cause:

  Second encoder communication failed.

Cause	Troubleshooting	Solution
1. The encoder is wired improperly. 2. The encoder cable is connected loosely. 3. The encoder Z signal suffers from interference. 4. The encoder is faulty. 5. Check whether H0F.29–H0F.33 are set correctly.	Check encoder wiring. Check for strong vibration, which loosens the encoder cable and even damages the encoder. Use a new encoder cable. If the fault disappears, the original encoder cable is damaged. Check whether ambient devices are generating interference and whether multiple interference sources are present in the cabinet. Make servo drive stay in "Rdy" status and rotate motor shaft counterclockwise (CCW) manually and observer whether H0b.17 (electrical angle) increases/decreases smoothly. Turning one circle corresponds to five 0–360° (for Z series motors). For X series motors, turning one circle corresponds to four 0–360°. If H0b.17 changes abnormally during motor rotating, the encoder is faulty. If no alarm is reported during motor shaft rotating but an alarm is reported during servo drive running, interference may exist. Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change. Check the encoder manual to see if H0F.29–H0F.33 are set to the correct values.	Connect the cables again according to the correct wiring diagram. Connect the cables again and ensure encoder terminals are connected securely. It is recommended to use the cables provided by Inovance. If a customized cable is used, check whether this cable is a shielded twisted pair cable that complies with the specifications. Route the motor cables and encoder cables through different routes. Ensure the servo motor and servo drive are grounded properly. Check whether the connectors at both ends of the encoder are in good contact and whether any pin retracts. Use a new encoder cable. If the fault persists after encoder cables are replaced, the encoder may be faulty. In this case, replace the servo motor. Check the encoder manual to see if H0F.29–H0F.33 are set to the correct values.

- E770.8: Full closed-loop encoder data transmit delay is too large

Cause:

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

Cause	Troubleshooting	Solution
1. The value of H01.59 is set too large.	Power off and restart the drive.	Decrease the value of H01.59.
2. Too many encoder data bits.		Use an encoder with fewer data bits.

- E771.0: Communication handshake failure between interpolator and drive
  Cause:

  Communication handshake failed between the interpolator and drive.

Cause	Troubleshooting	Solution
Communication between T2 interpolator and motor is abnormal during power-on initialization.	• Check whether power cycling is not performed after parameters are written to the interpolator. • Check the wiring between the interpolator and motor.	• Power off and on again. • Check the wiring. If the alarm remains after several power cycling, replace the motor.

- E939.0: Motor power cable disconnected
  Cause:

  At least one phase of the motor is disconnected.

Cause	Troubleshooting	Solution
1. One or two phases of the motor power cable are disconnected. 2. The actual current loop gain is set improperly.	Check the wiring of U/V/W power cables. The power cable is not disconnected. The current feedback and torque reference follow are abnormal. Perform inductive resistance auto-tuning and current loop auto-tuning again.	Check whether the power cables are disconnected or in poor contact. Re-connect the power cables. Replace the servo motor. Perform inductive resistance auto-tuning and current loop auto-tuning again.

- EA33.0: Encoder read/write check error
  Cause:

  Internal parameters of the encoder are abnormal.

Cause	Troubleshooting	Solution
1. The serial incremental encoder cable is disconnected or loose.	Check the wiring.	Check whether the encoder cables are connected incorrectly, disconnected, or in poor contact. If the motor cables and encoder cables are bundled together, separate them.
2) An error occurs when reading/writing the RS485 encoder parameters.	If the fault persists after the servo drive is powered off and on repeatedly, the encoder is faulty.	Replace the servo motor.

- EA33.1: Fully closed-loop Inovance 2nd encoder data read/write error
  Cause:

  Internal parameters of the encoder are abnormal.

Cause	Troubleshooting	Solution
1. The serial incremental encoder cable is disconnected or loose.	Check the wiring.	Check whether the encoder cables are connected incorrectly, disconnected, or in poor contact. If the motor cables and encoder cables are bundled together, separate them.
2) An error occurs when reading/writing the RS485 encoder parameters.	If the fault persists after the servo drive is powered off and on repeatedly, the encoder is faulty.	Replace the servo motor.

- EA34.0: Abnormal Hall state
  Cause:

  Hall signal output is all high or all low.

Cause	Troubleshooting	Solution
Hall signal output is all high or all low.	Check the wiring of the Hall sensor. Collect the states of the Hall sensor with the oscilloscope in InoDriverShop. Push the motor, and observe whether there is 0 or 7 in the states.	Check the U, V and W wiring of the Hall sensor. If the alarm persists after several power cycling, the Hall sensor must be faulty and you must replace it. Check whether the encoder shield is connected properly. If a phase of the Hall sensor is connected incorrectly, you can adjust the level active state of a single phase through H32.55.

- EA34.1: Dynamic Hall auto-tuning error

  Cause:

  Dynamic Hall auto-tuning error.

Cause	Troubleshooting	Solution
Anomaly was found during electrical angle evaluation.	Check whether the motor can move normally. Check whether the Hall signal output corresponds to the electrical angle change. Check whether the motor is equipped with a Hall sensor. Check the wiring of the Hall sensor.	Ensure that the motor can move on one side regardless of the limit. If the motor parameters are normal, but one Hall signal change does not correspond to a 60° electrical angle approximately after several tests, the Hall signal output must be abnormal and you must replace the Hall sensor. Check whether the motor is equipped with a Hall sensor. Check the wiring of the Hall sensor.

- EA34.2: Static Hall auto-tuning error

  Cause:

  Static Hall auto-tuning error

Cause	Troubleshooting	Solution
Failed to enable static Hall auto-tuning.	1: Check whether the motor is connected to an incremental encoder.	Only motors with an incremental encoder support static Hall auto-tuning.
	2. Check whether H32.62 is 1 when H0A.13 is set to 6.	If not, perform dynamic Hall auto-tuning again.

- EB00.0: Position deviation too large

  Cause:

  The position deviation in the position control mode is larger than the setpoint of 6065h (Threshold of excessive position deviation).

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive U/V/W cables or the encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.
3. The motor stalls due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. • References in the position control mode: H0b.13 (Input position reference counter) • References in the speed control mode: H0b.01 (Speed reference) • References in the torque control mode: H0b.02 (Internal torque reference) Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
4. The gain values are too low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain set: H08.00...H08.02 2nd gain set: H08.03...H08.05	Adjust the gain values manually or perform gain auto-tuning.

Cause	Troubleshooting	Solution
5. The position reference increment is too large.	Position control mode: • In CSP mode, check the gear ratio 6091.01h/ 6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. • In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). • In HM mode, check the gear ratio 6091.01h/ 6091.02h, and determine 6099.01h and 6099.02h.	• CSP: Decrease the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. • PP: Decrease the value 6081h or increase the acceleration/deceleration ramp (6083h, 6084h). • HM: Decrease 6099.01h and 6099.02h or increase the acceleration/deceleration ramp (609Ah). • Decrease the gear ratio according to actual conditions.
6. The value of 6065h is insufficient for the operating conditions.	Check the value of 6065h.	Increase the setpoint of 6065h.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB00.1: Position deviation overflow
  Cause:

  The position deviation is too large.

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive U/V/W cables or the encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.

Cause	Troubleshooting	Solution
3. The motor stalls due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. • References in the position control mode: H0b.13 (Input position reference counter). • References in the speed control mode: H0b.01 (Speed reference). • References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
4. The gain values are too low.	Check the position loop gain and speed loop gain of the servo drive. • 1st gain set: H08.00... H08.02 • 2nd gain set: H08.03... H08.05	Adjust the gain values manually or perform gain auto-tuning.
5. The position reference increment is too large.	Position control mode: • In CSP mode, check the gear ratio 6091.01h/ 6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. • In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). • In HM mode, check the gear ratio 6091.01h/ 6091.02h, and determine 6099.01h and 6099.02h.	• CSP: Decrease the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. • PP: Decrease the value 6081h or increase the acceleration/deceleration ramp (6083h, 6084h). • HM: Decrease 6099.01h and 6099.02h or increase the acceleration/deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions.

Cause	Troubleshooting	Solution
6. The value of 6065h is insufficient for the operating conditions.	Check the value of 6065h.	Increase the setpoint of 6065h.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB01.1: Individual position reference increment too large

  Cause:

  The target position increment is too large.

Cause	Troubleshooting	Solution
The target position increment is too large.	Check the variation between two adjacent target positions using the software tool.	Check whether the maximum speed of the motor fulfills the application requirement. If yes, reduce the target position reference increment, which is to lower the profile reference speed. If not, replace the servo motor. Before switching the mode or enabling the servo drive, check whether the target position is aligned with current position feedback. The communication sequence of the host controller is abnormal, leading to slave data error. Check the communication sequence of the host controller.

- EB01.2: Position reference increment too large continuously

  Cause:

  The target position increment is too large continuously.

Cause	Troubleshooting	Solution
The target position increment is too large continuously.	Check the variation between two adjacent target positions using the software tool.	Check whether the maximum speed of the motor fulfills the application requirement. If yes, reduce the target position reference increment, which is to lower the profile reference speed. If not, replace the servo motor. Before switching the mode or enabling the servo drive, check whether the target position is aligned with current position feedback. The communication sequence of the host controller is abnormal, leading to slave data error. Check the communication sequence of the host controller.

- EB01.3: Command overflow
  Cause:

  The target position is still in the process of transmission when the servo limit or software position limit signal is activated and the 32-bit upper/lower limit is reached.

Cause	Troubleshooting	Solution
The target position is still in the process of transmission when the servo limit or software position limit signal is activated and the 32-bit upper/lower limit is reached.	Check whether the host controller continues sending commands after overtravel alarm is reported by the servo drive.	Detect the servo limit signal (bit0 and bit1 of 60FDh is recommended) through the host controller. Stop sending limit direction commands when an active servo limit signal is detected by the host controller.

- EB02.0: Position deviation exceeding threshold in fully closed-loop
  Cause:

  The absolute value of position deviation in fully closed-loop mode exceeds the value of H0F.08 (Excessive position deviation threshold in fully closed-loop mode).

Cause	Troubleshooting	Solution
1. U/V/W output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive U/V/W cables or the encoder cable is disconnected.	Check the wiring.	Connect the cables again. The servo drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.
3. The motor stalls due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. • References in the position control mode: H0b.13 (Input position reference counter). • References in the speed control mode: H0b.01 (Speed reference). • References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.
4. The gain values are too low.	Check the position loop gain and speed loop gain of the servo drive. • 1st gain set: H08.00... H08.02 • 2nd gain set: H08.03... H08.05	Adjust the gain values manually or use gain auto-tuning.
5. The input pulse frequency is high.	When the position reference source is pulse reference, check whether the input pulse frequency is too high or whether the acceleration/ deceleration time is set to 0 or an excessively low value.	Reduce the position reference frequency or the electronic gear ratio. When the host controller is used to output position pulses, you can set the acceleration time in the host controller. If the acceleration/deceleration time cannot be set in the host controller, increase the values of H05.04 and H05.06.

Cause	Troubleshooting	Solution
6. The value of H0F.08 is insufficient for the operating conditions.	Check the value of H0F.08.	Increase the setpoint of H0F.08.
7. The servo drive/motor is faulty.	Monitor the operation waveform through the oscilloscope function in the software tool: position references, position feedback, speed references, and torque references.	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB02.1: Fully closed-loop position deviation overflow
  Cause:

  The absolute value of the fully closed-loop position deviation is greater than 2^{31}.

Cause	Troubleshooting	Solution
1. UVW phase loss or incorrect phase sequence occurs on the servo drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
2. The servo drive UVW cables or the encoder cables are disconnected.	Check the wiring.	Connect the cables again. The drive power cables must be connected in the correct order at both ends. If necessary, replace all cables and ensure a reliable connection.
3. The motor stalls due to mechanical factors.	Check the reference and motor speed (H0b.00) through the software tool or keypad. • References in the position control mode: H0b.13 (Input position reference counter). • References in the speed control mode: H0b.01 (Speed reference). • References in the torque control mode: H0b.02 (Internal torque reference). Check whether the reference value is not 0 but the motor speed is 0 rpm in the corresponding mode.	Rectify the mechanical-related problem.

Cause	Troubleshooting	Solution
4. The gain values are too low.	Check the position loop gain and speed loop gain of the servo drive. • 1st gain set: H08.00...H08.02 • 2nd gain set: H08.03...H08.05	Adjust the gain values manually or perform gain auto-tuning.
5. The position reference increment is too large.	Position control mode: • In IP/CSP mode, check the gear ratio 6091.01h/6091.02h to determine the position reference increment for an individual synchronization period and convert it to the speed information. • In PP mode, check the gear ratio 6091.01h/6091.02h and determine the 6081h (Profile velocity). • In HM mode, check the gear ratio 6091.01h/6091.02h, and determine 6099.01h and 6099.02h.	• IP/CSP: Decreases the position reference increment per synchronization period. The host controller should cover the position ramp when generating references. • PP: Decreases the value of 6081h or decreases the acceleration/deceleration ramp (6083h, 6084h). • HM: Decreases 6099.01h and 6099.02h or decreases the acceleration/deceleration ramp (609Ah). Reduce the gear ratio as needed.
6. The value of H0F.08 is insufficient for the operating conditions.	Check the value of 6065h.	Increase the setpoint of 6065h.
7. The servo drive/motor is faulty.	Monitor the operating waveform using the oscilloscope function of Inovance commissioning software and check whether the operating waveform includes the following information: position reference, position feedback, speed reference, torque reference	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

- EB03.0: Electronic gear ratio beyond the limit - H05.02
  Cause:

  The electronic gear ratio exceeds the limit: [0.001, 4000 x Encoder resolution/10000].

Cause	Troubleshooting	Solution
The electronic gear ratio converted by converted exceeds the maximum gear ratio or is less than the minimum gear ratio.	Check if the electronic gear ratio is within the range of 0.001–4000 × Encoder resolution/10000.	Change the value of H05.02.

- EB03.1: Electronic gear ratio beyond the limit - Electronic gear ratio 1
  Cause:

  The electronic gear ratio exceeds the limit: [0.001, 4000 × Encoder resolution/10000].

Cause	Troubleshooting	Solution
Electronic gear ratio 1 exceeds the maximum gear ratio or is less than the minimum gear ratio.	Check if electronic gear ratio 1 is within the range of 0.001–4000 × Encoder resolution/10000.	Change the values of H05.07/H05.09.

- EB03.2: Electronic gear ratio beyond the limit - Electronic gear ratio 2
  Cause:

  Electronic gear ratio 2 exceeds the limit: [0.001, 4000 × Encoder resolution/10000].

Cause	Troubleshooting	Solution
Electronic gear ratio 2 exceeds the maximum gear ratio or is less than the minimum gear ratio.	Check if electronic gear ratio 2 is within the range of 0.001–4000 × Encoder resolution/10000.	Change the values of H05.11/H05.13.

- EB04.0: Large gantry position deviation
  Cause:

  Gantry position deviation is too large.

Cause	Troubleshooting	Solution
Gantry position deviation is too large. The gantry position deviation is too large after mechanical homing enabling is off.	Check whether the gantry position deviation exceeds the threshold set in H14.45, or is related to any instrument or device.	Increase the value of H14.45.

- EB04.1: Gantry position deviation overrun
  Cause:

  Gantry position deviation overruns.

Cause	Troubleshooting	Solution
The deviation of two gantry axes exceeds the internal 32-bit data.	Check whether the gantry alignment mode is suitable. Check whether the position command of the two axes are the same and whether the mechanical structure is abnormal.	Check whether the gantry alignment mode is suitable. Check whether the position command of the two axes are the same and whether the mechanical structure is abnormal.

- ED02.0: Modbus communication timeout
  Cause:

  Modbus communication timeout

Cause	Troubleshooting	Solution
Modbus communication timeout.	Increase the value of H0E.83.	Determine the Modbus access cycle by frame grab.

- EE08.0: Synchronization (SYNC) signal loss
  Cause:

  The SYNC signal is turned off when the EtherCAT network is in the OP state.

Cause	Troubleshooting	Solution
The SYNC signal is not generated due to hardware errors.	Check whether the SYNC signal period is 0 using the oscilloscope in the software tool.	Replace the servo drive. Contact Inovance for maintenance.
The data received by the slave is abnormal during synchronous communication.	Check whether the STP is used as the communication cable. Check whether the servo drive is well grounded. Check the Ethernet port of the servo drive is damaged.	Use the STP cable. Connect the cable according to the wiring instructions. Check the network connection status through the first LED on the left.

