2023

Summa ED3L PN Series AC Servodrive Product Manual

MODEL: ED3L-□□APA

ESTUN AUTOMATION CO.,LTD.

About this Manual

Purpose

This manual provides the information required for the Selection, Wiring, Connection, Settings, Trial Operation, Tuning and Functions of the Summa ED3L Series AC Servo Drive (referred to as **ED3L**).

Read and understand this manual to ensure correct usage of the product.

Terms and Abbreviations

Terms that may be used in this manual are defined as follows.

Term	Meaning
Motor	A Rotary Servo Motor produced by ESTUN.
Drive	A Servo Drive, which is used for controlling the motion of Rotary Servo Motor.
Servo System	A Servo Control System that includes a Servo Motor, a Servo Drive with a host controller and peripheral devices.
Servo ON	Supplying power to the Motor.
Servo OFF	Not supplying power to the Motor.
ESView	The Engineering Tool for setting up and tuning Servo Drives or a computer in which the Engineering Tool is installed.

Abbreviations that may be used in describing EhterCAT or CANopen are defined as follows.

Abbreviation	Meaning
APRD	Auto-increment Physical Read
APWR	Auto-increment Physical Write
APRW	Auto-increment Physical ReadWrite
ARMW	Auto-increment Physical Read Multiple Write
BRD	Boardcast Read
BRW	Boardcast ReadWrite
BWR	Boardcast Write
CiA	CAN in Automation
CoE	CAN application protocol over Profinet
DC	Distributed Clocks
EEPROM	Electrically Erasable Programmable Read Only Memory
ESC	Profinet Slave Controller

Abbreviation	Meaning
ESI	Profinet Slave Information
ESM	Profinet State Machine
FMMU	Fieldbus Memory Management Unit
FPRD	Configured Address Physical Read
FPWR	Configured Address Physical Write
FPRW	Configured Address Physical ReadWrite
FRMW	Configured Address Physical Read Multiple Write
LRD	Logical memory Read
LWR	Logical memory Write
LRW	Logical memory ReadWrite
OD	Object Dictionary
OP	Operational state of Profinet state machine
PDO	Process Data Object
PREOP	Pre-Operational state of Profinet state machine
RxPDO	Receive PDO
SAFEOP	Safe-Operational state of Profinet state machine
SDO	Service Data Object
SyncManager	Synchronization Manager
TxPDO	Transmit PDO

Abbreviations that may be used in describing data types and ranges are defined as follows.

Abbreviation	Data Type	Range
INT8	Signed 8 bit	-128 to +127
INT16	Signed 16 bit	-32768 to +32767
INT32	Signed 32 bit	-2147483648 to +2147483627
UINT8	Unsigned 8 bit	0 to 255
UINT16	Unsigned 16 bit	0 to 65535
UINT32	Unsigned 32 bit	0 to 4294967295
STRING	String value	(reserved)

Symbols

The symbols that may be found in this document are defined as follows.

Symbol	Description
 DANGER	Indicates a hazard with a high level of risk that, if not avoided, will result in death or serious injury.
 WARNING	Indicates a hazard with a medium or low level of risk which, if not avoided, could result in minor or moderate injury.
 CAUTION	Indicates a potentially hazardous situation that, if not avoided, could cause equipment damage, data loss, and performance degradation, or unexpected results.
 IMPORTANT	Indicates precautions or restrictions that must be observed. Also indicates alarm displays and other precautions that will not result in machine damage.
 NOTE	Provides additional information to emphasize or supplement important points of the main text.

The names of reverse signals (ones that are taken effect when low) are written with a forward slash (/) before the signal abbreviation. For example:

$\overline{\text{S-ON}}$ = /S-ON $\overline{\text{P-CON}}$ = /P-CON

Parameters are referenced as PnXXX where XXX refers to a unique number. Some parameters have multiple functions encoded within a single parameter. For these parameters, sub-indices are used to reference the multiple functions.

For example:

- Pn112 Speed Feedforward - is a single value without any sub-indices
- Pn000 Basic Function Selection 0 - is made up of 4 sub-indexes describing different functions
  - Pn000.0 Servo ON
  - Pn000.1 Forward Drive Prohibit Input (P-OT)
  - Pn000.2 Reverse Drive Prohibit Input (N-OT)
  - Pn000.3 Reserved parameter (Do not change)

Safety Precautions

General Precautions

DANGER	■ Never remove covers, cables, connectors, or optional devices while power is being supplied to the Drive. ■ Never connect a three-phase power supply to the terminals U, V, and W of the driver. ■ Wait for five minutes after turning the power supply OFF and then make sure that the CHARGE indicator is not lit before starting wiring or inspection work. ■ Never touch the power supply terminals after turning OFF the power supply while the CHARGE lamp is lit, because high voltages may still be present in the Drive.

WARNING	■ Use a power supply that is appropriate for the product, check number of phases, voltage, frequency, and AC/DC type. ■ Connect the ground terminals on the Drive and Motor to ground poles according to local electrical codes. ■ Never damage, pull on, apply excessive force to, place heavy objects on, or pinch cables. ■ Never attempt to disassemble, repair, or modify the product. ■ Make sure that the device in an emergency stop state at any time when the product has been connected to the machine and ready for the operation. ■ Never touch inside the Drive.

CAUTION	■ The Drive heat sinks, regenerative resistors, Motor, and other components can be very hot while power is ON or soon after the power is turned OFF. Implement safety measures, such as installing covers, so that hands and parts such as cables do not come into contact with hot components. ■ For the control power supply, use a power supply device with double insulation or reinforced insulation. ■ Never use the product in an environment that is subject to water, corrosive gases, or flammable gases, or near flammable materials. ■ Never attempt to use a Drive or Motor that is damaged or that has missing parts. ■ Install external emergency stop circuits that shut OFF the power supply and stops operation immediately when an error occurs. ■ In locations with poor power supply conditions, install the necessary protective devices (such as AC reactors) to ensure that the input power is supplied within the specified voltage range. ■ Always use a Noise Filter to minimize the effects of electromagnetic interference. ■ Always use a Motor and Drive in one of the specified combinations. ■ Never touch a Drive or Motor with wet hands.

Storage Precautions

CAUTION

- Follow all instructions on the packages, and never place an excessive load on the product during storage.
- Never install or store the product in any of the following locations:
  -- locations that are subject to direct sunlight.
  -- locations that are subject to ambient temperatures exceed product specifications.
  -- locations that are subject to relative humidity exceed product specifications.
  -- locations that are subject to corrosive or flammable gases.
  -- locations that are subject to dust, salts, or iron powder.
  -- locations that are subject to water, oil, or chemicals.
  -- locations that are subject to vibration or shock exceeds product specifications.
  -- locations that are subject to radiation.

Installation Precautions

CAUTION

- Install the Drive in a control cabinet that provides fire and electrical protection.
- Install the Drive and Motor in a way that will support their mass.
- Never install or store the product in any of the following locations:
  -- locations that are subject to direct sunlight.
  -- locations that are subject to ambient temperatures exceed product specifications.
  -- locations that are subject to relative humidity exceed product specifications.
  -- locations that are subject to corrosive or flammable gases.
  -- locations that are subject to dust, salts, or iron powder.
  -- locations that are subject to water, oil, or chemicals.
  -- locations that are subject to vibration or shock exceeds product specifications.
  -- locations that are subject to radiation.
- Never allow any foreign matter to enter a Drive or a Motor with a Cooling Fan.
- Never cover the outlet from cooling fan of Drive or Motor.
- Never step on or place a heavy object on the product.
- Install the Drive in the specified orientation.
- Provide the specified clearances between the Drive and the control cabinet as well as with other devices.

Wiring Precautions

CAUTION

- Never bypass the electromagnetic contactor in the wiring between the Drive and the Motor.
- Firmly connect the power terminal to the Motor terminal.
- Provide an adequate air gap around the Drive installation.
- Use shielded twisted-pair cables or screened unshielded multi-twisted-pair cables for I/O Signal Cables and Encoder Cables.
- The wiring length of the encoder is up to 20 meters.
- Minimize the frequency that the power supply is turned ON and OFF.

Operation Precautions

CAUTION

- In order to prevent accidents, please test the Motor with no load (not connected to the Drive shaft).
- When starting to operate on the supporting machine, set the user parameters that match the machine in advance.
- Note that the signals for the Forward Drive Prohibit (P-OT) and the Reverse Drive Prohibit (N-OT) are disabled during JOG operation.
- When overtravel occurs, the power supply to the Motor is turned OFF and the brake is released. If the Motor is used to drive a vertical load, set the Motor to enter a 'zero-clamped' state after the Motor stops. Also, install safety devices (such as an external brake or counterweight) to prevent the moving parts of the machine from falling.
- If not using auto-tuning, make sure that an appropriate moment of inertia ratio is setup to avoid vibration.
- If an alarm occurs, reset it after troubleshooting the cause and ensuring safety.
- Never use the brake of the Motor for normal braking.

Maintenance Precautions

WARNING

- Wiring and inspections must be performed only by qualified engineers.
- Disconnect all connections to the Drive when testing the insulation resistance of the Drive.
- Never use gasoline, thinner, alcohol, acid or alkaline detergent to avoid discoloration or damage to the casing.
- When replacing the Drive, transfer the user parameters from the replaced Drive to new Drive.
- Never change the wiring while the power is on.
- Never disassemble the Motor without permission.

Disposal Precautions

CAUTION

When disposing of the product, treat it as ordinary industrial waste. However, local ordinances and national laws must be observed. Implement all labeling and warnings as required.

Contents

Chapter 1 ED3L Servo Drive

1.1 Product Features

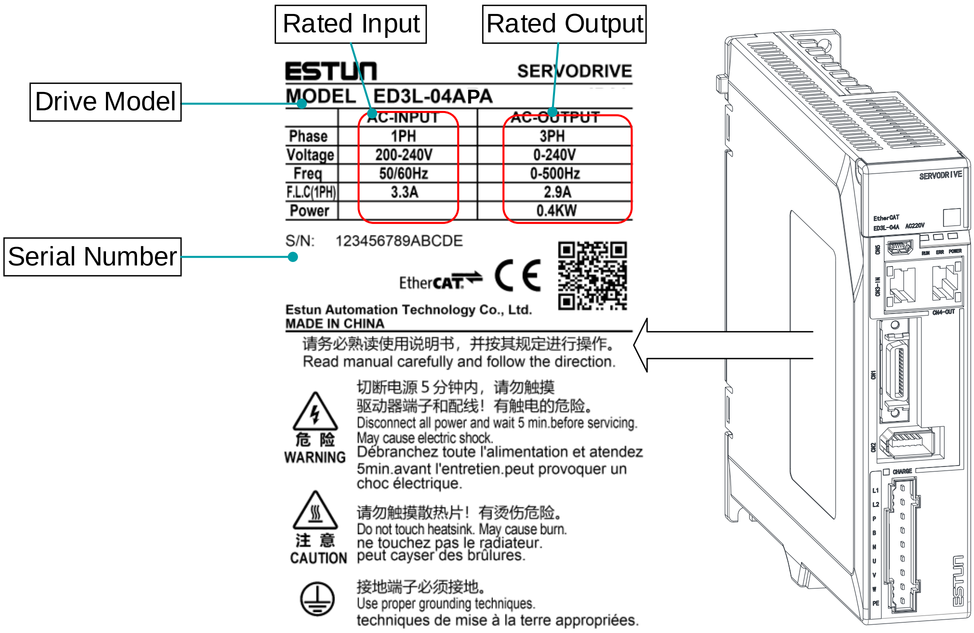
As a new single-axis AC servo product from ESTUN, ED3L is designed with its excellent performance and practical control functions to create a complete set of solutions with the best cost performance for customers.

Matching with the EM3A and the EM3G、EMG、EM3J servo motors, compatible with mainstream controllers, it offers high-speed, high-precision, and high-performance machine solutions.

ED3L has the following outstanding features.

- Profinet support, update rates down to 500 µs
- Compact size
- Zero stacking gap installation
- 200 V ac from 50 W to 2 kW
- 400 V ac from 1.0KW to 7.5kW
- Optional 17-bit incremental encoder (magnetic) and 17-bit absolute value encoder (photoelectric)and20-bit incremental/23-bit absolute encoder (photoelectric)
- Comprehensive tuning technology including: Auto-tuning function, adaptive vibration suppression, friction compensation

1.2 Interpreting the Nameplate



1.3 Model Designations

ED3L - 02 A P A FS02

ED3L: Summa ED3L Series Servo Drives

02: Rated output power

Marking	Specification
A5	0.05 kW
01	0.1 kW
02	0.2 kW
04	0.4 kW
08	0.75 kW
10	1.0 kW
15	1.5 kW
20	2.0 kW
30	3.0kW
50	5.0 kW
75	7.5 kW

A: Voltage Class

Marking	Specification
A	200 V
D	400 V

P: Options

Marking	Specification
P	Profinet

A: Encoder type

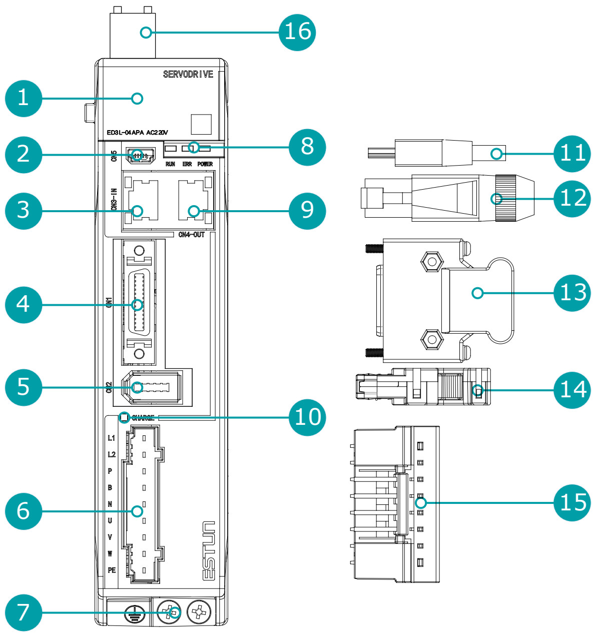
Marking	Specification
A	Serial encoder
C	Wire-saving encoder

FS02: 扩展功能

记号	规格
FS02	支持STO

1.4 Part Names

Rated power from 50W to 400W

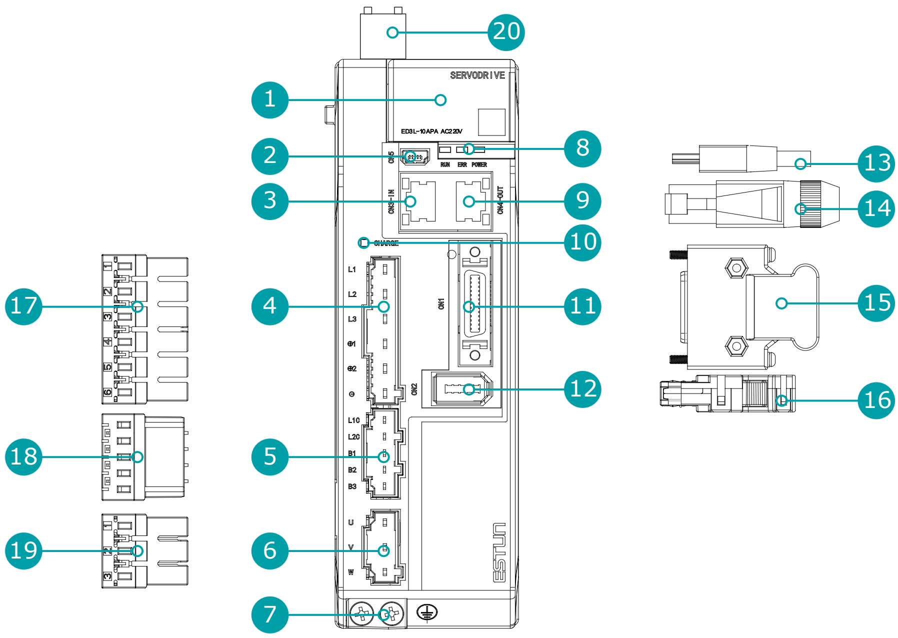


No.	Name	Description
1	Panel Operator	A module for Servo status displays and parameter settings
2	USB Connector	Connects a computer for ESView V4
3、9	Profinet Input Connector	Connect to an Profinet device
4	IO Signal Connector	Connects to sequence I/O signals
5	Encoder Connector	Connects to the encoder in the Motor
6	Main Circuit and Motor Connector	L1, L2: main power input terminals P, N: common DC bus terminals P, B: external regenerative resistor terminals U, V, W: motor power terminals PE: ground terminal
7	Grounding Terminal	Connects to the ground terminal of the Motor main circuit cable
8	communication indicators	• RUN: running indicator lamp • ERR: Error indicator lamp • POWER: power on indicator lamp
10	CHARGE Indicator Lamp	Lit while the main circuit power is being supplied Note: Even if you turn OFF the main circuit power supply, this indicator will be lit as long as the internal capacitor remains charged. Never touch the main circuit or Motor terminals while this indicator is lit, in case the electric shock.
11	USB Terminals	Standard Mini USB Type-B
12	Profinet Terminals	Standard RJ-45 terminal

No.	Name	Description
13	IO Signal Terminals	Connection terminals for sequence IO signals
14	Encoder Terminals	Connection terminals for the encoder cable in the Motor
15	Main Circuit and Motor Terminals	Connection terminals for power input and motor power.
16	Safety connection terminal	Safe Torque Shutdown (STO)

Note: Independent STO safety connection terminal only - FS02 driver has

Rated power from 750W to 2kW



NOTE

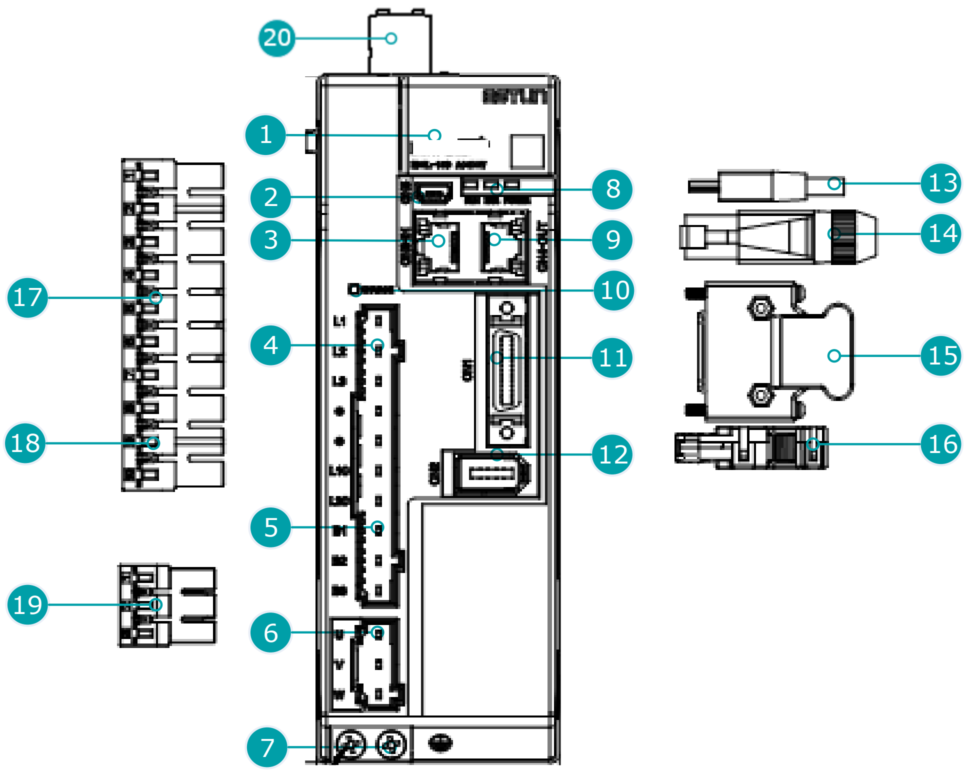
The figure above shows an example of a product with a rated power of 750W to2kW. Products with a rated power of 2kW~3kW are similar in appearance and have the same components.

Note: Independent STO safety connection terminal only - FS02 driver has

No.	Name	Description
1	Panel Operator	A module for Servo status displays and parameter settings
2	USB Connector	Connects a computer for ESView V4
3	Profinet Input Connector	Connect to an Profinet device
4	Main Circuit Connector	• L1、L2、L3: main power input terminals • ⊕1, ⊕2, ⊖: DC terminals
5	Control Circuit Connector	• L1C, L2C: control power input terminals • B1, B2, B3: external regenerative resistor terminals
6	Motor Connector	Connects to a Motor main circuit cable
7	Grounding Terminal	Connects to the ground terminal of the Motor main circuit cable

No.	Name	Description
8	communication indicators	• RUN: running indicator lamp • ERR: Error indicator lamp • POWER: power on indicator lamp
9	Profinet Output Connector	Connects to an Profinet device or be vacant
10	CHARGE Indicator Lamp	Lit while the main circuit power is being supplied Note: Even if you turn OFF the main circuit power supply, this indicator will be lit as long as the internal capacitor remains charged. Never touch the main circuit or Motor terminals while this indicator is lit, in case the electric shock.
11	IO Signal Connector	Connects to sequence I/O signals
12	Encoder Connector	Connects to the encoder in the Motor
13	USB Terminals	Standard Mini USB Type-B
14	Profinet Terminals	Standard RJ-45 terminal
15	IO Signal Terminals	Connection terminals for sequence IO signals
16	Encoder Terminals	Connection terminals for the encoder cable in the Motor
17	Main Circuit Terminals	The connection terminals for the main circuit power supply
18	Control Circuit Terminals	The connection terminals for the control power supply
19	Motor Terminals	The connection terminals for the Motor main circuit cable
20	Safety connection terminal	Safe Torque Shutdown (STO)

400VAC, rated power from 1kW to 3kW



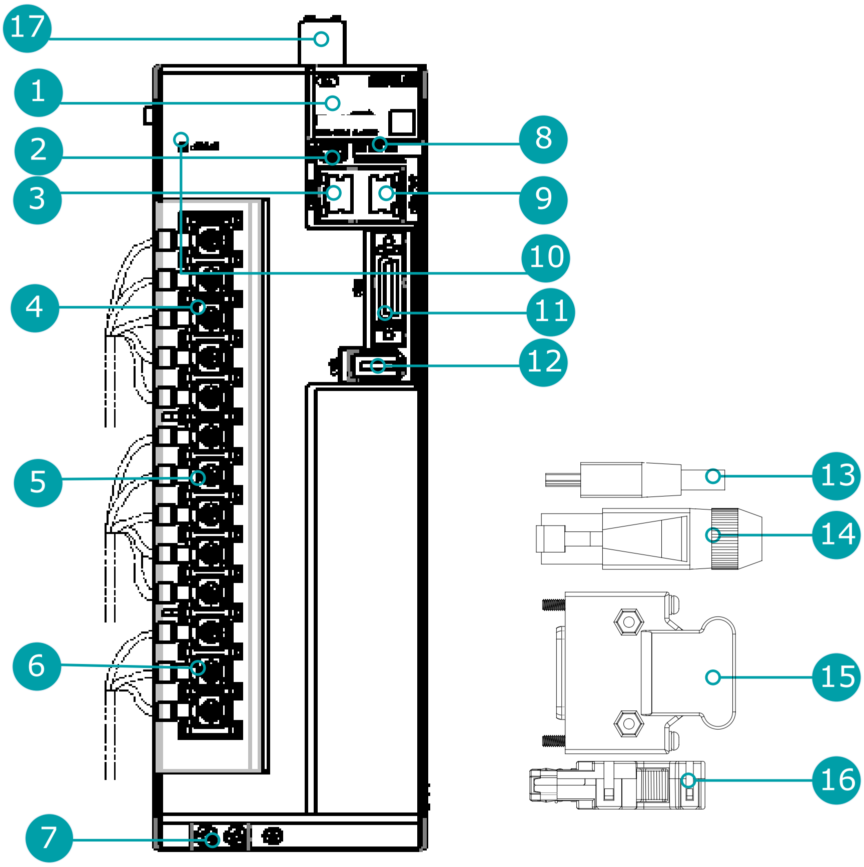
NOTE

The figure above shows an example of a product with a rated power of 1kW to 1.5kW. Products with a rated power of 2kW~3kW are similar in appearance and have the same components.

Note: Independent STO safety connection terminal only - FS02 driver has

No.	Name	Description
1	Panel Operator	A module for status displays and parameter settings.
2	USB Connector	Socket for USB communication cable when using ESView V4 on PC.
3	Profinet Input Connector	Input signal socket for Profinet communication cable.
4	Main Circuit Port	• L1, L2, L3: main power input terminals • ⊕, ⊖: DC Connectors
5	Control Circuit Port	• L1C, L2C: control power input terminals • B1, B2, B3: external regenerative resistor Connectors
6	Motor Power Connection Port	Socket for motor power cable.
7	Grounding Terminal	Connected to the earth terminal of the motor power cable.
8	Profinet Communication Indicator	• RUN: Run indicator • ERR: Error indicator • POWER: System indicator
9	Profinet Output Connection Port	Output signal connection port for Profinetcommunication cables.
10	CHARGE Indicator Lamp	Lights up when the main circuit is powered on. Note: If voltage remains in the capacitors inside the drive after the main circuit has been switched off, and the indicator lamp will be ON, do not touch the main circuit and motor terminals at this time to avoid electric shock.
11	IO Signal Connection Port	Socket for IO signal connectors.
12	Encoder Connection Port	Socket for the encoderconnectors of the motor.
13	USB Connector	Standard Mini USB Type-B.
14	Profinet Connector	Standard RJ-45 terminal.
15	IO Signal Connector	Connector for IO signal cables.
16	Encoder Connector	Connector for motor encoder cables.
17	Main Circuit Connector	Connector for the drive’s main circuit cables.
18	Control Circuit Connector	Connector for the drive control circuit cables.
19	Motor Power Cable Connector	Connector for the motor power cables.
20	Safety connection terminal	Safe Torque Shutdown (STO)

400VAC , rated power from 5kW to 7.5kW



Note: Independent STO safety connection terminal only - FS02 driver has

No.	Name	Description
1	Panel Operator	A module for status displays and parameter settings.
2	USB Connector	Socket for USB communication cable when using ESView V4 on PC.
3	Profinet Input Connector	Input signal socket for Profinet communication cable.
4	Main Circuit Port	• L1, L2, L3: main power input terminals • ⊕, ⊖: DC Connectors
5	Control Circuit Port	• L1C, L2C: control power input terminals • B1, B2, B3: external regenerative resistor Connectors
6	Motor Power Connection Port	Socket for motor power cable.
7	Grounding Terminal	Connected to the earth terminal of the motor power cable.
8	Profinet Communication Indicator Lamp	• RUN: Run indicator • ERR: Error indicator • POWER: System indicator
9	Profinet Output Connection Port	Output signal connection port for Profinet communication cables.
10	CHARGE Indicator Lamp	Lights up when the main circuit is powered on. Note: If voltage remains in the capacitors inside the drive after the main circuit has been switched off, and the indicator lamp will be ON, do not touch the main circuit and motor terminals at this time to avoid electric shock.

No.	Name	Description
11	IO Signal Connection Port	Socket for IO signal connectors.
12	Encoder Connection Port	Socket for the encoderconnectors of the motor.
13	USB Connector	Standard Mini USB Type-B.
14	Profinet Connector	Standard RJ-45 terminal.
15	IO Signal Connector	Connector for IO signal cables.
16	Encoder Connector	Connector for motor encoder cables.
17	Safety connection terminal	Safe Torque Shutdown (STO)

1.5 Ratings and Specifications

Drive Model: ED3L-		A5AEA	01AEA	02AEA	04AEA	08AEA	10AEA	15AEA	20AEA
Continuous Output Current [Arms]		0.9	1.1	1.5	2.9	5.1	6.9	9.5	12.6
Instantaneous Maximum Output Current [Arms]		3.3	4.0	5.8	11.5	19.5	21.0	31.6	42.0
Power Supply Capacity [kVA]	Single-phase	0.2	0.3	0.6	1.2	1.9	2.6	4.0 (注)	–
	Three-phase	–	–	–	–	1.6	2.0	3.0	3.5

400VAC						
Drive Model: ED3L-	10D	15D	20D	30D	50D	75D
Continuous Output Current [Arms]	3.6	5.0	7.1	12.0	17.0	27.3
Max Output Current [Arms]	10.9	16.3	24.7	37.8	53.0	70.7
Mains Power Equipment Capacity [kVA] (3-phase)	1.8	2.8	3.5	5.0	8.2	12.0

General specifications		Description
Input Power	200VAC	Single-phase AC 200V～240V, -15%～+10%, 50Hz/60Hz 3-phase AC200V～240V, -15%～+10%, 50Hz/60Hz (rated power ⩾ 0.75kW)
	400VAC	3-phase AC380V～440V, -15%～+10%, 50Hz/60Hz
Control Power	200VAC	Single-phase AC 200V～240V, -15%～+10%, 50Hz/60Hz
	400VAC	Single-phase AC 200V～440V, -15%～+10%, 50Hz/60Hz
Control Mode		SVPWM control

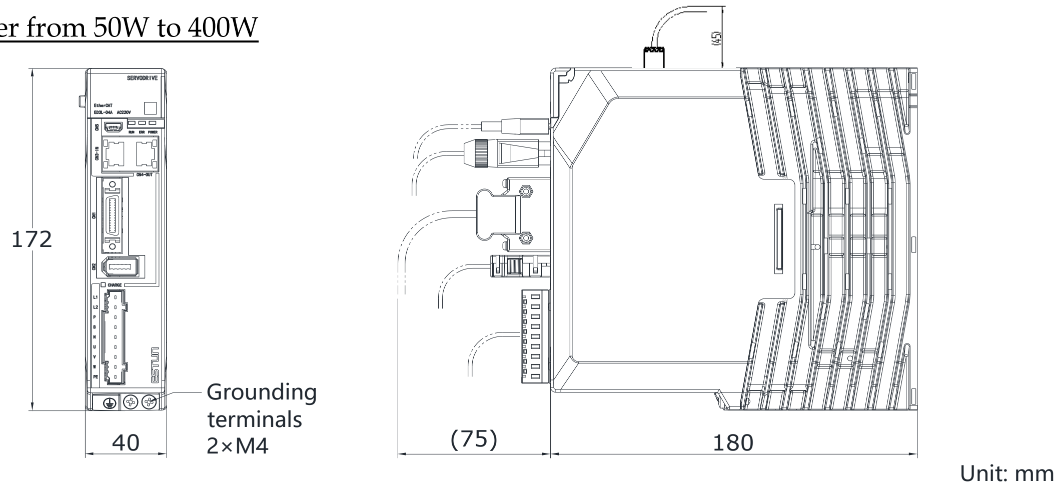
Feedback			Serial encoder: ● 17 bits absolute magnetoelectric encoder ● 17bits or 20bits incremental encoder ● 23bits absolute encoder
Environmental Conditions	Operation	Temperature	-5℃ to 55℃ (-5℃ to 40℃ for zero stacking gap installation)
		Humidity	5% to 95% (with no condensation)
	Storage	Temperature	-20℃ to +85℃
		Humidity	5% to 95% (with no condensation)
	Protection Class		IP20 (in the case of all terminals are installed in place)
	Altitude		1,000 m or less
	Vibration Resistance		4.9m/s^2
	Shock Resistance		19.6m/s^2
	Power System		TN System
Mounting			Base-mounted
Performance	Speed Control Range		1:5000
	Coefficient of Speed Fluctuation		±0.01% of rated speed max. (For a load fluctuation of 0% to 100%)
			0% of rated speed max. (For a load fluctuation of ±10%)
			±0.1% of rated speed max. (For a temperature fluctuation of 25°C±25°C)
	Soft Start Time Setting		0 s to 10 s (Can be set separately for acceleration and deceleration.)
I/O Signals	Input Signals		Allowable voltage range: 24 VDC±20% Number of input points: 5
			Input Signals are S-ON (Servo ON), N-OT (Reverse Drive Prohibit), P-OT (Forward Drive Prohibit), PCL (Forward External Torque Limit) or EXT1 (Touch Probe 1), NCL (Reverse External Torque Limit) or EXT2 (Touch Probe 2).
	Output Signals		Allowable voltage range: 5 VDC to 30 VDC Number of output points: 3 (1 of them fixed for Servo Alarm)
			Output Signals are TGON (Rotation Detection), ALM (Servo Alarm), COIN (Positioning Completion). Except ALM, a signal can be allocated and the positive and negative logic can be changed.
Profinet Communications	Applicable Communications Standards		IEC 61158 Type12, IEC 61800-7 CiA402 Drive Profile
	Physical Layer		100BASE-TX (IEEE802.3)
	Communications Connectors		CN3-IN (RJ45): Profinet signal input connector CN4-OUT (RJ45): Profinet signal output connector
	Cable		Category 5, 4 shielded twisted pairs
	Sync Manager		SM0: Mailbox output, SM1: Mailbox input, SM2: Process data output, and SM3: Process data input

	FMMU	FMMU 0: Mapped in process data output (RxPDO) area. FMMU 1: Mapped in process data input (TxPDO) area. FMMU 2: Mapped to mailbox status.
	Profinet Commands (Data Link Layer)	APRD, FPRD, BRD, LRD, APWR, FPWR, BWR, LWR, ARMW, FRMW
	Process Data	Assignments can be changed with PDO mapping.
	MailBox (CoE)	Emergency messages, SDO requests, SDO responses, and SDO information (TxPDO/RxPDO and remote TxPDO/RxPDO are not supported.)
	MailBox (FoE)	Firmware update by FoE
	Distributed Clocks	Free-Run Mode and DC Mode (Can be switched), SM2 (SM2 event sync) Applicable DC cycles: 125 µs to 8 ms in 125-µs increments
	Slave Information Interface	2048 bytes (read-only)
CiA402 Drive Profile		Homing mode Profile position mode Profile velocity mode Profile torquemode Interpolated position mode Cyclic synchronous position mode Cyclic synchronous velocity mode Cyclic synchronous torquemode Touch probe function Torque limit function
FoE (File Over Profinet)		Download a new firmware via FoE protocol
USB Communications	Interface	Personal computer (with ESView V4)
	Communications Standard	Conforms to USB2.0 standard (12 Mbps), OTG
Display		Five 7-segment LEDs
Indicator Lamps		CHARGE, POWER, SYS, RUN, ERR, L/A IN , L/A OUT
Panel Operator		4 Buttons
Regenerative Processing		• Rated power from 50W to 400W must connect an external regenerative resistor. • Rated power from 750W to 1kW are built-in.
Protective Functions		Overcurrent, Overvoltage, Undervoltage, Overload, Regeneration Error, Overspeed, etc.
Utility Functions		Alarm history, Jogging, Mechanical analysis, Load inertia identification, Auto-Tuning, etc.