Cause	Troubleshooting	Solution
The data transmitted by the master is abnormal during synchronous communication.	The synchronous clock of the host controller is not activated. Excessive error occurs on the synchronization clock of the host controller.	Measure the synchronization cycle through an actual oscilloscope or the oscilloscope tool in the Inovance servo commissioning software. If the synchronization cycle is 0, the host controller synchronous clock is not activated. In this case, check whether the network cables connected to each slave come in from the IN port and out from the OUT port. If yes, restart the network. If the network cable is connected in the correct sequence, restart the network. If the synchronization period is not 0 and within the permissible fluctuation range (2 μs) of the drive, increase the synchronization loss threshold of the slave (H0E.32h).
When the servo drive is enabled, the network status switches from OP to non-OP.	Check whether the network status switches from OP to non-OP.	Check the network status switchover program of the host controller.

- EE08.1: Status switchover error

  Cause:

  When the servo drive is enabled, the EtherCAT network status switches from OP to other status.

Cause	Troubleshooting	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.
The data received by the slave is abnormal during synchronous communication.	Check whether the STP is used as the communication cable. Check whether the servo drive is well grounded. Check the Ethernet port of the servo drive is damaged.	Use the STP cable. Connect the cable according to the wiring instructions. Check the network connection status through the first LED on the left.

Cause	Troubleshooting	Solution
The data transmitted by the master is abnormal during synchronous communication.	The synchronous clock of the host controller is not activated. Excessive error occurs on the synchronization clock of the host controller.	Measure the synchronization cycle through an actual oscilloscope or the oscilloscope tool in the Inovance servo commissioning software. If the synchronization cycle is 0, the host controller synchronous clock is not activated. In this case, check whether the network cables connected to each slave come in from the IN port and out from the OUT port. If yes, restart the network. If the network cable is connected in the correct sequence, restart the network. If the synchronization period is not 0 and within the permissible fluctuation range (2 μs) of the drive, increase the synchronization loss threshold of the slave (H0E.32h).
When the servo drive is enabled, the network status switches from OP to non-OP.	Check whether the network status switches from OP to non-OP.	Check the network status switchover program of the host controller.

- EE08.3: Network cable connected improperly
  Cause:

  The network cable of the servo drive is connected improperly. (The low 16 bits of H0E.29 represents the number of IN port loss events. The high 16 bits of H0E.29 represents the number of OUT port loss events.)

Cause	Troubleshooting	Solution
The physical connection of the data link is unstable or the process data is lost due to plug-in/ plug-out of the network cable.	Check whether the network cable of the servo drive is connected securely. Check whether strong vibration occurs on site. Check whether the network cable was unplugged. Check whether the network cable used is the one designated by Inovance.	Check the connection of the network port through the change of the H0E.29 value. Use a new network cable that can connect reliably.

- EE08.4 Data frame loss protection error
  Cause:

  PDO data is corrupted due to EMC interference or an inferior network cable.

Cause	Troubleshooting	Solution
The data is lost due to EMC interference, poor quality of the network cable or improper connection.	Check whether the high 16 bits of H0E.25 have values that are increased.	• Check whether the servo drive is grounded properly and rectify the EMC problem. • Check whether the network cable used is the one designated by Inovance. • Check whether the network cable is connected properly.

- EE08.5: data frame transfer error
  Cause:

  The upstream slave detects that the data frame has been corrupted and marked, which is then transferred to the downstream slave, leading to an alarm.

Cause	Troubleshooting	Solution
The upstream station detects that the data frame has been corrupted and marked, which is then transfered to the slave, leading to an alarm.	Check whether a processing unit error occurs due to transfer error (H0E.27) or invalid frames (H0E.28) upon occurrence of the fault, and check whether no counting is performed in RX-ERR of Port0.	Check the upstream slave to locate the fault cause.

- EE08.6: Data update timeout
  Cause:

  The slave is in the OP status and does not receive the data frame in a long time.

Cause	Troubleshooting	Solution
The data frame is lost or aborted in the upstream slave or the master performance is not up to standard.	Check through the software tool whether the phase difference between SYNC and IRQ exceeds the value of H0E.22 multiplied by the communication period.	• Check whether the operating load of the master CPU is excessive. Increase the communication time or set H0E-22 to a larger value. • Check whether link loss occurs on the upstream slave.

- EE09.0: Software position limit setting error
  Cause:

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

Cause	Troubleshooting	Solution
The lower limit of the software limit is equal to or larger than the upper limit.	Check the values of 607D.01h and 607D.02h.	Reset the values and ensure the former is smaller than the latter.

- EE09.1: Home setting error

  Cause:

  The home offset exceeds the upper/lower limit.

Cause	Troubleshooting	Solution
1) The home offset is beyond the software limit.	The home offset is outside the software position limit when the encoder works in the incremental mode, absolute linear mode, and single-turn absolute mode.	Set the home offset to a value within the software position limit.
2) The home offset is beyond the upper/lower limit in the rotating mode.	The home offset is outside 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/lower limit.

- EE09.2: Gear ratio beyond the limit

  Cause:

  The electronic gear ratio exceeds the limit: (0.001, 4000 x Encoder resolution/ 10000).

Cause	Troubleshooting	Solution
The electronic gear ratio setpoint exceeds the limit: (0.001, 4000 x Encoder resolution/10000).	The gear ratio 6091.01h/ 6091.02h exceeds the preceding range.	Set the gear ratio within the required range.

- EE09.3: No synchronization signal

  Cause:

  The MCU does not receive the synchronization signal when the servo communication is switched to OP status.

Cause	Troubleshooting	Solution
1) The communication synchronization clock is configured improperly.	Replace with another master (such as Beckhoff or Omron PLC) and perform tests to compare between different masters.	Rectify improper configurations.
2) The IN/OUT port for EtherCAT communication is connected reversely.	Check the connection of the IN and OUT ports.	Connect the IN and OUT ports in the correct sequence.
3) The slave controller chip is damaged.	If the fault persists after the master is replaced, measure the synchronization signal generated by the slave controller integrated circuit with an oscilloscope. If there is no signal, the slave controller integrated circuit is damaged.	Return to the factory for maintenance.
4) The MCU pins are damaged.	Test the synchronization signal generated by the slave controller integrated circuit with an oscilloscope. If there is a signal, the pins of the MCU integrated circuit are damaged.	Return to the factory for maintenance.

- EE09.5: PDO mapping beyond the limit
  Cause:

  The mapping objects in TPDO or RPDO exceeds 40 bytes.

Cause	Troubleshooting	Solution
The mapping objects in TPDO or RPDO exceeds 40 bytes.	Check the number of self-indexes configured in 1600h or 1A00h.	The mapping objects in TPDO or RPDO must not exceed 40 bytes.

- EE10.0: Protection against MailBox setting error
  Cause:
  - Check if the SM channel is enabled.
  - Check if the read-write direction is configured correctly.
  - Check if it is the Mailbox mode (single-cache mode).
  - Check if the length of the received data is between the minimum and maximum set lengths.
  - Check if the address of the received data is between the minimum and maximum set addresses.
  - Check the read-write mailbox memory for overlap.

Cause	Troubleshooting	Solution
1. The master station is configured incorrectly. 2. The slave XML file is incorrect.	Fault code is displayed on the panel.	Check the configuration of SM0 and SM1 channels for errors.

- EE10.1: SM2 setting error
  Cause:
  - PDO mapping object dictionary index exceeds the set maximum (0x1600–0x170A).
  - When SM2 is not enabled, the length of SM and the length of RxPDO are not equal to 0.
  - The length of the RxPDO does not match.
  - Not writing.
  - In the preop state, the address of RxPDO is not in the set address field (maximum and minimum addresses), or in a non-preop state, the address of SM2 is equal to the starting address of RxPDO.
  - The memory of SM2 overlaps with adjacent SM1 or SM3.

Cause	Troubleshooting	Solution
The master station is configured incorrectly. The slave XML file is incorrect.	Check the configuration of SM2 for errors. Check whether the index of the RxPDO mapping object dictionary is out of bounds (the maximum index is 0x0A).	Ensure that the SM2 channel is configured correctly. The index of the RxPDO mapping object dictionary is correct.

- EE10.2: SM3 setting error
  Cause:
  - PDO mapping object dictionary index exceeds the set maximum (0x1A00–0x1B0A).
  - When SM3 is not enabled, the length of SM and the length of TxPDO are not equal to 0.
  - The length of the TxPDO does not match.
  - Not reading.
  - In the preop state, the address of TxPDO is not in the set address field (maximum and minimum addresses), or in a non-preop state, the address of SM3 is equal to the starting address of TxPDO.
  - Buffer overruns. The memory of SM2 overlaps SM3 and SM0 or SM1.

Cause	Troubleshooting	Solution
The master station is configured incorrectly. The slave XML file is incorrect.	Check the configuration of SM3 for errors. Check whether the index of the TxPDO mapping object dictionary is out of bounds (the maximum index is 0x1A).	Ensure that the SM3 channel is configured correctly. The index of the TxPDO mapping object dictionary is correct.

- EE10.3: PDO watchdog setting error
  Cause:
  - The watchdog is enabled but the count is 0.
  - The watchdog is not enabled but the count is non-zero.

Cause	Troubleshooting	Solution
The watchdog is enabled but the count is 0. The watchdog is not enabled but the count is non-zero.	The settings of the master station is incorrect.	Make sure the watchdog time is configured correctly.

- EE10.4: Protection against incomplete PLL (no sync signal)
  Cause:

  During SAFEOP-to-OP, DC is enabled, but not running.

Cause	Troubleshooting	Solution
During SAFEOP_2_OP, DC is enabled, but not running.	The settings of the master station is incorrect.	Make sure a sync0 signal is generated.

- EE10.5: PHY setting error
  Cause:

  An error occurred during PHY chip configuration in power-on initialization, and the PHY cannot work normally.

Cause	Troubleshooting	Solution
The PHY chip is damaged, or the pin is falsely or continuously soldered.	The alarm persists in spite of a power cycle.	Return to the factory for maintenance.

- EE11.0: ESI check error
  Cause:

  The attempt to load the XML file fails during EtherCAT communication.

Cause	Troubleshooting	Solution
The XML file is not downloaded.	Check whether the XML version displayed in H0E.96 is normal.	Download the XML file.
The servo drive is faulty. The XML file is modified unexpectedly.	The XML version number is not empty.	H0E. 37 is set to 1 and power on and off again.

- EE11.1: EEPROM read failure
  Cause:

  The EEPROM communication of external EtherCAT devices fails.

Cause	Troubleshooting	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
  Cause:

  The communication is normal but the message in the EEPROM is wrong or lost.

Cause	Troubleshooting	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.

- EE11.3: ESI and drive mismatch

Cause	Troubleshooting	Solution
1. The downloaded XML file is not compatible with the drive. 2. The servo drive is faulty. The XML file is modified unexpectedly.	Check whether the XML version displayed in H0E.96 is normal.	Download the XML file.

- EE12.0: EtherCAT initialization failure

Cause	Troubleshooting	Solution
1. The device configuration file is not programmed.	The slave ID is null when the host controller scans the slave.	Program the device configuration file.
2. The servo drive is faulty.	The servo drive is faulty.	Replace the servo drive.

- EE13.0: EtherCAT sync period setting error
  Cause:

  The synchronization period is not an integer multiple of 125 μs or 250 μs after the network switches to the OP mode.

Cause	Troubleshooting	Solution
The synchronization cycle is not a integral multiple of 125 μs or 250 μs.	Check the setting of the synchronization period in the controller.	Modify the synchronization cycle to an integral multiple of 125 μs or 250 μs.

- EE15.0: Excessive EtherCAT sync period error

  Cause:

  The synchronization cycle error exceeds the threshold.

Cause	Troubleshooting	Solution
Excessive error occurs to the synchronization cycle of the controller.	• Measure the synchronization cycle of the controller. • Through a digital oscilloscope. • Measure the synchronization cycle of the controller by using the oscilloscope function in the software tool.	Increase the value of H0E.32.

Note

You can clear the fault or restart the power supply 30s after overload occurs.

- EE16.0: MCU and ESC communication error

  Cause:

  MCU and ESC communication timeout

Cause	Troubleshooting	Solution
MCU and ESC communication timeout	The fault persists after the servo drive is powered off and on repeatedly.	Replace the servo drive.

- EEE0.0: gantry paired axis error

  Cause:

  Gantry paired axis error.

Cause	Troubleshooting	Solution
Gantry paired axis error.	Check whether the gantry paired axis.	Eliminate the fault.

8.3.3.2 Internal Faults

When any one of the following fault occurs, contact Inovance for technical support.

- E111.0: Internal parameter error
- E602.0: Angle auto-tuning failure
- E220.0: Phase sequence incorrect
- EA40.0: Parameter auto-tuning failure

8.3.4 Description of Alarm Codes

- E108.0: Parameter write error
  Cause:

  Parameter values cannot be written to EEPROM.

Cause	Troubleshooting	Solution
Parameter writing error	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.1: Parameter read error
  Cause:

  Parameter values cannot be read from EEPROM.

Cause	Troubleshooting	Solution
The parameter-read operation is abnormal, and the system indicates an EEPROM read failure.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.2: EEPROM write check error
  Cause:

  The check on the data written in EEPROM failed.

Cause	Troubleshooting	Solution
A check error occurs after parameter writing.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.3: EEPROM read check error
  Cause:

  The check on the data read in EEPROM failed.

Cause	Troubleshooting	Solution
An error occurs during parameter-reading.	Modify a certain parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E108.4: Single data stored too many times
  Cause:

  Single data is stored too frequently.

Cause	Troubleshooting	Solution
That may damage EEPROM over time.	Check H0b.90 and H0b.91. H0b.90 shows the parameter in question or object dictionaries (in hexadecimal). If H0b.91=15, H0b.90 shows internal variables of software. Check "Func Test 1" through the oscilloscope channel. Be sure to display it in hexadecimal. This channel displays the address that EEPROM is storing. Check the storage count through the oscilloscope channel "Func Test 2".	If the alarm is caused by manually modifying a certain parameter or object dictionary, there will be no frequent storage of a certain data during operation, and you can reset the fault. Check the abnormal parameter through H0b. 90 or oscilloscope channel, and find out the cause. For example, if the host controller program frequently writes parameters through SDO, you can modify the program to stop it or set H0E.01 to 0 (Do not access EEPROM when writing parameters or object dictionaries).

- E110.0: Frequency-division pulse output setting error
  Cause:

  The frequency-division output setpoint (H05.17) exceeds the encoder resolution.

Cause	Troubleshooting	Solution
The number of frequency divisions (quadrupled) exceeds the motor revolutions	Check the setpoint of H05.17.	Adjust the value of H05.17 on the basis of the motor revolutions.

- E120.3: The motor and drive do not match in the power
  Cause:

  the motor and drive do not match in the rated power.

Cause	Troubleshooting	Solution
The rated current/voltage of the motor is higher than that of the drive.	Check whether the rated motor current/voltage is larger than that of the drive.	Replace the motor or drive.

- E121.0: Invalid S-ON command

  Cause:

  A redundant S-ON signal is sent when some auxiliary functions are used.

Cause	Troubleshooting	Solution
The external S-ON signal is active when servo drive is enabled internally.	Check whether auxiliary functions (H0d.02, H0d.03, and H0d.12) are used and DI function 1 (FunIN.1: S-ON, S-ON signal) is active.	Deactivate the DI assigned with FunIN.1 (both hardware DI and virtual DI).

- E126.3: PR process segment write parameter out of limit

  Cause:

  In the process segment mode, the written value exceeds the upper limit of the parameter.

Cause	Troubleshooting	Solution
In the process segment mode, the written value exceeds the upper limit of the parameter.	Check the upper and lower limits of the parameter.	In the process segment mode, the written value exceeds the upper limit of the parameter.

- E510.0: Frequency division pulse output overspeed

  Cause:

  The output pulse frequency exceeds the frequency upper limit allowed by the hardware (4 MHz) when pulse output is used (H05.38 = 0 or 1 or 2).

Cause	Troubleshooting	Solution
The MCU detects excessive pulse increment fed back by FPGA.	When 1.H05.38 is set to 0 (encoder frequency-division output) or 2 (2nd encoder frequency-division output), check whether the output pulse frequency corresponding to the motor speed upon fault exceeds the limit. Output pulse frequency (Hz) = Motor speed (rpm)/60 x H05.17. The input pulse frequency exceeds 2 MHz or interference exists in the pulse input pins when 2.H05.38 is set to 1 (Reference pulse synchronous output). Low speed pulse input pins: open-collector input terminals: PULLHI, PULSE+, PULSE-, SIGN+, SIGN-; maximum pulse frequency: 200 kpps. High-speed pulse input pins: differential input terminals: HPULSE+, HPULSE-, HSIGN+, HSIGN-; maximum pulse frequency: 8 Mpps.	1. Decrease the value of H05.17 (encoder frequency-division pulses) to allow the output pulse frequency, within the speed range required by the machine, to drop below the frequency upper limit allowed by the hardware. 2. Decrease the input pulse frequency to a value within the frequency upper limit allowed by hardware. In this case, if you do not modify the electronic gear ratio, the motor speed will decrease. If the input pulse frequency is high but is still within the frequency upper limit allowed by the hardware, take anti-interference measures (use STP cable for pulse input and set pin filter parameter H0A.24 or H0A.30). This is to prevent false alarms caused by interference pulses superimposed to actual pulse references.

- E600.0: Inertia auto-tuning failure
  Cause:

  Vibration cannot be suppressed. You can set notch parameters (H09.12...H09.23) manually to suppress vibration.

  The auto-tuned values fluctuate dramatically. Increase the maximum operating speed, reduce the acceleration/deceleration time, and shorten the stroke of the lead screw during ETune operation.

  Mechanical couplings of the load are loose or eccentric. Rectify the mechanical faults.

  An alarm occurs during auto-tuning and causes interruption. Rectify the fault causes and perform inertia auto-tuning again.

  The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/deceleration time to ensure the motor current is unsaturated.

The position following-up is too poor. That is, the maximum speed of the motor is less than the speed setpoint of the inertia auto-tuning. Ensure that the speed setpoint is less than the maximum speed of the motor.

Cause	Troubleshooting	Solution
1. Continuous vibration occurs during auto-tuning. 2. The auto-tuned values fluctuate dramatically. 3. Mechanical couplings of the load are loose or the mechanism is eccentric. 4. A warning occurs during auto-tuning, interrupting the operation. 5. The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/deceleration time to ensure the motor current is unsaturated. 6. The position following-up is too poor. That is, the maximum speed of the motor is less than the speed setpoint of the inertia auto-tuning.	Perform internal inspection to check whether the torque jitters upon stop (not FFT. Check whether three times more than the last auto-tuned value for variation less than 5 times; 0.5 times more than last auto-tuned value for variation above 5 times.	1. Rectify the fault and perform auto-tuning again. Rectify the fault causes and perform inertia auto-tuning again. 2. For vibration that cannot be suppressed, enable vibration suppression. 3. Ensure mechanical couplings are connected securely. 4. Increase the maximum operating speed, reduce the acceleration/deceleration time, and shorten the stroke of the lead screw during ETune operation. 5. Ensure that the speed setpoint is less than the maximum speed of the motor.

- E601.0: Homing alarm
  Cause:

  Homing time exceeds the setpoint.

Cause	Troubleshooting	Solution
1. The home switch is faulty.	There is only high-speed searching but no low-speed searching during homing. After high-speed searching, low-speed searching in the reverse direction applies.	If a hardware DI is used, check whether the corresponding DI function is allocated to a certain DI in group 2003h and check the wiring of this DI. Change the DI logic manually and observe the value of H0B.03 (monitored DI status) to monitor whether the servo drive receives corresponding DI level changes. If the home signal is Z signal but it cannot be found, check the condition of the Z signal.
2. The homing time limit is too short.	Check whether the value of H05.35h (Time limit for homing) is too small.	Increase the value of H05.35.
3. The speed in high-speed searching for the home switch signal is too low.	Check the distance between the start position of homing and the home switch. Then check whether the setpoint of 6099.01h (Speed in high-speed searching for the home switch signal) is too low, resulting in a long homing process.	Increase the value of 6099.01h.

- E601.1: Homing switch error
  Cause:

  The homing switch is set improperly.

Cause	Troubleshooting	Solution
The home switch is set improperly.	Check whether the limit signals at both sides are activated. Check whether the limit signal and the deceleration point signal/home signal are both activated. Check whether the positive and negative position limits are activated successively.	Set the position of the physical switch properly.

- E601.2: Homing mode setting error
  Cause:

  The homing method value is too large.

Cause	Troubleshooting	Solution
The homing method value is too large.	Check the homing method value (object dictionary 6098h).	Change the value of 6098h.

- E601.4: Gantry homing mode setting error
  Cause:

  Gantry homing mode setting error.

Cause	Troubleshooting	Solution
You have set a wrong homing mode for the gantry through H05.31.	Check the setting.	Change the setting.

- E602.9: Angle auto-tuning not done for incremental encoder motor
  Cause:

  Angle auto-tuning is not performed for the incremental encoder motor.

Cause	Troubleshooting	Solution
Angle auto-tuning is not performed for the incremental encoder, and corresponding alarm is enabled.	Check whether bit1 of H32.04 is set.	1. The alarm is automatically reset after the angle auto-tuning is completed. 2. If you do not need this alarm, reset bit1 of H32.04.

- E607.0: Large gantry torque deviation
  Cause:

  Gantry torque deviation is too large.

Cause	Troubleshooting	Solution
Large gantry torque deviation	Gantry torque deviation is too large.	Check the wiring of the gantry.

- E608.0: Master-to-slave parameter setting error
  Cause:

  Master-to-slave parameter setting error.

Cause	Troubleshooting	Solution
Master-to-slave parameter setting error	The parameter value exceeds the limit or the communication between drives is poor.	Check the setpoint of H14.03.

- E609.0: Data save timeout
  Cause:

  Wire breakage occurred when the software was downloading data.

Cause	Troubleshooting	Solution
Wire breakage occurred when the software was downloading data.	Check that the drive is connected to the software.	Download the data again.

- E609.1: Data save overflow
  Cause:

  Wire breakage occurred when the software was downloading data.

Cause	Troubleshooting	Solution
Wire breakage occurred when the software was downloading data.	Check that the drive is connected to the software.	Download the data again.

- E609.2: Failed to save data
  Cause:

  Failed to save data.

Cause	Troubleshooting	Solution
The FLASH memory chip or the interface between MCU and FLASH failed.	Power on multiple times and download data again.	If the problems persists, replace the drive.

- E609.3: Failed to erase data
  Cause:

  Failed to erase data.

Cause	Troubleshooting	Solution
The FLASH memory chip or the interface between MCU and FLASH failed.	Power on multiple times and download data again.	If the problems persists, replace the drive.

- E621.1: Overload current limiting torque attained
  Cause:

  Overload current limiting torque attained.

Cause	Troubleshooting	Solution
1. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque. 2. The acceleration/ deceleration is too frequent or the load inertia is too large. 3. The motor and encoder cables are connected incorrectly or in poor contact. 4. The gain adjustment is improper or the stiffness is too high. 5. The motor is stalled due to mechanical factors, resulting in overload during operation. 6. The servo drive is faulty.	1. Confirm the overload characteristics of the servo drive or servo motor. Check whether the average load rate (H0b.12) of the servo drive keeps exceeding 100.0%. 2. Detect whether the value of H3277 is set too high.	1. Replace with a servo drive of higher capacity and a matching servo motor, or reduce the load and increase the acceleration/ deceleration time.

- E631.4: P-MOS short circuit

  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, the P-MOS short circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	1. Replace the servo drive. 2. Turn off the brake switch H02.16.

- E631.5: N-MOS short circuit

  Cause:

  The brake circuit is faulty.

Cause	Troubleshooting	Solution
When braking is used, the N-MOS short circuit occurred on the brake circuit.	Ensure the brake cable is connected, check if the fault persists after the servo drive is powered off and on again.	1. Replace the servo drive. 2. Turn off the brake switch H02.16.

- E730.0: Encoder battery alarm

  Cause:

  The voltage of the absolute encoder battery is lower than 3.0 V.

Cause	Troubleshooting	Solution
The voltage of the absolute encoder battery is lower than 3.0 V.	Measure the battery voltage.	Use a new battery with the matching voltage.

Note

E731.0 and E733.0 can trigger E730.0. See E731.0 and E733.0 for other solutions.

- E730.1: Inovance 2nd encoder battery voltage low
  Cause:

  Inovance 2nd encoder battery voltage is lower than 3.0 V.

Cause	Troubleshooting	Solution
Inovance 2nd encoder battery voltage is too low.	Measure the battery voltage.	Use a new battery with the matching voltage.

- E831.1: AI1 zero offset too large
  Cause:

  The zero drift of AI1 exceeds 500 mV.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI1 input filter time.
2. The servo drive is faulty.	Disconnect AI1 and measure whether the actual terminal voltage exceeds 0.5 V.	If not, replace the servo drive.

- E831.2: AI2 zero offset too large
  Cause:

  The zero drift of AI2 exceeds 500 mV.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI2 input filter time.
2. The servo drive is faulty.	Disconnect AI2 and measure whether the actual terminal voltage exceeds 0.5 V.	If not, replace the servo drive.

- E834.1: AI1 overvoltage
  Cause:

  AI1 input voltage is greater than 11.5 V.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI1 input filter time.
2. The input voltage is too high.	Measure whether the actual terminal voltage exceeds 11.5 V.	Adjust the input voltage to a value lower than 11.5 V.

- E834.2: AI2 overvoltage
  Cause:

  AI2 input voltage is greater than 11.5 V.

Cause	Troubleshooting	Solution
1. The wiring is incorrect or interference exists.	Check the wiring according to the correct wiring diagram.	Use shielded twisted pairs and shorten the circuit length. Increase AI2 input filter time.
2. The input voltage is too high.	Measure whether the actual terminal voltage exceeds 11.5 V.	Adjust the input voltage to a value lower than 11.5 V.

- E900.0: DI emergency braking
  Cause:

  The logic of the DI terminal (including the hardware DI and virtual DI) allocated with DI function 34 (FunIN.34) is effective.

Cause	Troubleshooting	Solution
The DI function 34 (EmergencyStop) is triggered.	Check whether the logic of the DI allocated with DI function 34 (FunIN.34: Emergency stop) is valid.	Check the operation mode and clear the active DI braking signal without affecting the safety performance.

- E902.0: Invalid DI/VDI setting
  Cause:

  DI function parameters are set to invalid values.

Cause	Troubleshooting	Solution
DI or VDI function selections are invalid.	Check whether DI function configure parameters in H03 and H17 are set to invalid values.	Set DI/VDI function parameters to valid values.

- E902.1: Invalid DO/VDO setting
  Cause:

  DO/VDO function parameters are set to invalid values.

Cause	Troubleshooting	Solution
DO or VDO function selections are invalid.	Check whether DI function configure parameters in H04 and H17 are set to invalid values.	Set DO/VDO function parameters to valid values.

- E902.2: Invalid setting for torque reach
  Cause:

  The DO parameters set for torque reach in the torque control mode are invalid.

Cause	Troubleshooting	Solution
The DO parameters set for torque reach in the torque control mode are invalid.	Check whether the value of H07.22 is lower than or equal to the value of H07.23 (unit: 0.1%).	Set H07.22 to a value higher than that of H07.23.

- E909.0: Motor overload alarm
  Cause:

  The accumulative heat of the motor reaches 90% of the fault threshold.

Cause	Troubleshooting	Solution
1. The motor cables and encoder cable are connected improperly or in poor contact.	Check the wiring among the servo drive, servo motor and the 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. When customized cables are used, prepare and connect the customized cables according to the wiring instructions.
2. The load is so heavy that the effective torque outputted by the motor keeps exceeding the rated torque.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load rate (H0b.12) keeps exceeding 100.0%.	Use a servo drive of higher capacity and a matching servo motor. Reduce the load and increase the acceleration/deceleration time.
3. Acceleration/Deceleration is too frequent or the load inertia is too large.	Check the mechanical inertia ratio or perform inertia auto-tuning. View the value of H08.15 (load moment of inertia ratio). Confirm the individual operation cycle when the servo motor operates cyclically.	Increase the acceleration/deceleration time.

Cause	Troubleshooting	Solution
4. Gains are improper or the stiffness level is too high.	Check whether the motor vibrates and generates unusual noise during operation.	Readjust the gain.
5. The servo drive model or motor model is set improperly.	View the model of the motor equipped with a serial-type encoder in H00.05 and the servo drive model in H01.10.	Read the servo drive nameplate and set the servo drive model (H01.10) and motor model properly.
6. The motor is stalled due to mechanical factors, resulting in overload during operation.	Check the running reference and motor speed (H0b.00) through Inovance servo commissioning software or keypad: • References in the position control mode: H0b.13 (Input position reference counter) • References in the speed control mode: H0b.01 (Speed reference) • References in the torque control mode: H0b.02 (Internal torque reference) Check whether the reference value is not 0 or is very large but the motor speed is 0 RPM in the corresponding mode.	Rectify the mechanical-related problem.
7. The servo drive is faulty.	Power off and on the servo drive.	Replace the servo drive.

- E910.0: Control circuit overvoltage

Cause	Troubleshooting	Solution
Overvoltage occurred on the control circuit of the drive.	Measure whether the input voltage in the control circuit cable is within the following range: 220 V servo drive: Value range: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Value range: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V) Check whether control circuit cables are connected properly and whether the voltage of control circuit cables (L1C, L2C) is within the specified range.	Re-connect or replace the cables.

- E920.0: External braking resistor overload

  Cause:

  The accumulative heat of the braking resistor exceeds the set value.

Cause	Troubleshooting	Solution
1. The external braking resistor is connected improperly or disconnected.	Remove the external braking resistor and measure whether its resistance is "∞" (infinite). Measure whether the resistance between terminals P⊕ and C is "∞" (infinite).	Replace with a new external braking resistor. If the resistance measured is the same as the nominal value, connect the external braking resistor between terminals P ⊕ and C.
		Connect the external braking resistor between terminals P ⊕ and C with a proper cable.
2. The jumper between terminals P ⊕ and D is shorted or disconnected when the built-in braking resistor is used.	Measure whether the resistance between terminals P ⊕ and D is "∞" (infinite).	Ensure terminals P ⊕ and D are jumpered.

Cause	Troubleshooting	Solution
3. H02.25 (Braking resistor type) is set improperly when an external braking resistor is used.	• View the setpoint of H02.25. • Check whether the resistance of the external braking resistor connected between P ⊕ and C is too large by comparing it with the value listed in Table "Specifications of the braking resistor". • Check whether the value of H02.27 is larger than the resistance of the external braking resistor between terminals P ⊕ and C.	Set H02.25 according to section “Wiring and Setting of Braking Resistor” in SV680-INT Series Servo Drive Hardware Guide. H02.25 = 1 (external, naturally ventilated) H02.25 = 2 (external, forced-air cooling)
4. The resistance of the external braking resistor is too large.		Select a proper braking resistor according to section "Specifications of the Braking Resistor" in SV680-INT Series Servo Drive Hardware Guide.
5. The setpoint of H02.27 (Resistance of external braking resistor) is higher than the resistance of the external braking resistor used.		Set H02.27 according to the resistance of the external braking resistor used.
6. The input voltage of the main circuit is beyond the specified range.	Check whether the input voltage of the main circuit cable on the drive side is within the following range: • 200 V servo drive:Value range: 200 V to 240 VAllowable deviation: –10% to +10% (198 V to 242 V) • 400 V servo drive:Value range: 400 V to 440 VAllowable deviation: –10% to +10% (342 V to 484 V)	Replace or adjust the power supply according to the specified range.

Cause	Troubleshooting	Solution
7. The load moment of inertia ratio is too large.	Perform moment of inertia auto-tuning according to section "Inertia auto-tuning" in SV680-INT Series Servo Drive Function Guide. Or calculate the total mechanical inertia based on mechanical parameters. Check whether the actual load inertia ratio exceeds 30.	• Select an external braking resistor with large capacity and set H02.26 (Power of the external braking resistor) to a value consistent with the actual power. • Select a servo drive with large capacity. • Reduce the load if allowed. • Increase the acceleration/ deceleration time if allowed. • Increase the motor operation cycle if allowed.
8. The motor speed is excessively high and deceleration is not done within the set time. The motor is in the continuous deceleration status during cyclic operation.	View the motor speed curve in cycle running and check whether the motor is in deceleration status for a long period.	
9. The capacity of the servo drive or the braking resistor is insufficient.	View the motor's single cycle speed curve and calculate whether maximum braking energy can be absorbed completely.	
10. The servo drive is faulty.	-	Replace the servo drive.

- E921.0: Dynamic brake resistor overload alarm
  Cause:

  The dynamic braking resistor is close to overload.

Cause	Troubleshooting	Solution
The accumulative heat of the dynamic braking resistor is close to the maximum thermal capacity of the resistor.	Check whether the value of H0b.98 exceeds 70%.	Ensure that the motor cannot be driven reversely in the dynamic braking state.