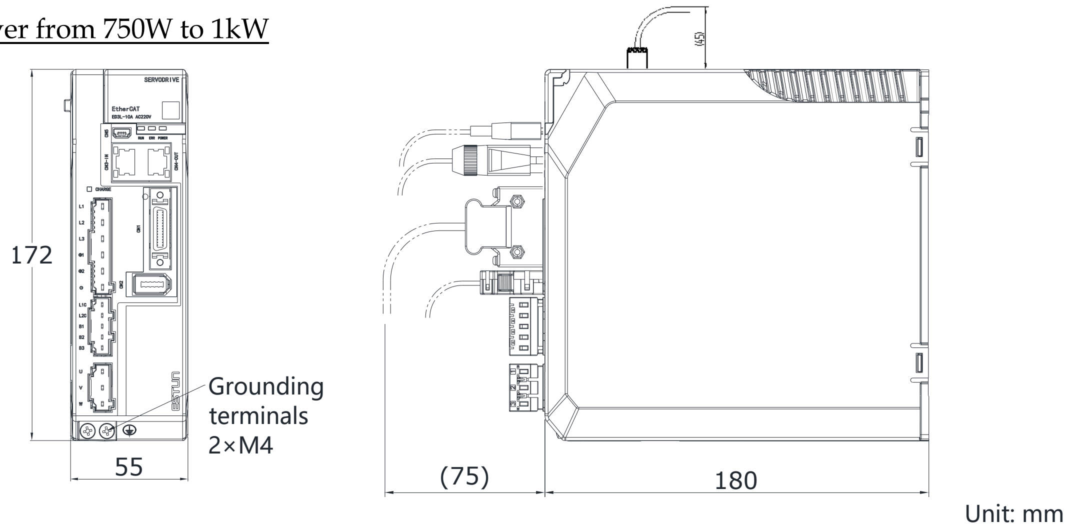
Note: When operating from a single-phase power supply for the ED3L-15AEA (rated power 1.5 kW), please deratify to 1.2 kW.

1.6 Dimensions

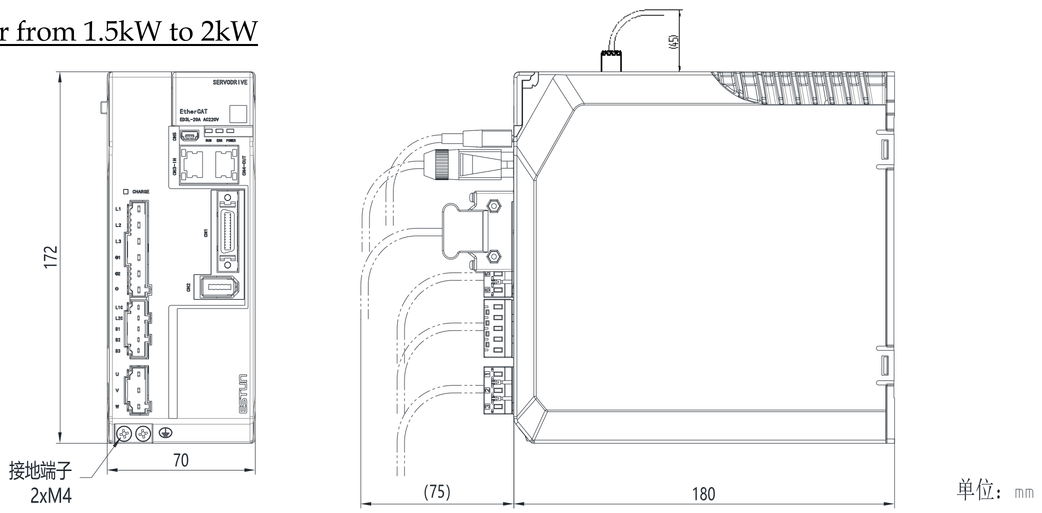
Rated power from 50W to 400W



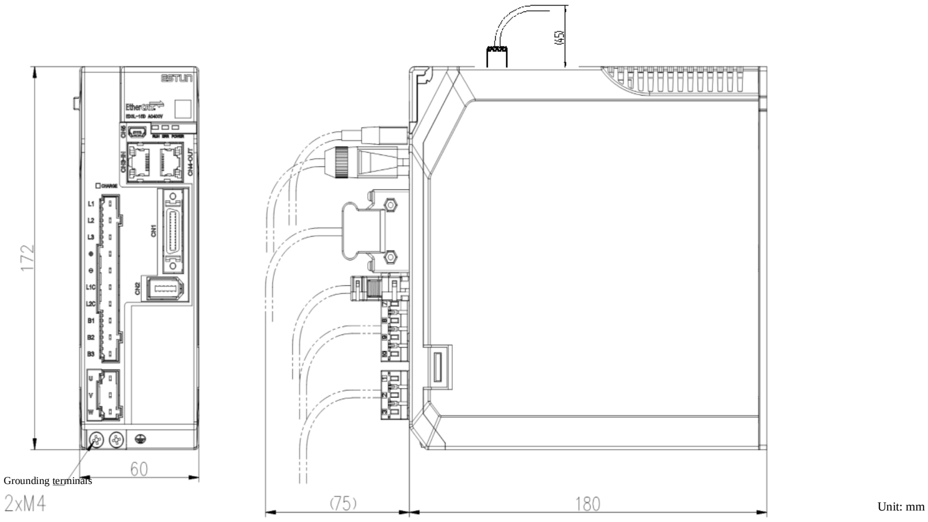
Rated power from 750W to 1kW



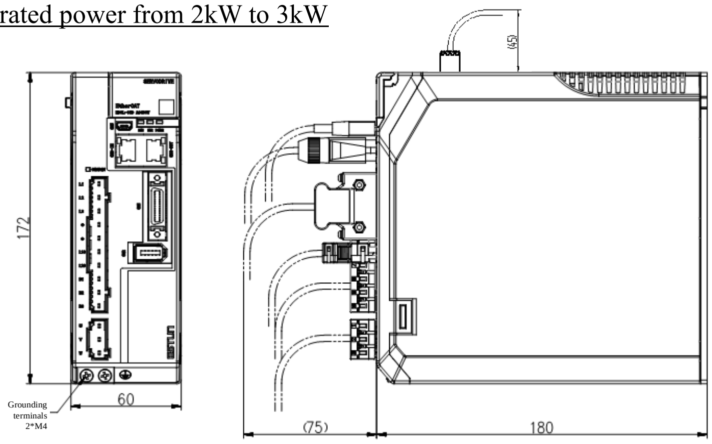
Rated power from 1.5kW to 2kW



400VAC, rated power from 1kW to 1.5kW

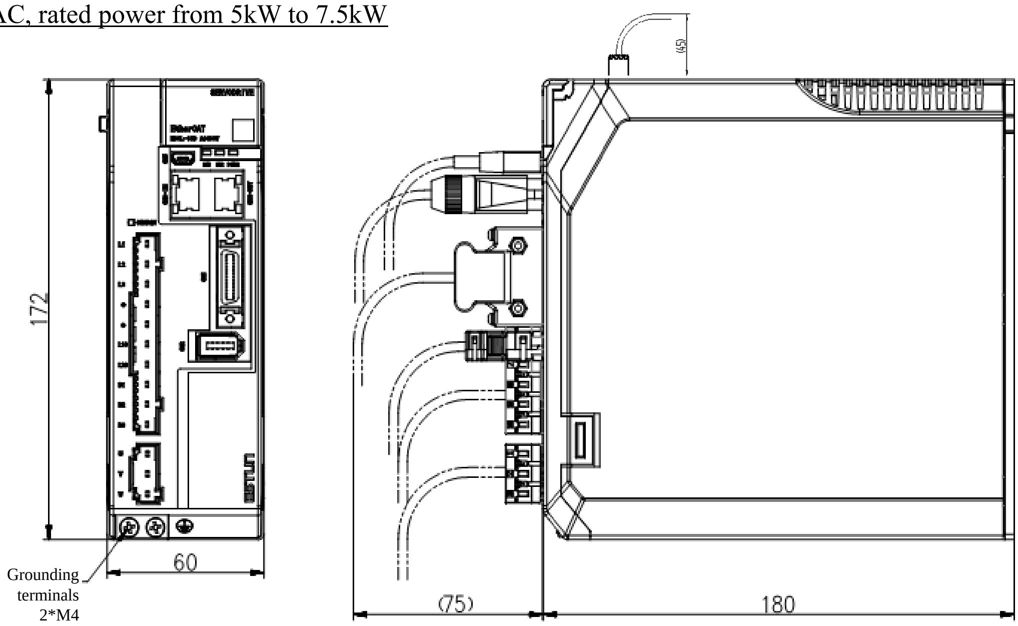


400VAC, rated power from 2kW to 3kW



Unit: mm

400VAC, rated power from 5kW to 7.5kW

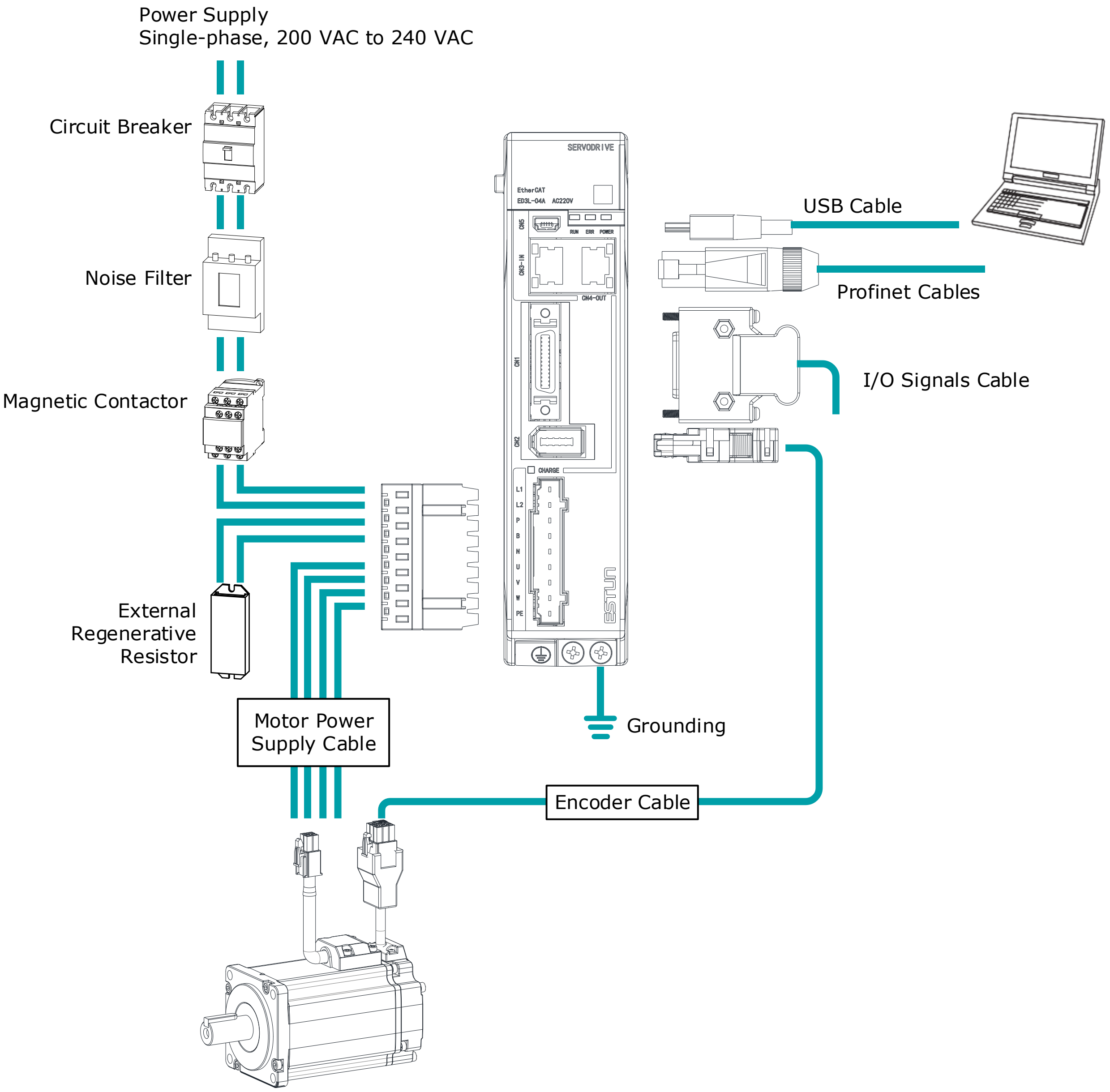


Unit: mm

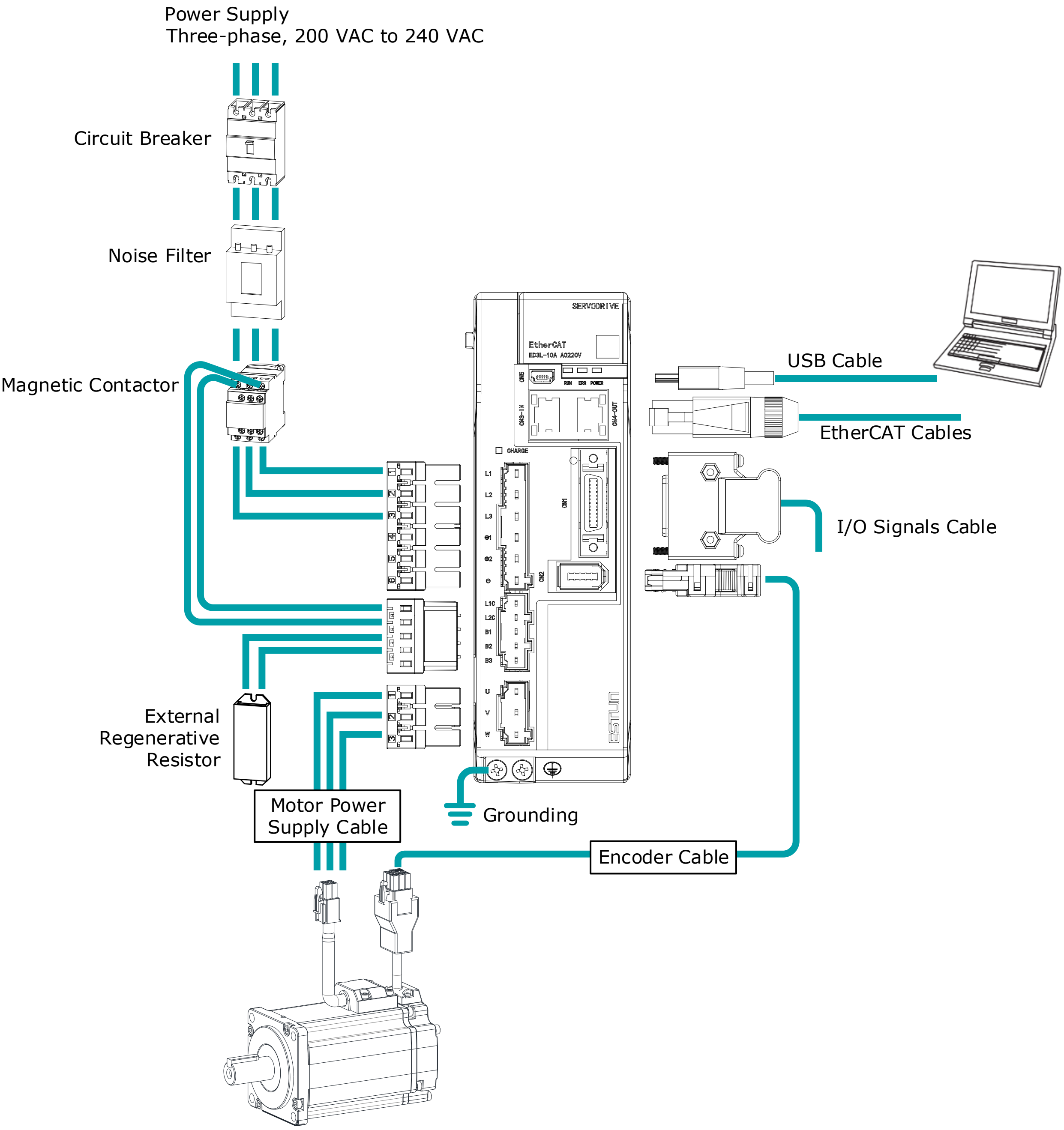
1.7 System Configuration

1.7.1 Example Diagram

Rated power from 50W to 400W

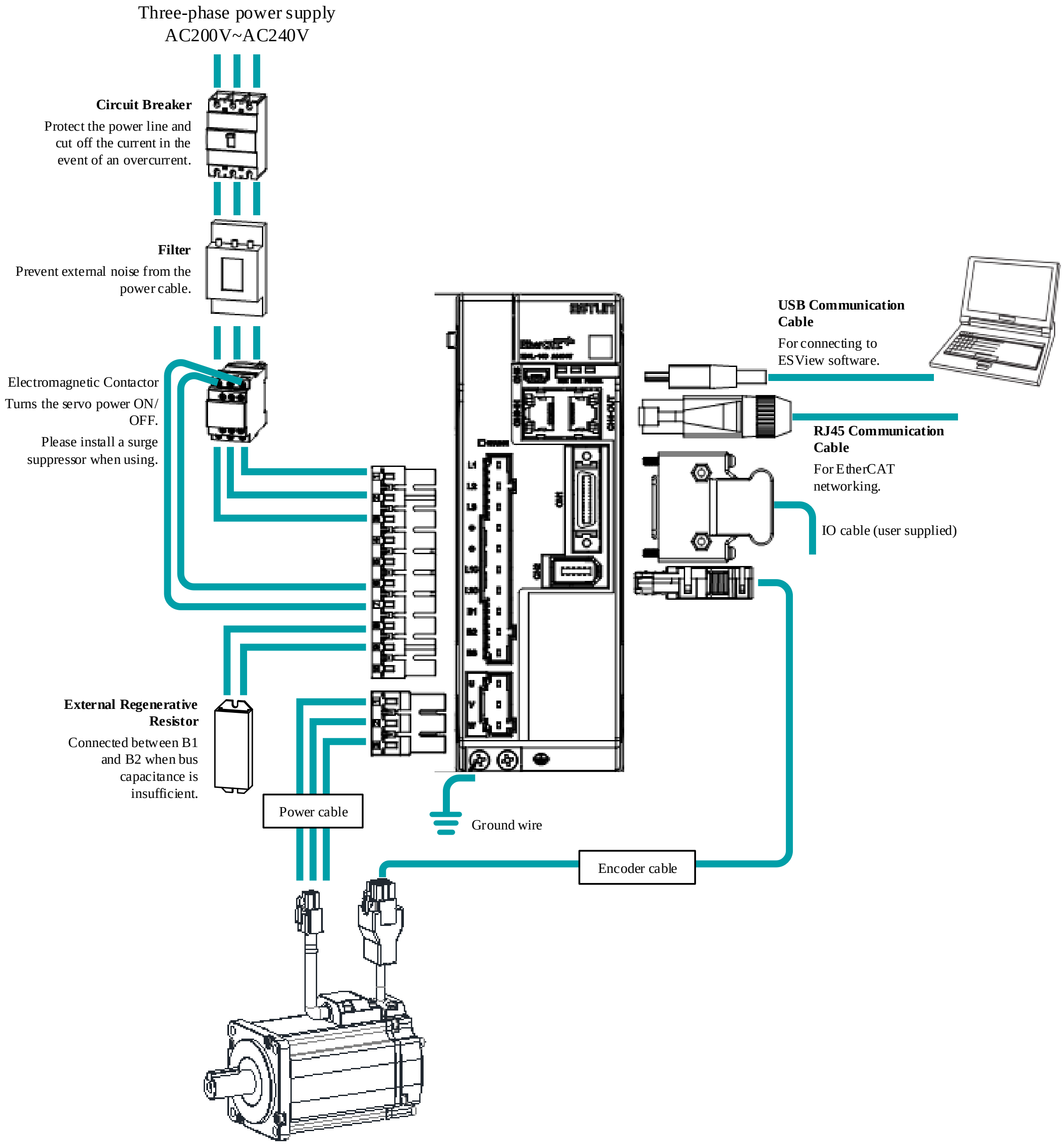


Rated power from 750W to 2kW



400VAC, rated power from 1kW to 7.5kW

Take a 1kW drive as an example:



1.7.2 Minimum System Configuration

Minimum system configuration of 200VAC

The minimum system configuration includes at least the following components.

Component Name	Description
Power Supply	Single-phase 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz Note: Single-phase power supply is used for 400W drive.
	Mains power supply (L1,L2,L3): three-phase AC 200V to 240V, -15% to +10%, 50Hz/60Hz
Circuit Breaker	Used a Type C MCB to protect the power supply line and cut off the circuit when an overcurrent occurs. The minimum rated current of the circuit breaker depends on the Drive model.
Noise Filter	Used to prevent external noise interference from the power supply. The rated current is 10 A or 20 A.
Magnetic Contactor	Control the power-on and power-off of the input circuit.
External Regenerative Resistor	When the busbar capacitance is insufficient, remove the short wiring and connect an external regenerative resistor. The minimum value of the regenerative resistor depends on the Drive model.
Drive	ED3L serial AC servodrive.
Motor	Matched EM3A servomotor or EMG servomotor (only for the rated power is greater than or equal to 1kW).
Controller	A device that realizes servo application and mechanical motion programming.
PC software	ESView V4
Cables	Encoder cables, motor power cables, Profinet communication cables, IO cables, etc.

Minimum system configuration of 400VAC

The minimum system configuration consists of at least the following components.

Component	Specification
Power supply	Control power supply (L1C,L2C): Single-phase AC AC 220V~440V, -15%~+10%, 50Hz/60Hz
	Mains power supply (L1,L2,L3): three-phase 380V~440V, -15% ~+10%, 50Hz/60Hz
Circuit breaker	Please use a Type C MCB to protect the power cord and to cut the circuit in the event of overcurrent. The minimum current rating of the circuit breaker varies with the drive model.
Noise filter	Protection against external noise interference from the power cable, with the current rated at 10A or 20A.
Electromagnetic contactor	ON/OFF control of the input circuit.

Component	Specification
External regenerative resistor	The minimum resistance value of the external regenerative resistor varies with the drive model.
Drive	ED3L Series Servo Drives.
Motor	Suitable for use with EM3A servo motors or EM3G (at rated power ≥ 0.9kW) servo motors.
Controller	The device provided for servo applications, mechanical motion programming.
PC debugging tool	ESView V4 software for PC.
Cables	Encoder cables, motor power cables, Profinet communication cables, IO cables, etc.

1.7.3 Peripheral Devices Specification

Drive Mode	Main circuit voltage	Built-in Regenerative Resistor	Min. Allowable Resistance	Min.Rated Current for Circuit Breaker
ED3L-A5AEA	Single-phase 200 VAC to 240VAC	–	45Ω	4A
ED3L-01AEA	Single-phase 200 VAC to 240VAC	–	45Ω	4A
ED3L-02AEA	Single-phase 200 VAC to 240VAC	–	45Ω	4A
ED3L-04AEA	Single-phase 200 VAC to 240VAC	–	45Ω	4A
ED3L-08AEA	Single-phase or three-phase 200 VAC to 240VAC	50Ω, 60W	25Ω	6A
ED3L-10AEA	Single-phase or three-phase 200 VAC to 240VAC	50Ω, 60W	25Ω	6A
ED3L-15AEA	Single-phase or three-phase 200 VAC to 240VAC	40Ω／80W	25Ω	16A
ED3L-20AEA	Single-phase 200 VAC to 240VAC	40Ω／80W	25Ω	16A
ED3L-10DEA	3-phase AC 380V~440V	100Ω／80W	65Ω	4A(3-phase)
ED3L-15DEA	3-phase AC 380V～440V	100Ω／80W	65Ω	6A(3-phase)
ED3L-20DEA	3-phase AC 380V～440V	50Ω／80W	40Ω	10A(3-phase)
ED3L-30DEA	3-phase AC 380V～440V	50Ω／80W	40Ω	16A(3-phase)
ED3L-50DEA	3-phase AC 380V～440V	35Ω／80W	20Ω	20A(3-phase)
ED3L-75DEA	3-phase AC 380V～440V	35Ω／80W	20Ω	25A(3-phase)

1.8 Part Numbers

Drive Model	Power	Motor Model	Power Cable	Encoder Cable
ED3L-A5A	50W	EM3A-A5ALA	EC3P-N9118-□□ (without brake) EC3P-B9118-□□ (Absolute) EC3P-N9718-□□ (without brake, IP65 plug) EC3P-B9718-□□ (Absolute, IP65 plug)	EC3S-I1724-□□ EC3S-A1724-□□ EC3S-I1124-□□ EC3S-A1124-□□
ED3L-01A	100W	EM3A-01ALA		
ED3L-02A	200W	EM3A-02ALA EM3A-02AKA EM3A-02AFA		
ED3L-04A	400W	EM3A-04ALA EM3A-04AKA EM3A-04AFA		EC3P-N8118-□□ (without brake) EC3P-B8118-□□ (with brake) EC3P-N8718-□□ (without brake, IP65) EC3P-B8718-□□ (with brake, IP65)
ED3L-08A	750W	EM3A-08ALA EM3A-08AKA EM3A-08AFA		
ED3L-10A	1kW	EM3A-10ALA EM3A-10AKA EM3A-10AFA		
	1kW	EMG-10AFD EMG-10ALB EMG-10AKB	EC3P-N9314-□□ (without brake) EC3P-B9314-□□ (Absolute)	EC3S-I1324-□□ EC3S-A1324-□□
ED3L-15A	1.5kW	EMG-15A	EC3S-I1324-□□ (without brake) EC3S-A1324-□□ (Absolute)	EC3P-N9314-□□(without brake) EC3P-B9314-□□ (with brake)
		EM3G-13A	EC3S-I1924-□□ (without brake) EC3S-A1924-□□ (Absolute)	
		EM3A-15A	EC3S-I1924-□□ (without brake) EC3S-A1924-□□ (Absolute)	
ED3L-20A	2kW	EMG-20A	EC3S-I1324-□□ (without brake) EC3S-A1324-□□ (Absolute)	
		EM3A-20A	EC3S-I1924-□□ (without brake) EC3S-A1924-□□ (Absolute)	
ED3L-10D	1kW	EM3G-09D□A224	EC3S-A1924-□□(Absolute)	EC3P-N9314-□□(without brake) EC3P-B9314-□□ (with brake)
ED3L-15D	1.5kW	EM3A-15D□B224 EM3G-13D□A224	EC3S-A1924-□□(Absolute)	EC3P-N9314-□□(without brake) EC3P-B9314-□□(with brake)
ED3L-20D	2kW	EM3A-20D□B224 EM3G-18D□A224	EM3A-20D□B224 EM3G-18D□A224	EC3P-N9314-□□(without brake) EC3P-B9314-□□(with brake)
ED3L-30D	3kW	EM3A-30DLA224 EM3G-29DLA244	EC3S-A1924- (Absolute)	EC3P-N8313-□□(without brake) EC3P-B8313-□□(with brake) EC3P-N8212-□□(without brake) EC3P-B8212-□□(with brake)

Drive Model	Power	Motor Model	Power Cable	Encoder Cable
ED3L-50D	5kW	EM3A-40DLA224 EM3A-50DLA224 EM3G-44DLA224	EC3S-A1924-　(Absolute)	EC3P-N9313-□□(without brake) EC3P-B9313-□□(with brake) EC3P-N9319-□□(without brake) EC3P-B9319-□□(with brake) EC3P-N9219-□□(without brake) EC3P-B9219-□□(with brake)
ED3L-75D	7.5kW	EM3G-55DLA224 EM3G-75DLA224	EC3S-A1924-　(Absolute)	EC3P-N9219-□□(without brake) EC3P-B9219-□□(with brake) EC3P-N9211-□□(without brake) EC3P-B9211-□□(with brake)

□□: The last two digits of the cable indicate the length (e.g. 1M5, 03, 05, 08, 10, 12, 15, 20), in metres (mm). Flexible cables are also available, marked with "-RX".

Chapter 2 Installation

2.1 Installation Precautions

- Installation Near Sources of Heat

  Implement measures to prevent temperature increases caused by external heat sources so that the ambient temperature of the Drive is within the specified limits.
- Installation Near Sources of Vibration

  Install a vibration absorber on the installation surface of the Drive so that the Drive will not be subjected to vibration.
- Other Precautions

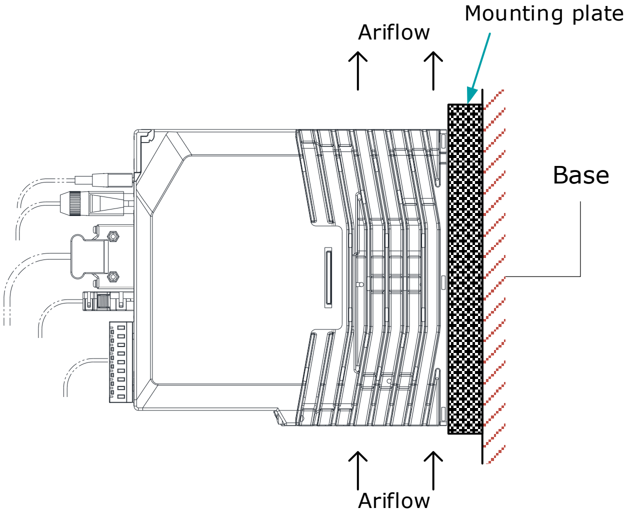
  Never install the Drive in a location subject to high temperatures, high humidity, water drops, cutting oil, excessive dust, excessive dirt, excessive iron powder, corrosive gasses, or radioactivity.

2.2 Mounting Types and Orientation

The Drives are based mounted and should be fitted to a non-painted metal surface. Mount the Drive vertically, as is shown in Figure 2-1.

Mount the Drives so that the Display Panel is facing toward the operator. Prepare two or three mounting holes for the Drive and mount it securely in the mounting holes (The number of mounting holes depends on the size of the Drive).

Figure 2-1 Base-mounted diagram

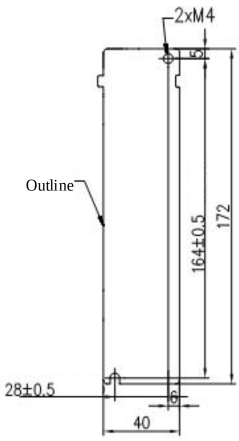


2.3 Mounting Hole Dimensions

Use all mounting holes to securely mount the Drive to the mounting surface.
To mount the Drive, use a screwdriver that is longer than the depth of the Drive.

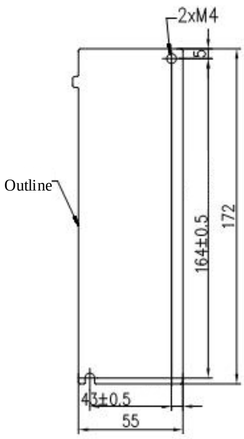
Wiring diagram for mounting holes at 200VAC

ED3L-A5AEA
ED3L-01AEA
ED3L-02AEA
ED3L-04AEA



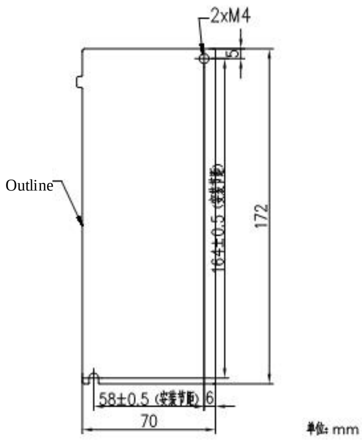
Machining Diagram for Mounting Holes (Mounting pitch)

ED3L-08AEA
ED3L-10AEA



Machining Diagram for Mounting Holes (Mounting pitch)

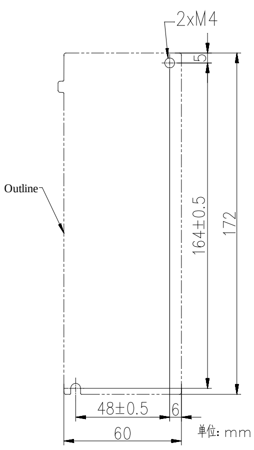
ED3L-15AEA
ED3L-20AEA



Machining Diagram for Mounting Holes (Mounting pitch)

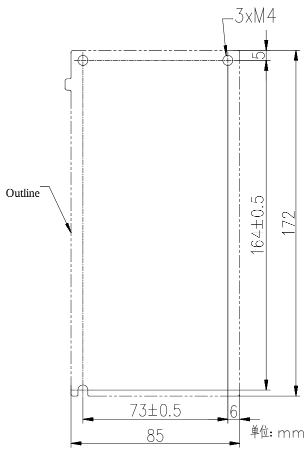
Wiring diagram for mounting holes at 400VAC

ED3L-10DEA
ED3L-15DEA



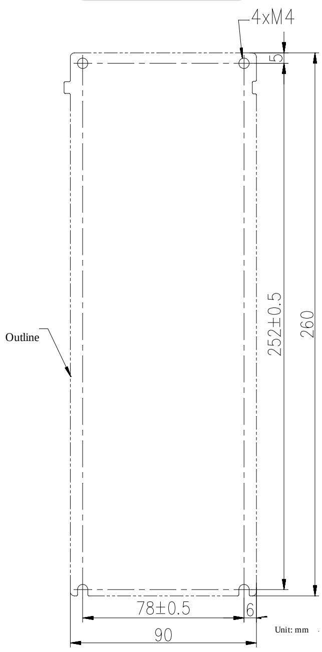
Machining Diagram for Mounting Holes (Mounting pitch)

ED3L-20DEA
ED3L-30DEA



Machining Diagram for Mounting Holes (Mounting pitch)

ED3L-50DEA
ED3L-75DEA



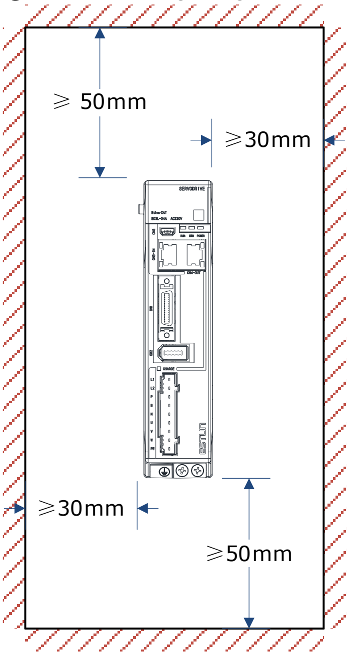
Machining Diagram for Mounting Holes (Mounting pitch)

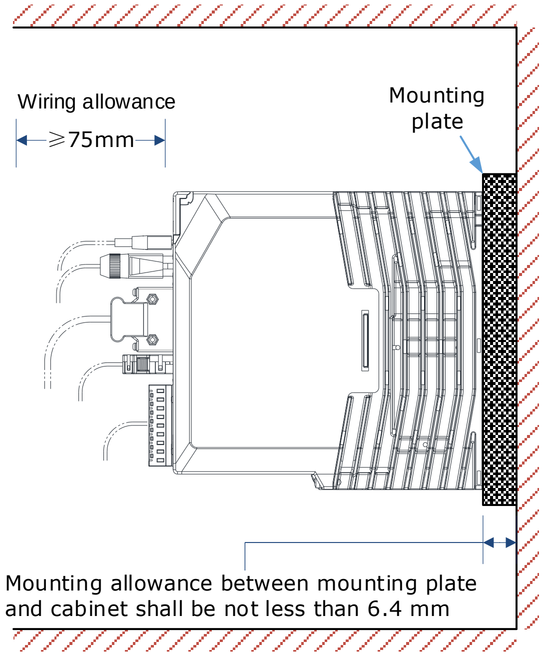
2.4 Mounting Interval

Installing One Drive in a Control Cabinet

When installing a single Drive use Figure 2-2 as a reference for free space around the installation.