- E922.0: Resistance of the external braking resistor too small
  Cause:

  The value of H02.27 (resistance of external braking resistor) is lower than the value of H02.21 (permissible min. resistance of external braking resistor).

Cause	Troubleshooting	Solution
When an external braking resistor is used (H02.25 = 1 or 2), the resistance of this resistor is lower than the minimum resistance allowed by the servo drive.	Measure whether the resistance of the external braking resistor between terminals P ⊕ and C is lower than the value of H02.21 (Permissible minimum resistance of braking resistor).	• If yes, replace with an external braking resistor that matches the drive, set H02.27 to a value consistent with the resistance of this resistor, and connect this resistor between terminals P ⊕ and C. • If not, set H02.27 to a value consistent with the resistance of the external braking resistor used.

- E924.0: Regenerative transistor overtemperature
  Cause:

  The estimated temperature of the regenerative transistor is higher than H0A.49 (discharge overtemperature threshold).

Cause	Troubleshooting	Solution
1. The junction temperature of the regenerative transistor is too high. 2. The regenerative transistor will be turned off automatically after overload occurs.	The regenerative transistor temperature exceeds the threshold defined by H0A.49.	Control the working conditions and usage of the regenerative transistor.

- E940.0: Change of controlled motor is detected. It is recommended to restore factory settings before use
  Cause:

  Change of controlled motor is detected. It is recommended to restore factory settings before use

Cause	Troubleshooting	Solution
It is detected that the control type of the controlled motor has changed (for example, changing from rotary servo motor control to linear motor control). To ensure the normal functions and thresholds of the drive, it is recommended to restore the factory settings before use. The alarm is raised only once.	Check whether the value of H00.00 is changed.	It is recommended to restore the factory settings before use when any change is made in the controlled motor. You can also maintain the original parameter settings.

- E941.0: Parameter modifications activated at next power-on
  Cause:

  When the parameter effective mode of the drive is set to "Re-power-on", after the parameter value is changed, the servo drive prompts the user to power on again.

Cause	Troubleshooting	Solution
The parameters modified are those whose "Effective time" is "Next power-on".	Check whether parameters you modified are those whose "Effective Time" is "Next power-on".	Power off and on the servo drive again.

- E942.0: Parameter saved frequently
  Cause:

  The number of parameters modified at a time exceeds 700.

Cause	Troubleshooting	Solution
Too many parameters are modified and saved to EEPROM at a brief interval.	Check whether parameters are modified through the host controller at a brief interval.	Check the operation mode. For parameters that need not be saved to EEPROM, set H0E.01 to the correct value before the host controller perform write operation.

- E950.0: Forward overtravel alarm
  Cause:

  The logic of the DI allocated with FunIN.14: P-OT (positive limit switch) is valid.

Cause	Troubleshooting	Solution
1. The logic of the DI assigned with FunIN.14 (P-OT function 14, positive limit switch) is effective.	Check whether a certain DI in group H03 is assigned with FunIN.14. Check whether the logic of DI corresponding to the bit of H0b.03 (Monitored DI status) is effective.	Check the running mode. On the prerequisite of safety, send a reverse command or rotate the motor to deactivate the logic of the DI terminal allocated with DI function 14.
2. The servo position feedback reaches the positive software position limit.	Check whether the position feedback (H0b.17) is close to the value of H0A.41. Check whether the software position limit is set in H0A.40.	Ensure the servo drive references are proper, allowing the load travel range to be within the software position limit.

- E952.0: Reverse overtravel alarm
  Cause:

  The logic of the DI allocated with FunIN.15: N-OT (negative limit switch) is valid.

Cause	Troubleshooting	Solution
1. The logic of the DI assigned with FunIN.15 is effective.	Check whether a certain DI in group H03 is assigned with FunIN.15. Check whether the logic of DI corresponding to the bit of H0b.03 (Monitored DI status) is effective.	Check the operation mode. On the prerequisite of ensuring safety, send a forward run command or rotate the motor to deactivate the logic of DI assigned with FunIN.15.
2. The servo position feedback reaches the negative software position limit.	Check whether the position feedback (H0b.17) is close to the value of H0A.43. Check whether the software position limit is set in H0A.40.	Ensure the servo drive references are proper, allowing the load travel range to be within the software position limit.

- E954.0: Position command overflow
  Cause:

  Position reference overflow.

Cause	Troubleshooting	Solution
in PR mode, the position command is beyond the limit.	1. Check the position command. 2. Check the limit value.	Change the value of the position command and the limit.

- E956.0: Forward position reference overtravel in process segment position mode
  Cause:

  Forward position reference overtravel occurs in the process segment position mode.

Cause	Troubleshooting	Solution
Forward position reference overtravel occurs in the process segment position mode.	E956.0 occurs when the position reference exceeds the value of H22.04 when the motor runs forwardly in the process segment position mode.	Reduce the position reference to a value lower than the setpoint of H22.04.

- E958.0: Reverse position reference overtravel in process segment position mode
  Cause:

  Reverse direction position reference overtravel occurs in the process segment position mode.

Cause	Troubleshooting	Solution
Reverse position reference overtravel occurs in the process segment position mode.	E958.0 occurs when the position reference is less than the value of H22.06 when the motor runs reversely in the process segment position mode.	Increase the position reference to a value greater than the setpoint of H22.06.

- E971.0: Undervoltage alarm for voltage drop protection
  Cause:

  The bus voltage is lower than the undervoltage threshold. This alarm can be masked by setting bit1 of H0A.88 to 1.

Cause	Troubleshooting	Solution
The bus voltage is lower than the undervoltage threshold.	Check the bus voltage. This alarm can be masked by setting bit1 of H0A.88 to 1.	Check the power supply.

- E980.0: Frequency division output overflow
  Cause:

  Frequency division output overflow.

Cause	Troubleshooting	Solution
The frequency division output is too large. Calculation overflows.	Check if an E510.0 alarm has occurred and set H05.17 to a proper value so that E510.0 disappears.	Set H05.17 to a proper value or reduce the maximum operating speed.

- EA34.9: Hall is not configured
  Cause:

  Hall is not configured.

Cause	Troubleshooting	Solution
H00.26 is configured when dynamic Hall auto-tuning is enabled.	1. When 1.H0A.13 = 6, check whether bit3 of H00.26 is set to 1. 2. For a non-Hall sensor (bit3 of H00.26 is set to 0), check whether H0A.13 is set to 6 incorrectly.	1. For a Hall-enabled motor, you need to perform Hall auto-tuning (H0A.13=6) and set bit3 of H00.26 to 1. 2. For a non-Hall motor, Hall auto-tuning is unavailable (H0A.13 cannot be set to 6).

- EA41.0: Torque ripple compensation failure
  Cause:

  Torque ripple compensation failure.

Cause	Troubleshooting	Solution
Auto-tuning torque fluctuation compensation failure	1. Check whether homing is not performed during cogging torque ripple auto-tuning of the incremental encoder. 2. Confirm whether emergency stop or external fault interruption occurs during cogging torque ripple auto-tuning. 3. Torque ripple compensation auto-tuning failed. Please try again.	1. Perform homing during cogging torque ripple auto-tuning of the incremental encoder. 2. Avoid emergency stop or external fault interruption during cogging torque ripple auto-tuning. 3. Torque ripple compensation auto-tuning failed. Please try again.

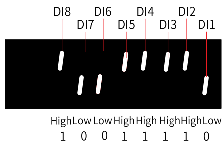
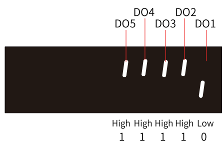
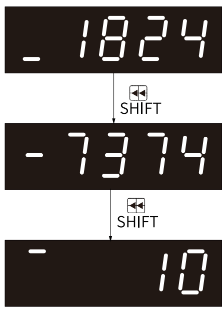
9 Appendix

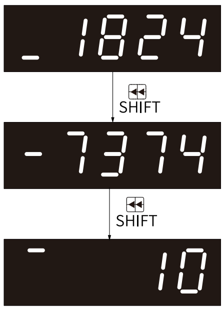
9.1 Display of Monitoring Parameters

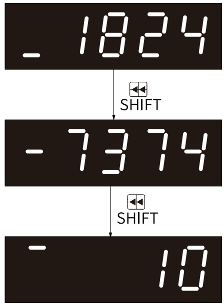
- Group H0b: Displays parameters used to monitor the operating state of the servo drive.
- Set H02.32 (Default keypad display) properly. After the motor operates normally, the keypad switches from status display to parameter display. The parameter group number is H0b and the offset within the group is the setpoint of H02.32.
- For example, if H02.32 is set to 00 and the motor speed is not 0 rpm, the keypad displays the value of H0b.00.

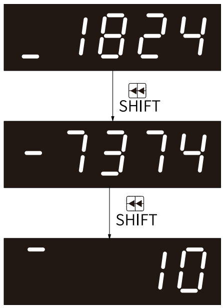
The following table describes the monitoring parameters in group H0b.

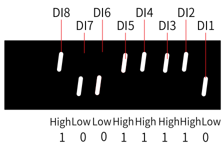
Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.00	Motor speed actual value	1	[mm/s]/[rpm]	Display the motor speed actual value.	3000 [mm/s]/[rpm] is displayed as:  -3000 [mm/s]/[rpm] is displayed as: 
H0b.01	Speed reference	1	[mm/s]/[rpm]	Indicates the present speed reference of the drive in the position and speed control modes.	3000 [mm/s]/[rpm] is displayed as:  -3000 [mm/s]/[rpm] is displayed as: 
H0b.02	Internal torque reference	0.1	%	Display the present torque reference. The setpoint 100.0% corresponds to the rated torque of the motor.	Display of 100.0%:  Display of -100.0%: 

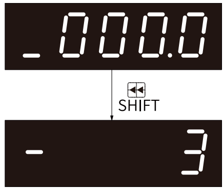
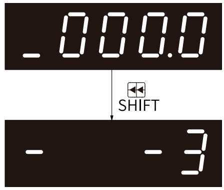
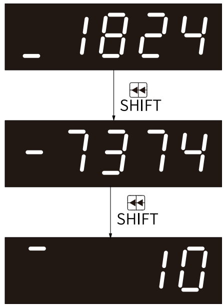
Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.03	Input (DI) signal monitoring	1	-	Displays the optocoupler status of DI terminals: When the upper LED turns on, the optocoupler is disabled (indicated by "1"). Lower LED segments turned on: The optocoupler is switched on (indicated by "0"). The value of H0b.03 read in the software tool is a decimal.	For example, if DI1 is low level and DI2 to DI8 are high level, the corresponding binary value is "10011110", and the value of H0b.03 read in the software tool is 158. Display on the operating panel: 
H0b.05	Output (DO) signal monitoring	1	-	Displays the optocoupler status of DO1 to DO5: When the upper LED turns on, the optocoupler is disabled (indicated by "1"). Lower LED segments turned on: The optocoupler is switched on (indicated by "0"). The value of H0b.05 read in the software tool is a decimal.	For example, if DO1 is low level and DO2 to DO5 are high level, then, the binary value is "11110". The value of H0b.05 read in the software tool is 30. Display on the operating panel: 
H0b.07	Absolute position counter	1	Reference unit	It indicates the present absolute position of the motor (in reference unit).	Display of 1073741824 in reference unit: 

Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.09	Mechanical angle	0.1	°	Indicates the current mechanical angle (p) of the motor. The value 0 indicates that the mechanical angle is 0°. Maximum value of H0b.09 for an incremental encoder: Number of encoder pulses per revolution x 4 - 1. For example, the maximum value of H0b.09 for a 2500-PPR incremental encoder is 9999. Maximum value of H0b.09 for an absolute encoder is 65535. The actual mechanical angle is calculated using the following formula: $\text{Actual mechanical angle} = \frac{\text{H0b.09}}{\text{Max. value of H0b.09} + 1} \times 360.0°$	Display of 10000p: 
H0b.10	Electrical angle	0.1	°	Display the electrical angle of the motor.	Display of 360.0°: 
H0b.12	Average load ratio	0.1	%	Displays the ratio of the average load torque to the rated torque of the motor.	Display of 100.0%: 
H0b.13	Input position reference counter (32-bit decimal)	1	Reference unit	Counts and displays the number of input position references.	Display of 1073741824 in reference unit: 
H0b.15	Encoder position deviation counter (32-bit decimal)	1	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: 

Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.17	Feedback pulse counter (32-bit decimal)	1	Encoder unit	Counts and displays the number of pulses fed back by the motor encoder (encoder unit).	Display of 1073741824 in encoder unit: 
H0b.19	Total power-on time (32-bit decimal)	0.1	s	Counts and displays the total power-on time of the servo drive.	Display of 429496729.5s: 
H0b.24	Phase current RMS value	0.1	A	Displays the RMS value of the phase current of the motor.	Display of 4.60 A: 
H0b.26	Bus voltage	0.1	V	Displays the DC bus voltage of the main circuit input voltage after rectification.	Display of 311.0 V rectified from 220 VAC:  Display of 537.0 V rectified from 380 VAC: 
H0b.27	Module temperature	1	°C	Displays the temperature of the power module inside the servo drive.	Display of 27°C: 

Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.33	Fault log	1	-	Used to select the previous fault to be viewed. 0: Present fault 1: 2nd last fault 2: 3rd last fault ... 19: 20th last fault	0: Display of present fault: 
H0b.34	Fault code of the selected fault	1	-	Display the fault code of the selected fault. When no fault occurs, the value of H0b.34 is 0.	If H0b.33 is 0, and H0b.34 is E941.0, the current fault code is 941.0. Corresponding display: 
H0b.35	Timestamp of the selected fault	0.1	s	Displays the total operating time of the servo drive when the fault displayed in H0b.35 occurred. When no fault occurs, the value of H0b.35 is 0.0.	If H0b.34 is E941.0 and H0b.35 is 1073741824, the current fault code is 941 and the total operating time of the servo drive is 1073741824s when the fault occurs. 
H0b.37	Motor speed upon occurrence of the selected fault	1	[mm/s]/[rpm]	Displays the speed of the motor when the fault displayed in H0b.37 occurred. When no fault occurs, the value of H0b.37 is 0.	3000 [mm/s]/[rpm] is displayed as:  -3000 [mm/s]/[rpm] is displayed as: 

Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.38	Motor phase U current upon occurrence of the selected fault	0.1	A	Displays the RMS value of motor phase U winding current when the fault displayed in H0b.38 occurred. When no fault occurs, the value of H0b.38 is 0.0.	Display of 4.60 A: 
H0b.39	Motor phase V current upon occurrence of the selected fault	0.1	A	Display the RMS value of motor phase V winding current when the fault displayed in H0b.39 occurred. When no fault occurs, the value of H0b.39 is 0.0.	Display of 4.60 A: 
H0b.40	Bus voltage upon occurrence of the selected fault	0.1	V	Display the DC bus voltage of the main circuit when the fault displayed in H0b.40 occurred. When no fault occurs, the value of H0b.40 is 0.0.	Display of 311.0 V rectified from 220 VAC:  Display of 537.0 V rectified from 380 VAC: 
H0b.41	Input terminal state on selected fault	1	-	Display the high/low level status of DI1 to DI8 when the fault displayed in H0b.41 occurred. The method for determining the DI level status is the same as that of H0b.03. When no fault occurs, all DIs are displayed as low level in H0b.41 (indicated by the decimal value 0).	Display of H0b.41 = 158: 
H0b.53	Position deviation counter (32-bit decimal)	1	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: 

Parameter	Name	Accuracy	Unit	Meaning	Example
H0b.55	Motor speed actual value	0.1	[mm/s]/[rpm]	Display the motor speed actual value.	3000.0 [mm/s]/[rpm] is displayed as:  -3000.0 [mm/s]/[rpm] is displayed as: 
H0b.64	Real-time input position reference counter	1	Reference unit	Displays the value of the position reference counter before being divided or multiplied by the electronic gear ratio. This value is independent of the servo drive status and the control mode.	Display of 1073741824 in reference unit: 

9.2 DIDO Function Assignment [P]

Code	Name	Function Name	Description	Remarks
Description of DI Signals				
FunIN.1	S-ON	Servo ON	Disabled: Servo motor disabled Enabled: Servo motor enabled	The corresponding terminal logic must be level-triggered. The change of the corresponding DI/VDI or terminal logic is activated at next power-on.

Code	Name	Function Name	Description	Remarks
FunIN.2	ALM-RST	Alarm reset signal	Inactive: Disabled Active: Enabled	Edge-triggered will be applied even if level-triggered is selected. To reset No. 1 and NO.2 resettable faults, switch off the S-ON signal first. The servo drive may, depending on the alarm type, continue running after reset.
FunIN.3	GAIN-SEL	Gain switchover switch	● H08.08 = 0: ● Inactive: Speed control loop being PI control ● Active: Speed control loop being P control ● When H08.08 = 1, and H08.09 = 1: ● Inactive: Fixed to the 1st group of gains ● Active: Fixed to the 2nd group of gains	The corresponding terminal logic is recommended to be level-triggered.
FunIN.4	CMD-SEL	Main/Auxiliary reference switchover	Inactive: Current reference being A Active: Current reference being B	The corresponding terminal logic is recommended to be level-triggered.
FunIN.5	DIR-SEL	Multi-reference direction	Inactive: Reference direction by default Active: Reverse to reference direction.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.6	CMD1	Multi-reference switchover CMD1	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.7	CMD2	Multi-reference switchover CMD2	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.8	CMD3	Multi-reference switchover CMD3	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.9	CMD4	Multi-reference switchover CMD4	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.10	M1-SEL	Mode switchover M1-SEL	Used to perform switchover between speed control, position control, and torque control based on the selected control mode (values 3, 4, 5 of H02-00).	The corresponding terminal logic is recommended to be level-triggered.
FunIN.11	M2-SEL	Mode switchover M2-SEL	Used to perform switchover between speed control, position control, and torque control based on the selected control mode (value 6 of H02-00).	The corresponding terminal logic is recommended to be level-triggered.

Code	Name	Function Name	Description	Remarks
FunIN.12	ZCLAMP	Zero clamp enable	Active: Zero clamp enabled Inactive: Zero clamp disabled	The corresponding terminal logic is recommended to be level-triggered. ● When H06.15 is set to 100 or above, zero clamp is performed when the speed is lower than H06.15. The movement is triggered again only when the speed command is greater than (H06.15) + 20 RPM. ● When H06.15 is set to below 100, zero clamp is performed when the speed is lower than H06.15. The movement is triggered again only when the speed command is greater than (H06.15) + 10 RPM.
FunIN.13	INHIBIT	Position reference inhibited	Active: Pulse reference input inhibited Inactive: Pulse reference input allowed	It is originally pulse inhibit. The position references include internal and external position references. The corresponding terminal logic must be level-triggered.
FunIN.14	P-OT	Positive limit switch	Active: Forward drive inhibited Inactive: Forward drive permitted	Overtravel prevention applies when the machine moves beyond the limit. It is recommended that the corresponding terminal logic is level-triggered.
FunIN.15	N-OT	Negative limit switch	Overtravel prevention applies when the load moves beyond the limit. Active: Reverse drive inhibited Inactive: Reverse drive allowed	The corresponding terminal logic is recommended to be level-triggered.
FunIN.16	P-CL	Positive external torque limit	The torque limit source is switched based on H07.07 (Torque limit source). H07.07 = 1: Active: Positive external torque limit activated Inactive: Positive internal torque limit activated	The corresponding terminal logic is recommended to be level-triggered.
FunIN.17	N-CL	Negative external torque limit	The torque limit source is switched based on H07.07 (Torque limit source). H07.07 = 1: Active: Negative external torque limit activated Inactive: Negative internal torque limit activated	The corresponding terminal logic is recommended to be level-triggered.

Code	Name	Function Name	Description	Remarks
FunIN.18	JOGCMD+	Forward jog	Active: Input based on command Inactive: Command input stopped	The corresponding terminal logic is recommended to be level-triggered.
FunIN.19	JOGCMD–	Reverse jog	Active: Input in reverse to the command Inactive: Command input stopped	The corresponding terminal logic is recommended to be level-triggered.
FunIN.20	POSSTEP	Step reference	Active: Execute step reference set in H05-05, servo motor running Inactive: Servo motor in locked state	The corresponding terminal logic is recommended to be level-triggered.
FunIN.21	HX1	Hand wheel override signal 1	HX1 active, HX2 inactive: X10. HX1 inactive, HX2 active: X100. Other: X1.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.22	HX2	Hand wheel override signal 2		
FunIN.23	HX_EN	Handwheel enable signal	Inactive: Execute position control as defined by H05-00. Active: Execute position control based on handwheel signal in position mode	The corresponding terminal logic is recommended to be level-triggered.
FunIN.24	GEAR_SEL	Electronic gear ratio switchover	Inactive: Electronic gear ratio 1 Active: Electronic gear ratio 2	The corresponding terminal logic is recommended to be level-triggered.
FunIN.25	TOQDirSel	Torque reference direction	Inactive: Forward. Active: Reverse	The corresponding terminal logic is recommended to be level-triggered.
FunIN.26	SPDDirSel	Speed reference direction	Inactive: Forward. Active: Reverse	The corresponding terminal logic is recommended to be level-triggered.
FunIN.27	POSDirSel	Position reference direction	Inactive: Actual position reference direction same as the set direction Active: Actual position reference direction opposite to the set direction	The corresponding terminal logic is recommended to be level-triggered.
FunIN.28	PosInSen	Multi-position reference enable	Inactive: The reference is ineffective. Active: The reference is enabled.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.29	XintFree	Interruption fixed length cleared	Inactive: Disabled Active: Enabled	-

Code	Name	Function Name	Description	Remarks
FunIN.31	HomeSwitch	Home switch	Inactive: The switch is not triggered Active: The switch is triggered.	The corresponding terminal logic must be level-triggered. It is recommended to assign this function to a high-speed DI terminal. If the logic is set to 2 (rising edge active), the servo drive forcibly changes it to 1 (active high). If the logic is set to 3 (falling edge active), the servo drive forcibly changes it to 0 (active low). If the logic is set to 4 (both rising edge and falling edge active), the servo drive forcibly changes it to 0 (low level active).
FunIN.32	HomingStart	Homing enable	Inactive: Disabled Active: Enabled	-
FunIN.33	XintInhibit	Interrupt positioning inhibited	Active: Interrupt positioning inhibited. Inactive: Interrupt positioning allowed.	The corresponding terminal logic must be level-triggered. • If the logic is set to 2 (rising edge active), the servo drive forcibly changes it to 1 (active high). • If the logic is set to 3 (falling edge active), the servo drive forcibly changes it to 0 (active low). • If the logic is set to 4 (both rising edge and falling edge active), the servo drive forcibly changes it to 0 (low level active).
FunIN.34	Emergence Stop	Emergency stop	Active: Position lock is applied after stop at zero speed. Inactive: Current operating state is unaffected.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.35	ClrPosErr	Position deviation cleared	Active: Clear the position deviation Inactive: Do not clear the position deviation	It is recommended to assign this function to DI8 or DI9.
FunIN.36	V_LmtSel	Internal speed limit source	Inactive: H07.19 used as positive/negative internal speed limit Active: H07.20 used as positive/negative internal speed limit	The corresponding terminal logic is recommended to be level-triggered.
FunIN.37	PulseInhibit	Pulse reference inhibited	When the position reference source is pulse reference (H05.00 = 0) in the position control mode: Inactive: Respond to pulse references Active: Not respond to pulse references	The corresponding terminal logic is recommended to be level-triggered.

Code	Name	Function Name	Description	Remarks
FunIN.38	TouchProbe1	Touch probe 1	Inactive: Touch probe is not triggered. Active: Touch probe is triggerable.	The touch probe logic is only related to the touch probe function (60B8h).
FunIN.39	TouchProbe2	Touch probe 2	Inactive: Touch probe is not triggered. Active: Touch probe is triggerable.	The touch probe logic is only related to the touch probe function (60B8h).
FunIN.40	Multi-speed	Multi-speed enable	Inactive: The internal multi-speed reference is ineffective. Active: The internal multi-speed reference is enabled.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.41	HomeRecord	Present position as the home	Inactive: The switch is not triggered Active: Triggered	The corresponding terminal logic is recommended to be level-triggered.
FunIN.42	MultiBlockTrig	Axis control command executed immediately	Inactive: Do not execute Active: Execute immediately	-
FunIN.43	MultiBlockWr	Axis control command not executed immediately	Inactive: Do not execute Active: Execute (not immediately)	-
FunIN.44	ClrCmdOkAndArrOk	Positioning and reference completed signal cleared	Inactive: No operation Active: Clear	-
FunIN.45	XintEn	Interrupt positioning selection	Inactive: Disabled Active: Enabled	-
FunIN.46	PrEnable	Technology segment enable	Inactive: Stop technology segment Active: Start technology segment	The corresponding terminal logic is recommended to be level-triggered.
FunIN.47	PrCMD1	Technology segment command switchover 1	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.
FunIN.48	PrCMD2	Technology segment command switchover 2	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.
FunIN.49	PrCMD3	Technology segment command switchover 3	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.
FunIN.50	PrCMD4	Technology segment command switchover 4	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.

Code	Name	Function Name	Description	Remarks
FunIN.51	PrEvent1	Event trigger technology segment 1	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.52	PrEvent2	Event trigger technology segment 2	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.53	PrEvent3	Event trigger technology segment 3	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.54	PrEvent4	Event trigger technology segment 4	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.55	PrSuspend	Process segment suspend	Inactive: Continue the already enabled technology segment. Active: Suspend the technology segment	The corresponding terminal logic is recommended to be level-triggered.
FunIN.56	GantryTrqAlignEnable	Gantry torque alignment	Inactive: Disabled Active: Enabled	-
FunIN.57	Gantry-DI-AlignClear	Gantry DI alignment	Inactive: Disabled Active: Enabled	-
FunIN.58	Gantry-DI-AlignEnable	Gantry DI alignment clear	Inactive: Disabled Active: Enabled	-
FunIN.59	GantrySyncEnable	Gantry sync enable	Inactive: Disabled Active: Enabled	-
Description of DO signals				
FunOUT.1	S-RDY	Ready to switch on	The servo drive is ready to receive the S-ON signal. Inactive: The servo drive not ready. Active: The servo drive is ready.	-
FunOUT.2	TGON	Motor rotation signal	Inactive. Absolute value of filtered motor speed is lower than the setpoint of H06.16. Active. Absolute value of filtered motor speed reaches the setpoint of H06.16.	-

Code	Name	Function Name	Description	Remarks
FunOUT.3	ZERO	Zero speed signal	Inactive: Difference between motor speed feedback and reference value larger than H06.19 (Threshold of zero speed output signal) Active: The difference between the motor speed feedback and the reference value is within the threshold defined by H06.19.	-
FunOUT.4	V-CMP	Speed matching signal	Active when the absolute value of the difference between the motor speed and the speed reference lower than H06.17 (Threshold of V-Cmp signal) in the speed control mode	-
FunOUT.5	COIN	Positioning completed	Inactive: Positioning not completed Active: Positioning completed	-
FunOUT.6	NEAR	Proximity	Inactive: large positioning deviation Active: position deviation near	-
FunOUT.7	C-LT	Torque limited signal	Confirming torque limit: Active: Servo drive torque reference reaching the torque limit value and restricted to this value Inactive: Servo drive torque reference not reaching the torque limit value	-
FunOUT.8	V-LT	Velocity limited signal	Confirming speed limit in torque control: Active: Motor speed limited Inactive: Motor speed unlimited	-
FunOUT.9	BK	Brake	Active - Brake signal is output. Disabled - Brake signal not output.	-
FunOUT.10	WARN	Alarm	Inactive - The servo drive issued no alarm or the alarm has been reset. Active - The servo drive issued an alarm.	-
FunOUT.11	ALM	Fault	The servo drive is faulty. Inactive - No fault occurred on the servo drive or the fault has been reset.	-

Code	Name	Function Name	Description	Remarks
FunOUT.15	Xintcoin	Interrupt positioning completed	Active: Interrupt positioning completed Invalid: Interruption fixed length not completed	-
FunOUT.16	HomeAttain	Homing is completed.	Homing state: Active: Homing completed in the position control mode Inactive: Homing not completed	-
FunOUT.17	ElecHome Attain	Electrical homing completed	Electrical homing state: Active: Electrical homing completed Inactive: Electrical homing not completed	-
FunOUT.18	ToqReach	Torque reached signal	Active: Absolute value of torque reference reached setpoint Inactive: Absolute value of torque reference smaller than setpoint	-
FunOUT.19	V-Arr	Speed reached signal	Active: Speed feedback reaches setpoint Inactive: Speed feedback smaller than setpoint	-
FunOUT.21	SrvOn	Enable completed	Active: Enable completed. Inactive: Enable not completed.	-
FunOUT.22	CmdOk	Internal command completed	Inactive: Internal command transmit not completed. Active: Internal command transmit completed.	-
FunOUT.23	WrNextBlockEn	Command input	Active: Writing the next segment allowed. Inactive: Writing the next segment inhibited.	-
FunOUT.24	MC_OK	Internal motion completed	Inactive: Internal command transmit or positioning not completed. Active: Internal command transmit and positioning completed.	-
FunOUT.25	CMP	Comparison DO	Inactive: The servo drive did not pass the target position comparison point. Active: The servo drive passed the target position comparison point.	-

Code	Name	Function Name	Description	Remarks
FunOUT.26	LoopState	Closed loop state	0: Semi-closed-loop Position feedback signals come from the built-in encoder of the servo motor. 1: Full closed-loop Position feedback signals come from the full closed-loop external encoder.	-
FunOUT.27	LEFTLIMT	Left limit	Inactive: The drive is not at the left limit. Active: The drive is at the left limit.	Only Inovance DDL communication reading head supports this feature.
FunOUT.28	RIGHTLIMT	Right limit	Inactive: The drive is not at the right limit. Active: The drive is at the right limit.	Only Inovance DDL communication reading head supports this feature.
FunOUT.30	WARN OR ALM	Warning or fault output	Active: An alarm or fault is present. Inactive: No warning or fault.	-
FunOUT.31	Communication-forced DO		See *"Table 9–1 Communication forced DO wire breakage output" on page 679*. .	-
FunOUT.32	EDM	EDM output	Active - STO is triggered Inactive - STO is not triggered	The EDM outputs active signals only when both the 24 V input voltages for STO1 and STO2 are disconnected.
FunOUT.33	GantryAlignStatus	Gantry alignment	Inactive: Not aligned Active: Aligned	-

Table 9–1 Communication forced DO wire breakage output

Type	Data	Description
bit0	0	Maintain DO1 output
	1	DO1 output prohibited
bit1	0	Maintain DO2 output
	1	DO2 output prohibited
bit2	0	Maintain DO3 output
	1	DO3 output prohibited
bit3	0	Maintain DO4 output
	1	DO4 output prohibited
bit4	0	Maintain DO5 output
	1	DO5 output prohibited

9.3 DIDO Function Assignment [N]

Code	Name	Function Name	Description	Remarks
Description of DI Signals				
FunIN.1	S-ON	Servo ON	Disabled: Servo motor disabled Enabled: Servo motor enabled	The corresponding terminal logic must be level-triggered. The change of the corresponding DI/VDI or terminal logic is activated at next power-on.
FunIN.2	ALM-RST	Alarm reset signal	Inactive: Disabled Active: Enabled	Edge-triggered will be applied even if level-triggered is selected. To reset No. 1 and NO.2 resettable faults, switch off the S-ON signal first. The servo drive may, depending on the alarm type, continue running after reset.
FunIN.5	DIR-SEL	Multi-reference direction	Inactive: Reference direction by default Active: Reverse to reference direction.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.6	CMD1	Multi-reference switchover CMD1	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.7	CMD2	Multi-reference switchover CMD2	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.8	CMD3	Multi-reference switchover CMD3	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.9	CMD4	Multi-reference switchover CMD4	Used to select a reference from 16 references.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.14	P-OT	Positive limit switch	Active: Forward drive inhibited Inactive: Forward drive permitted	Overtravel prevention applies when the machine moves beyond the limit. It is recommended that the corresponding terminal logic is level-triggered.
FunIN.15	N-OT	Negative limit switch	Overtravel prevention applies when the load moves beyond the limit. Active: Reverse drive inhibited Inactive: Reverse drive allowed	The corresponding terminal logic is recommended to be level-triggered.
FunIN.18	JOGCMD+	Forward jog	Active: Input based on command Inactive: Command input stopped	The corresponding terminal logic is recommended to be level-triggered.
FunIN.19	JOGCMD–	Jog in the reverse direction	Active: Input in reverse to the command Inactive: Command input stopped	The corresponding terminal logic is recommended to be level-triggered.