Figure 2-2 Installing a single Drive in a control cabinet

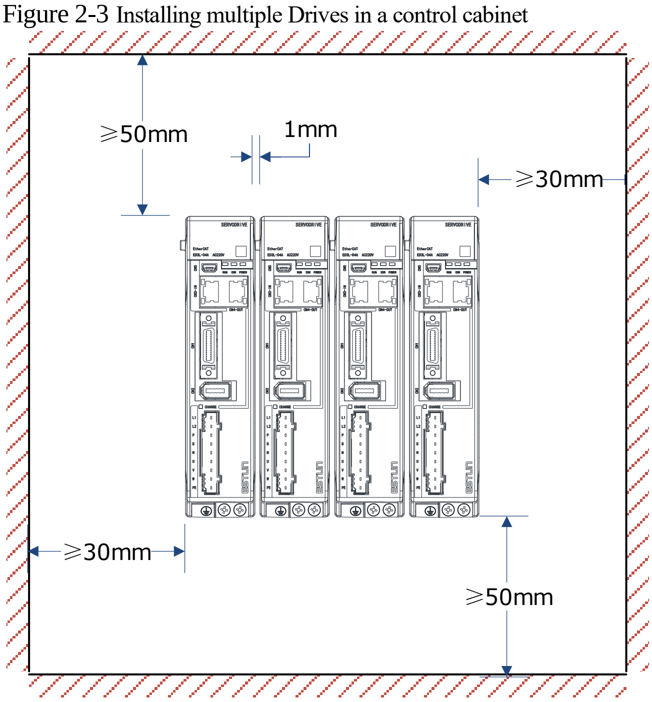




Installing multiple Drives in a Control Cabinet

When installing a multiple Drives use Figure 2-3 as a reference for free space around the installation.

Figure 2-3 Installing multiple Drives in a control cabinet



NOTE

The ED3L can be mounted so that the distance between adjacent Drives is 1mm.

The ED3L 50D and 75D drives do not allow close mounting due to wiring, and the distance between drives is to be confirmed upon assembly of the cable, for which 80mm is the recommended

Chapter 3 Wiring and Connecting

3.1 Precautions for Wiring

3.1.1 General Precautions

DANGER

Never change any wiring while power is being supplied, in case a risk of electric shock or injury.

WARNING

- Wiring and inspections must be performed only by qualified engineers.
- Check all wiring and power supplies carefully.
  Incorrect wiring or incorrect voltage application to the output circuits may cause short-circuit failures. If a short-circuit failure occurs as a result of any of these causes, the holding brake will not work. This could damage the machine or cause an accident that may result in death or injury.
- Connect the AC and DC power supplies to the specified Drive terminals.

CAUTION

- Wait for at least five minutes after turning OFF the power supply and then make sure that the CHARGE indicator is not lit before starting wiring or inspection work. Never touch the power supply terminals while the CHARGE lamp is lit after turning OFF the power supply because high voltage may still remain in the Drive.
- Observe the precautions and instructions for wiring and trial operation precisely as described in this document.
- Check the wiring to be sure it has been performed correctly.
  Connectors and pin layouts are sometimes different for different models. Always confirm the pin layouts in technical documents for your model before operation.
- Use shielded twisted-pair cables or screened unshielded multi-twisted-pair cables for I/O Signal Cables and Encoder Cables.
- The main circuit cable of the Drive must be guaranteed to work normally at 75 °C.
- Observe the following precautions when wiring the Drive's main circuit terminals.
  - Turn ON the power supply to the Drive only after all wiring, including the main circuit terminals, has been completed.
  - If a connector is used for the main circuit terminals, remove the main circuit connector from the Drive before you wire it.
  - Insert only one wire per insertion hole in the main circuit terminals.
  - When you insert a wire, make sure that the conductor wire (e.g. whiskers) does not come into contact with adjacent wires.
- Install molded-case circuit breakers and other safety measures to provide protection against short circuits in external wiring.

IMPORTANT

- Use a molded-case circuit breaker or fuse to protect the main circuit.
  The Drive connects directly to a commercial power supply; it is not isolated through a transformer or other device. Always use a molded-case circuit breaker or fuse to protect the Servo System from accidents involving different power system voltages or other accidents.
- Install an earth leakage breaker.
  The Drive does not have a built-in ground fault protective circuit. To configure a safer system, install a ground fault detector against overloads and short-circuiting, or install a ground fault detector combined with a molded-case circuit breaker.
- Never turn the power supply ON and OFF more than necessary.
  Use the Drive for applications that require the power supply to turn ON and OFF frequently. Such applications will cause elements in the Drive to deteriorate.
- After you have started actual operation, allow at least one hour between turning the power supply ON and OFF (as a guideline).

3.1.2 Countermeasures against Noise

IMPORTANT

The Drive is designed as an industrial device. It therefore provides no measures to prevent radio interference. The Drive uses high-speed switching elements in the main circuit. Therefore, peripheral devices may be affected by switching noise.

If the equipment is to be used near private houses or if radio interference is a problem, take countermeasures against noise.

Since the Drive uses microprocessors, it may be affected by switching noise from peripheral devices.

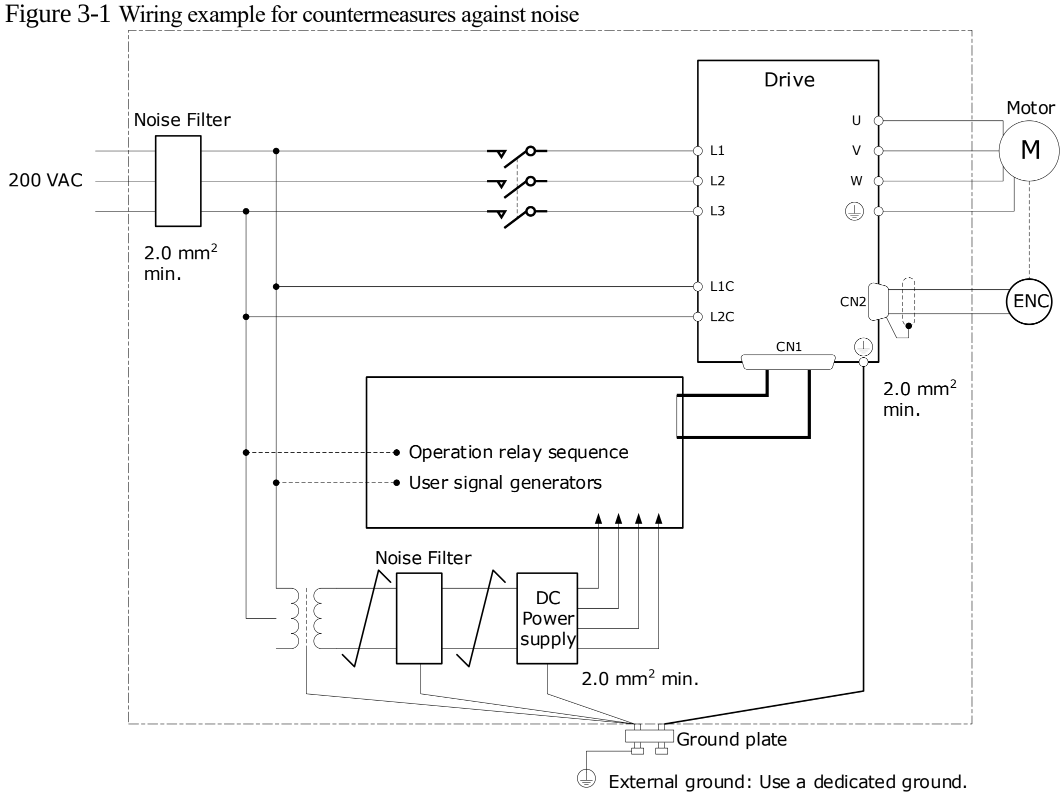
To prevent the noise from the Drive or the peripheral devices from causing malfunctions of any devices, take the following countermeasures against noise as required.

- Install the input reference device and Noise Filter as close to the Drive as possible.
- Always install a Surge Absorber for relays, solenoids, and Magnetic Contactor coils.
- Never place the following cables in the same duct or bundle them together. Also, separate the cables from each other by at least 30 cm.
  - Main Circuit Cables and I/O Signal Cables
  - Main Circuit Cables and Encoder Cables
- Never share the power supply with an electric welder or electrical discharge machine. If the Drive is placed near a high-frequency generator, install Noise Filters on the input side on the Main Circuit Power Supply Cable and Control Power Supply Cable even if the same power supply is not shared with the high-frequency generator. Refer to the section Noise Filters for information on connecting Noise Filters.
- Implement suitable grounding measures. Refer to the section 3.1.4 Grounding for information on grounding measures.

Noise Filters

You must attach Noise Filters in appropriate places to protect the Drive from the adverse effects of noise. Figure 3-1 is an example of wiring for countermeasures against noise.

Figure 3-1 Wiring example for countermeasures against noise

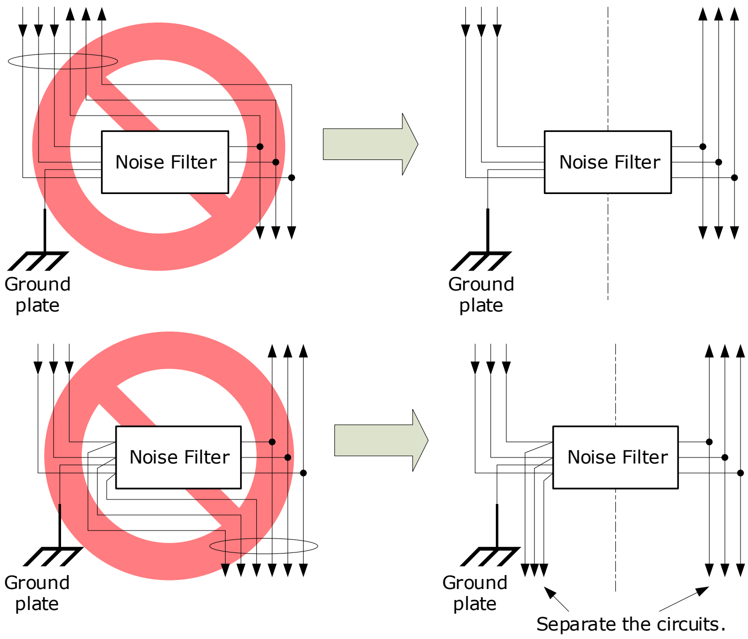


- For the ground wire, use a wire with a thickness of at least 2.0 mm2 (preferably, flat braided copper wire).
- Whenever possible, use twisted-pair wires to wire all connections marked with

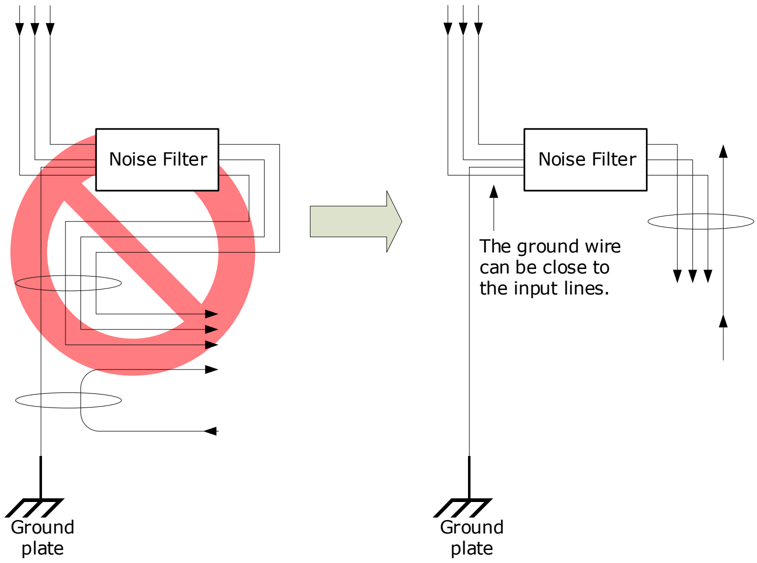
Noise Filter Wiring and Connection Precautions

Always observe the following precautions when wiring or connecting Noise Filters.

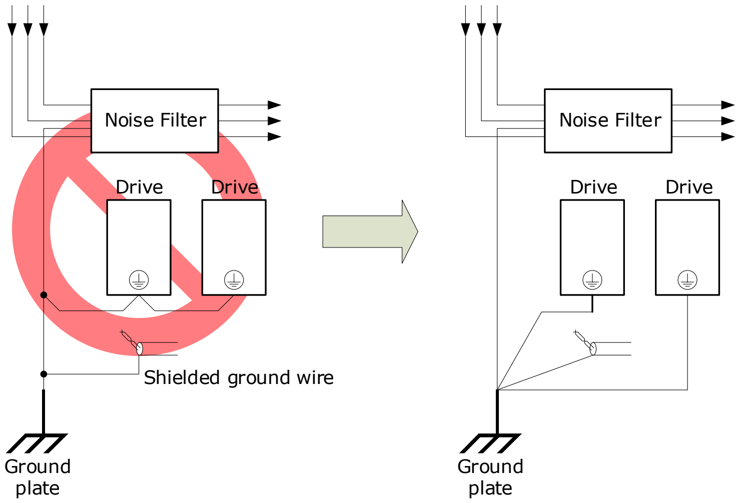
- Separate input lines from output lines. Do not place input lines and output lines in the same duct or bundle them together.



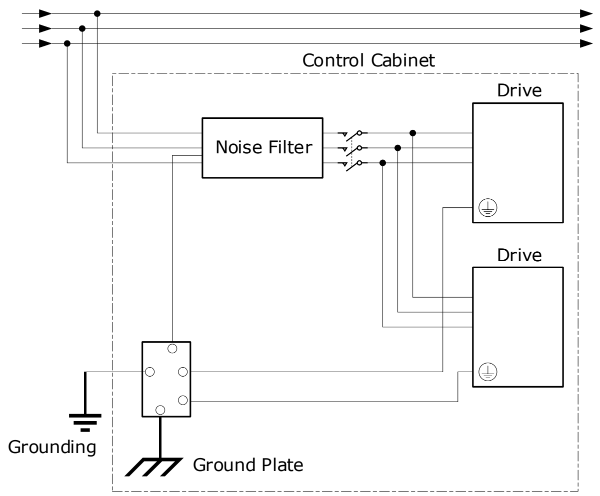
- Separate the Noise Filter ground wire from the output lines. Do not place the Noise Filter ground wire, output lines, and other signal lines in the same duct or bundle them together.



- Connect the Noise Filter ground wire directly to the grounding plate. Do not connect the Noise Filter ground wire to other ground wires.



- If a Noise Filter is located inside a control panel, first connect the Noise Filter ground wire and the ground wires from other devices inside the control panel to the grounding plate for the control panel, then ground the plate.



3.1.3 Recommended EMC Filters

To comply with the limits based on IEC/EN 61800-3 second environment (C2) the Drive and Motor must be installed with an EMC/RFI filter. Recommended filters are:

Driver voltage	Power Range	EMC C2
200VAC	50W～1.5kW	Schaffner FN 3270H-10-44
	2kW	Schaffner FN 3270H-20-44
400VAC	1kW~2 kW	Schaffner FN 3025HP-10-71
	3kW~5 kW	Schaffner FN 3025HP-10-71
	7.5kW	Shanghai Aerodev DNF51-3PH-3×20A

NOTE

These filters have been tested with cable lengths of 3m and 20m.

3.1.4 Grounding

Implement grounding measures as described in this section. Implementing suitable grounding measures will also help prevent malfunctions, which can be caused by noise. Always use an unpainted backplane for electrical cabinets.

Observe the following precautions when wiring the ground cable.

- Ground the Drive to a resistance of 100 mΩ or less.
- Be sure to ground at one point only.
- Ground the Motor directly if the Motor is insulated from the machine.

Motor Frame Ground or Motor Ground

If the Motor is grounded thought the machine, the switching noise current can flow from the main circuit of the Drive through the stray capacitance of the Motor. To prevent this always connect the Motor frame terminal (FG) or ground terminal (FG) of the Motor to the ground terminal ⏚ on the Drive. Also, be sure to ground the ground terminal ⏚.

Noise on I/O Signal Cables

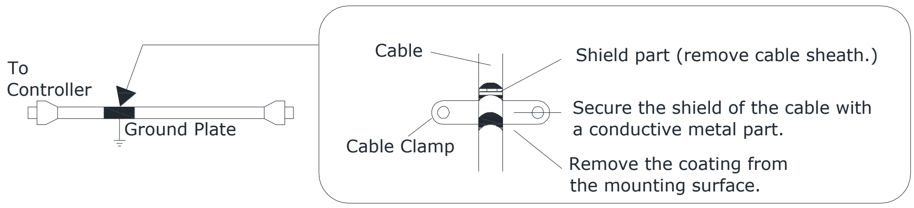
To prevent noise entering the I/O Signal Cable connect the shield of the I/O Signal Cable to the connector shell and ensure the shell is connected to ground.

If placing cables in metal conduits, ensure the conduit is connected to ground.

For all grounding, use a single grounding point.

Cable Fixing

It is recommended that all cable shields are secured with a conductive metal clamp to the ground plate. For example:



Ferrite Coils

While ferrite coils can be used to solve application specific EMC issues, they should not be necessary for applications.

3.1.5 IO signal cable selection and wiring

IO signal cable selection

Due to the external environment on the IO signal line strong interference noise impact， In order to ensure that the signal does not distort and attenuate during transmission, it is recommended that the signal line be shielded with a shielded cable with a shielded layer (at least 70% copper cladding).

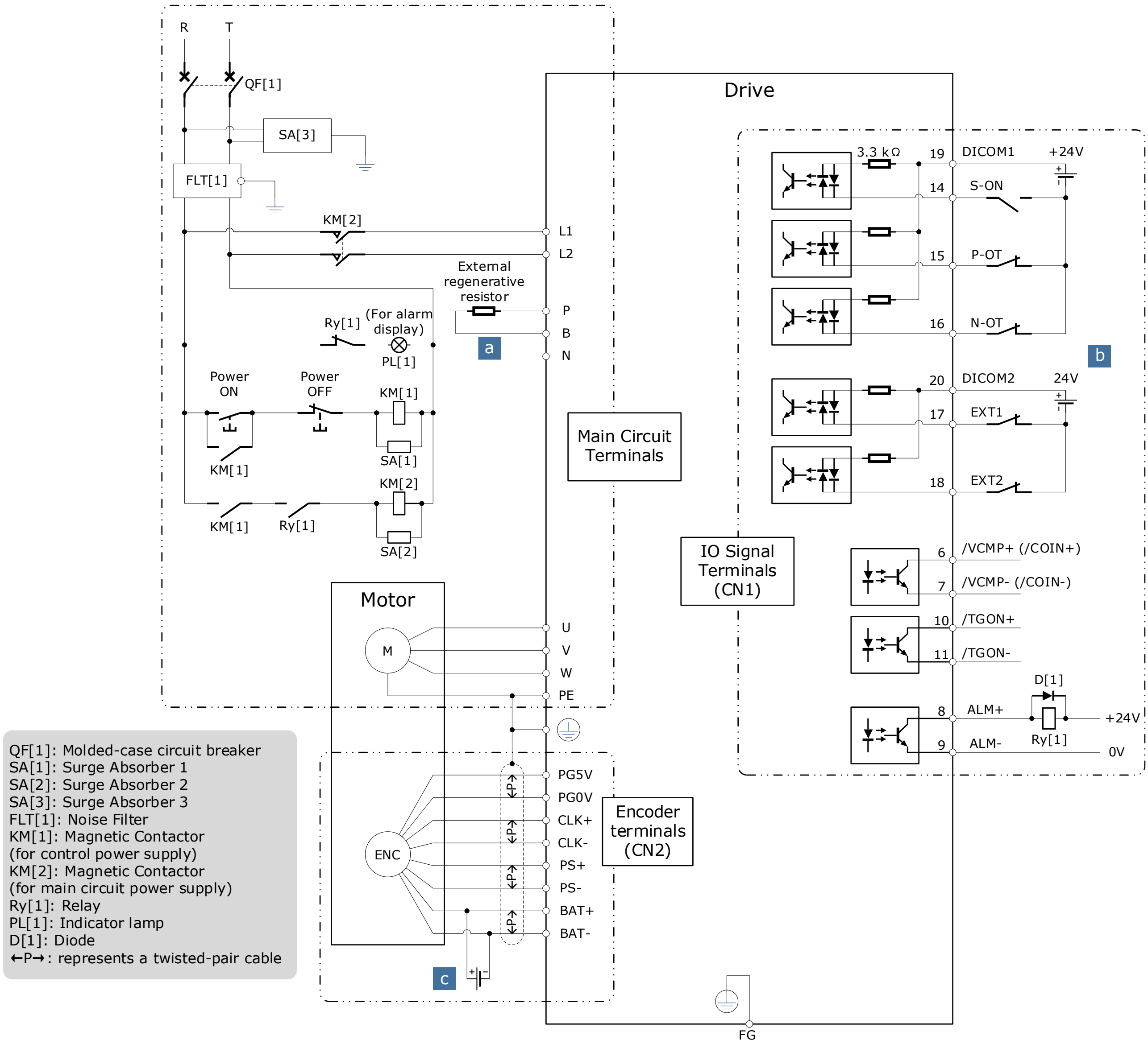
I/O signal cable wiring

The weak current signal (within 24V) should be wired at least 30cm away from the main loop route (L1, L2, L3, U, V, W) and other power lines or power lines, otherwise the IO signal will be interfered. If the number of drivers is large, separate the 5V signal line (especially the ECAT signal) from the 24V signal line as much as possible.

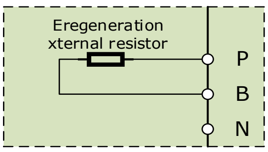
If the IO signal is a BK (holding brake) signal, the following requirements should be met: the 24V power supply for the IO signal should be independent of the 24V power supply of the motor holding brake.

3.2 Basic Wiring Diagrams

Rated power from 50W to 400W

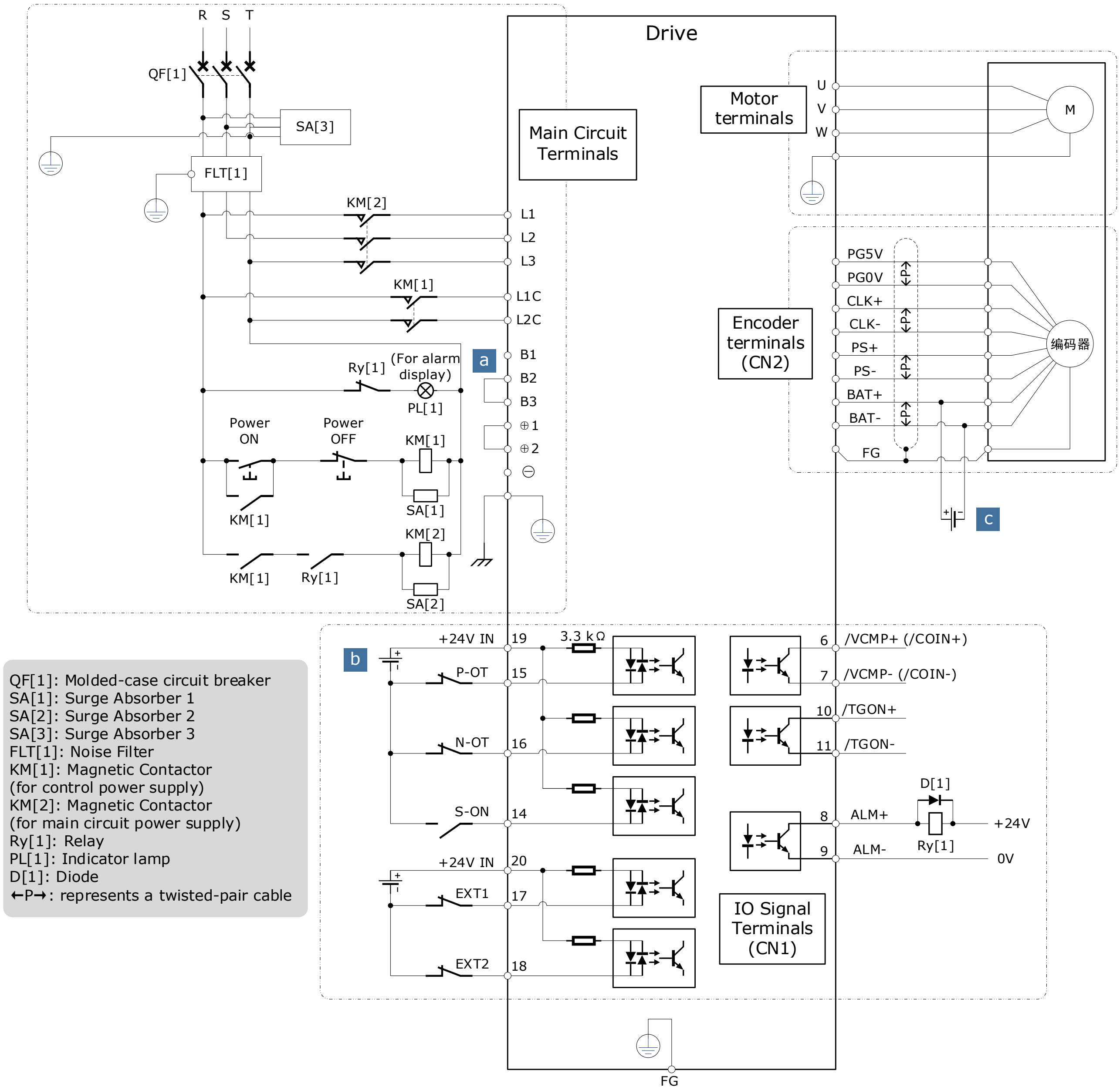


a: When an external discharge resistor is required, an external regenerative resistor is connected between P and B. The connection method is as follows. In addition, check and set "Pn521.0=0".

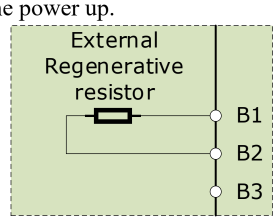


b: The external wiring of the input signals can use the co-cathode method or the co-anode method.
c: The connection of the battery is only for the Motors with the absolute encoder.

Rated power from 750W to 2kW



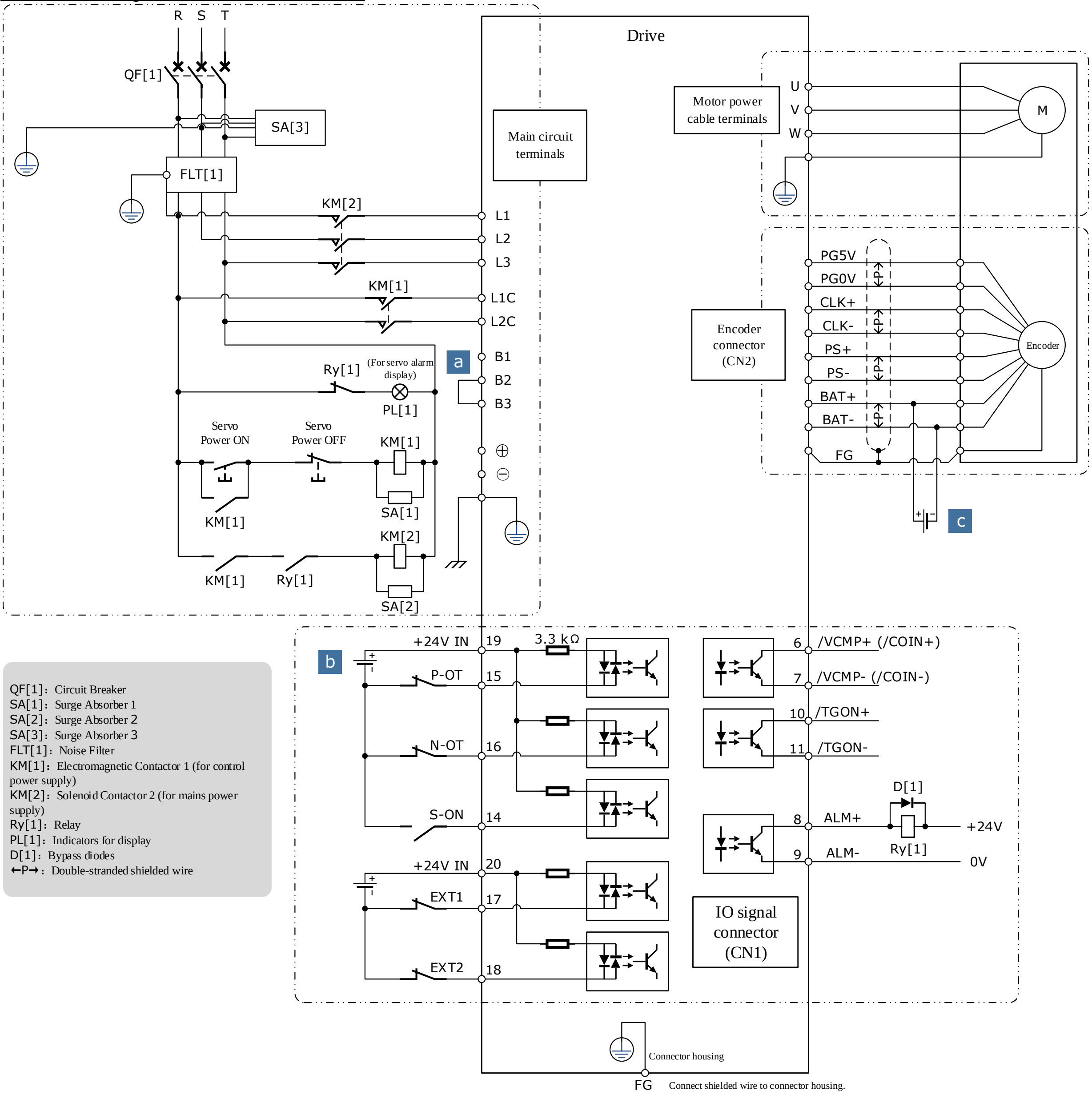
a: When the busbar capacitance is insufficient, remove the short wiring between B2 and B3, and connect an external regenerative resistor between B1 and B2, as is shown in the following figure. In addition, check and set Pn521.0 as 0 after the power up.



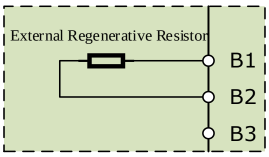
b: The external wiring of the input signals can use the co-cathode method or the co-anode method.

c: The connection of the battery is only for the Motors with the absolute encoder.

400VAC, rated power from 1kW to 7.5kW



a: When an external bleeder resistor is required, remove the jumper between B2 and B3 and connect an external regenerative resistor between B1 and B2, as shown below. In addition, check and set "Pn521.0 = 0".

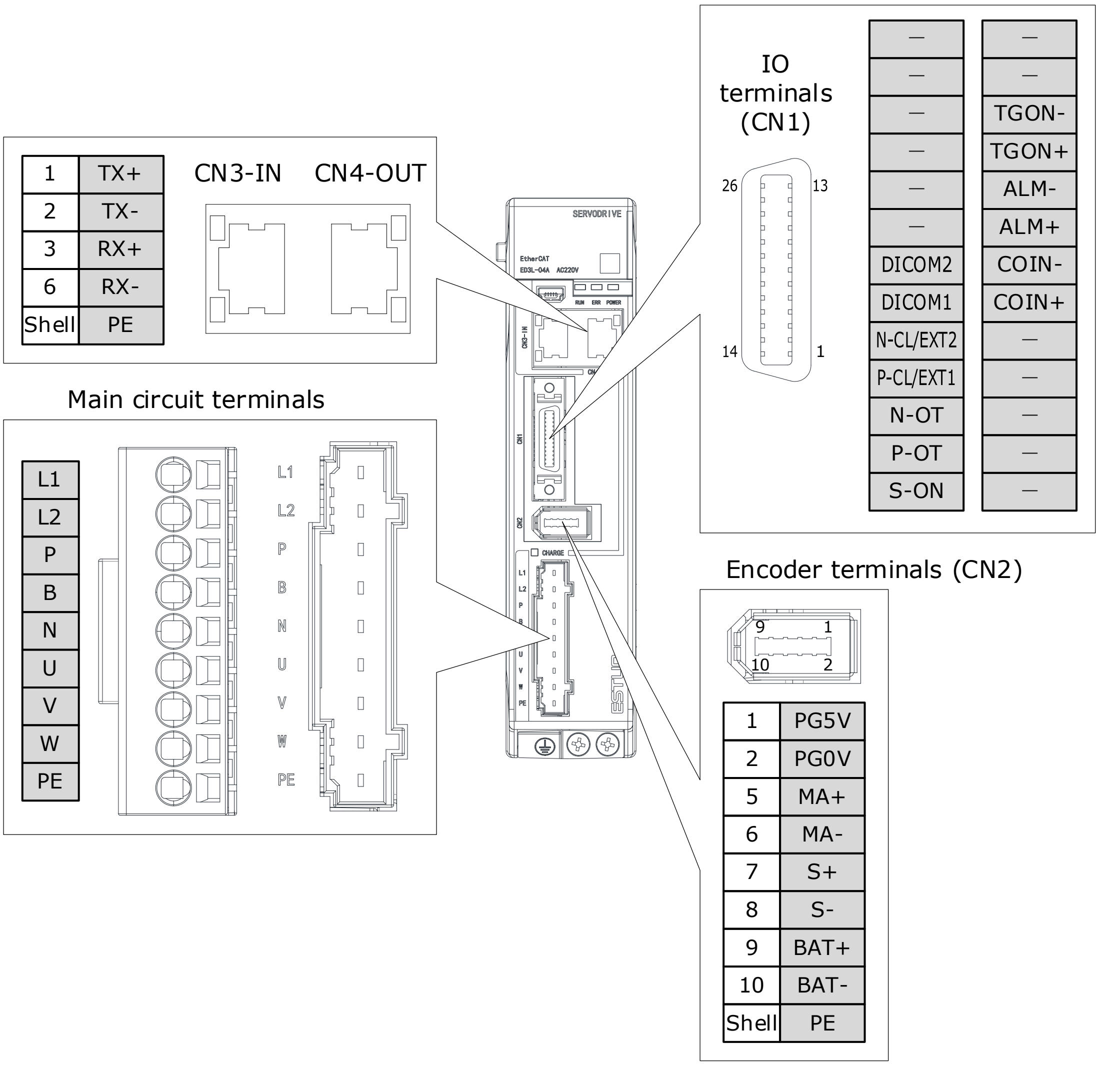


b: The input signal can be wired with a common cathode or common anode.