Code	Name	Function Name	Description	Remarks
FunIN.24	GEAR_SEL	Electronic gear ratio switchover	Inactive: Electronic gear ratio 1 Active: Electronic gear ratio 2	The corresponding terminal logic is recommended to be level-triggered.
FunIN.28	PosInSen	Multi-position reference enable	Inactive: The reference is ineffective. Active: The reference is enabled.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.31	HomeSwitch	Home switch	Inactive: The switch is not triggered Active: The switch is triggered.	The corresponding terminal logic must be level-triggered. It is recommended to assign this function to a high-speed DI terminal. If the logic is set to 2 (rising edge active), the servo drive forcibly changes it to 1 (active high). If the logic is set to 3 (falling edge active), the servo drive forcibly changes it to 0 (active low). If the logic is set to 4 (both rising edge and falling edge active), the servo drive forcibly changes it to 0 (low level active).
FunIN.34	Emergence Stop	Emergency stop	Active: Position lock is applied after stop at zero speed. Inactive: Current operating state is unaffected.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.38	TouchProbe1	Touch probe 1	Inactive: Touch probe is not triggered. Active: Touch probe is triggerable.	The touch probe logic is only related to the touch probe function (60B8h).
FunIN.39	TouchProbe2	Touch probe 2	Inactive: Touch probe is not triggered. Active: Touch probe is triggerable.	The touch probe logic is only related to the touch probe function (60B8h).
FunIN.40	Multi-speed	Multi-speed enable	Inactive: The internal multi-speed reference is ineffective. Active: The internal multi-speed reference is enabled.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.46	PrEnable	Technology segment enable	Inactive: Stop technology segment Active: Start technology segment	The corresponding terminal logic is recommended to be level-triggered.
FunIN.47	PrCMD1	Technology segment command switchover 1	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.
FunIN.48	PrCMD2	Technology segment command switchover 2	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.

Code	Name	Function Name	Description	Remarks
FunIN.49	PrCMD3	Technology segment command switchover 3	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.
FunIN.50	PrCMD4	Technology segment command switchover 4	Switchover among 16 technology segments	The corresponding terminal logic is recommended to be level-triggered.
FunIN.51	PrEvent1	Event trigger technology segment 1	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.52	PrEvent2	Event trigger technology segment 2	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.53	PrEvent3	Event trigger technology segment 3	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.54	PrEvent4	Event trigger technology segment 4	Process segment A triggered by rising edge. Process segment B triggered by falling edge.	The corresponding terminal logic is recommended to be level-triggered.
FunIN.55	PrSuspend	Process segment suspend	Inactive: Continue the already enabled technology segment. Active: Suspend the technology segment	The corresponding terminal logic is recommended to be level-triggered.
FunIN.56	GantryTrqAlignEnable	Gantry torque alignment	Inactive: Disabled Active: Enabled	-
FunIN.57	Gantry-DI-AlignClear	Gantry DI alignment	Inactive: Disabled Active: Enabled	-
FunIN.58	Gantry-DI-AlignEnable	Gantry DI alignment clear	Inactive: Disabled Active: Enabled	-
FunIN.59	GantrySyncEnable	Gantry sync enable	Inactive: Disabled Active: Enabled	-
Description of DO signals				
FunOUT.1	S-RDY	Ready to switch on	The servo drive is ready to receive the S-ON signal. Inactive: The servo drive not ready. Active: The servo drive is ready.	-
FunOUT.2	TGON	Motor rotation signal	Inactive. Absolute value of filtered motor speed is lower than the setpoint of H06.16. Active. Absolute value of filtered motor speed reaches the setpoint of H06.16.	-

Code	Name	Function Name	Description	Remarks
FunOUT.9	BK	Brake	Active - Brake signal is output. Disabled - Brake signal not output.	-
FunOUT.10	WARN	Alarm	Inactive - The servo drive issued no alarm or the alarm has been reset. Active - The servo drive issued an alarm.	-
FunOUT.11	ALM	Fault	The servo drive is faulty. Inactive - No fault occurred on the servo drive or the fault has been reset.	-
FunOUT.25	CMP	Position compare DO	Inactive: The servo drive did not pass the target position comparison point. Active: The servo drive passed the target position comparison point.	-
FunOUT.26	LoopState	Closed loop state	0: Semi-closed-loop Position feedback signals come from the built-in encoder of the servo motor. 1: Full closed-loop Position feedback signals come from the full closed-loop external encoder.	-
FunOUT.27	LEFTLIMT	Left limit	Inactive: The drive is not at the left limit. Active: The drive is at the left limit.	Only Inovance DDL communication reading head supports this feature.
FunOUT.28	RIGHTLIMT	Right limit	Inactive: The drive is not at the right limit. Active: The drive is at the right limit.	Only Inovance DDL communication reading head supports this feature.
FunOUT.31	Communication-forced DO		See *"Table 9–2 Communication forced DO wire breakage output" on page 684*. .	-
FunOUT.32	EDM	EDM output	Active - STO is triggered Inactive - STO is not triggered	The EDM outputs active signals only when both the 24 V input voltages for STO1 and STO2 are disconnected.
FunOUT.33	GantryAlignStatus	Gantry alignment	Inactive: Not aligned Active: Aligned	-

Table 9–2 Communication forced DO wire breakage output

Type	Data	Description
bit0	0	Maintain DO1 output
	1	DO1 output prohibited
bit1	0	Maintain DO2 output
	1	DO2 output prohibited

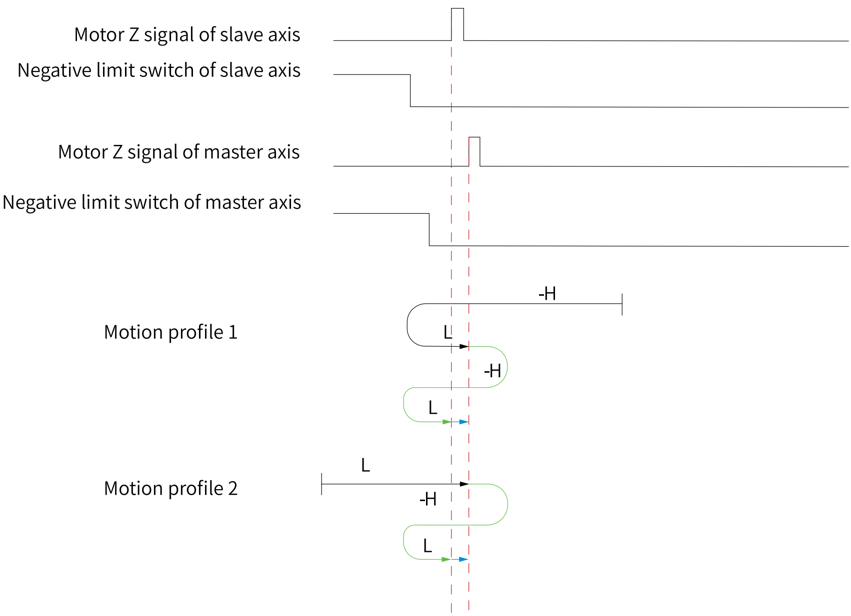
9.4 Flexible Gantry Homing Trajectory

- The black trajectory is generated by looking for the master axis home signal. The green trajectory is generated by looking for the slave axis home signal. The blue trajectory is returning to the home position of the master axis.
- When the master axis home signal is found, it begins looking for the slave axis home signal in the reverse direction at high speed.
- After the slave axis home signal is found, it continue to move to the home position of the master axis.

6098 = 1

Home: Z signal

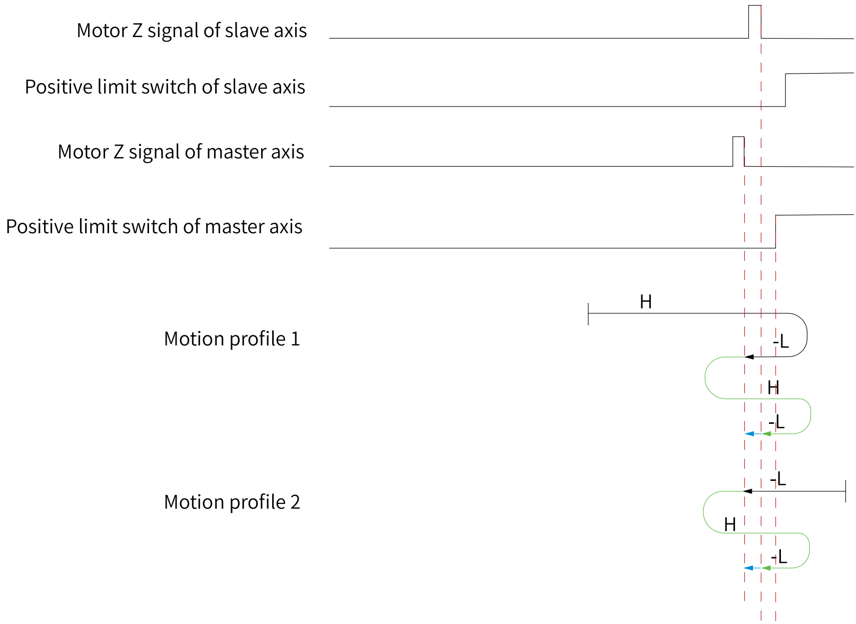
Deceleration point: negative limit switch



6098 = 2

Home: Z signal

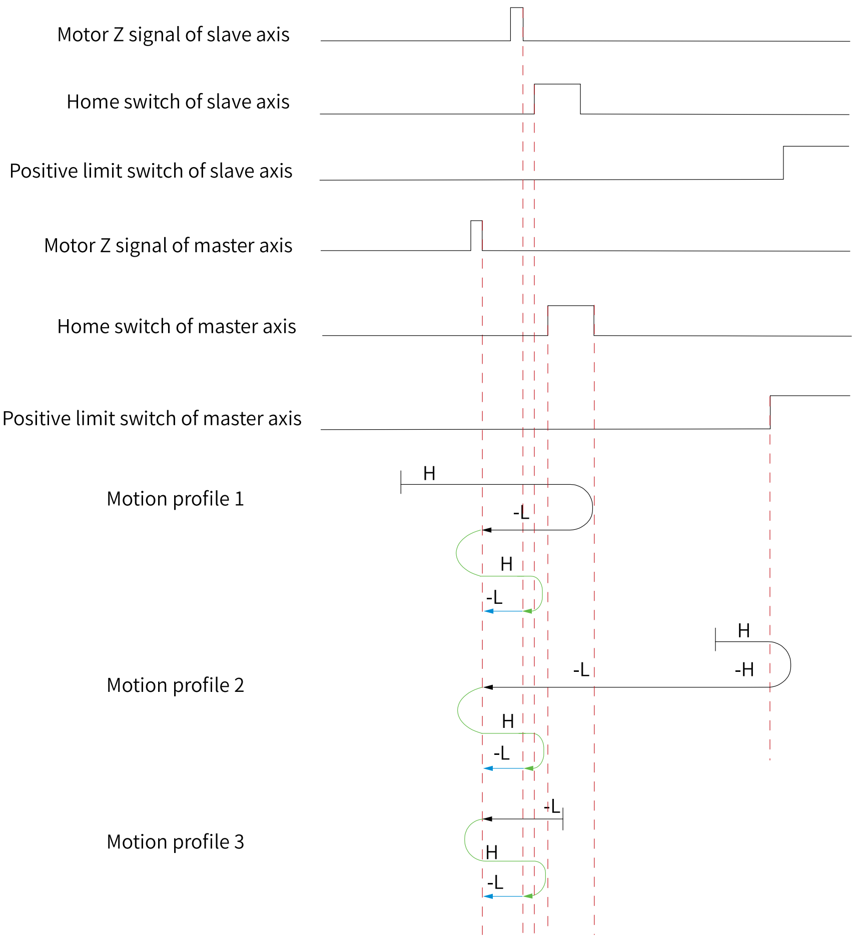
Deceleration point: positive limit switch



6098 = 7

Home: Z signal

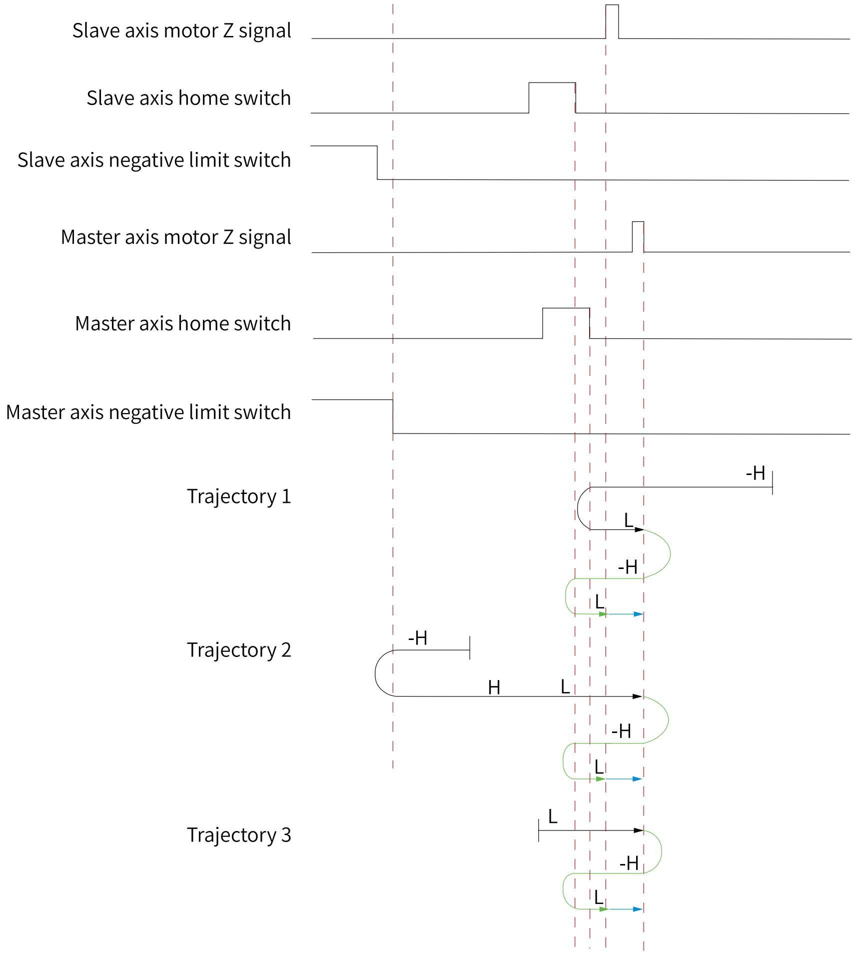
Deceleration point: home switch (HW)



6098 = 11

Home: Z signal

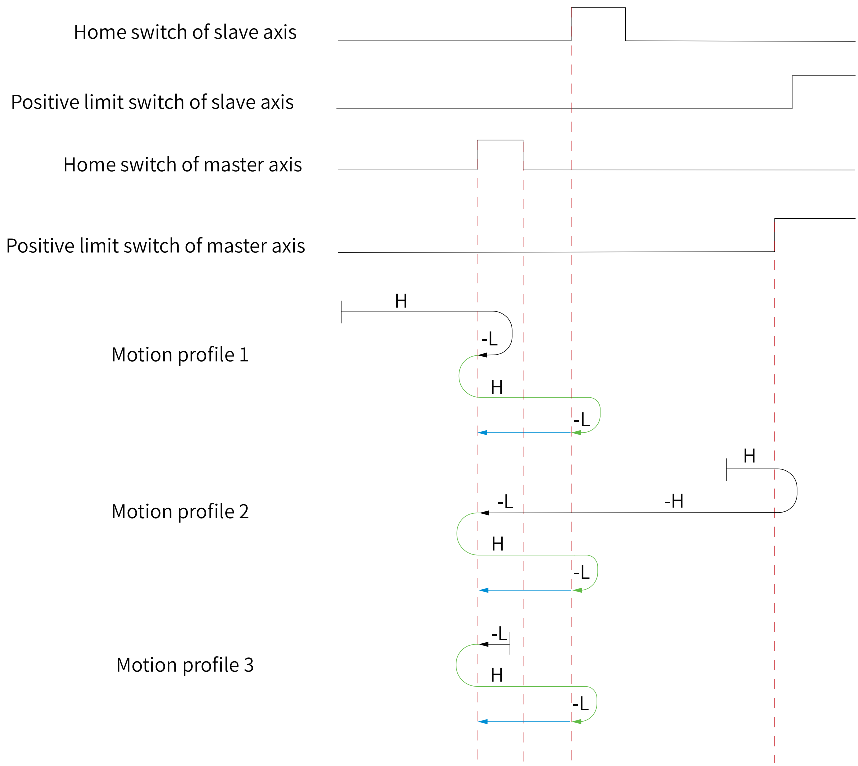
Deceleration point: home switch (HW)