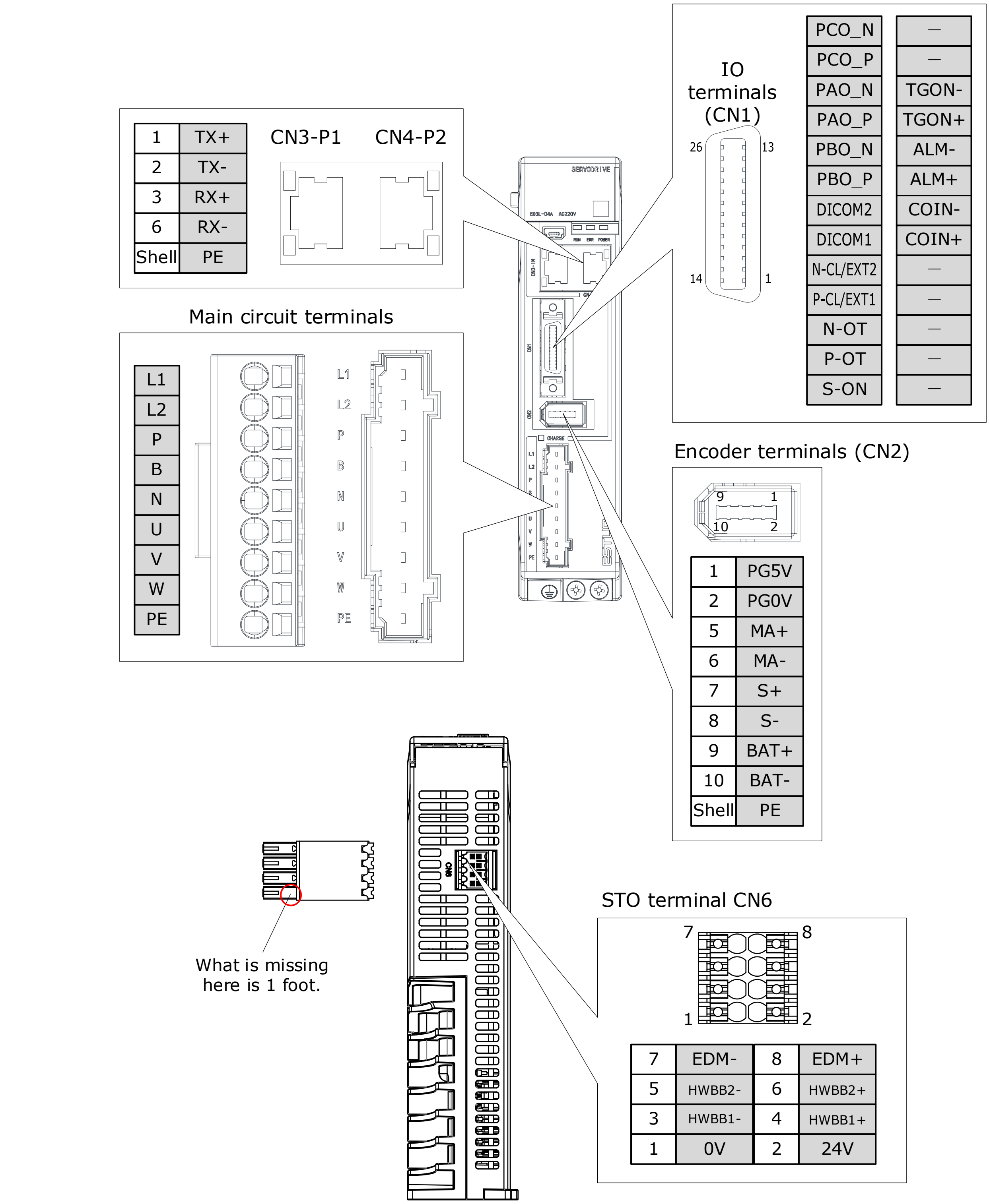
c: Only servo motors with absolute encoders use the battery case wiring.

3.3 Terminals Arrangements

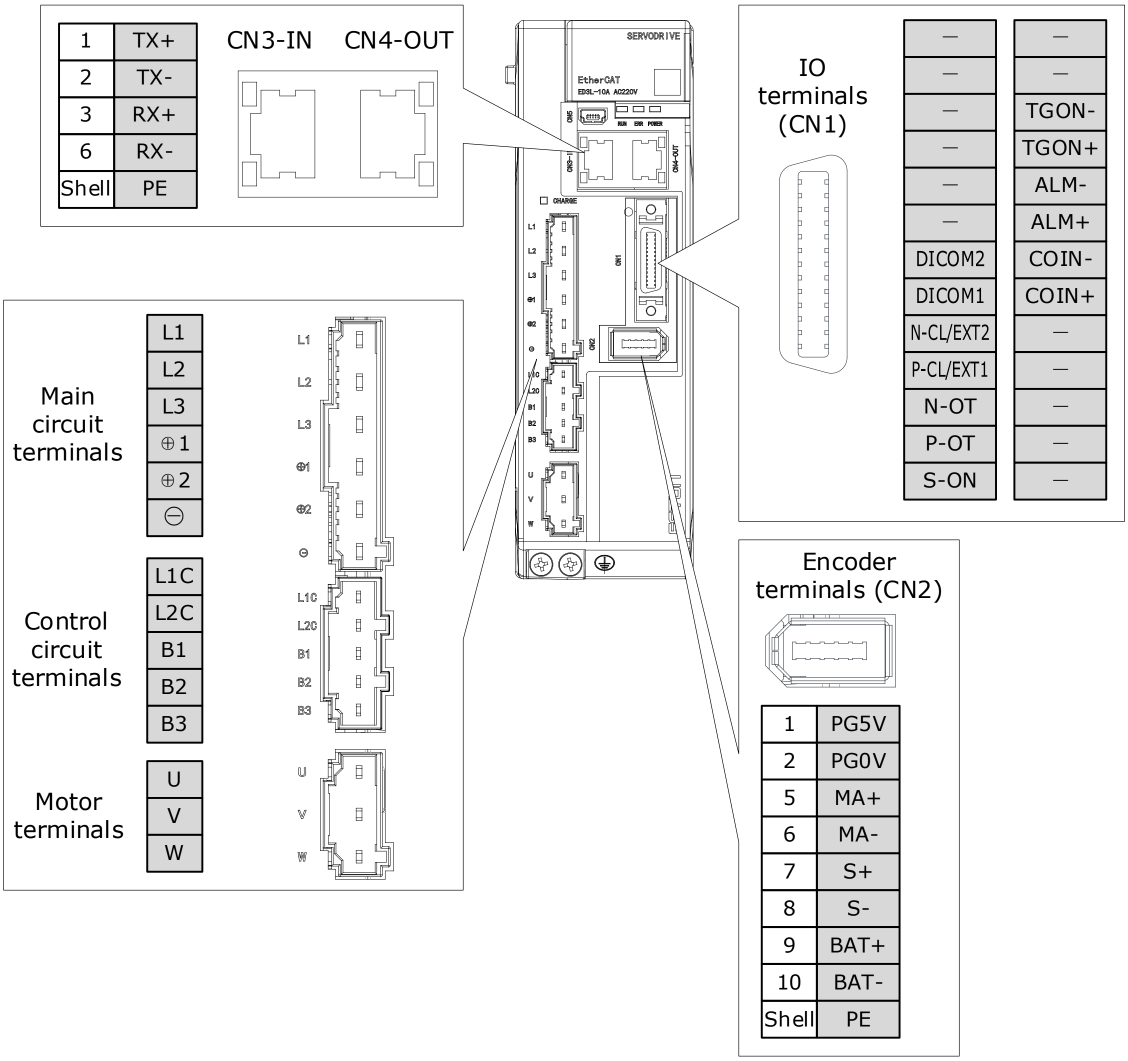
200VAC ， Rated power from 50W to 400W



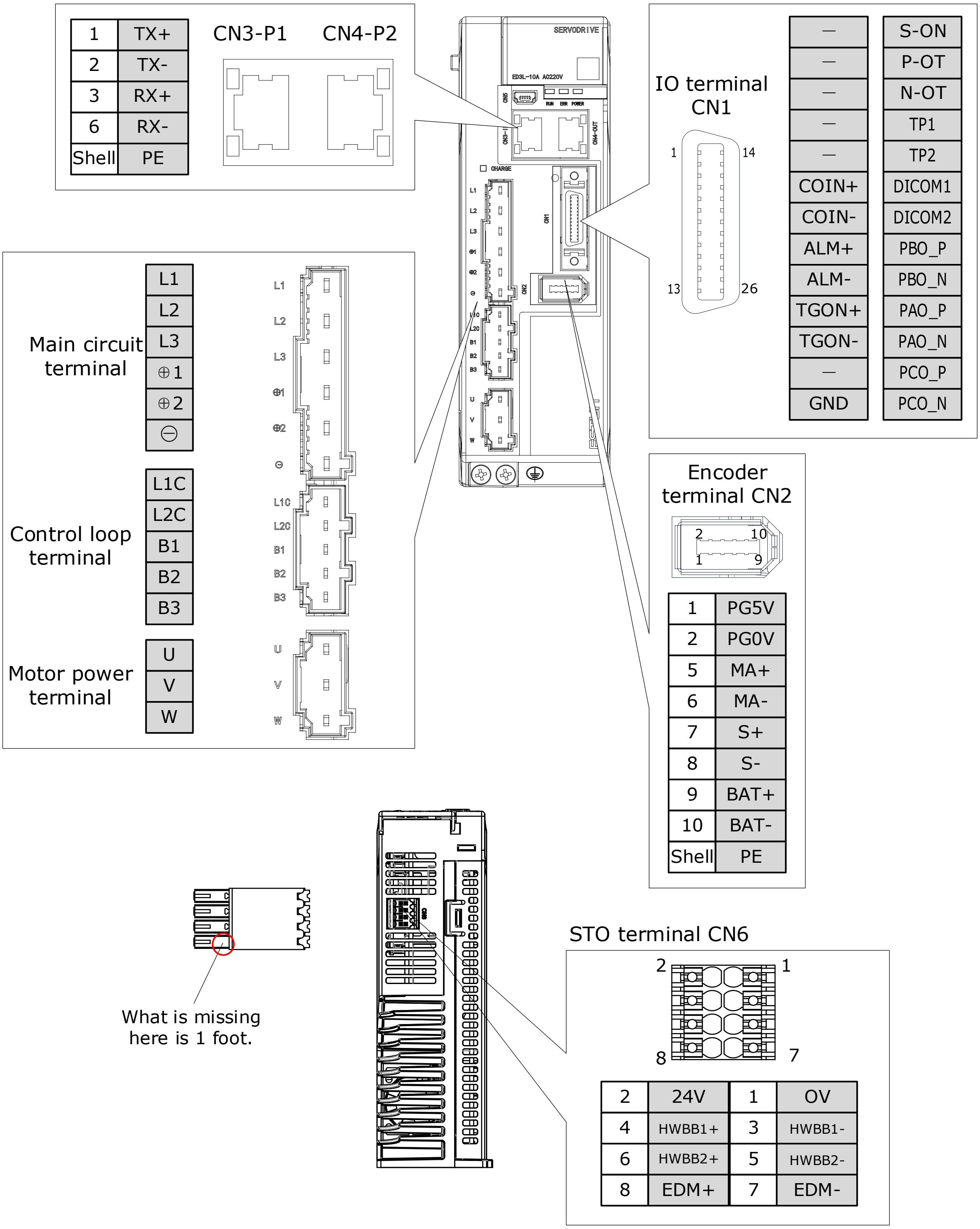
200VAC ， Rated power from 50W to 400W（-FS02 driver）



200VAC ， Rated power from 750W to 2kW



200VAC ， Rated power from 750W～2kW（-FS02 driver）



1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

IO terminal CN1

—	S-ON
—	P-OT
—	N-OT
—	TP1
—	TP2
COIN+	DICOM1
COIN-	DICOM2
ALM+	PBO_P
ALM-	PBO_N
TGON+	PAO_P
TGON-	PAO_N
—	PCO_P
GND	PCO_N

Main circuit terminal: L1, L2, L3, ⊕1, ⊕2, ⊖

Control loop terminal: L1C, L2C, B1, B2, B3

Motor power terminal: U, V, W

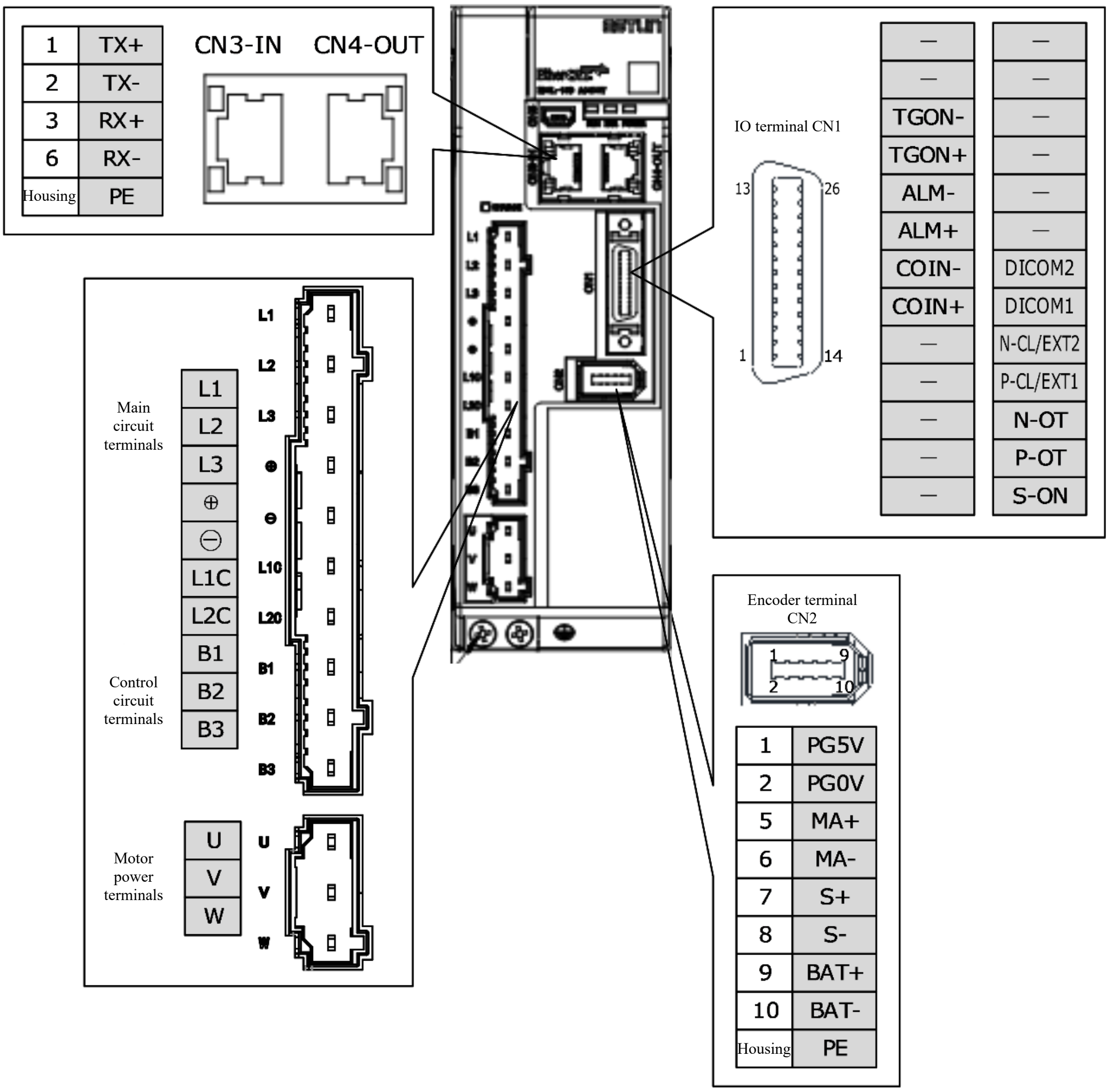
Encoder terminal CN2

1	PG5V
2	PG0V
5	MA+
6	MA-
7	S+
8	S-
9	BAT+
10	BAT-
Shell	PE

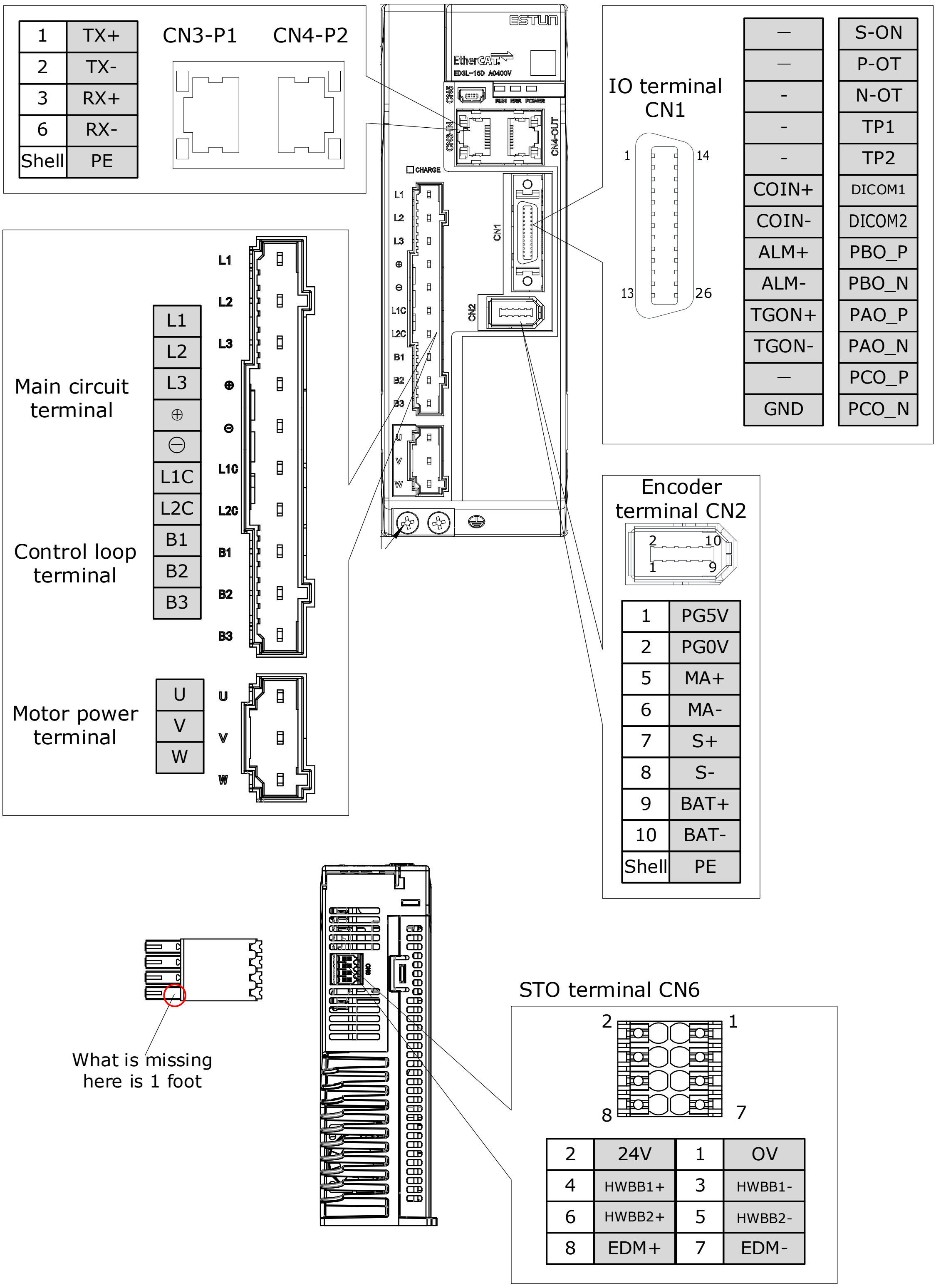
STO terminal CN6

2	24V	1	OV
4	HWBB1+	3	HWBB1-
6	HWBB2+	5	HWBB2-
8	EDM+	7	EDM-

400VAC, rated power from 1kW to 1.5kW



400VAC ，rated power from 1kW～1.5kW（-FS02 driver）



1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

L1	
L2	
L3	
⊕	
⊖	
L1C	
L2C	
B1	
B2	
B3	

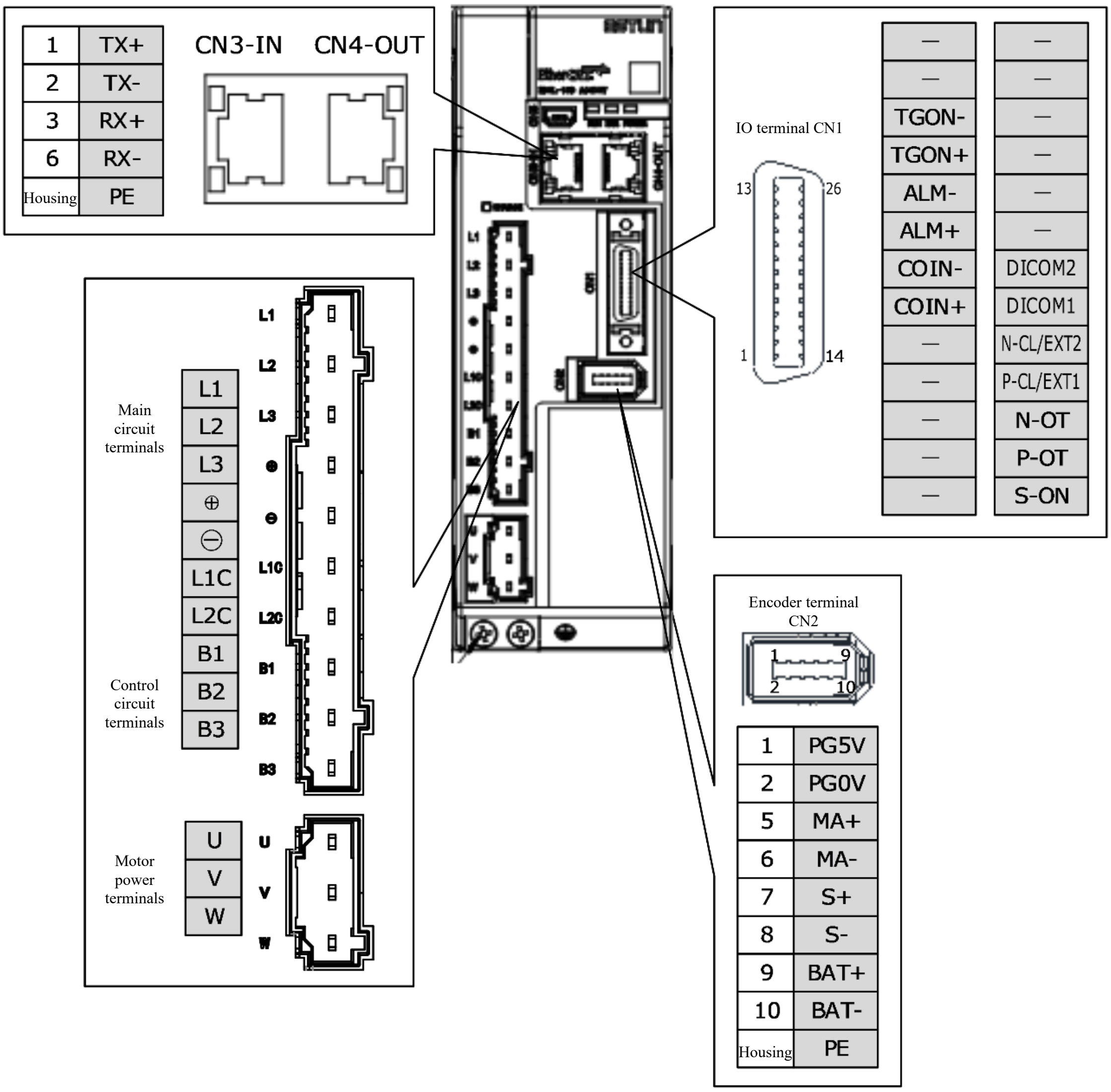
U
V
W

—	S-ON
—	P-OT
-	N-OT
-	TP1
-	TP2
COIN+	DICOM1
COIN-	DICOM2
ALM+	PBO_P
ALM-	PBO_N
TGON+	PAO_P
TGON-	PAO_N
—	PCO_P
GND	PCO_N

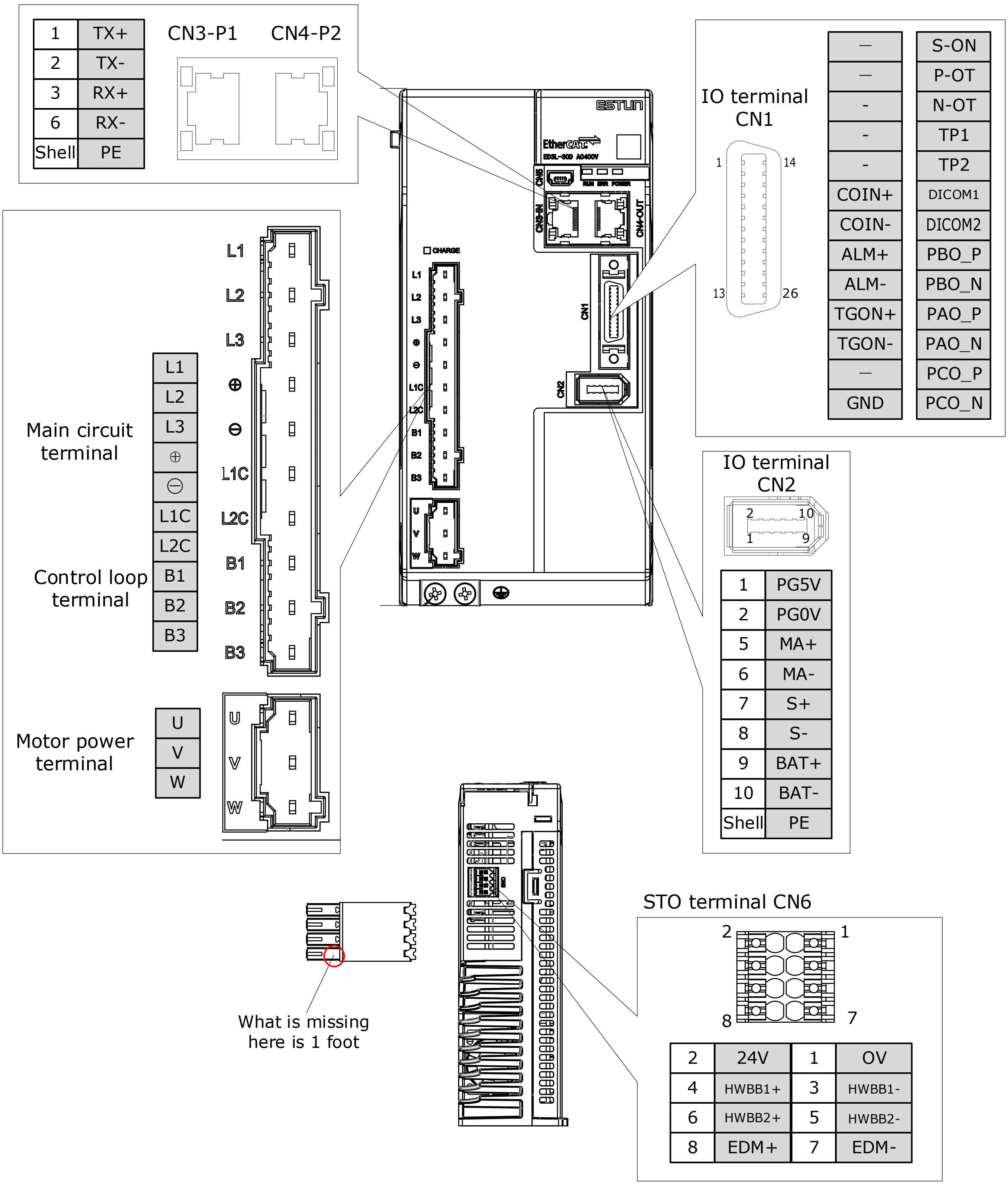
1	PG5V
2	PG0V
5	MA+
6	MA-
7	S+
8	S-
9	BAT+
10	BAT-
Shell	PE

2	24V	1	OV
4	HWBB1+	3	HWBB1-
6	HWBB2+	5	HWBB2-
8	EDM+	7	EDM-

400VAC, rated power from 2kW to 3kW



400VAC ， rated power from 2kW～3kW（-FS02 driver）



1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

IO terminal CN1

—	S-ON
—	P-OT
-	N-OT
-	TP1
-	TP2
COIN+	DICOM1
COIN-	DICOM2
ALM+	PBO_P
ALM-	PBO_N
TGON+	PAO_P
TGON-	PAO_N
—	PCO_P
GND	PCO_N

Main circuit terminal / Control loop terminal

L1
L2
L3
⊕
⊖
L1C
L2C
B1
B2
B3

Motor power terminal

U
V
W

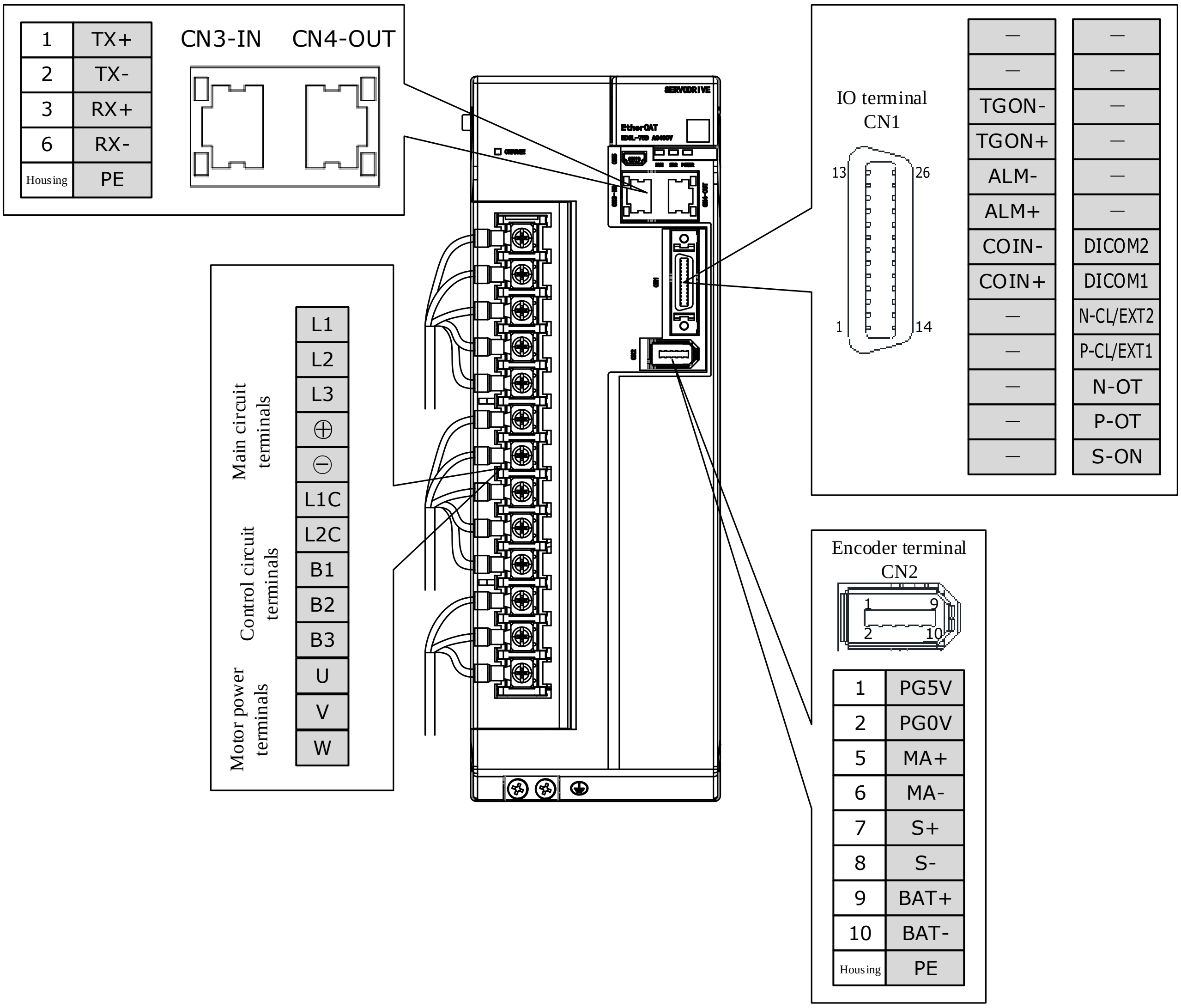
IO terminal CN2

1	PG5V
2	PG0V
5	MA+
6	MA-
7	S+
8	S-
9	BAT+
10	BAT-
Shell	PE

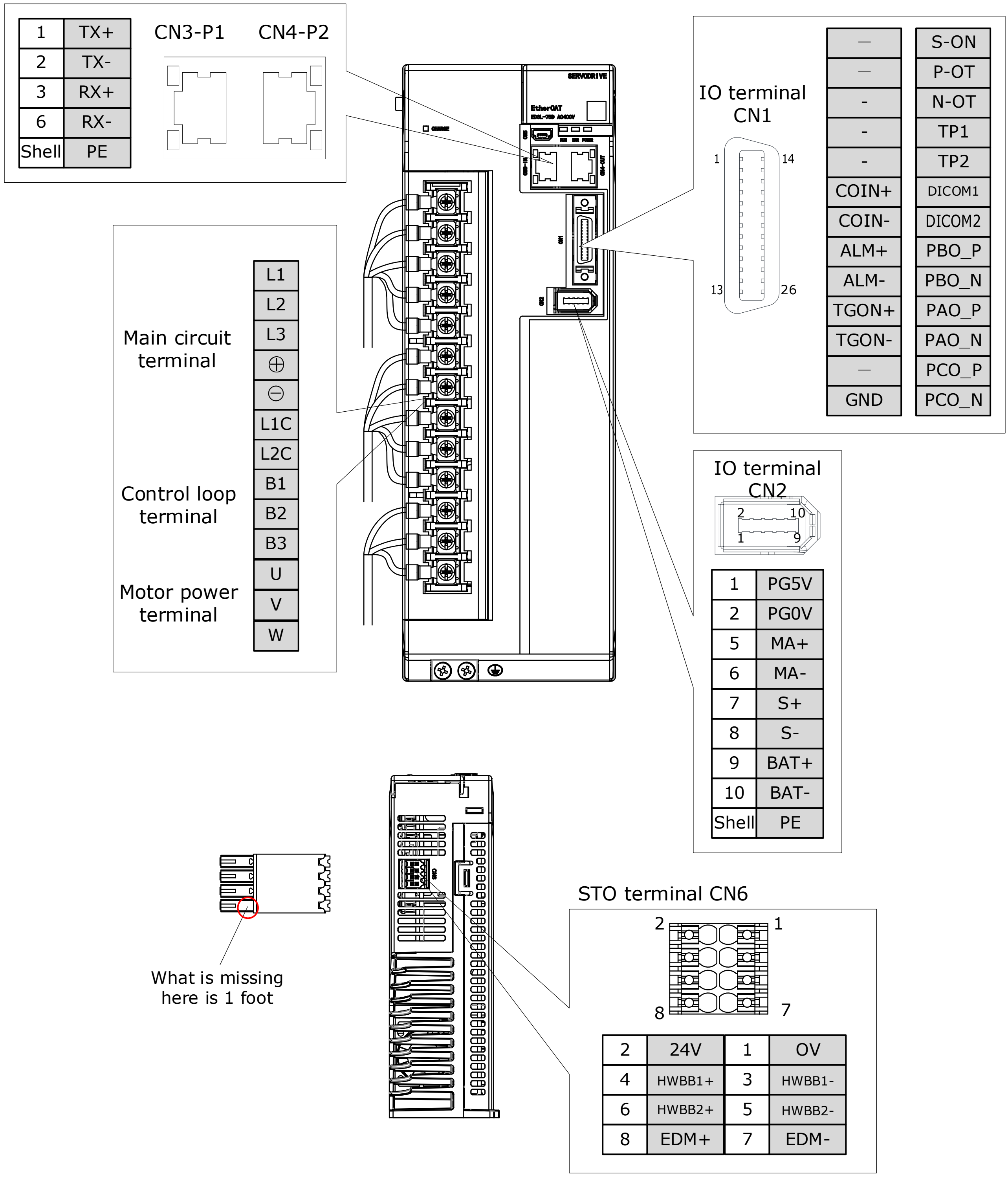
STO terminal CN6

2	24V	1	OV
4	HWBB1+	3	HWBB1-
6	HWBB2+	5	HWBB2-
8	EDM+	7	EDM-

400VAC, rated power from 5kW to 7.5kW



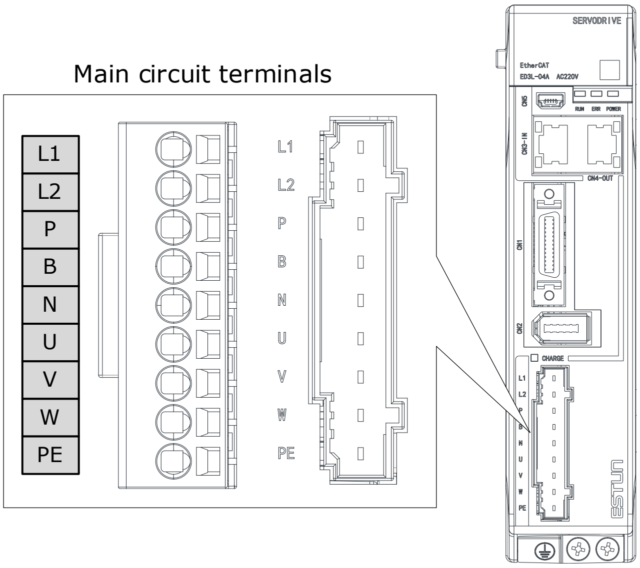
400VAC ， rated power from 5kW～7.5kW （-FS02 driver）



3.4 Wiring the Power Supply to Drive

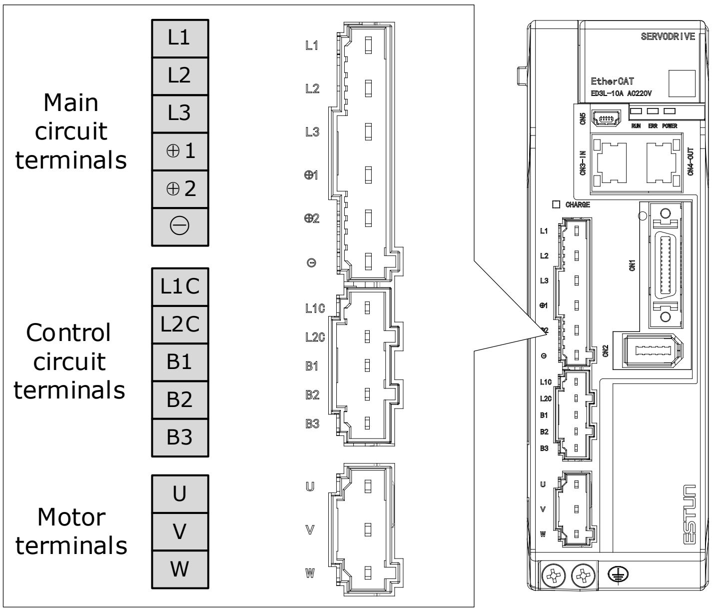
3.4.1 Terminals Arrangement

Rated power from 50W to 400W



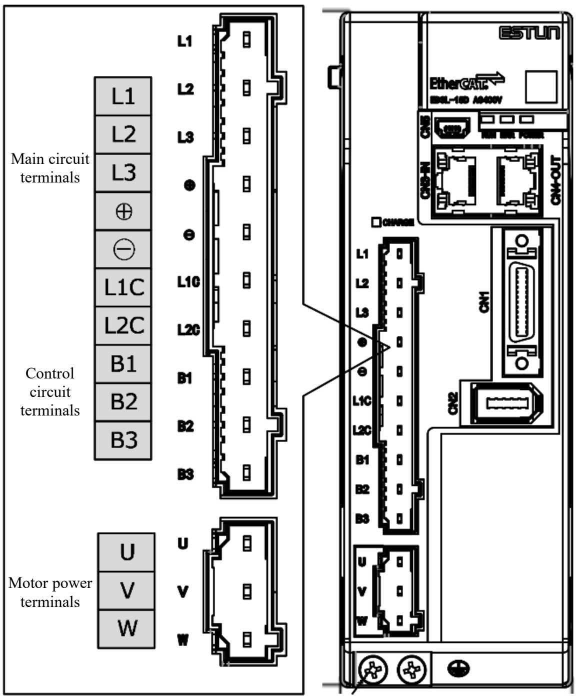
Symbols	Name	Specifications and Reference
L1, L2	Main circuit power supply input terminals	Single-phase, 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz
P, B	Regenerative Resistor terminal	Connects a regenerative resistor with a minimum resistance value of 45 ohm
P, N	DC terminals	For the common DC bus, connect all P of Drive to the positive pole, and N to the negative pole.
U, V, W	Motor terminals	Connects the U-phase, V-phase and W-phase of Motor
PE	Ground terminal	Always connect this terminal to prevent electric shock.

Rated power from 750W to 1kW



Symbols	Name	Specifications and Reference
L1, L2, L3	Main circuit power supply input terminals	Three-phase, 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz
⊕1, ⊕2	DC reactor terminals	For using a DC reactor, remove the short wiring, and connect a DC reactor between ⊕1 and ⊕2.
⊕2, ⊖	DC terminals	For the common DC bus, connect all ⊕2 of Drive to the positive pole, and ⊖ to the negative pole.
L1C, L2C	Control circuit terminals	Single-phase, 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz
B1, B2, B3	Regenerative Resistor terminal	There is a short wiring between B2 and B3 at the factory. When the busbar capacitance is insufficient, remove the short wiring, and connect an external regenerative resistor between B1 and B2.
U, V, W	Motor terminals	Connects the U-phase, V-phase and W-phase of Motor
⏚	Ground terminal	Always connect this terminal to prevent electric shock.

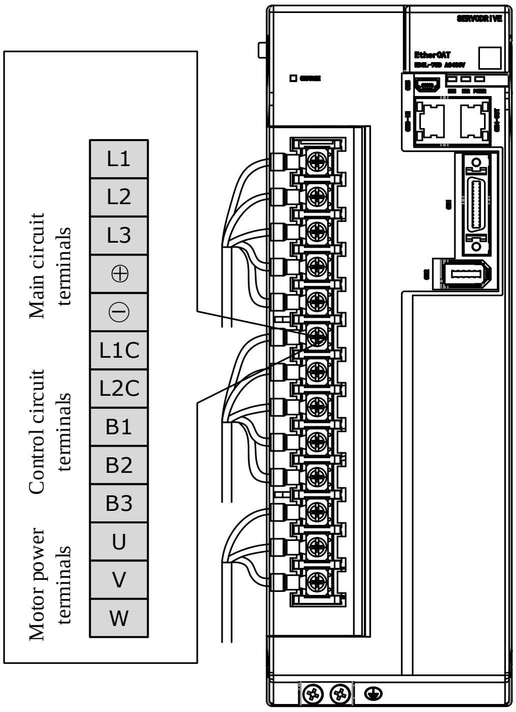
400VAC, rated power from 1kW to 3kW



Take for example a product with a power rating of 1kW~1.5kW. Products with power rating from 1.5kW to 3kW are similar in appearance and have the same components

Symbol	Name	Specifications
L1, L2, L3	Power supply input terminals	3-phase AC 380V～440V，-15%～+10%，50Hz/60Hz
⊕，⊖	DC busbar connectors	When multiple servo drives are used in a common DC bus configuration, ⊕ and ⊖ of all drives are connected in series, respectively.
L1C, L2C	Control power terminals	Single-phase AC 380V～440V, -15%～+10%, 50Hz/60Hz
B1, B2, B3	Regenerative resistor connectors	When using the built-in regenerative resistor: Keep the connection between B2 and B3 shorted. When using an external regenerative resistor: Please remove the jumper between B2 and B3 and connect the external regenerative resistor between B1 and B2.
U, V, W	Motor power connectors	• Connect the U, V and W phases of the motor.
⏚	Grounding terminals	Connect the power supply earth terminal for earthing.

400VAC, rated power from 5kW to 7.5kW



Symbol	Name	Specifications
L1, L2, L3	Power supply input terminals	3-phase AC 380V～440V，-15%～+10%，50Hz/60Hz
⊕， ⊖	DC busbar connectors	When multiple servo drives are used in a common DC bus configuration, ⊕ and ⊖ of all drives are connected in series, respectively.
L1C, L2C	Control power terminals	Single-phase AC 380V～440V, -15%～+10%, 50Hz/60Hz
B1, B2, B3	Regenerative resistor connectors	When using the built-in regenerative resistor: Keep the connection between B2 and B3 shorted. When using an external regenerative resistor: Please remove the jumper between B2 and B3 and connect the external regenerative resistor between B1 and B2.
U, V, W	Motor power connectors	• Connect the U, V and W phases of the motor.
⏚	Grounding terminals	Connect the power supply earth terminal for earthing.
L1, L2, L3	Power supply input terminals	3-phase AC 380V～440V, -15%～+10%, 50Hz/60Hz

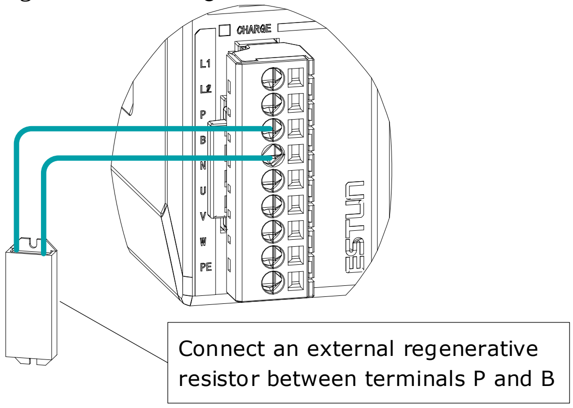
3.4.2 Wiring a Regenerative Resistor

When the busbar capacitance is insufficient, the driver needs an external regenerative resistor. The minimum resistance of a regenerative resistor varies by driver model, and the detailed specifications are shown in the table below.

Drive model	Rated power	The minimum value of the regenerative resistance	Connect the terminals
ED3L-A5AEA	0.05kW	45Ω	P、B
ED3L-01AEA	0.1kW		
ED3L-02AEA	0.2kW		
ED3L-04AEA	0.4kW		
ED3L-08AEA	7.5kW	25Ω	B1、B2
ED3L-10AEA	1.0kW		
ED3L-15AEA	1.5kW	10Ω	B1、B2
ED3L-20AEA	2.0kW		
ED3L-10DEA	1kW	65Ω	B1、B2
ED3L-15DEA	1.5kW		
ED3L-20DEA	2.0kW	40Ω	B1、B2
ED3L-30DEA	3.0kW		
ED3L-50DEA	5.0kW	20Ω	B1、B2
ED3L-75DEA	7.5kW		

Figure 3-2 is an example of connecting an external regenerative resistor for the drives rated power from 50W to 400W.

Figure 3-2 Wires a regenerative resistor



WARNING

Connect the external regenerative resistor as following to avoid damaging the drive or malfunction.

- It is necessary to connect an external regenerative resistor for the drives rated power from 50W to 400W. The minimum resistance value of the external regenerative resistor is 45 ohms.
  Never connect the external regenerative resistor between terminals P and N.
- In the case of the drives rated power from 750W to 1kW, confirms whether the bus capacitance is insufficient. If necessary, connect an external regeneration resistor between terminals B1 and B2. The minimum resistance value of the external regenerative resistor is 25 ohms.
  Never connect the external regenerative resistor between terminals B1 and B3.
- When an excternal regenerative resistor is connected, check and set Pn521.0 as 0 after the power up.
- Please check and confirm that the external regenerative resistor is mounted on non-combustible materials.

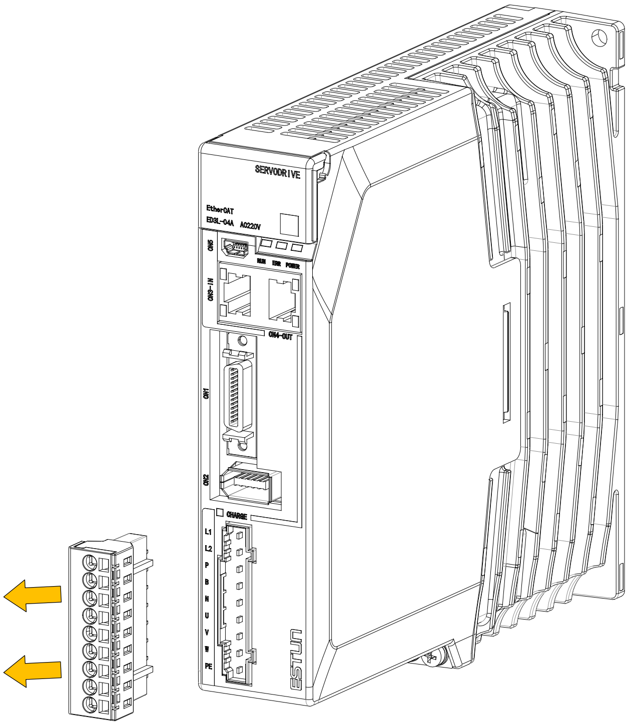
3.4.3 Wiring Procedure

Prepare the following items before preparing the wiring for the Main Circuit Terminals and Control Circuit Terminals.

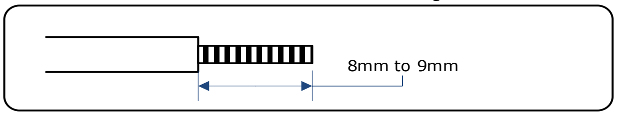
Required Item	Description
Flat-blade screwdriver or Terminal removal tool	• Flat-blade screwdriver: commercially available screwdriver with tip width of 3.0 mm to 3.5 mm • Terminal removal tool: an accessory of the Drive
Cold pressed terminals	Sleeve type ferrule with cross-section from 1.5 mm^2 to 2.5 mm^2
Wiring plier	Commercially available plier with crimping and stripping functions

Follow the procedure below to wire the Main Circuit Terminals and Control Circuit Terminals.

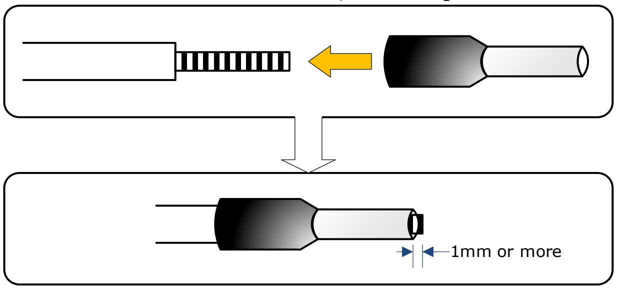
Step 1 Remove the Main Circuit Terminals and Control Circuit Terminals from the Drive.



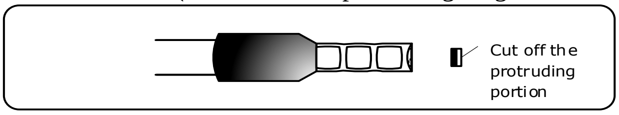
Step 2 Peel off the sheath so that the conductor portion of the cable will protrude from the tip of the ferrule.



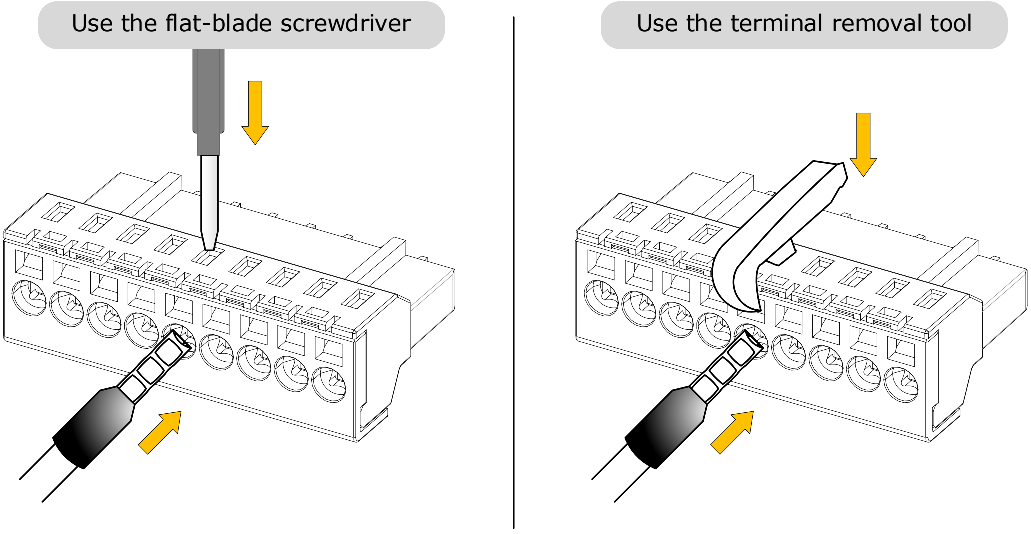
Step 3 Insert the cable into the ferrule (It should protrude 1 mm or more from the ferrule).



Step 4 Crimp the cable that has been inserted into the ferrule, and cut off the cable conductor portion protruding from the ferrule (The allowable protruding length after cutting should not be more than 0.5 mm).



Step 5 Use the flat-blade screwdriver or the terminal removal tool to press down the spring button corresponding to the terminal, and then insert the cable.



Step 6 Insert the crimped cable into the connection terminals, and then pull out the tool.

Step 7 Make all other connections in the same way.

Step 8 To change the wiring, pull the cable out of the connection terminals.
Use the flat-blade screwdriver to press down the spring button corresponding to the terminal, and then gently pull out the cable.

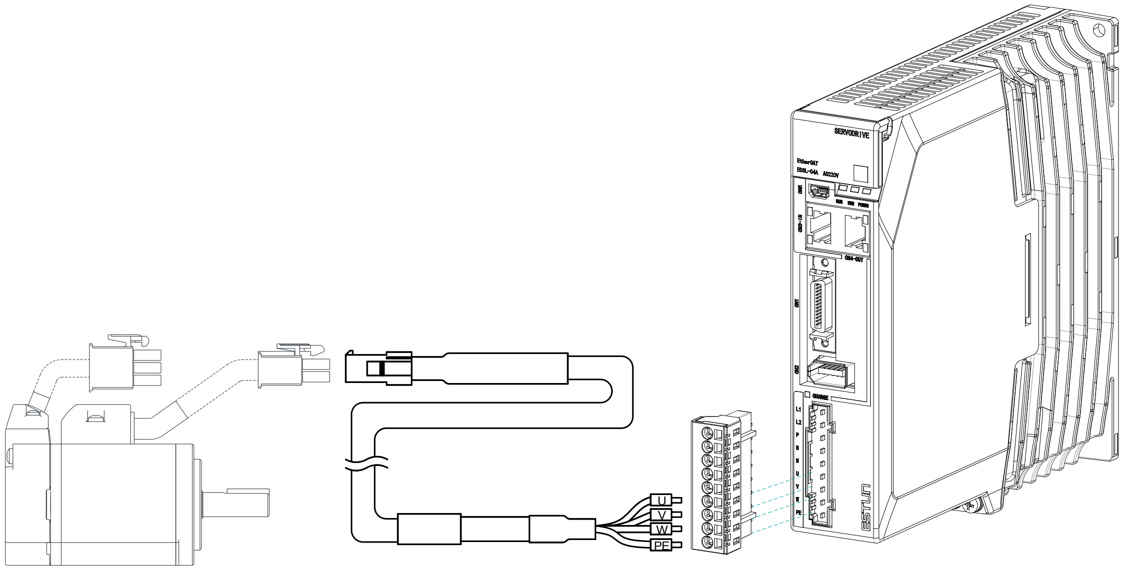
Step 9 When you have completed wiring, attach connection terminals to the Drive.

NOTE

The above wiring procedure is also applicable to the Motor Terminals.

----End

3.4.4 Motor Connection Diagram



3.4.5 Motor Power Cable Description

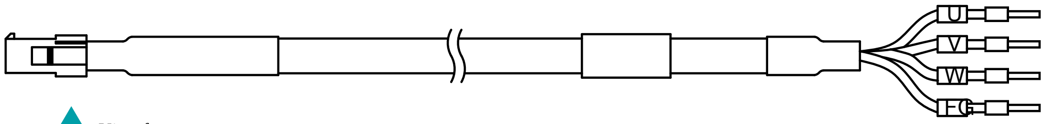
The Motor power cable depends on the Motor model. The common models are shown in the table below.

Motor model	Brake	IP65 Plug	Wire diameter	Motor power cable		
				length is 3.0m	length is 5.0m	length is 10.0m
EM3A-A5A EM3A-01A EM3A-02A EM3A-04A EM3A-08A EM3A-10A EM3J-04A EM3J-08A	No	No	1.0mm2	EC3P-N9118-03	EC3P-N9118-05	EC3P-N9118-10
	No	Yes		EC3P-N9718-03	EC3P-N9718-05	EC3P-N9718-10
	Yes	No		EC3P-B9118-03	EC3P-B9118-05	EC3P-B9118-10
	Yes	Yes		EC3P-B9718-03	EC3P-B9718-05	EC3P-B9718-10
EMG-10A	No	Yes		EC3P-N9314-03	EC3P-N9314-05	EC3P-N9314-10
	Yes	Yes		EC3P-B9314-03	EC3P-B9314-05	EC3P-B9314-10
EM3A-15A EM3A-20A EM3A-15D EM3A-20D EM3A-30D EM3G-09A EM3G-13A EMG-10A EMG-15A EMG-20A	Not provided	Yes	2.0mm^2	EC3P-N9314-03	EC3P-N9314-05	EC3P-N9314-10
	Provided	Yes		EC3P-B9314-03	EC3P-B9314-05	EC3P-B9314-10
	Not provided	Yes		EC3P-N8718-03	EC3P-N8718-05	EC3P-N8718-10
	Provided	Yes		EC3P-B8718-03	EC3P-B8718-05	EC3P-B8718-10
EM3A-30D	Not provided	Yes		EC3P-N8214-03	EC3P-N8214-05	EC3P-N8214-10
	Provided	Yes		EC3P-B8214-03	EC3P-B8214-05	EC3P-B8214-10

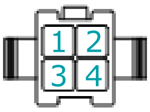
The following shows the diagram and wiring description of each Motor power cable.

Cable Model	Brake	IP65 Plug
EC3P-N9118-□□	No	No

Motor side Drive side



View from this end



Recommended wire diameter for U, V, W and FG: 1mm²

Motor side:

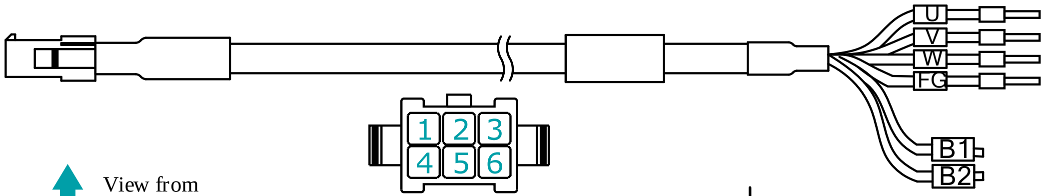
Pin No.	Signal	Color
1	U	Brown
2	V	Grey
3	W	Black
4	FG	Yellow/ green

Drive side:

Pin No.	Signal	Color
1	U	Brown
2	V	Grey
3	W	Black
4	FG	Yellow/ green

Cable Model	Brake	IP65 Plug
EC3P-B9118-□□	Yes	No

Motor side Drive side



View from this end

Recommended wire diameter for U, V, W and FG: 1mm²

Motor side:

Pin No.	Signal	Color
1	U	Brown
2	V	Grey
3	W	Black
4	FG	Yellow/ green
5	B1	White
6	B2	Green

Drive side:

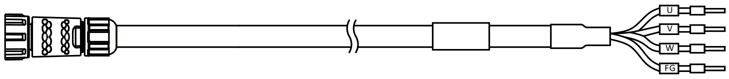
Pin No.	Signal	Color
1	U	Brown
2	V	Grey
3	W	Black
4	FG	Yellow/ green
5	B1	White
6	B2	Green

Recommended wire diameter for B1 and B2:0.5mm²

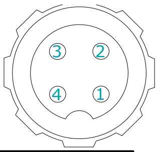
Cable Model	Brake	IP65 Plug
EC3P-N9718-□□	No	Yes

Motor side

Drive side



View from the insert side of pins

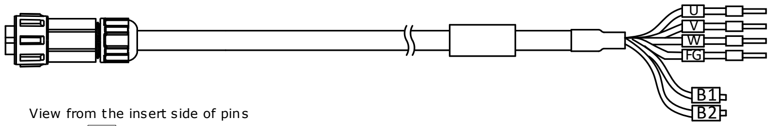


Pin	Signal	Pin	Signal
1	U		U
2	V		V
3	W		W
4	FG	Crimp terminal	FG

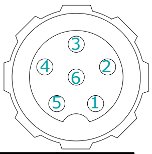
Cable Model	Brake	IP65 Plug
EC3P-B9718-□□	Yes	Yes

Motor side

Drive side



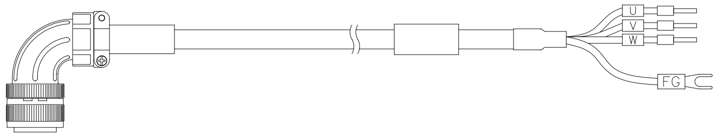
View from the insert side of pins



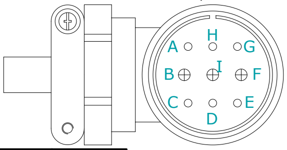
Pin	Signal	Pin	Signal
1	U		U
2	V		V
3	W		W
4	FG	Crimp terminal	FG
5	B1		B1
6	B2		B2

Cable Model	Brake	IP65 Plug
EC3P-N9314-□□	No	Yes

Motor side Drive side



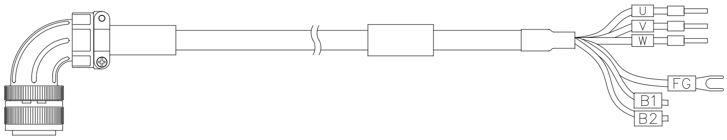
View from the insert side of pins



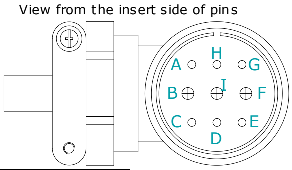
Pin	Signal		Pin	Signal
B	U			U
I	V			V
F	W			W
C	FG		Crimp terminal	FG
D	FG	Short wiring: BVR 1.5mm²		

Cable Model	Brake	IP65 Plug
EC3P-B9314-□□	Yes	Yes

Motor side Drive side



View from the insert side of pins



Pin	Signal		Pin	Signal
B	U			U
I	V			V
F	W			W
C	FG		Crimp terminal	FG
D	FG	Short wiring: BVR 1.5mm²		
G	B1			B1
H	B2			B2

3.4.6 Power Input Wiring Specifications

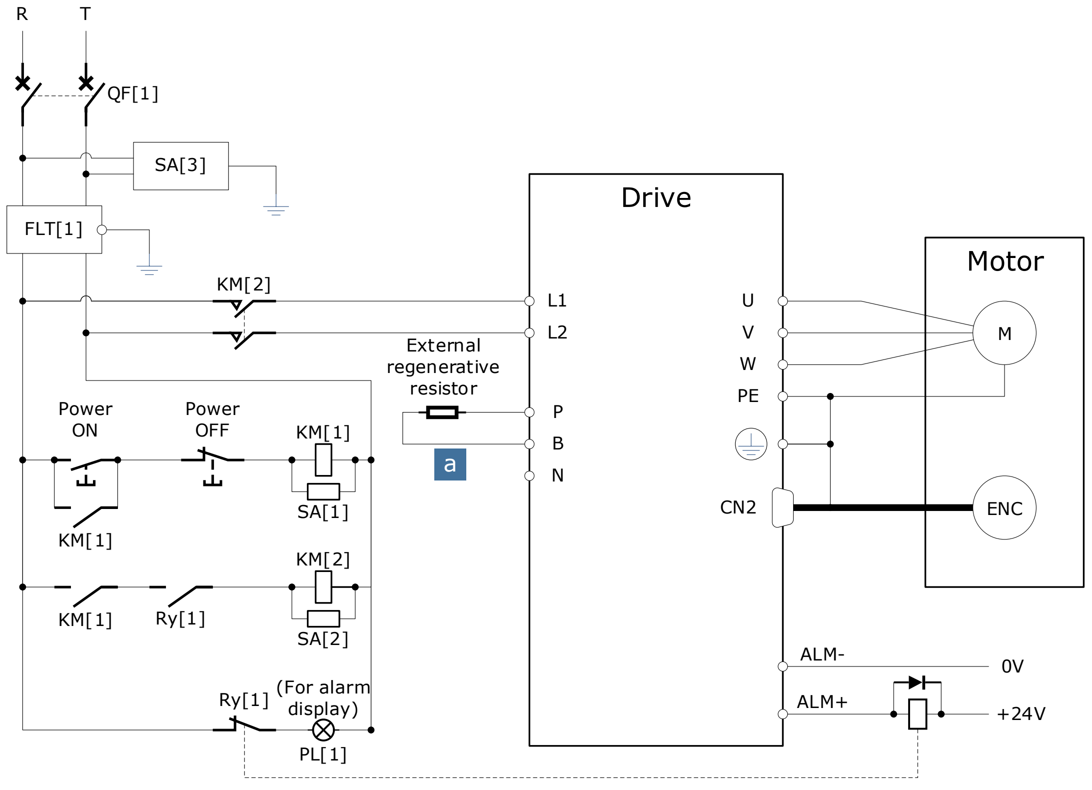
The power input wiring specification depends on the Motor model. The following table shows the recommended wire gauge for each Drive.

Drive model	Recommended wire gauge		
	AWG	Cross-sectional area (mm²)	Rated current (A)
ED3L-A5AEA	14	2.075	8.2
ED3L-01AEA	14	2.075	8.2
ED3L-02AEA	14	2.075	8.2
ED3L-04AEA	14	2.075	8.2
ED3L-08AEA	13	2.627	10.4
ED3L-10AEA	13	2.627	10.4
ED3L-15AEA	12	3.332	13.1
ED3L-20AEA	12	3.332	13.1
ED3L-10DEA	14	2.075	8.2
ED3L-15DEA	14	2.075	8.2
ED3L-20DEA	13	2.627	10.4
ED3L-30DEA	13	2.627	10.4
ED3L-50DEA	10	5.26	20.8
ED3L-75DEA	9	6.63	26.2

3.4.7 Power Input Wiring Example

200VAC Rated power from 50W to 400W

Use single-phase 200 VAC to 240 VAC as the power input for the Drives rated power from 50W to 400W.

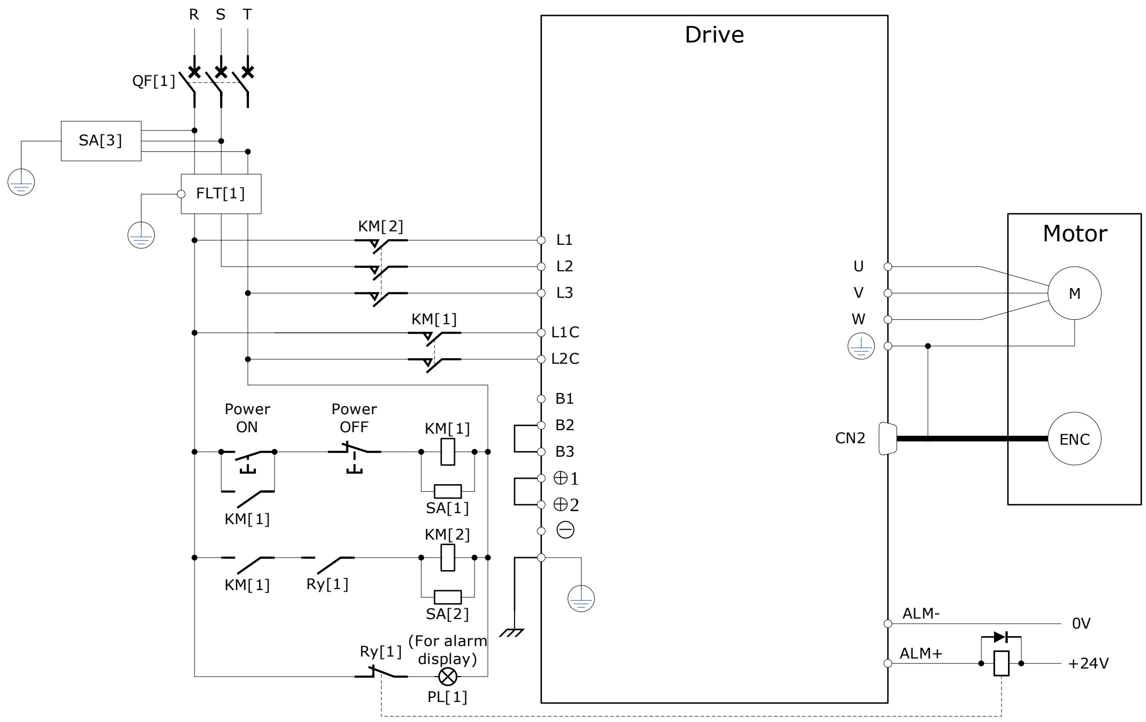


QF[1]: Molded-case circuit breaker SA[1]: Surge Absorber 1 SA[2]: Surge Absorber 2
SA[3]: Surge Absorber 3 FLT[1]: Noise Filter
Ry[1]: Relay PL[1]: Indicator lamp
KM[1]: Magnetic Contactor (for control power supply)
KM[2]: Magnetic Contactor (for main circuit power supply)

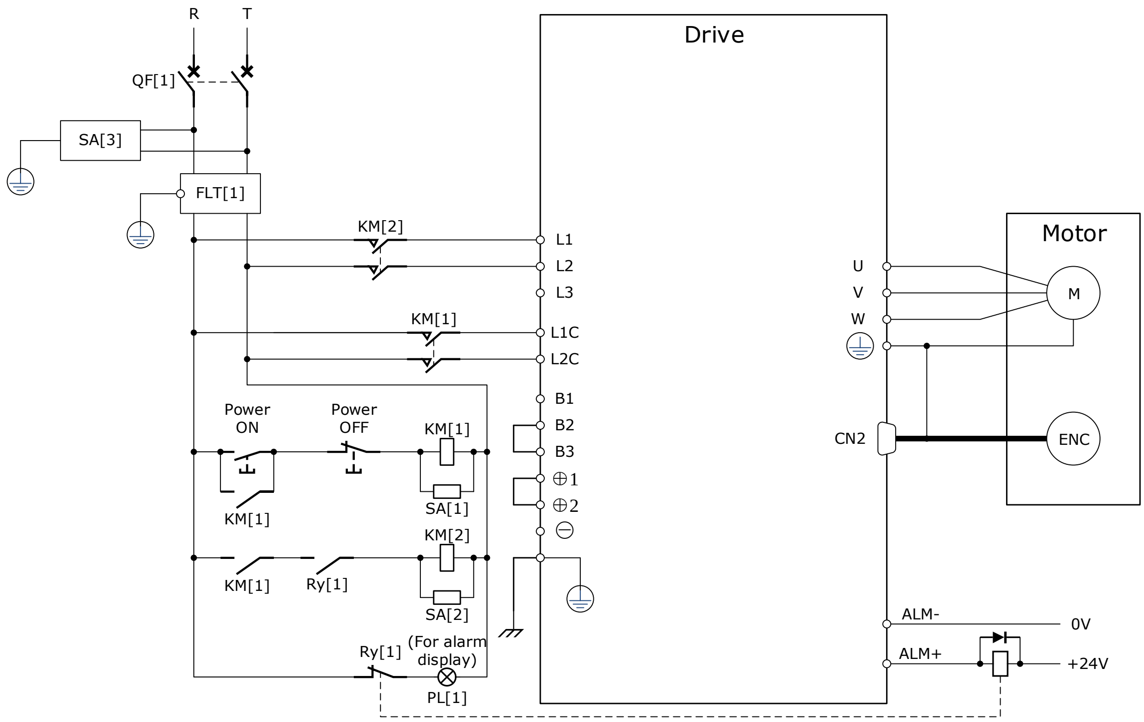
200VAC Rated power from 750W to 2kW

Use single-phase or three-phase 200 VAC to 240 VAC as the power input for the Drives rated power from 750W to 1.5kW.