6098 = 23

Home: home switch (HW)

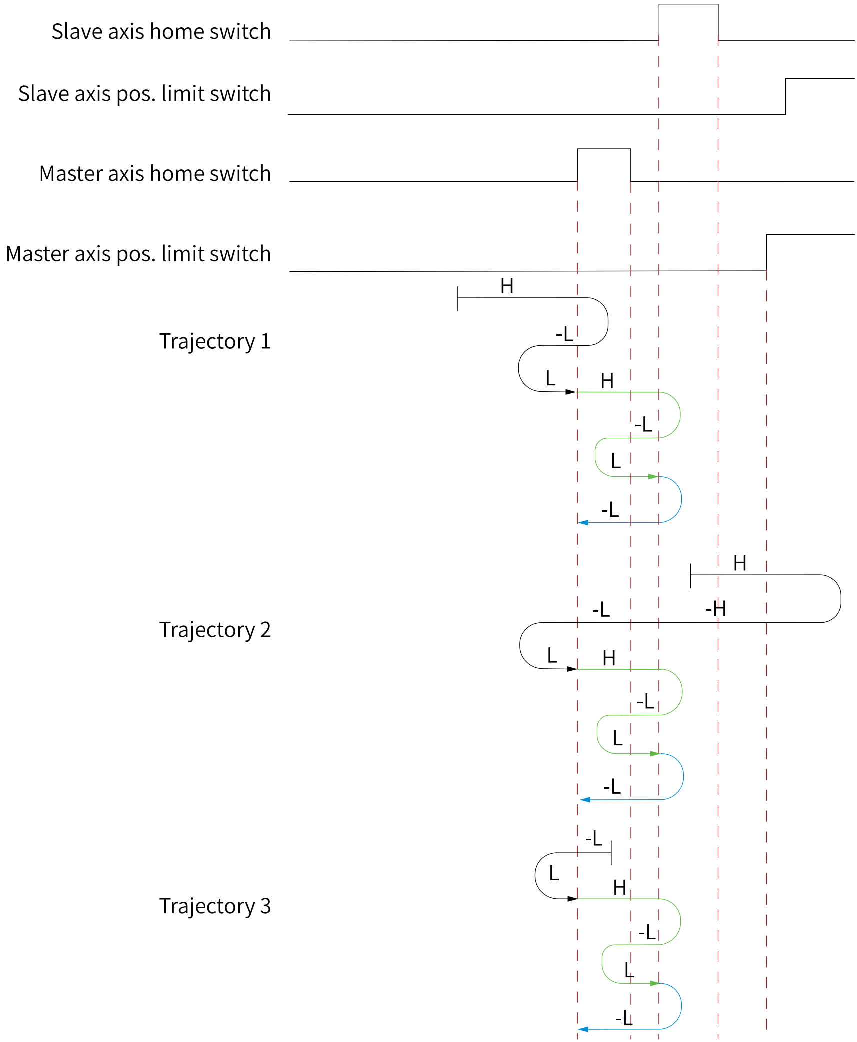
Deceleration point: home switch (HW)



6098 = 24

Home: home switch (HW)

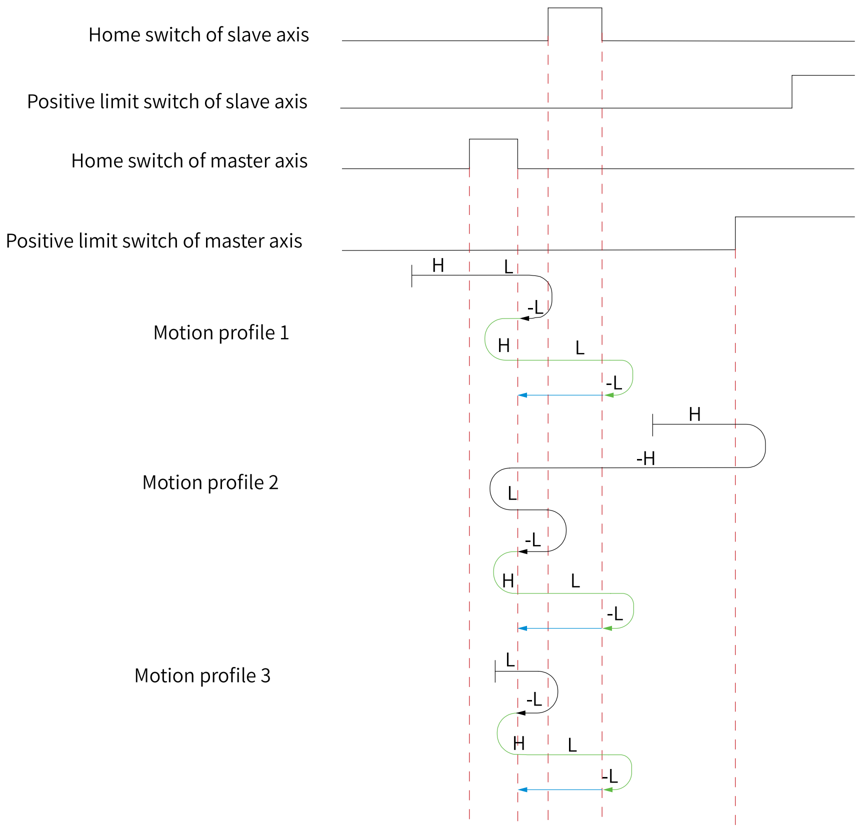
Deceleration point: home switch (HW)



6098 = 25

Home: home switch (HW)

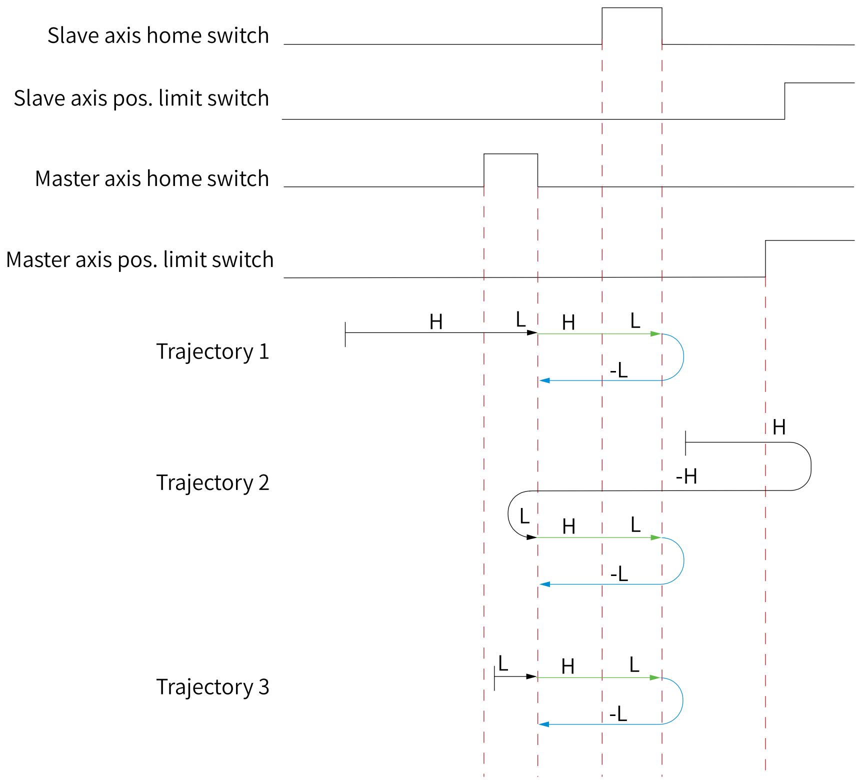
Deceleration point: home switch (HW)



6098 = 26

Home: home switch (HW)

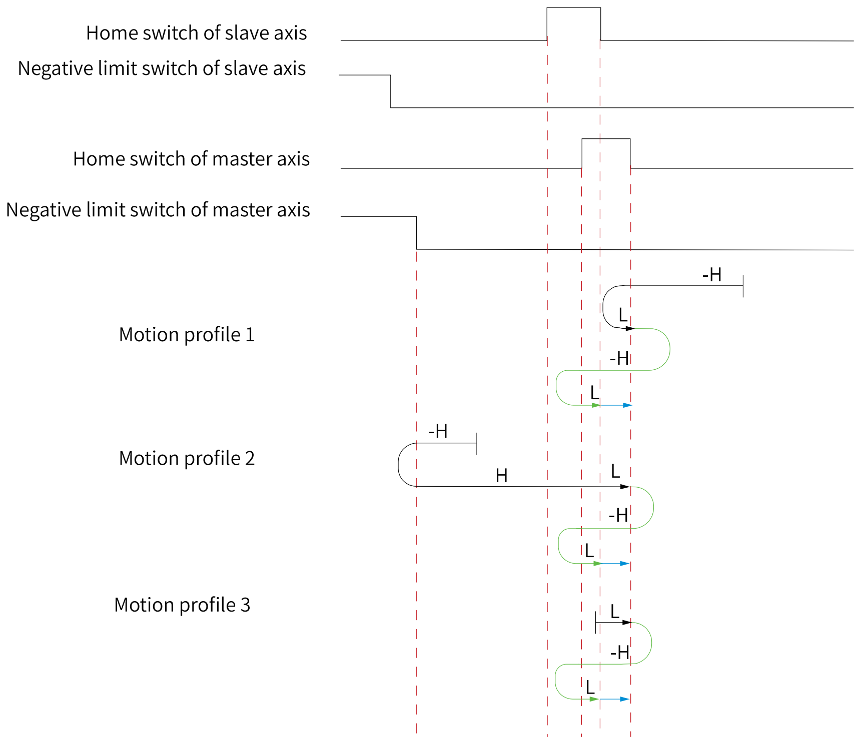
Deceleration point: home switch (HW)



6098 = 27

Home: home switch (HW)

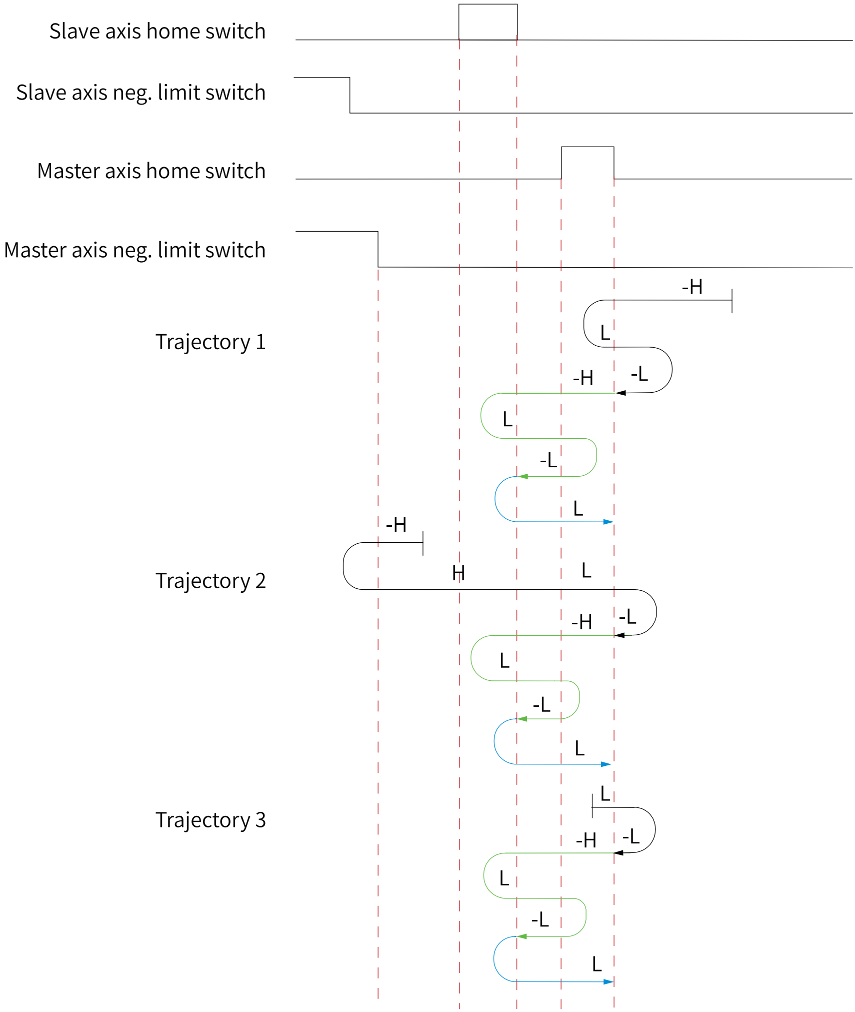
Deceleration point: home switch (HW)



6098 = 28

Home: home switch (HW)

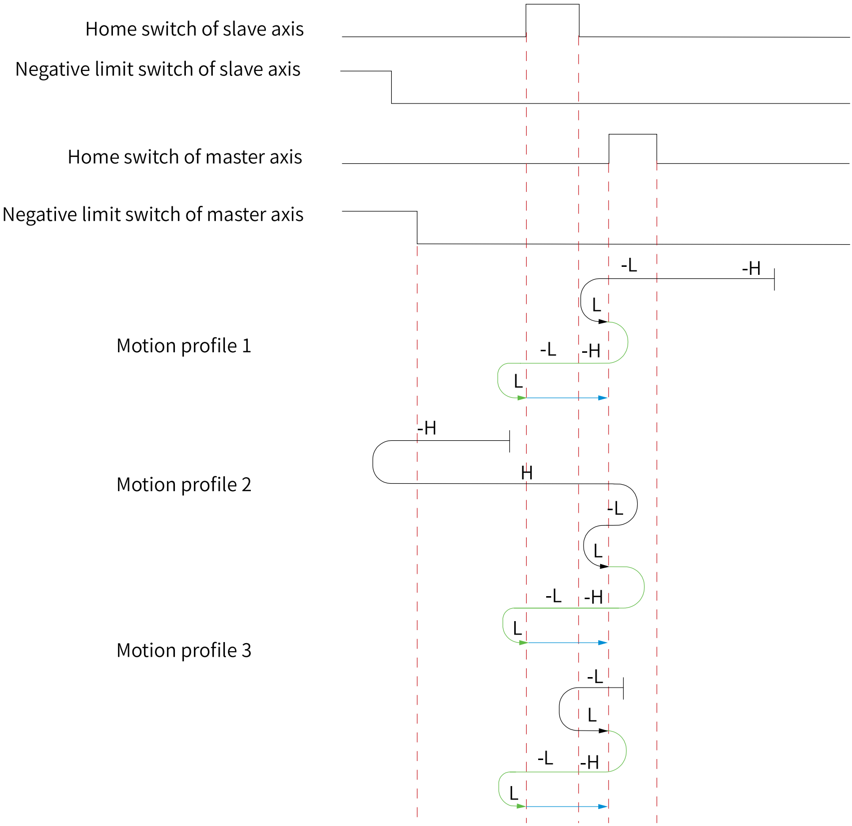
Deceleration point: home switch (HW)



6098 = 29

Home: home switch (HW)

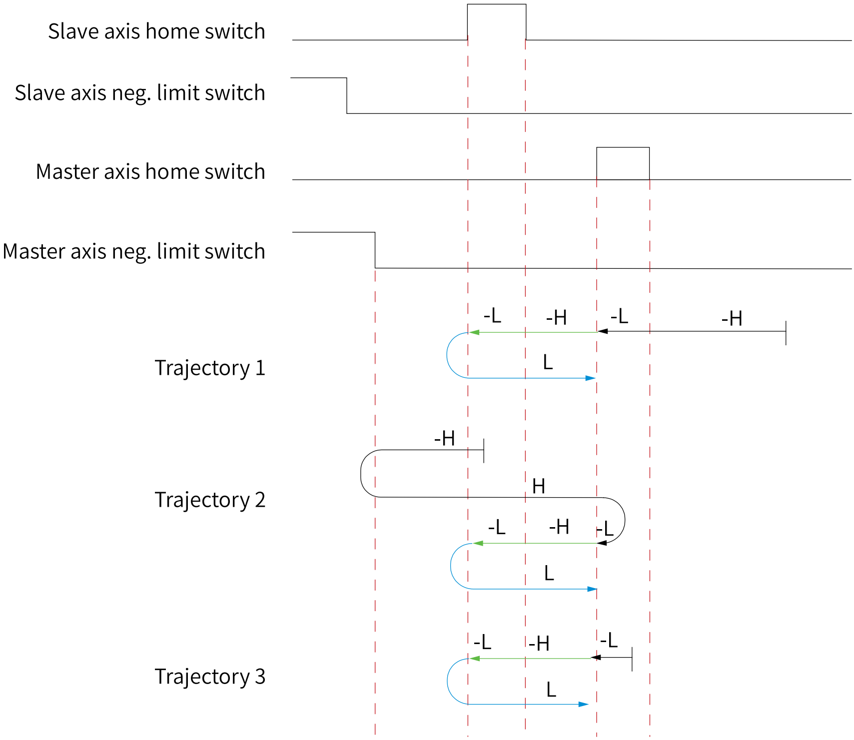
Deceleration point: home switch (HW)