The following figure shows the wiring example for using the three-phase AC input power.



The following figure shows the wiring example for using the single-phase AC input power.

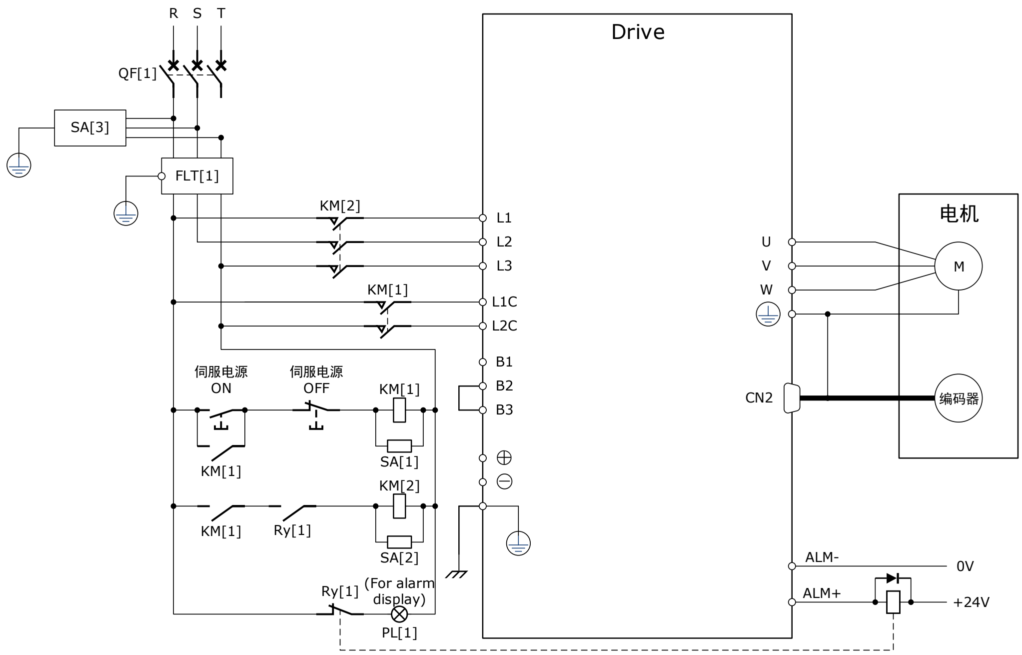


QF[1]: Molded-case circuit breaker SA[1]: Surge Absorber 1 SA[2]: Surge Absorber 2
SA[3]: Surge Absorber 3 FLT[1]: Noise Filter
Ry[1]: Relay PL[1]: Indicator lamp
KM[1]: Magnetic Contactor (for control power supply)
KM[2]: Magnetic Contactor (for main circuit power supply)

400VAC ， ated power from1kW to 5kW

The driver should use a three-phase AC 380V~440V input power supply.

【When using a three-phase AC power supply】

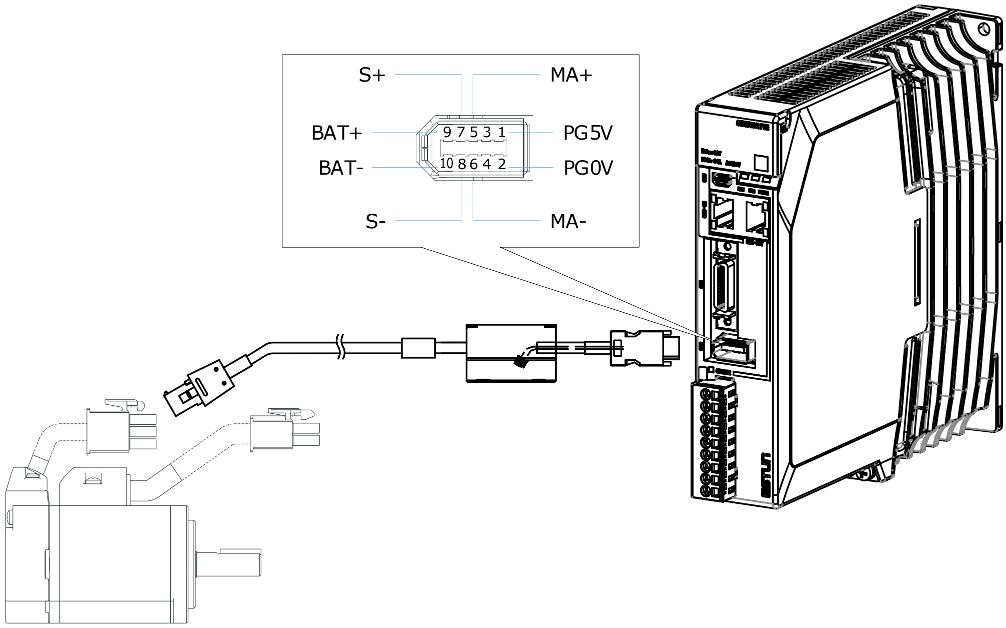


QF[1]: Molded-case circuit breaker SA[1]: Surge Absorber 1 SA[2]: Surge Absorber 2
SA[3]: Surge Absorber 3 FLT[1]: Noise Filter
Ry[1]: Relay PL[1]: Indicator lamp
KM[1]: Magnetic Contactor (for control power supply)

KM[2]: Magnetic Contactor (for main circuit power supply)

3.5 Wiring the Encoder

3.5.1 Connection Diagram



3.5.2 Encoder Cable Description

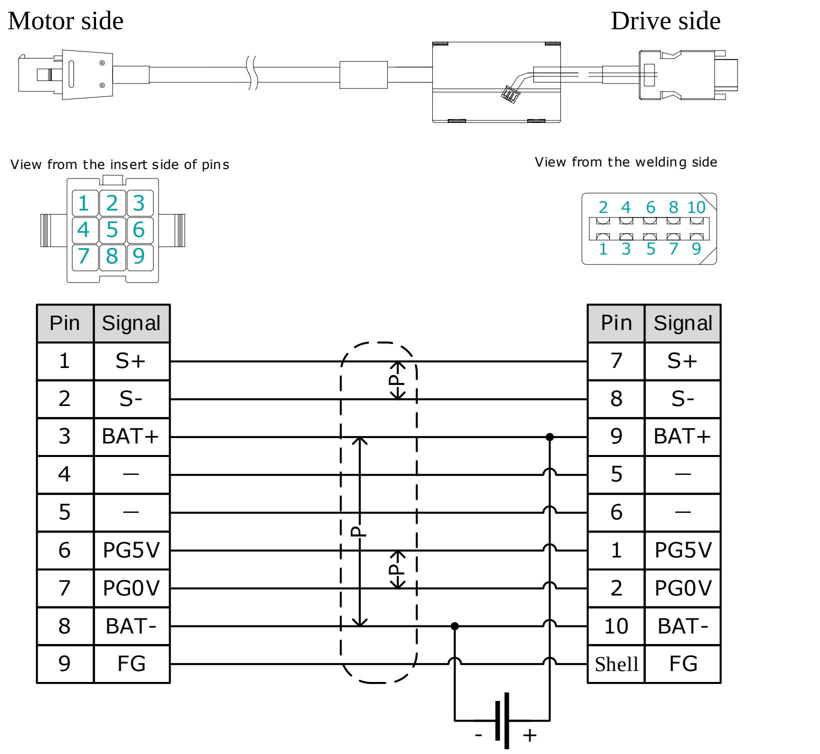
The encoder cable depends on the Motor model. The common models are shown in the table below.

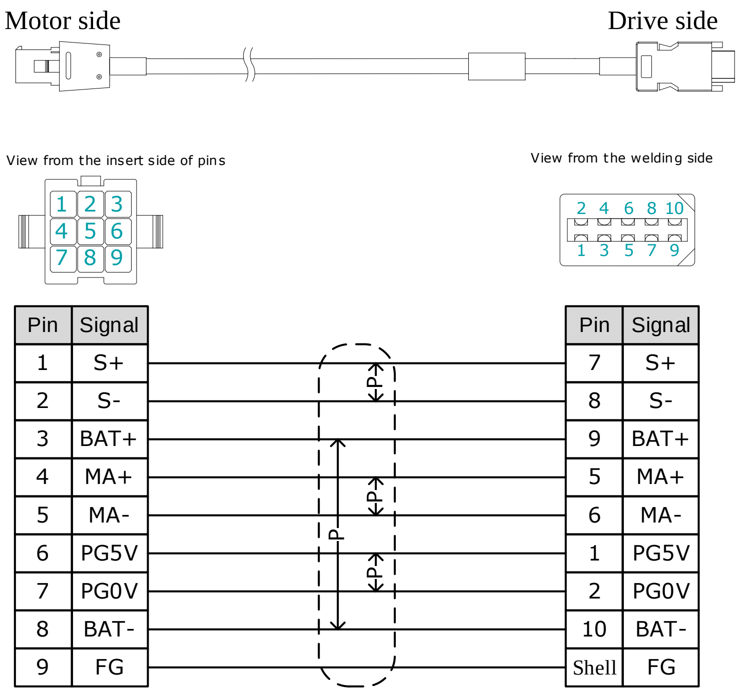
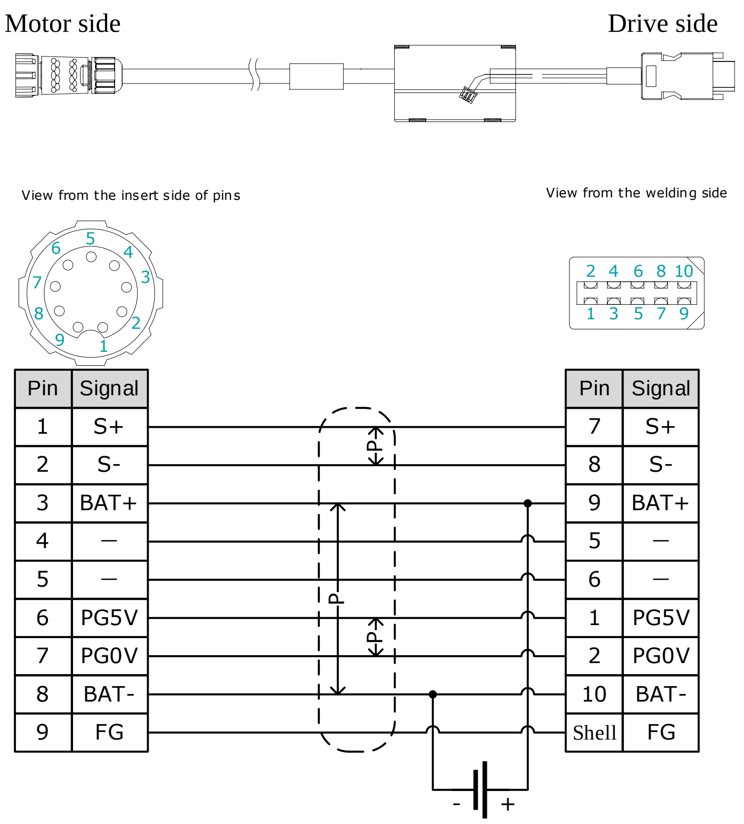
Motor model	Encoder	IP65	Motor power cable		
			length is 3.0m	length is 5.0m	length is 10.0m
EM3A-A5A EM3A-01A EM3A-02A EM3A-04A EM3A-08A EM3A-10A EM3J-02A EM3J-04A EM3J-08A	Incremental	NO	EC3S-I1124-03	EC3S-I1124-05	EC3S-I1124-10
	Absolute	NO	EC3S-A1124-03	EC3S-A1124-05	EC3S-A1124-10
	Incremental	YES	EC3S-I1724-03	EC3S-I1724-05	EC3S-I1724-10
	Absolute	YES	EC3S-A1724-03	EC3S-A1724-05	EC3S-A1724-10
EM3A-15A EM3A-15D EM3A-20A EM3A-20D EM3A-30A EM3A-30D EM3A-40D EM3A-50DLA EM3GAll aircraft types	Incremental	YES	EC3S-I1924-03	EC3S-I1924-05	EC3S-I1924-10
	Absolute	YES	EC3S-A1924-03	EC3S-A1924-05	EC3S-A1924-10

Motor model	Encoder	IP65	Motor power cable		
			length is 3.0m	length is 5.0m	length is 10.0m
EMG-10A EMG-15A EMG-20A	Incremental	YES	EC3S-I1324-03	EC3S-I1324-05	EC3S-I1324-10
	Absolute	YES	EC3S-A1324-03	EC3S-A1324-05	EC3S-A1324-10

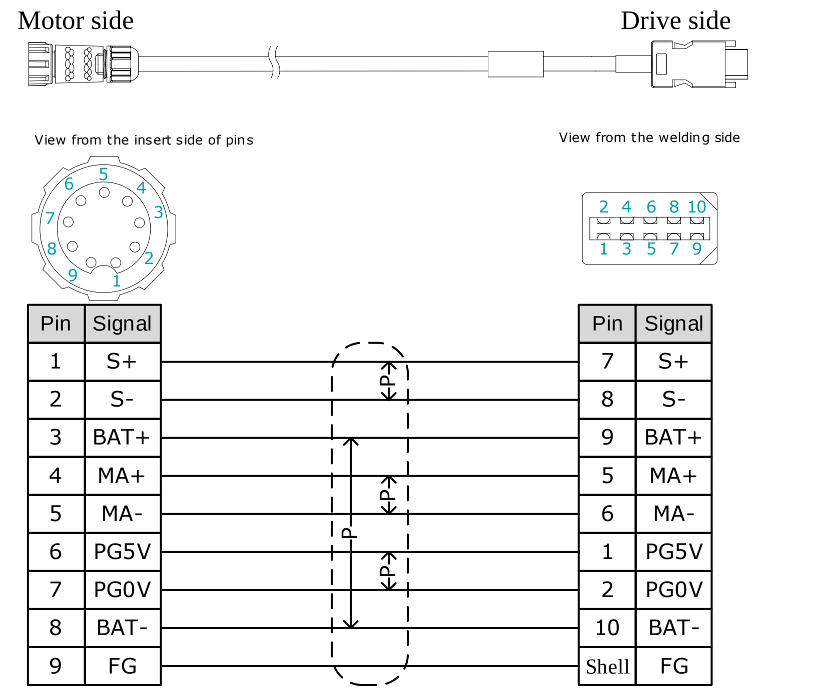
The following shows the diagram and wiring description of each encoder cable.

Applicable models	Cable Model	Encoder	IP65 Plug
EM3A-A5A□□□□1 EM3A-01A□□□□1 EM3A-02A□□□□1 EM3A-04A□□□□1 EM3A-08A□□□□1 EM3A-10A□□□□1	EC3S-A1124-□□	Absolute	No

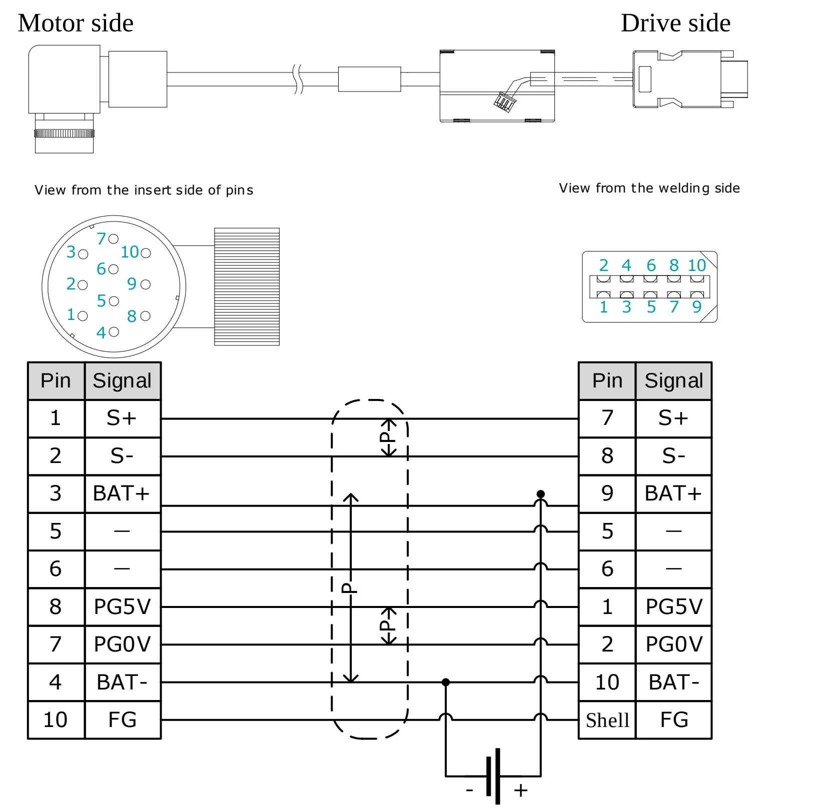


<table>
<tr><th>Applicable models</th><th>Cable Model</th><th>Encoder</th><th>IP65 Plug</th></tr>
<tr><td rowspan="2">EM3A-A5A□□
EM3A-01A□□
EM3A-02A□□
EM3A-04A□□
EM3A-08A□□
EM3A-10A□□</td><td>EC3S-I1124-□□</td><td>Incremental</td><td>No</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td rowspan="2">EM3A-A5A□□
EM3A-01A□□
EM3A-02A□□
EM3A-04A□□
EM3A-08A□□
EM3A-10A□□</td><td>EC3S-A1724-□□</td><td>Absolute</td><td>Yes</td></tr>
<tr><td colspan="3">
</td></tr>
</table>

Applicable models	Cable Model	Encoder	IP65 Plug
EM3A-A5A□□ EM3A-01A□□ EM3A-02A□□ EM3A-04A□□ EM3A-08A□□ EM3A-10A□□	EC3S-I1724-□□	Incremental	Yes
EMG-10A□□□□	EC3S-A1324-□□	Absolute	Yes

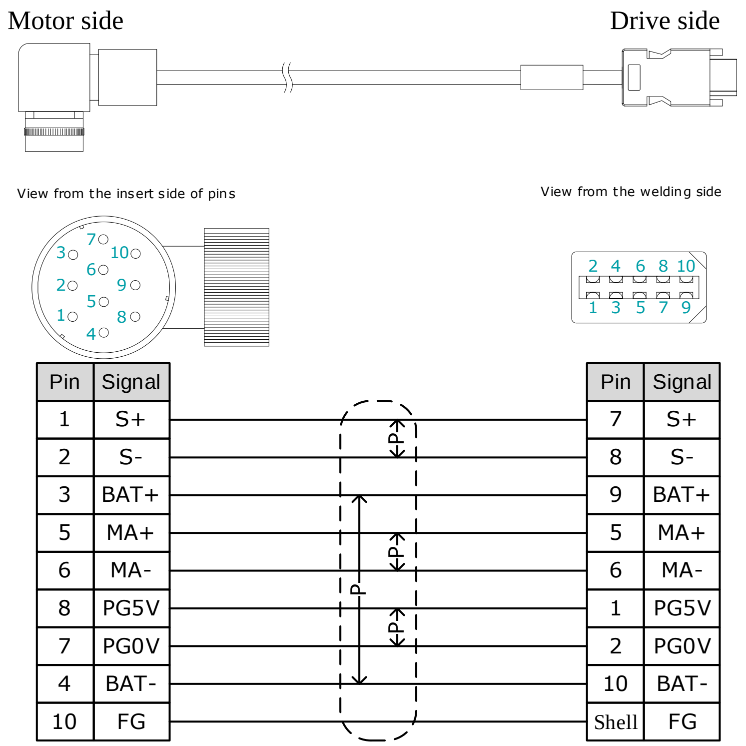


Pin	Signal	Pin	Signal
1	S+	7	S+
2	S-	8	S-
3	BAT+	9	BAT+
4	MA+	5	MA+
5	MA-	6	MA-
6	PG5V	1	PG5V
7	PG0V	2	PG0V
8	BAT-	10	BAT-
9	FG	Shell	FG



Pin	Signal	Pin	Signal
1	S+	7	S+
2	S-	8	S-
3	BAT+	9	BAT+
5	—	5	—
6	—	6	—
8	PG5V	1	PG5V
7	PG0V	2	PG0V
4	BAT-	10	BAT-
10	FG	Shell	FG

Applicable models	Cable Model	Encoder	IP65 Plug
EMG-10A□□□□	EC3S-I1324-□□	Incremental	Yes



Pin	Signal
1	S+
2	S-
3	BAT+
5	MA+
6	MA-
8	PG5V
7	PG0V
4	BAT-
10	FG

Pin	Signal
7	S+
8	S-
9	BAT+
5	MA+
6	MA-
1	PG5V
2	PG0V
10	BAT-
Shell	FG

3.5.3 Battery Case Connection

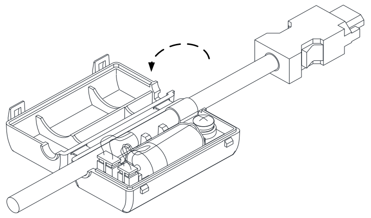
CAUTION

- Absolute encoders are fitted on motors with an encoder type of L; e.g. EM3A-02A**L**A211. These encoders require a battery supply to retain the absolute encoder data when the Drive power is removed.
- Battery model: LS 14500 (3.6V, AA)
- Replace the battery if the alarm A.47 or A.48 was occurred, and perform the operations Absolute encoder multi-turn reset and Absolute encoder alarm reset.

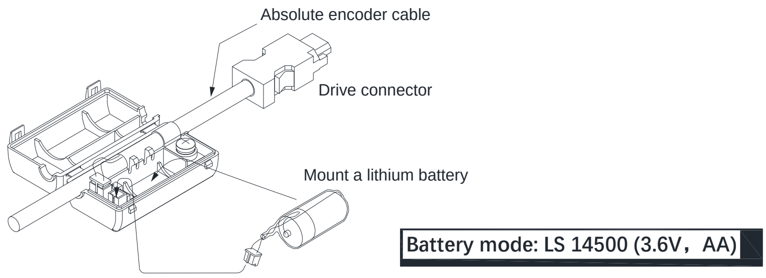
Follow the instructions below to install or replace the battery case.

Step 1 Turn ON only the control power supply to the Drive.

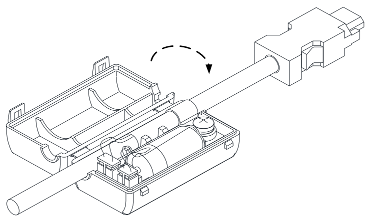
Step 2 Open the cover of the battery case.



Step 3 Remove the old battery and mount a new battery.



Step 4 Close the cover of the battery case.



Step 5 Repower up the Drive.

Step 6 Resert the Alarms.

NOTE

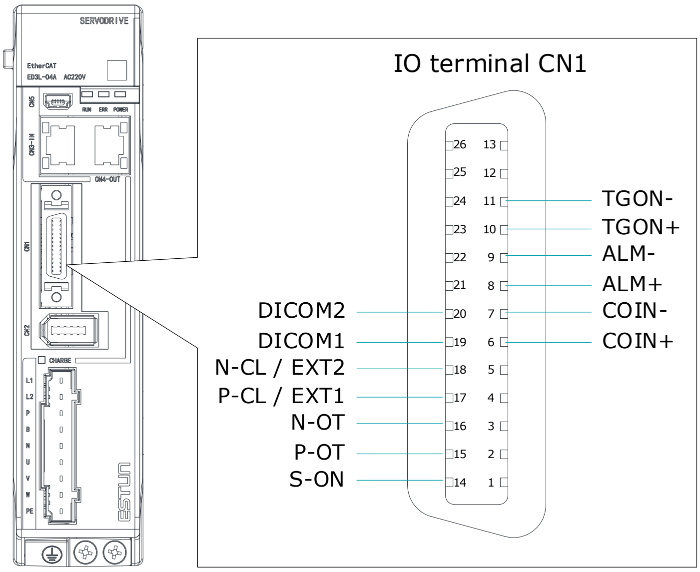
- Perform the Fn011 and Fn010 by Panel Operator to reset the alarms, for details, see the section Fn010 (Absolute encoder multi-turn reset) and Fn011 (Absolute encoder alarm reset).
- Also, you can reset the alarms by ESView V4, for details, see ESView Help Manual.

Step 7 Make sure the alarms have been cleared and the Drive operates normally.

----End

3.6 I/O Signal Connections

3.6.1 Signal Diagram



Note: the figure on the left is an example of facing the 400W Drive Panel Operator.

NOTE

The signal definitions for the IO signals of all drives are the same. The signal name in the diagram above is predefined at the factory. You can can assign the following signals by Pn509, Pn510, and Pn511, see the section 5.7 IO Signal Allocation in detail.

3.6.2 Pin Layout

Pin	Name	Type	Function
6	COIN+	Output	Positioning Completion signal indicates that Motor positioning has been completed during position control.
7	COIN-	Output	
8	ALM+	Output	Servo Alarm signal is output when the Drive detects an error.
9	ALM-	Output	
10	TGON+	Output	Rotation Detection signal indicates that the Motor is operating.
11	TGON-	Output	
14	S-ON	Input	Servo On signal can supply power to Motor.
15	P-OT	Input	Forward Drive Prohibit Input signal can stop Motor drive (to prevent overtravel) when the moving part of the machine exceeds the range of movement.
16	N-OT	Input	Reverse Drive Prohibit Input signal can stop Motor drive (to prevent overtravel) when the moving part of the machine exceeds the range of movement.
17	P-CL / EXT1	Input	Forward External Torque Limit Input or Touch Probe Input 1
18	N-CL / EXT2	Input	Reverse External Torque Limit Input or Touch Probe Input 2
19	DICOM1	Common	Power supply for CN1-14, CN1-15 and CN1-16, connects to a 24 VDC or 0V.
20	DICOM2	Common	Power supply for CN1-17 and CN1-18, connects to a 24 VDC or 0V.

3.6.3 Wiring Description

Input Signals Wiring

The input signals of the Drive are divided into two groups, and the details are as following.

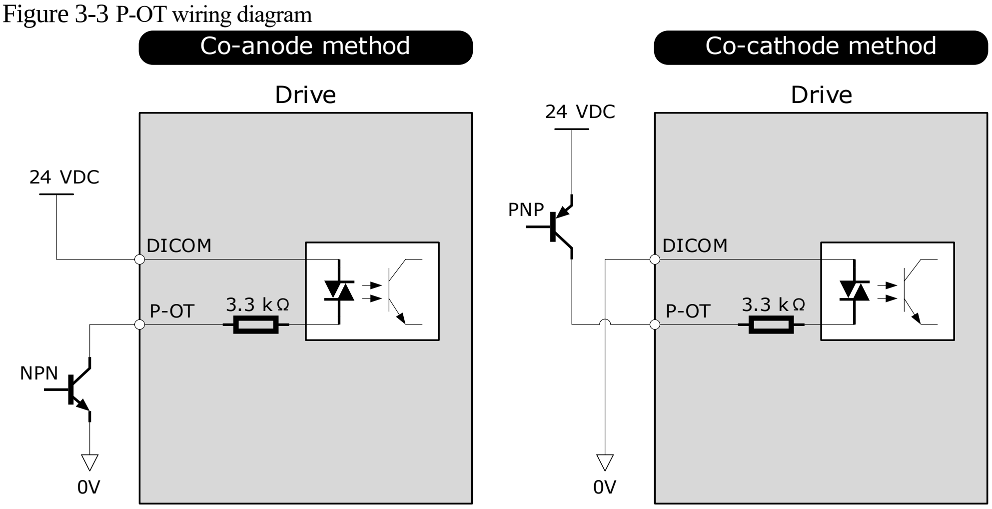
Group	Input Pins	Common Pin
Group 1	CN1-14, CN1-15, CN1-16	CN1-19
Group 2	CN1-17, CN1-18	CN1-20

NOTE

The wiring of the input signals can use the co-cathode method or the co-anode method.
The wiring example in the section 3.2 Basic Wiring Diagrams, the group 1 of pins uses a co-cathode connection, while the group 2 uses a co-anode connection.

Taking the input signal P-OT as an example, Figure 3-3 shows the connection diagram by using an external 24 VDC power supply, and the wiring of other input signals wiring is the same as it.

Figure 3-3 P-OT wiring diagram

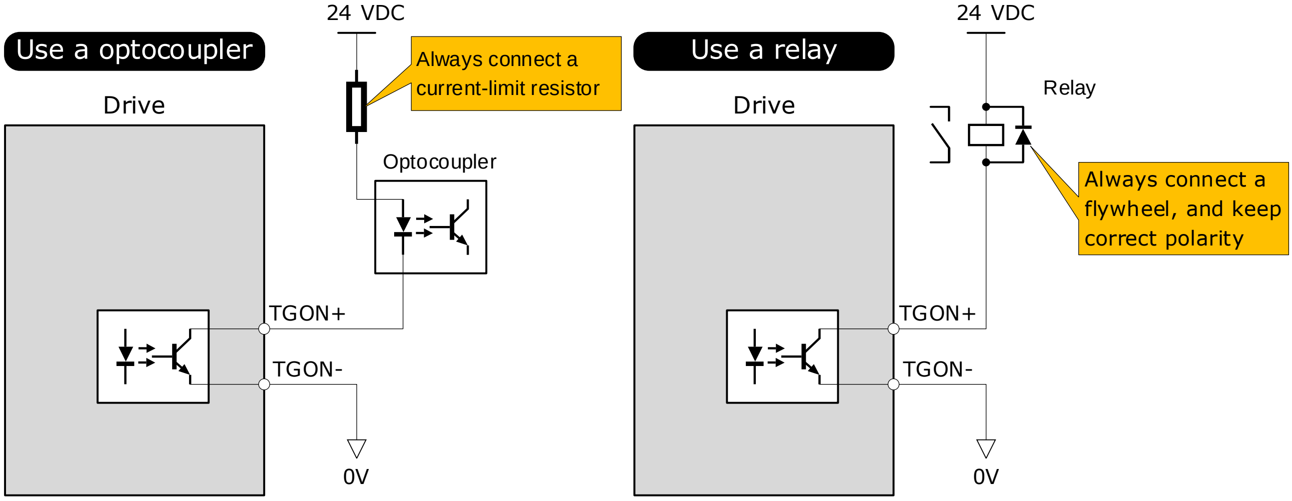


You can assign the input signals by Pn509 and Pn510, including TP (Touch Probe), S-ON (Servo ON), P-OT (Forward Drive Prohibit), N-OT (Reverse Drive Prohibit), P-CL (Forward External Torque Limit), N-CL (Reverse External Torque Limit), G-SEL (Gain Selection), HmRef (Homing), Remote (Remoted Input). For the input signal allocation, see the section 6.7.1 Input Signal Allocations.

Output Signals Wiring

Taking the output signal TGON as an example, Figure 3-4 shows the connection diagram for using the optocoupler or relay, and the wiring of other output signals wiring is the same as it.

Figure 3-4 TGON wiring diagram



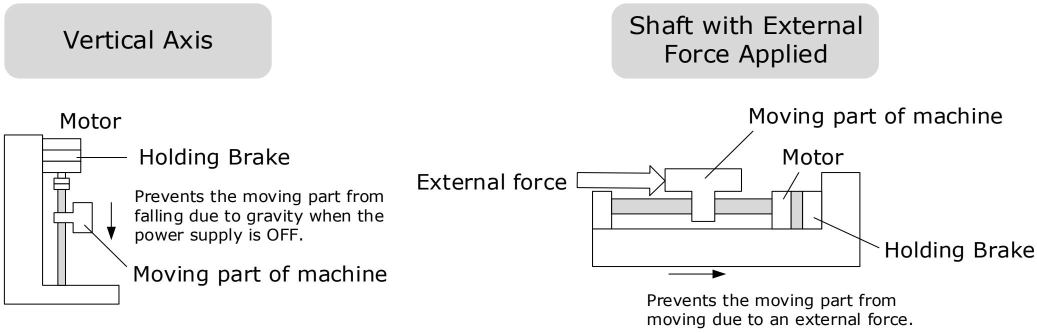
The maximum permissible voltage and current of the ptocoupler output circuit inside the servo drive are as follows:
Maximum voltage: 30 VDC
Maximum current: DC 50 mA

You can assign the output signals by Pn511, including COIN/VCMP (Positioning Completion or Speed Coincidence Detection), TGON (Rotation Detection), S-RDY (Servo Ready), CLT (Torque Limit Detection), BK (Brake), PGC (Motor C-pulse), OT (Overtravel), RD (Motor Excitation), TCR (Torque Detection), Remote (Remoted output). For the output signal allocation, see the section 6.7.2 Output Signal Allocations.

3.6.4 Holding Brake Wiring

A holding brake is used to hold the position of the moving part of the machine when the Drive is turned OFF so that moving part does not move due to gravity or an external force.

You can use the brake that is built into a Motor with a Brake, or you can provide one on the machine. The holding brake is used in the following cases.



IMPORTANT

- The brake built into a Motor with a Brake is a de-energization brake. It is used only to hold the Motor and cannot be used for braking. Use the holding brake only to hold a Motor that is already stopped.
- Keep the input voltage at least 21.6 V to make the brake work.
- The wiring of the brake signal has no polarity, please prepare a 24 VDC external power supply.
- Cable of 0.5mm² or above is recommended.

Taking the drives rated from 50W to 400W as an example, Figure 3-5 shows the connection diagram of the holding brake.

Figure 3-5 Holding brake wiring diagram

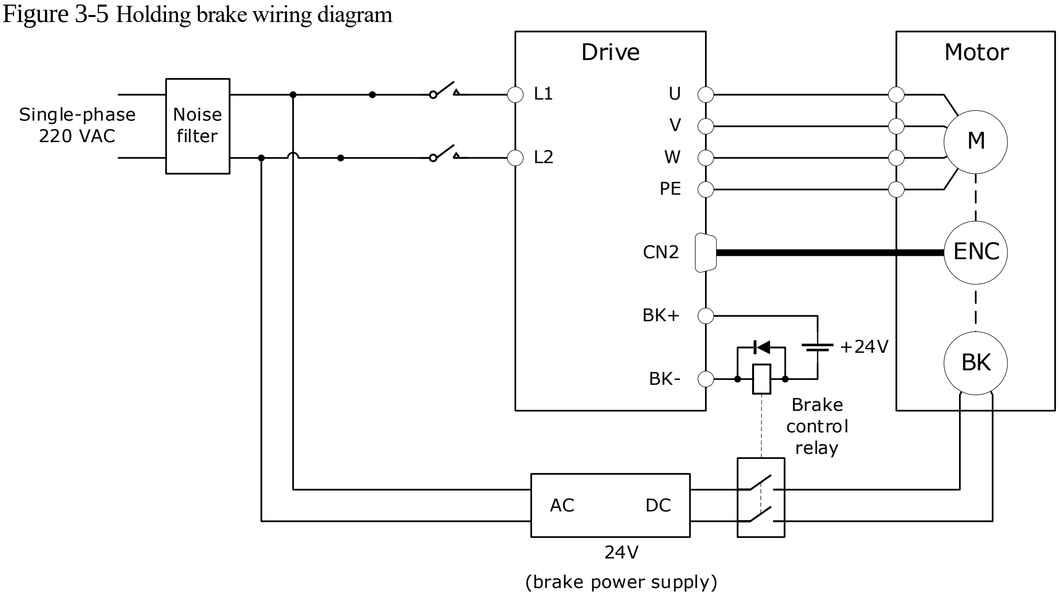


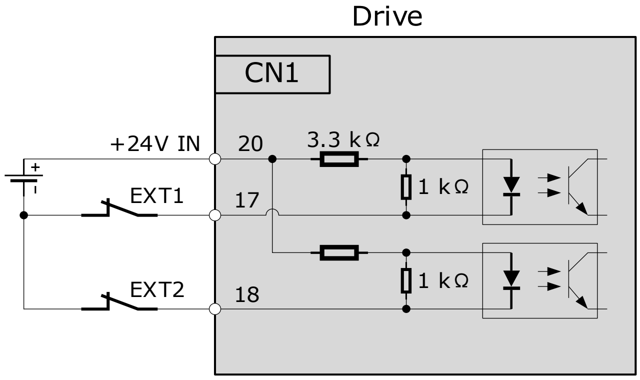
Table 3-1 lists brake specifications for each Motor matched with ED3L.

Table 3-1 Brake specifications

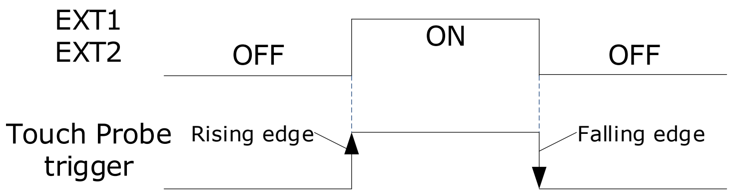
Motor Model	Voltage (V)	Holding torque (N·m)	Out of time (ms)	Absorption time(ms)	Power (W)
EM3A-A5A/01A	24V±10%	0.32	40	20	4
EM3A-02A/04A	24V±10%	1.5	25	50	7.4

3.6.5 Touch Probe Wiring

You shall only use the terminals CN1-17 and CN1-18 for Touch Probe input signal, which has been allocated at factory. The following figure shows the example diagram for the connection.



The timing sequence between input signals and trigger is as shown in below.



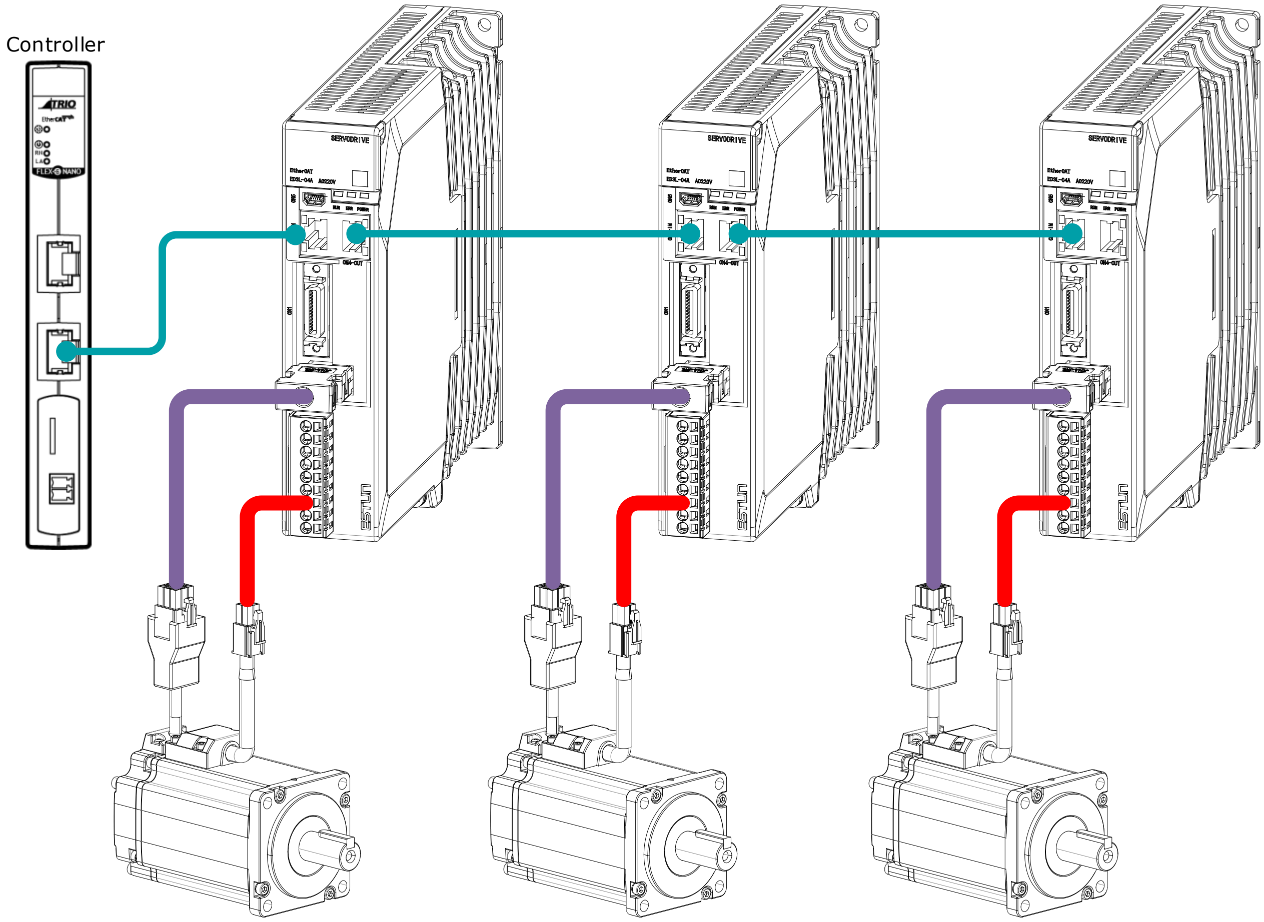
NOTE

For details about the function setting, see the section_

3.7 Communication Connections

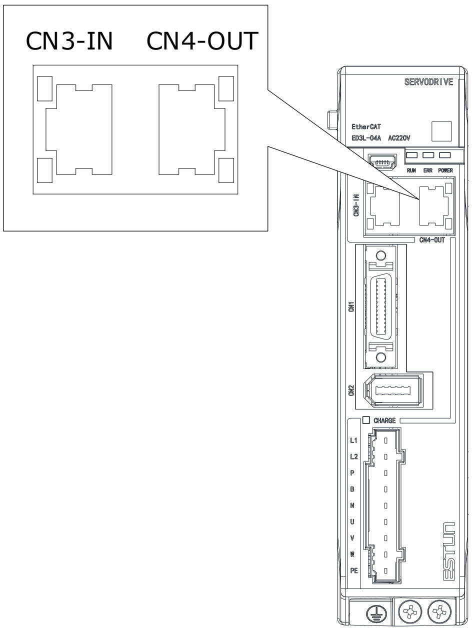
3.7.1 PROFINET Communication

Connection Diagram



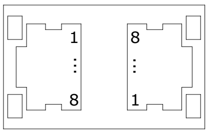
CN3-IN:
Connected by the OUT of the previous drive or controller.

CN4-OUT:
Connect to the next Drive's IN or not connect.



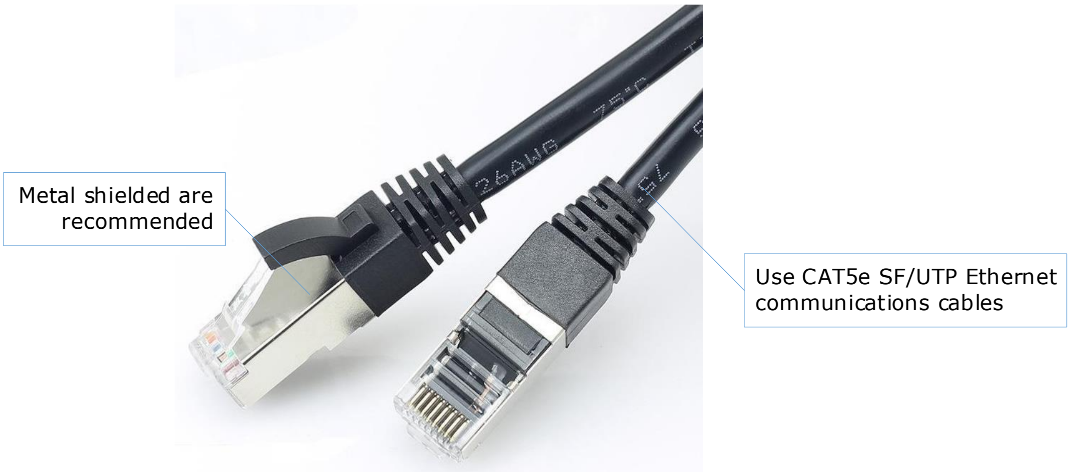
Pin Layout

PROFINET communication (CN3-IN and CN4-OUT) are RJ45 terminals. The communication cable as the master station or controller should be connected from CN3-IN, and CN4-OUT should be connected to the CN3-IN terminal of the next Drive (slave station).

Connectors	Pin	Name	Function
	1	TX+	Send data +
	2	TX-	Send data -
	3	RX+	Receive data +
	4	–	–
	5	–	–
	6	RX-	Receive data -
	7	–	–
	8	–	–
	Shell	PE	Protecting earthing (shield)

Cable Description

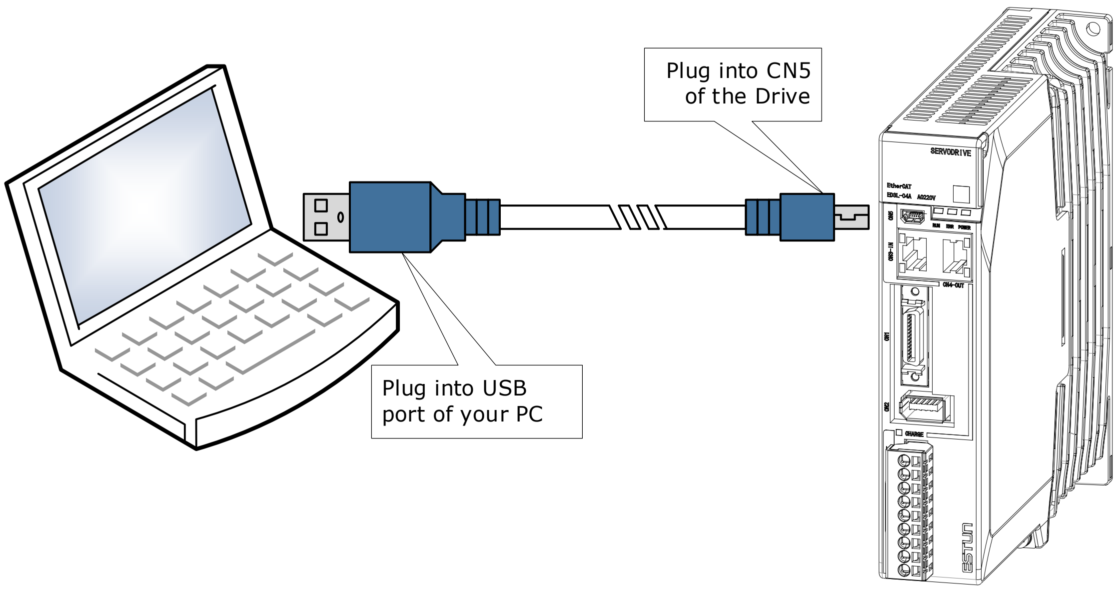
Use category 5 (CAT5e SF/UTP) Ethernet communications cables for network connections. Metal shielded connectors are recommended to prevent signal interference.



3.7.2 USB Communication Cable

Connects your PC to a Drive with a USB Communication Cable, in order to make the online operation of ESView V4.

Connection Diagram



Cable Description

You can purchase the **USB Communication Cable** provided by ESTUN, or you can purchase the commercially available products yourself.

The plug connected to your PC is USB Type-A, and the plug connected to the Drive is Mini USB Type-B.

Chapter 4 Basic Settings

You can implement the functions of parameter setting, display, monitoring, alarm, adjustment, etc. of the Drive in the following two ways.

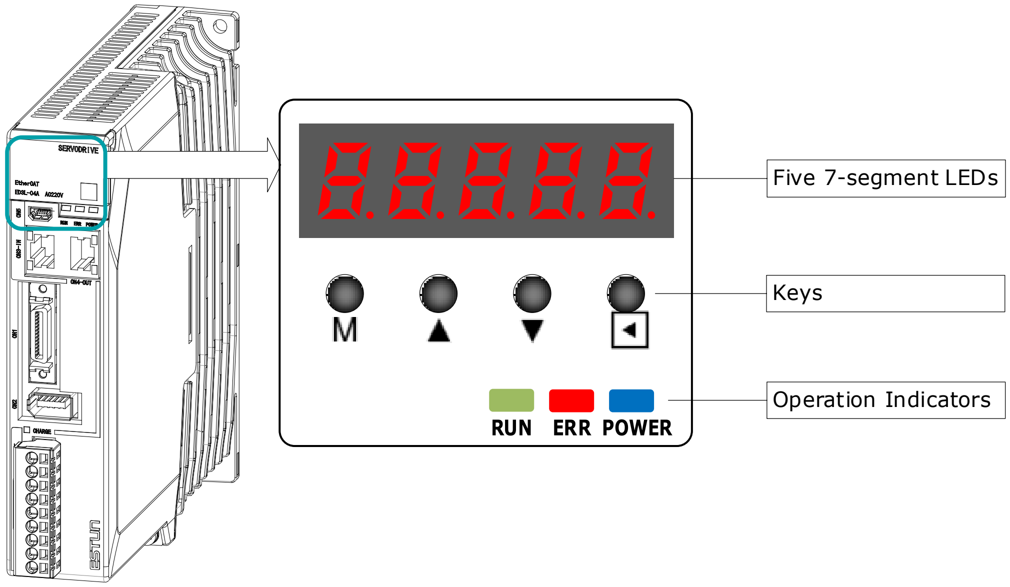
- Use the Panel Operator of the Drive
- Use the ESView V4 (Recommended)

4.1 Panel Operator

4.1.1 Key Names and Functions

There is a Panel Operator on the front of the Drive, as is shown in Figure 4-1.

Figure 4-1 Diagram of Panel Operator



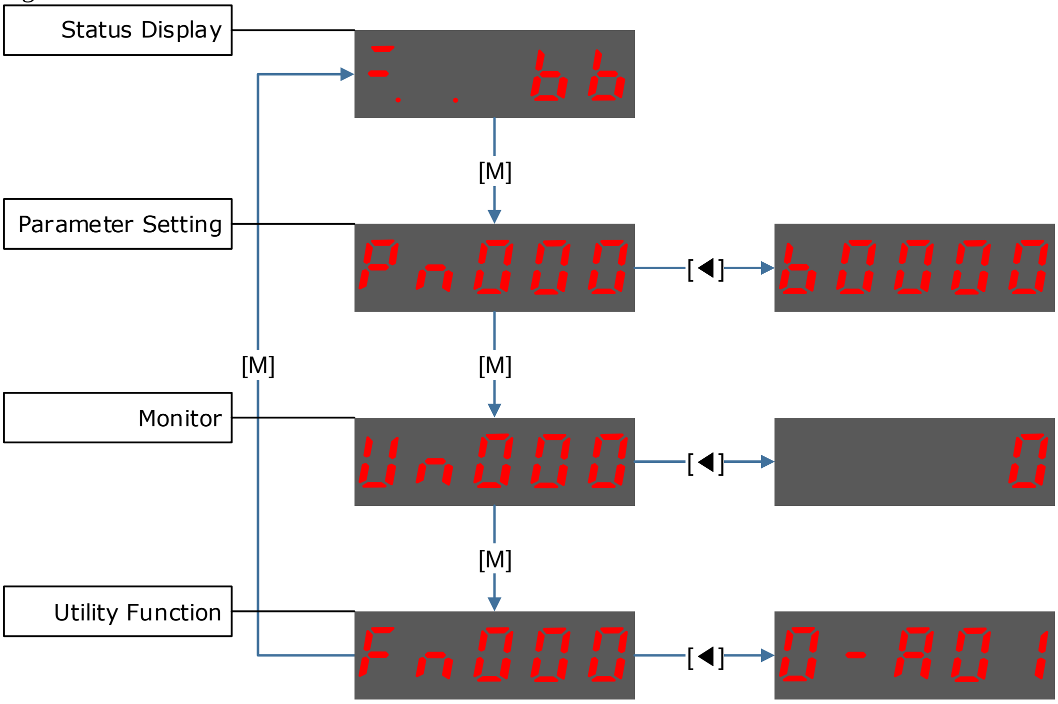
The names and functions of the keys on the Panel Operator are as follows.

Key	Functions
M	Press [**M**] key to select a basic mode, such as the status display mode, utility function mode, parameter setting mode, or monitor mode.
▲	Press [▲] Key to increase the set value.
▼	Press [▼] Key to decrease the set value.
◀	• Data setting key • To display parameter setting and set value. • To shift to the next digit on the left.

4.1.2 Basic Mode Selection

The basic modes include: Status Display Mode, Parameter Setting Mode, Utility Function Mode, and Monitor Mode. Select a basic mode with [**M**] key to display the operation status, set parameters and operation references, as is shown in Figure 4-2.

Figure 4-2 Select a basic mode

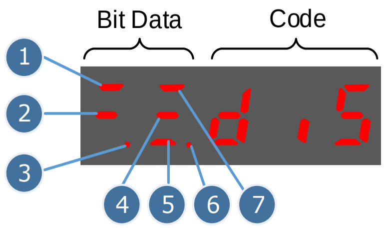


4.1.3 Status Display Mode

Power ON the Drive and wait for a while, the Panel Operator will initially display the Servo Status.

The information displayed by the status is divided into two parts:

- The first two digits are called **Bit Data**, what indicates the signal states during the operation of Drive.
- The last three digits are called **Code**, what indicates the operation states of Drive.



The display meaning of each segment on Bit Data are shown in Table 4-1, and they have different meanings under Speed or Torque Control Mode and Position Control Mode.

Table 4-1 Display meaning of each segment on Bit Data

No	Speed or Torque Control Mode		Position Control Mode	
	Meaning	Description	Meaning	Description
1	Speed Coincidence (VCMP)	Lit when the difference between the Motor speed and reference speed is the same as or less than the value set in Pn501 (Default setting is 10 rpm). Always lit in Torque Control Mode.	Positioning Completion (COIN)	Lit if error between position reference and actual Motor position is below preset value in Pn500 (Default setting is 10 pulses).
2	Servo OFF	Lit when servo is off. Not lit when servo is on.	Servo OFF	Lit when servo is off. Not lit when servo is on.
3	Control Power ON	Lit when Drive control power is ON.	Control Power ON	Lit when Drive control power is ON.
4	Speed Reference Input	Lit if input speed reference exceeds the value preset in Pn503 (Default setting is 20 rpm).	Reference Pulse Input	Lit if reference pulse is input.
5	Torque Reference Input	Lit if input torque reference exceeds preset value (10% rated torque is standard setting).	Deviation Counter Clear Signal Input	Lit when deviation counter clear signal is input.
6	Power Ready	Lit when main power supply circuit is normal.	Power Ready	Lit when main power supply circuit is normal.
7	Rotation Detection (TGON)	Lit if Motor speed exceeds the value preset in Pn503 (Default setting is 20 rpm).	Rotation Detection (TGON)	Lit if Motor speed exceeds the value preset in Pn503 (Default setting is 20 rpm).

The display meanings of Code are shown in Table 4-2.

Table 4-2 Display meanings of Code

Code	Meaning
	Servo initialization failed (check the encoder connection)
	Servo OFF (Motor Power OFF)
	Servo Ready
	Run Servo ON (Motor Power ON)
	Quick Stop State
	Servo Alarm State
	Safe State
	Forward Drive Prohibited
	Reverse Drive Prohibited
	(Forward and Reverse) Overtravel State
	Alarm Number Display

NOTE: When the Drive is in Servo Alarm State, you shall check and correct the fault according to the Alarm Number Display, and then, you can press [◀] key to try to clear the current alarm.

4.1.4 Parameter Setting Mode

Functions can be selected or adjusted by setting parameters. There are two types of parameters.

- Function Parameters: the functions allocated to each digit of the Panel Operator can be selected.
- Adjustment Parameters: a parameter is set to a value within the specified range of the parameter.

For a description of the parameter settings, please refer to the section Chapter 11 Parameters.

Function Parameters Setting

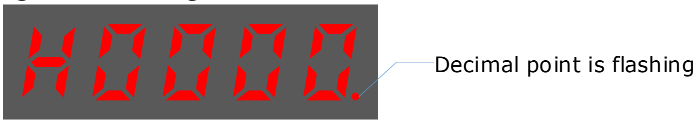
The example below shows how to change parameter Pn003 (Application Function Selections 3) from **0000** to **1032**.

Step 1 Press [**M**] key several times to select the Parameter Setting Mode.

Step 2 Press [▲] key or [▼] key to select the parameter Pn003.

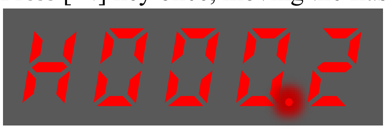
Step 3 Press [◀] key to display the current value of Pn003.

Step 4 Press and hold [◀] key for 1 second or more, and then a flashing decimal point will appear at the bottom right of the 5th digit.



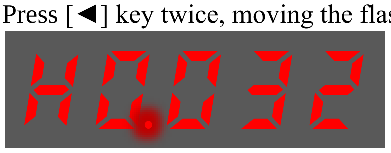
Step 5 Press [▲] key twice, changing the value of the 5th digit from **0** to **2**.

Step 6 Press [◀] key once, moving the flashing decimal point to the 4th digit.



Step 7 Press [▲] key three times, changing the value of the 4th digit from **0** to **3**.

Step 8 Press [◀] key twice, moving the flashing decimal point to the 2nd digit.



Step 9 Press [▲] key once, changing the value of the 2nd digit from **0** to **1**.

Step 10 Press and hold [◄] key for 1 second or more to return to the display of the Pn003 parameter value, or press the [**M**] key to return to the display of the Pn003.

NOTE

After completing the function parameters setting, restart the Drive to take effect.

----End

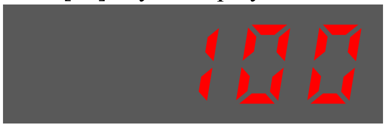
Adjustment Parameters Setting

The example below shows how to change parameter Pn102 (Speed Loop Gain) from **100** to **85**.

Step 1 Press [**M**] key several times to select the Parameter Setting Mode.

Step 2 Press [▲] key or [▼] key to select the parameter Pn102.

Step 3 Press [◄] key to display the current value of Pn102.



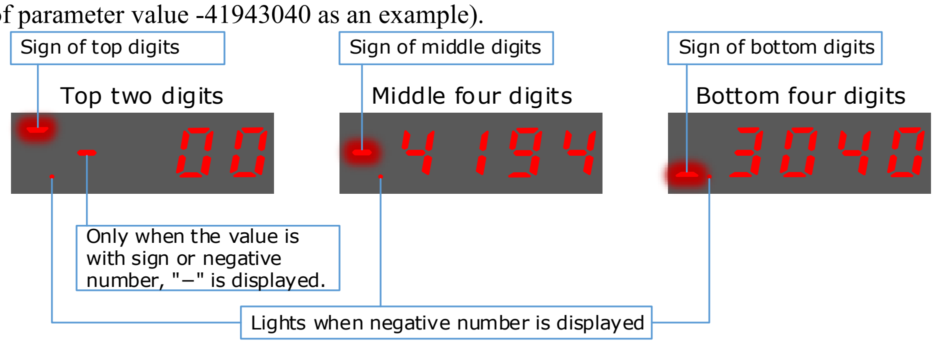
Step 4 Press [▲] key or [▼] key to change the value to 00085.
Press and hold [▲] key or [▼] key to jump the setting value quickly.

Step 5 Press [◄] key or [**M**] key to return to the display of Pn102.

----End

IMPORTANT

Panel Operator can only display 5 digits. The value of some adjustment parameters will be 6 digits or more. The display of the parameter values is as follows (take the display of parameter value -41943040 as an example).



The example below shows how to change parameter Pn504 (Deviation Counter Overflow Alarm) from **41943040** to **42943240**.

Step 1 Press [**M**] key several times to select the Parameter Setting Mode.

Step 2 Press [▲] key or [▼] key to select the parameter Pn504.

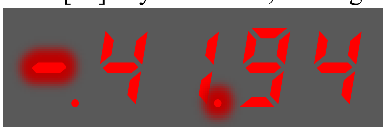
Step 3 Press [◀] key to display bottom four digits of the current value of Pn504.

Step 4 Press and hold [◀] key for 1 second or more, and then a flashing decimal point will appear at the bottom right of the 5th digit.

Step 5 Press [◀] key twice, moving the flashing decimal point to the 3rd digit.

Step 6 Press [▲] key twice, changing the value of the 3rd digit from **0** to **2**.

Step 7 Press [◀] key four times, moving the flashing decimal point to the 3rd of middle four digits.



Step 8 Press [▲] key once, changing the value of the 3rd digit from **1** to **2**.

Step 9 Press and hold [◀] key for 1 second or more to return to the display of the Pn504 parameter value, or press the [**M**] key to return to the display of the Pn504.

----End

4.1.5 Monitor Mode

The Monitor Mode can be used for monitoring the reference values, I/O signal status, and Drive internal status.

The Monitor Mode can be selected during Motor operation.

Select Monitor Mode

The example below shows how to display, the contents of monitor number Un003 (when the Motor rotates at 100).

Step 1 Press [**M**] key several times to select the Monitor Mode.

Step 2 Press [▲] key or [▼] key to select the monitor number Un003.

Step 3 Press [◀] key to display the data of Un003.

Step 4 Press [◀] key to return to the display of Un003.

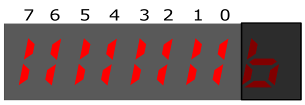
----End

Contents of Monitor Mode Display

Monitor Number	Content of Display	Unit
Un000	Motor speed	rpm
Un003	Internal torque reference (in percentage to the rated torque)	%
Un004	Encoder Rotation angle pulse number	1 pulse
Un005	Input signal monitor (lit for low level)	–
Un006	Touch Probe input signal monitor	–
Un007	Output signal monitor	–
Un008	Reserved	–
Un009	Input reference pulse counter	1 pulse
Un011	Pulse deviation counter	1 pulse
Un013	Reference pulse	1 pulse
Un015	Load Inertia Percentage	%
Un016	Motor Overload Ratio	%
Un019	Busbar Voltage	V
Un021	Encoder temperature	℃

Monitor Number	Content of Display	Unit
Un022	Main board temperature	℃

The status (low level or high level) of input signal allocated to each input terminal is displayed.

Display	Monitor No.	Description
	Un005	0: CN1-14 (lit for low level, not lit for high level) 1: CN1-15 (lit for low level, not lit for high level) 2: CN1-16 (lit for low level, not lit for high level) 3: CN1-17 (lit for low level, not lit for high level) 4: CN1-18 (lit for low level, not lit for high level)
	Un006	6: EXT1 (Touch Probe Input 1) 7: EXT2 (Touch Probe Input 2)
	Un007	0: CN1-6, 7 1: CN1-8, 9 2: CN1-10, 11

NOTE: Un007 represents the state of the output signal. The optocoupler ON and OFF of each output signal depends on whether the output signal is inverted:
If the signal is not inverted, lit for turning the optocoupler ON, and not lit for turning the optocoupler OFF.
If the signal is inverted, lit for turning the optocoupler OFF, and not lit for turning the optocoupler ON.

4.1.6 Utility Function Mode

This section describes how to apply the basic operations using the Panel Operator to run and adjust the Motor.

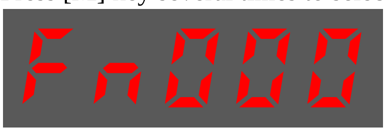
The following table shows the parameters in the Utility Function Mode.

Function Number	Name
Fn000	Alarm trace data display
Fn001	Initialize parameter settings
Fn002	JOG operation
Fn005	Automatic offset-adjustment of Motor current detection signal
Fn006	Manual offset-adjustment of Motor current detection signal
Fn007	Software version display
Fn009	Load inertia identification
Fn010	Absolute encoder multi-turn reset
Fn011	Absolute encoder alarm reset
Fn017	Auto-tuning tool
Fn018	PJOG operation

Fn000 (Alarm trace data display)

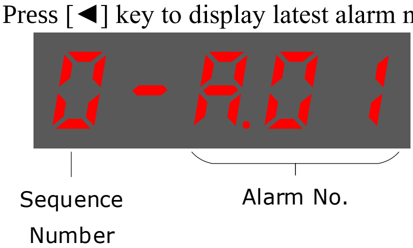
The alarm trace data display can display up to ten previously occurred alarms. The following are the steps to display the alarm trace data.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

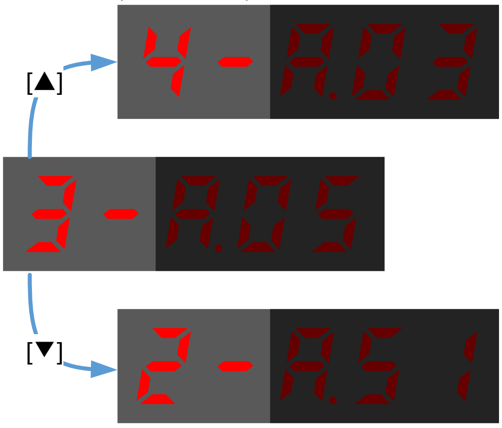


Step 2 Press [▲] key or [▼] key to select the function number Fn000.

Step 3 Press [◄] key to display latest alarm number.



Step 4 Press [▲] key or [▼] key to view the other alarm data.



Step 5 Press the [◀] key to return to the display of the Fn000.
Press and hold [◀] key for 1 second or more to clear all the alarm trace data.

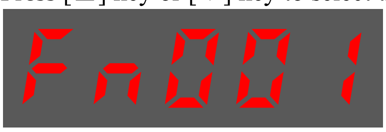
----End

Fn001 (Initialize parameter settings)

The following are the steps to initialize parameter settings.

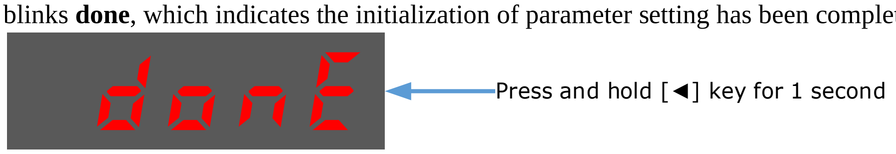
Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn001.



Step 3 Press [◀] key, and Panel Operator displays as below.

Step 4 Press and hold [◀] key for 1 second to initialize the parameter settings, until Panel Operator displays and blinks **done**, which indicates the initialization of parameter setting has been completed.



Step 5 Release [◀] key to return to the display of the Fn001.

----End

Fn002 (JOG operation)

This utility function often used for trial operation, refers to the section 8.3.3 JOG Operation.

Fn005 (Automatic offset-adjustment of Motor current detection signal)

Motor current detection offset adjustment has performed at ESTUN before shipping. Basically, the user need not perform this adjustment.

IMPORTANT

- Execute the automatic offset adjustment if the torque ripple is too big when compared with that of other Drives.
- Execute the automatic offset adjustment in the servo OFF state.

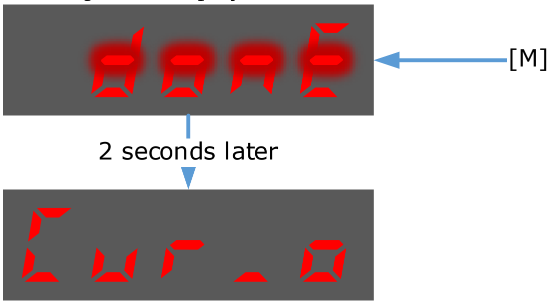
The following are the steps to execute the automatic offset adjustment.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn005.

Step 3 Press [◄] key, and Panel Operator displays as below.

Step 4 Press [**M**] key to execute the automatic offset adjustment.
Panel Operator displays and blinks **done**, and 2 seconds later, it will return to previous display.



Step 5 Press the [◄] key to return to the display of the Fn005.

----End

Fn006 (Manual offset-adjustment of Motor current detection signal)

To adjust the offset, perform the automatic adjustment (Fn005) first. And if the torque ripple is still big after the automatic adjustment, perform the manual offset-adjustment as follow.

IMPORTANT

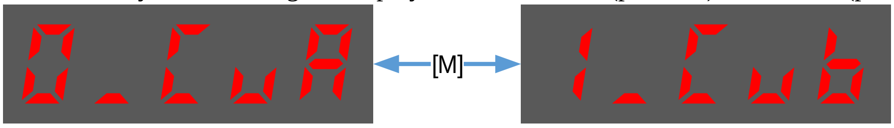
- Please carefully execute the manual offset-adjustment, in case worsen the characteristics of the Motor.
- When executing the manual offset-adjustment, run the Motor at a speed of approximately 100 rpm, and adjust the phase-U and phase-V offsets alternately several times until the torque ripple is minimized.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

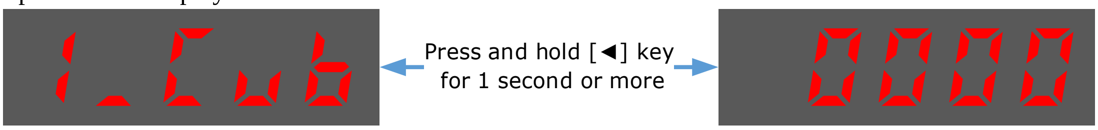
Step 2 Press [▲] key or [▼] key to select the function number Fn006.

Step 3 Press [◀] key, and Panel Operator displays as below.

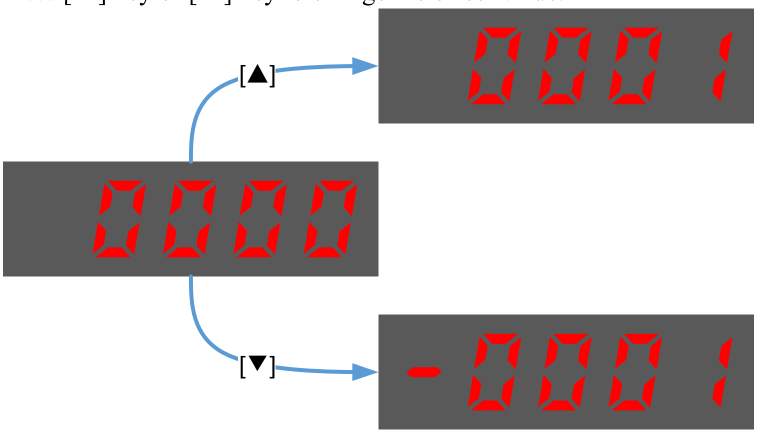
Step 4 Press [**M**] key for switching the display between 0_CuA (phase-U) and 1_Cub (phase-V).



Step 5 Select one phase display (e.g. 1_Cub, phase-V), and press and hold [◀] key for 1 second or more, Panel Operator will display the current offset value.



Step 6 Press [▲] key or [▼] key to change the offset value.



NOTE: the offset can be adjusted from -1024 to 1024.

Step 7 Press and hold [◀] key for 1 second or more to return to the phase display.

Step 8 Press [◀] key to return to the display of the Fn006.

----End

Fn007 (Software version display)

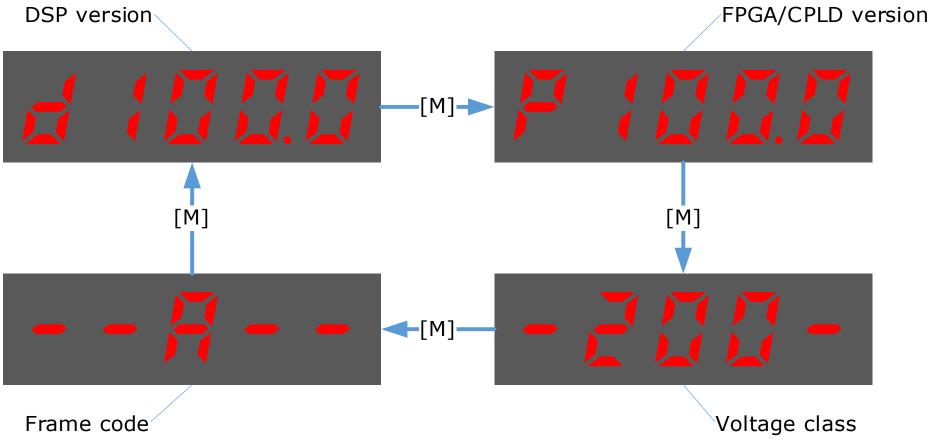
The following are the steps to display the software versions.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn007.