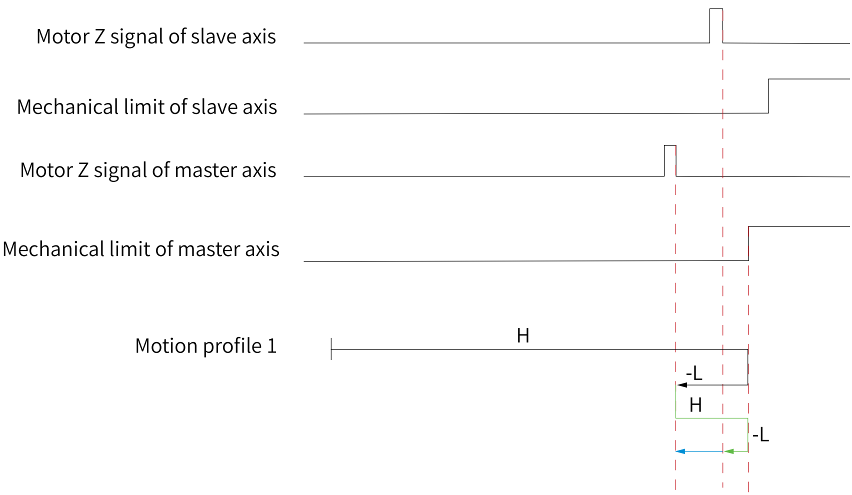
6098 = 30

Home: home switch (HW)

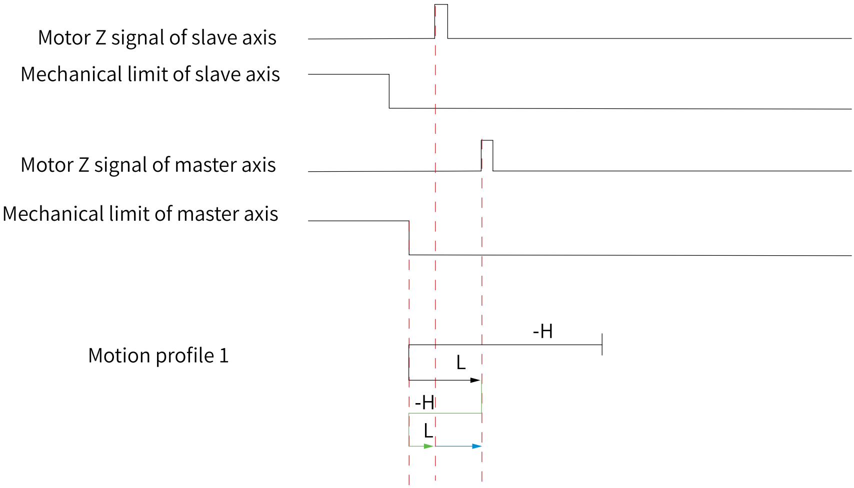
Deceleration point: home switch (HW)


Slave axis home switch
Slave axis neg. limit switch
Master axis home switch
Master axis neg. limit switch
-L
-H
-L
-H
Trajectory 1
L
-H
Trajectory 2
H
-L
-H
-L
L
-L
-H
-L
Trajectory 3
L

6098 = -2

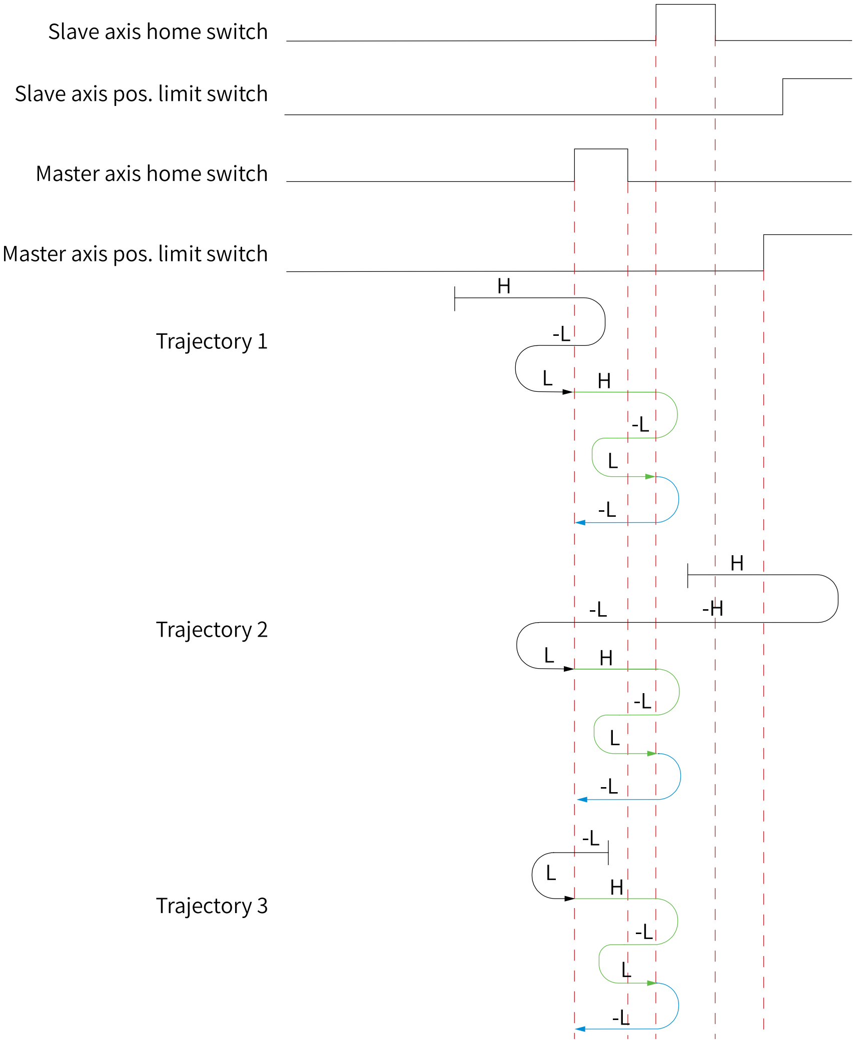

Motor Z signal of slave axis
Mechanical limit of slave axis
Motor Z signal of master axis
Mechanical limit of master axis
Motion profile 1
H
-L
H
-L

6098 = -1



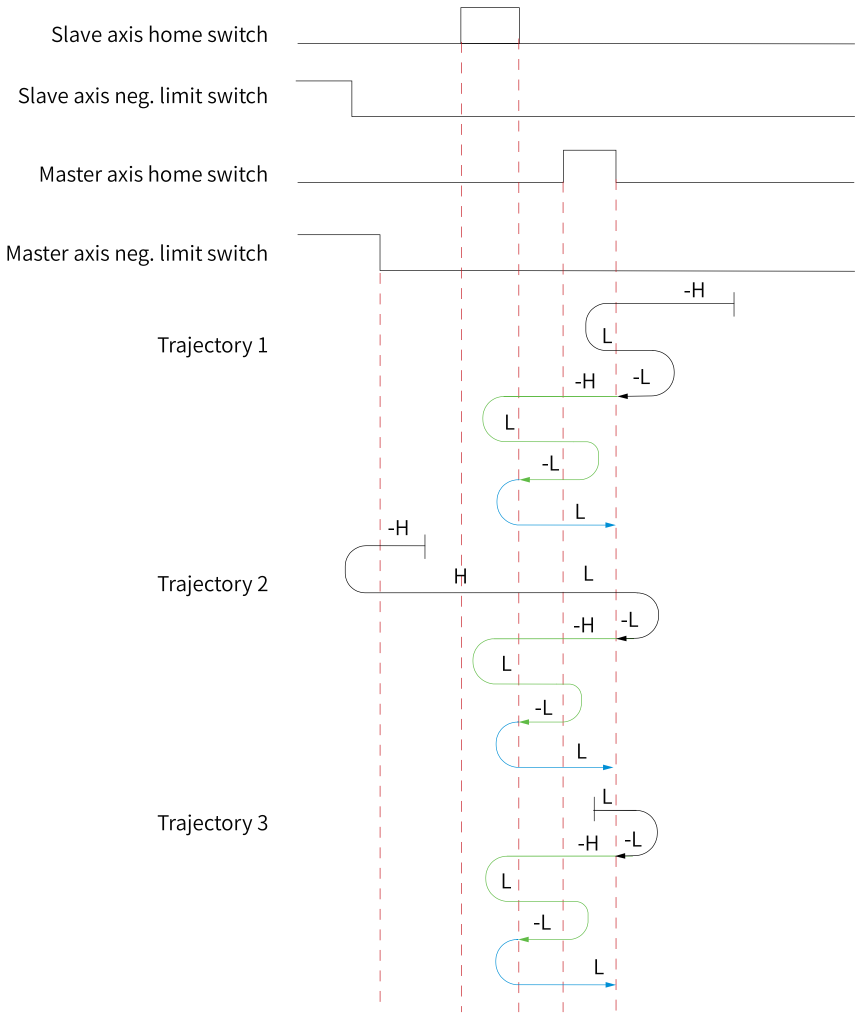
H05.31 = 0

Forward homing, home switch as deceleration point and home



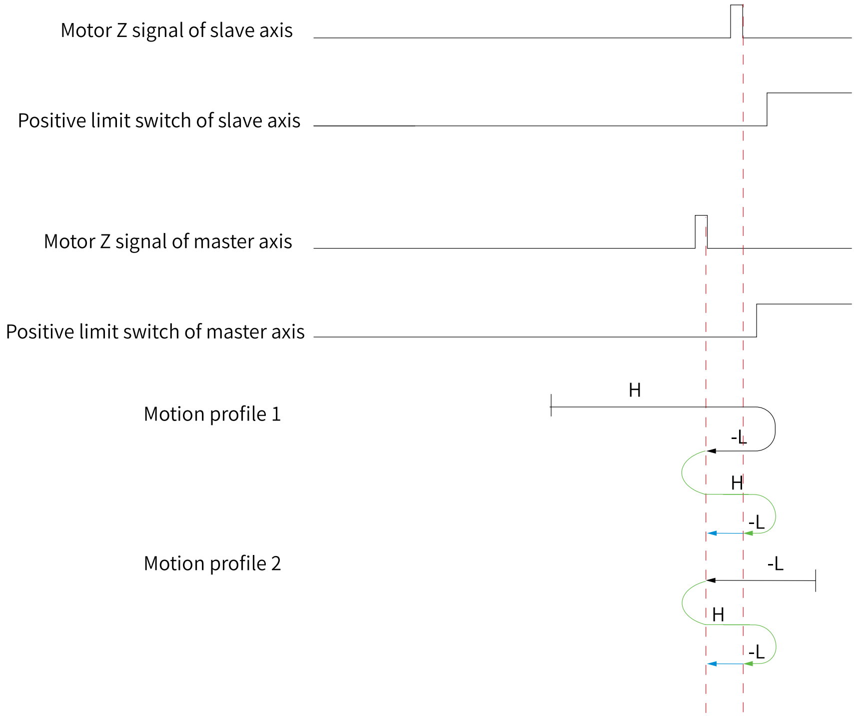
H05.31 = 1

Reverse homing, home switch as deceleration point and home



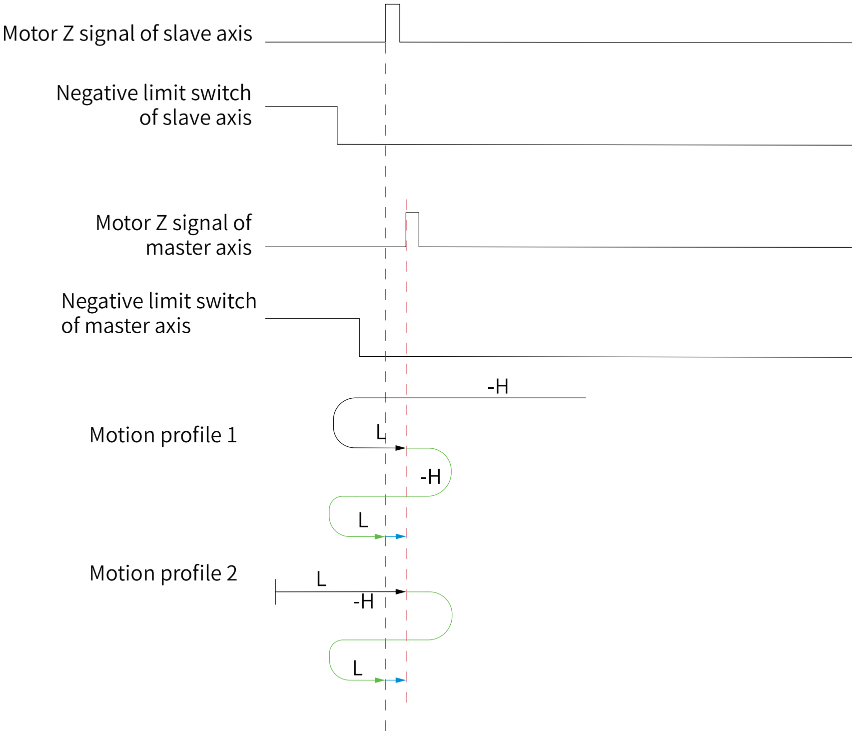
H05.31 = 8

Forward, positive limit switch as deceleration point and Z signal as home



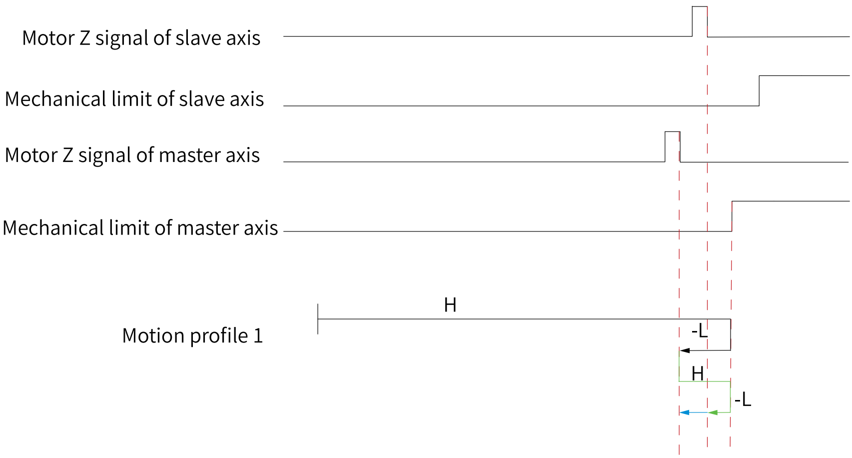
H05.31 = 9

Reverse, negative limit switch as deceleration point signal and Z signal as home



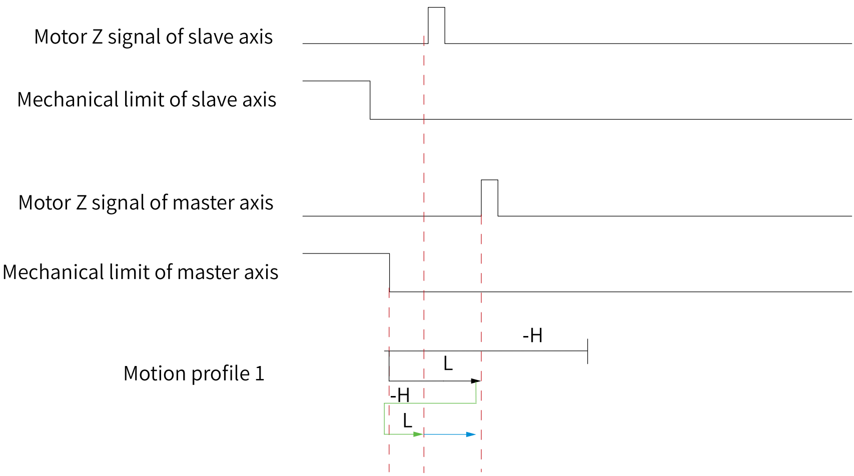
H05.31 = 12

Forward, mechanical limit as deceleration point and Z signal as home



H05.31 = 13

Reverse, mechanical limit as deceleration point and Z signal as home



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