Step 3 Press [◀] key to display the software versions.

Step 4 Press [**M**] key serval time to display between DSP version, FPGA/CPLD version, Voltage class and Structure code.



Step 5 Press [◀] key to return to the display of the Fn007.

----End

Fn009 (Load inertia identification)

This utility function often used for tuning, refers to the section 9.7.1 Load Inertia Identification.

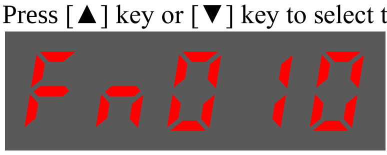
Fn010 (Absolute encoder multi-turn reset)

Important

- The clearing of multiturn data from the absolute encoder needs to be performed in the Servo OFF state。
- Before the driver is officially used, please perform a "clear multiturn data of the absolute encoder" operation.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn010.



Step 3 Press [◀] key, and Panel Operator displays as below.

Step 4 Press [**M**] key to reset the absolute encoder multi-turn data.

Step 5 Press [◀] key to return to the display of the Fn010.

----End

Fn011 (Absolute encoder alarm reset)

Important

- The clearing of multiturn data from the absolute encoder needs to be performed in the Servo OFF state。
- After the A.47 and A.48 alarms occur in the drive, the user needs to replace the encoder battery, see "3.5.3 Installing or Replacing the Battery". After the replacement is complete, the alarm can be cleared by Fn011.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn011.

Step 3 Press [◀] key, and Panel Operator displays as below.

Step 4 Press [**M**] key to reset the absolute encoder multi-turn data.

Step 5 Press [◀] key to return to the display of the Fn011.

----End

Fn017 (Auto-tuning tool)

This utility function often use used for tuning, refers to the section 9.3.2 Auto-Tuning Tool.

Fn018 (PJOG operation)

This utility function often used for trial operation, refers to the section 8.5 Program Jogging.

4.2 ESView V4

4.2.1 Installation

System Requirements

You need to provide for your own personal computer that meets the following basic hardware requirements.

Item	Description
OS	Windows 7 (32-bit or 64-bit) Windows 10 (32-bit or 64-bit) English (US), Chinese (Simply) version of the OS above.
CPU	1.6 GHz processor or more
Memory	System memory of 1 GB or more Graphics memory of 64 MB or more
Hard Disk	Free space of 1GB or more
Communication	USB; RJ45
Display	1,024×768 PIXEL or more 24bit color (TrueColor) or more

Preparation

Please prepare the Windows operating system, communication cable, and a decompression software in advance.

Visit ESTUN official website www.estun.com to find and download **ESView V4** on **Technical Support** > **Download** for getting the compressed file. For help, please contact ESTUN.

- Turn on the power supply of PC and start Windows. (Close down other software running.)
- Copy *ESView V4* compressed file into an appropriate folder.
- Disconnect if the Drive is connected to the PC with the cable.

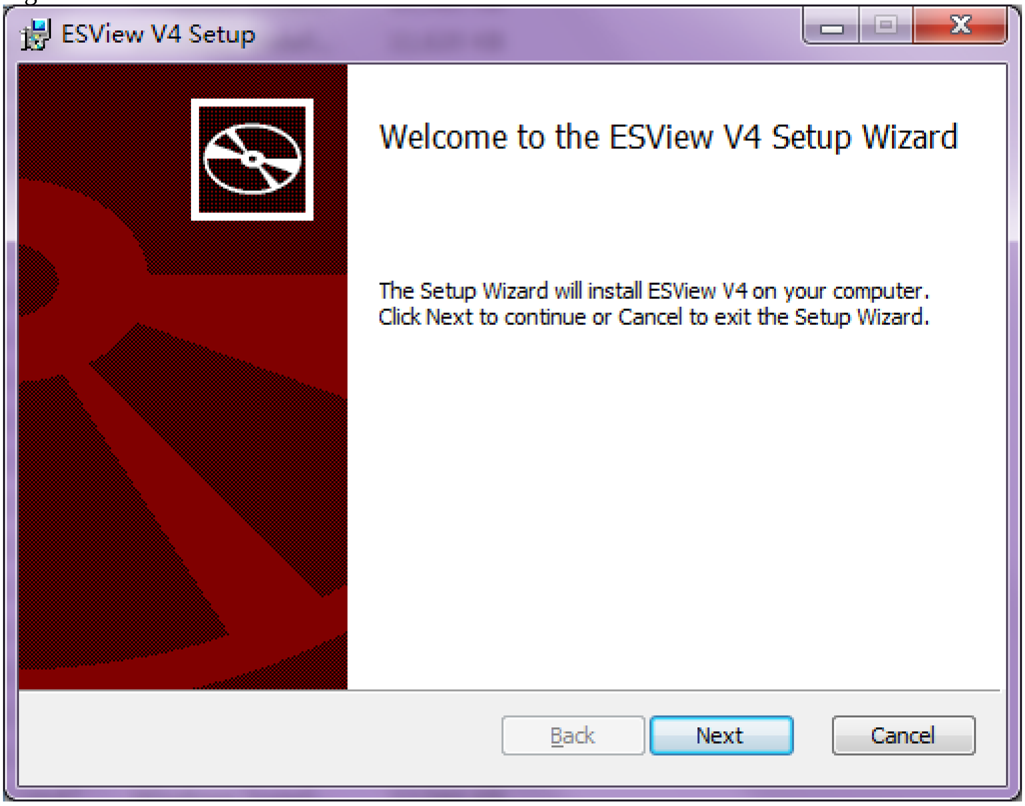
Install Software

Close other running software before installing the software and confirm that the Windows user has administrator privileges.

Step 1 Extract the *ESView V4* compressed file in an appropriate directory of your PC.

Step 2 Double click the *ESView V4* installation program.
The installation program will automatically start, as shown in the Figure 4-3.

Figure 4-3 Start to install ESView V4 softwar



Step 3 Follow the instructions of the installation wizard to install *ESView V4* to your PC.

----End

Install USB Driver

After installing the ESView V4 software successfully, you may also need to install the USB driver. If you have successfully installed a USB drive, you can skip what is described in this section, otherwise follow the steps below to install the USB driver.

Since the USB Driver can only support one designated port, you shall reinstall the USB Driver if you replaced another port on the PC side, or you can use the previous port.

Step 1 After installing the ESView V4 software successfully, connect the Drive to the PC by using the USB connection cable.

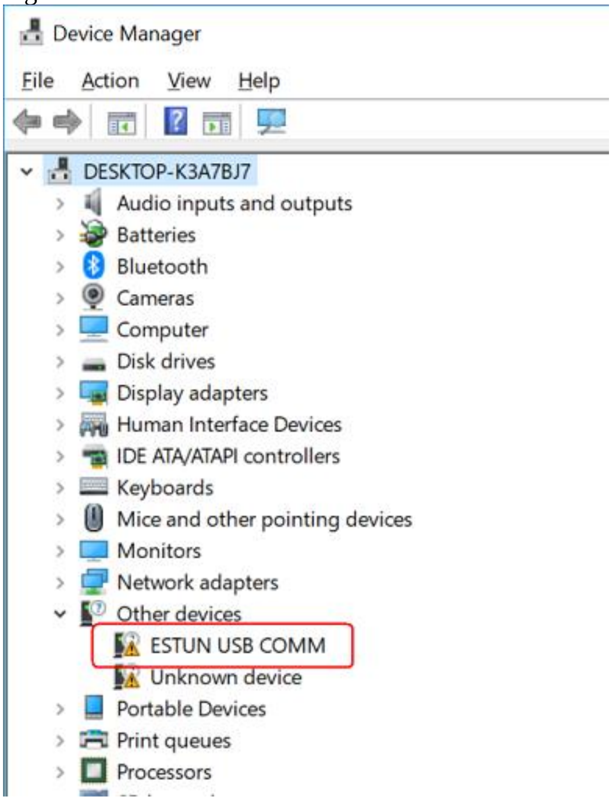
Step 2 Open the main directory of ESView V4 software (default location is *C:\ESView V4*), and extract the **USB Drivers.rar** compressed file to an appropriate directory of your PC.

Step 3 Open **Device Manager.**

- For Win7 OS, select **Start** > **Control Panel**.
  Click **Device Manager** on the displayed **All Control Panel Items**.
- For Win10 OS, just right-click **Start**, and select **Device Manager** on the pop-up menu.

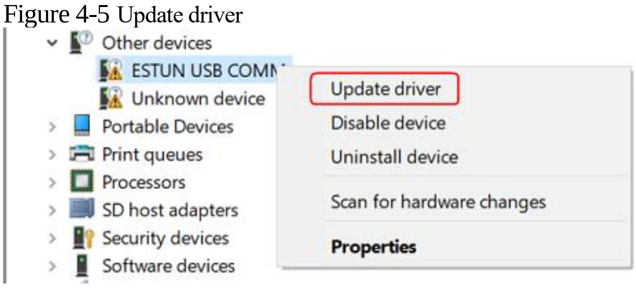
Step 4 An exclamatory mark attaches to the option **Other devices** > **ESTUN USB COMM** in **Device Manager** window, which indicates an error occurs in the driver and needs to update, as shown in Figure 4-4.

Figure 4-4 An error occurs in the driver



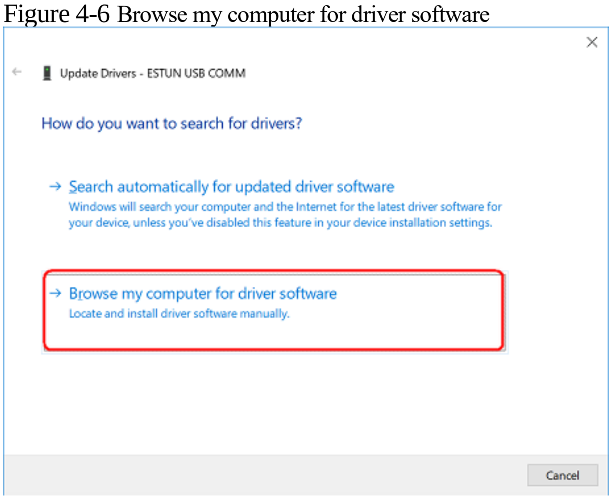
Step 5 Right-click **ESTUN USB COMM**, and select **Update driver** on the pop-up menu.

Figure 4-5 Update driver



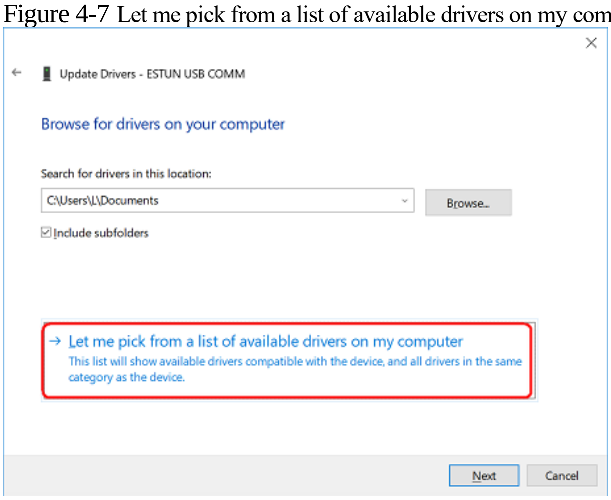
Step 6 Click **Browse my computer for driver software** on the **Update Drivers** dialog box.

Figure 4-6 Browse my computer for driver software



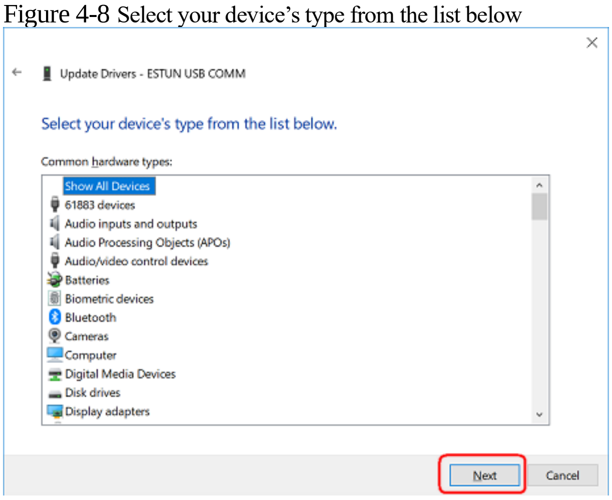
Step 7 Click **Let me pick from a list of available drivers on my computer**.

Figure 4-7 Let me pick from a list of available drivers on my computer



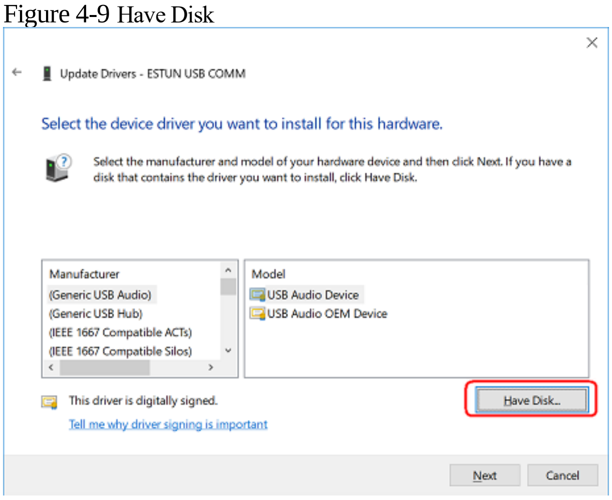
Step 8 Click Next.

Figure 4-8 Select your device's type from the list below



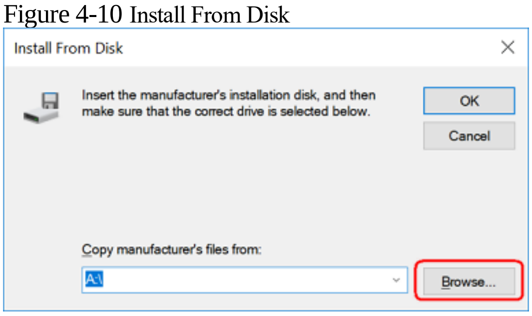
Step 9 Click **Have Disk**.

Figure 4-9 Have Disk



Step 10 Click **Browse** on the **Install From Disk** dialog box.

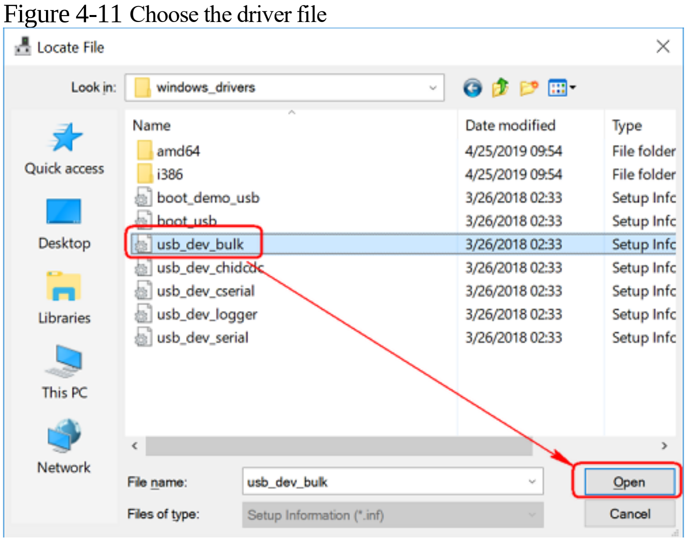
Figure 4-10 Install From Disk



Step 11 Set the **Look in** as the directory of *ESView V4* decompressed file *\USB Drivers\windows_drivers* on the **Locate File** dialog box.

Step 12 Choose *usb_dev_bulk.inf*, and then click **Open**.

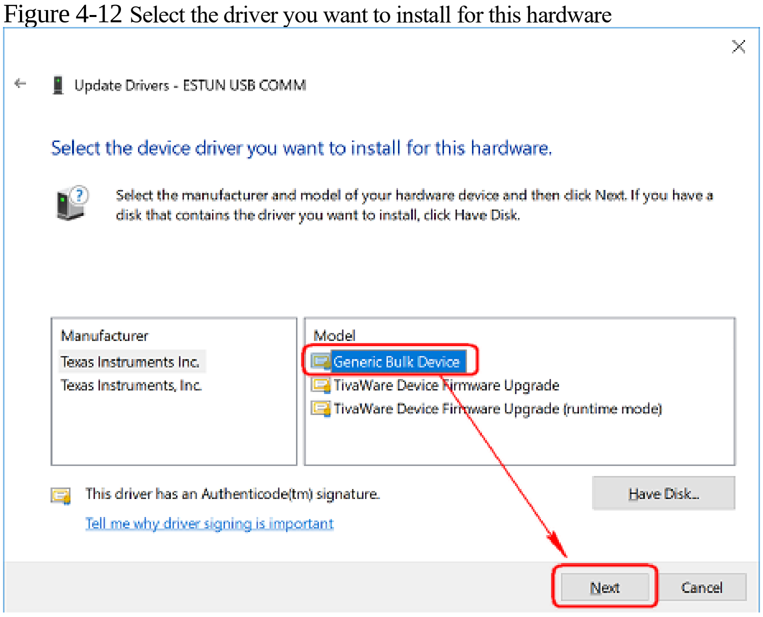
Figure 4-11 Choose the driver file



Step 13 Click **OK** on the **Install From Disk** dialog box.

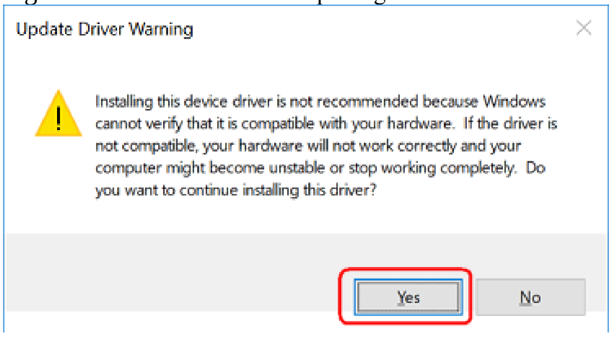
Step 14 Choose **Generic Bulk Device**, and then click **Next**.

Figure 4-12 Select the driver you want to install for this hardware



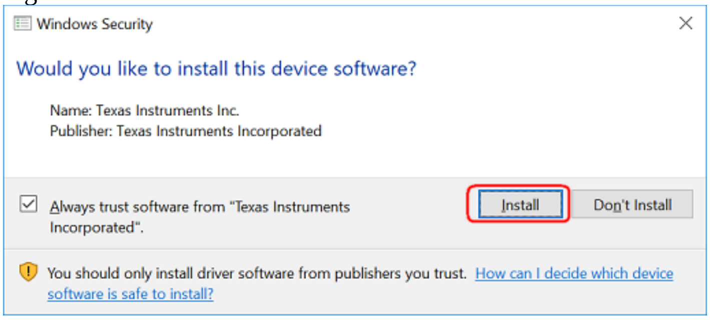
Step 15 Click **Yes** on the **Update Driver Warning** dialog box.

Figure 4-13 Confirm the driver updating



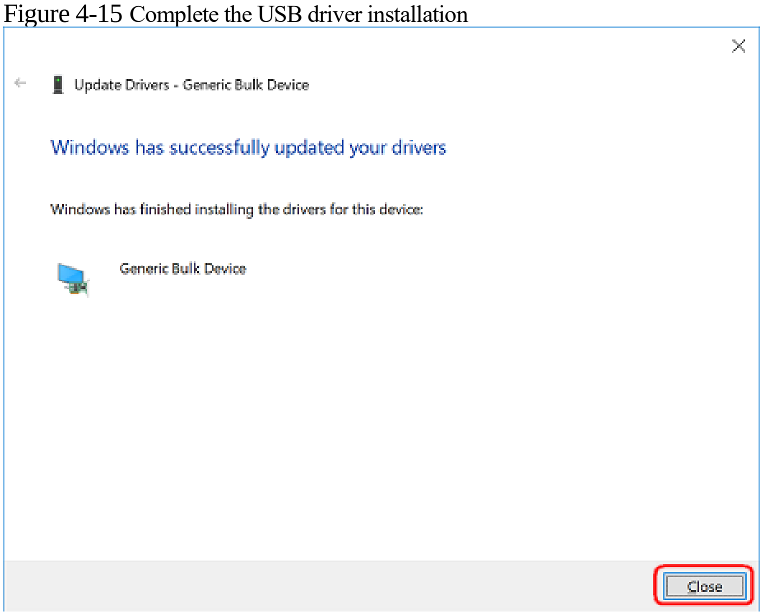
Step 16 Wait for a while, and then click **Install** on the **Windows Security** dialog box.

Figure 4-14 Confirm the installation



Step 17 The driver will be automatically installed to your PC, and then the installation result will be displayed. Click **Close** to complete the USB driver installation.

Figure 4-15 Complete the USB driver installation



----End

4.2.2 Start ESView V4

<u>Online Operation</u>

The parameters only can be written into or read from the Drive under the online operation. It is recommended that you perform an online operation for the first time to set the Drive.

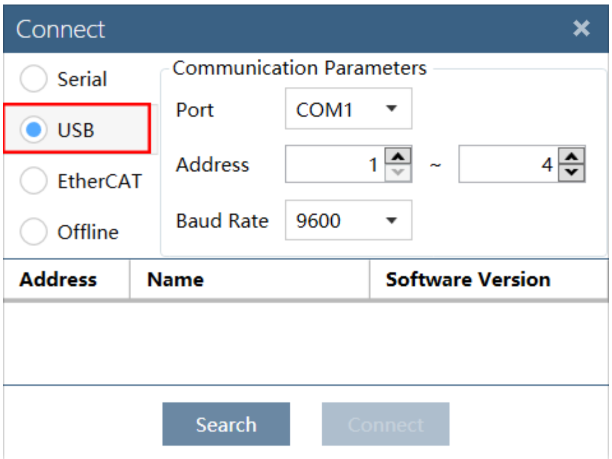
You need to connect the Drive to the PC by using the USB connection cable before the online operation.

Step 1 Connect the Drive to the PC by using the USB connection cable.

Step 2 Select **Programs** > **ESView V4** > **ESView V4** from the Windows **Start** Menu.
Also, you can find and click *ESView V4* shortcut on the desktop of Windows.

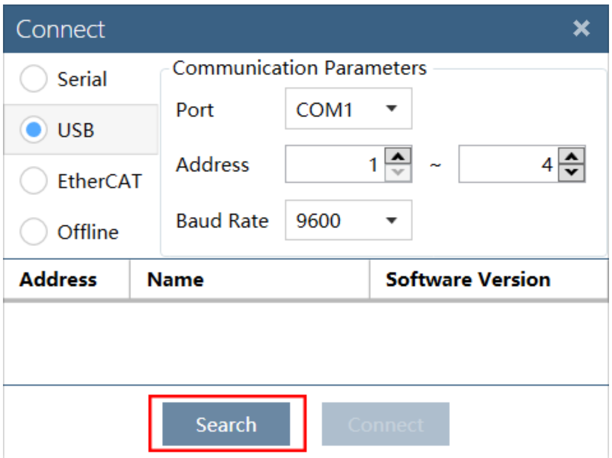
Step 3 The **Connect** dialog box will be displayed.
If you had started *ESView V4*, select **Home** > **Connect** in the **Menu** Bar.

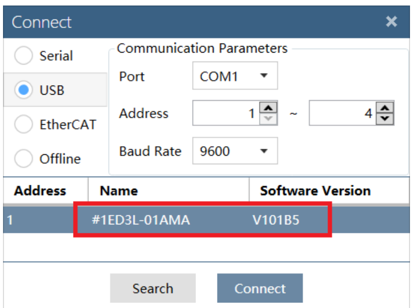
Step 4 Select **USB**.



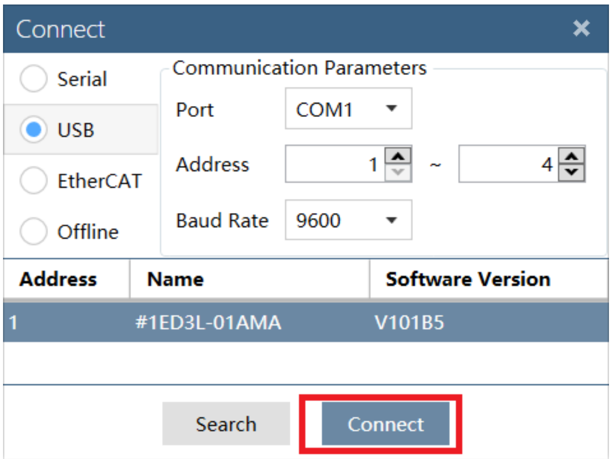
Step 5 Click **Search**.

Step 6 Select the found device.

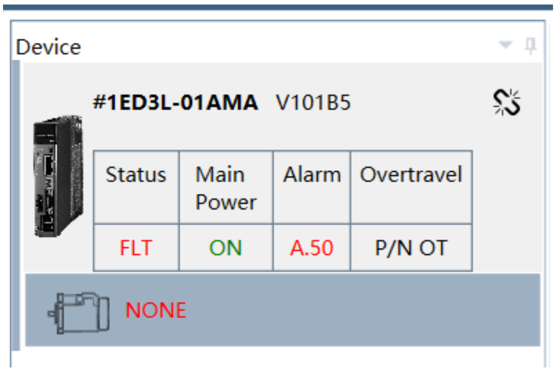




Step 7 Click **Connect**.



Step 8 The connected device will be displayed in the **Device** list on the left of the *ESView V4* main windows.



Now, you can make the necessary settings for the Drive or Motor in real time.

The **Device** list can display all the device you had connected or created (including online and offline), and their basic status.

If you want to delete a device from the **Device** list, click in the top right, and then click **OK** on the pop-up warning box.

----End

Offline Operation

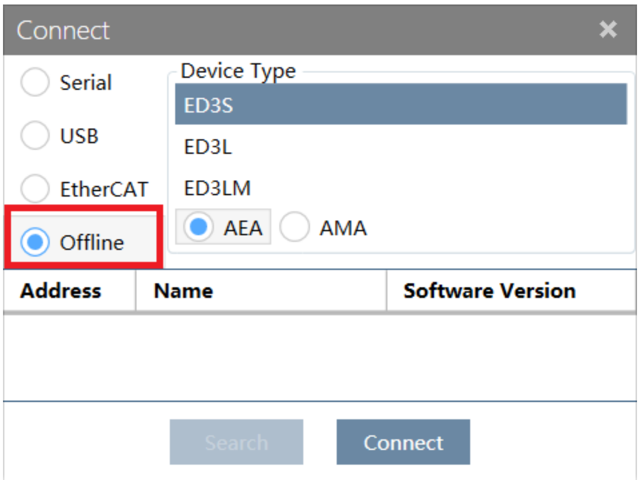
In offline operation, users do not need to connect any equipment, can perform oscilloscope, FFT, mechanical analysis and other image operations.

Although it is not necessary to connect the actual drive, some functions are limited and cannot be set correctly.

Step 1 Select **Programs** > **ESView V4** > **ESView V4** from the Windows **Start** Menu.
Also, you can find and click *ESView V4* shortcut on the desktop of Windows.

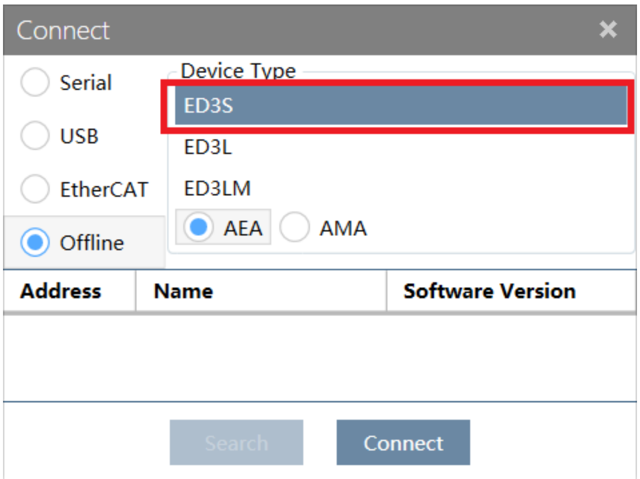
Step 2 The **Connect** dialog box will be displayed.
If you had started *ESView V4*, select **Home** > **Connect** in the **Menu** Bar.

Step 3 Select **Offline**.



Step 4 Select the desired **Device Type**, e.g. ED3S.

Step 5 Click **Connect**.



Step 6 The created device will be displayed in the **Device** list on the left of the *ESView V4* main windows.

NOTE

Since there is no online connection to a Drive, the functions that you can use are restricted.

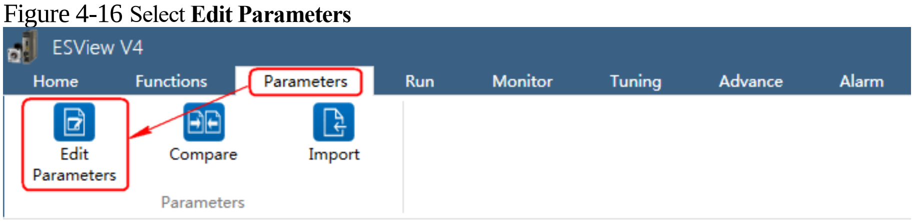
----End

4.2.3 Edit Parameters

Follow the below procedure to open the **Edit Parameters** window.

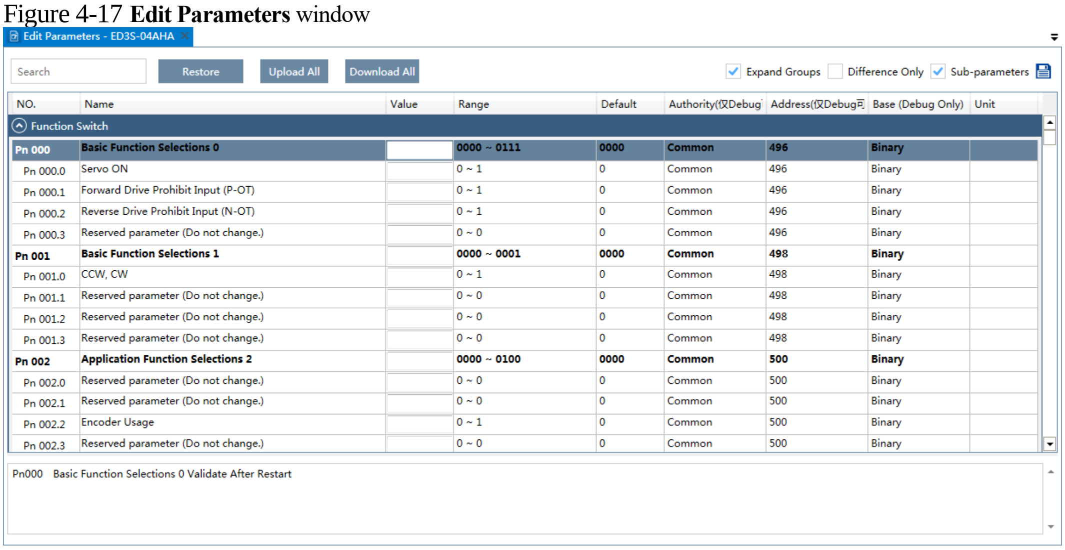
Step 1 Select **Parameters** > **Edit Parameters** in the **Menu Bar** of the *ESView V4* main windows.

Figure 4-16 Select **Edit Parameters**



Step 2 The **Edit Parameters** window will be displayed in **Function Display Area**.

Figure 4-17 **Edit Parameters** window



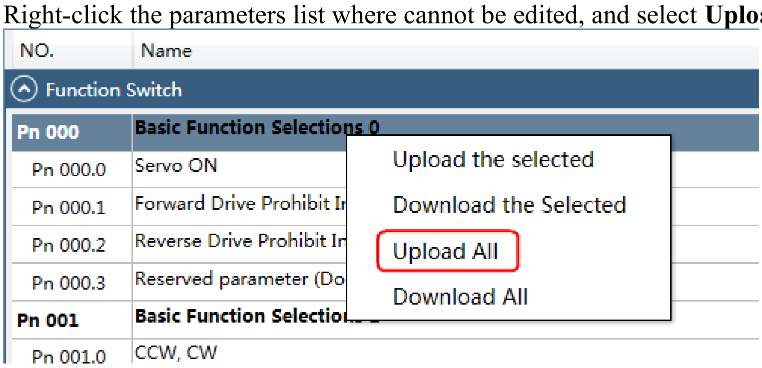
<u>Upload Parameters</u>

- Upload All

  In order to read all parameters from the Drive and fill them into **Value** column of the parameters list, you can:

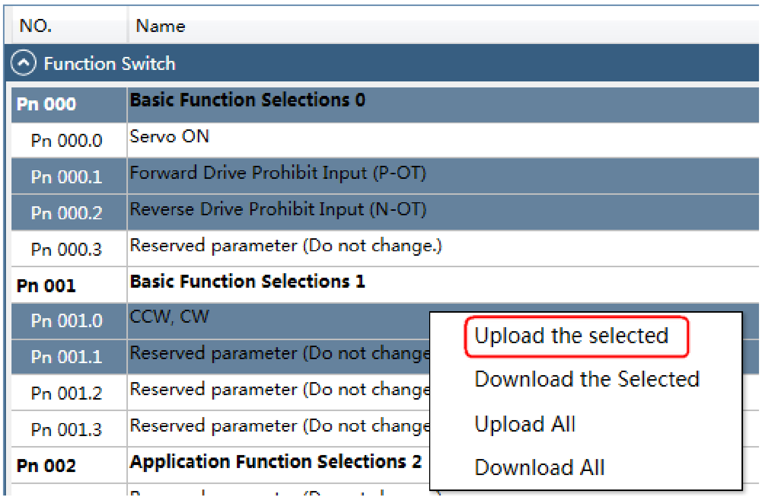
  – Click **Upload All** in the **Edit Parameters** window.

  – Right-click the parameters list where cannot be edited, and select **Upload All** in the pop-up menu.



- Upload the Selected

  Drag the mouse to select the desired parameters, or you can hold **Ctrl** key and click the desired parameter, and then right-click a selected parameter, and select **Upload the selected** in the pop-up menu.

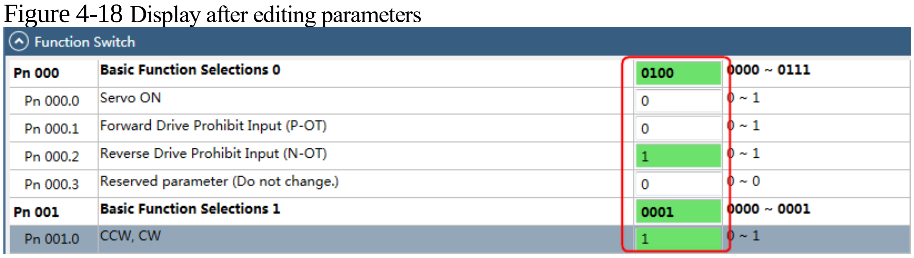


CAUTION	You can only fulfill the **Upload Parameter** function in **Online operation**. If a warning dialog box **Unable to upload the parameters** is displayed, check the connection between PC and the Drive.

Modify Parameters

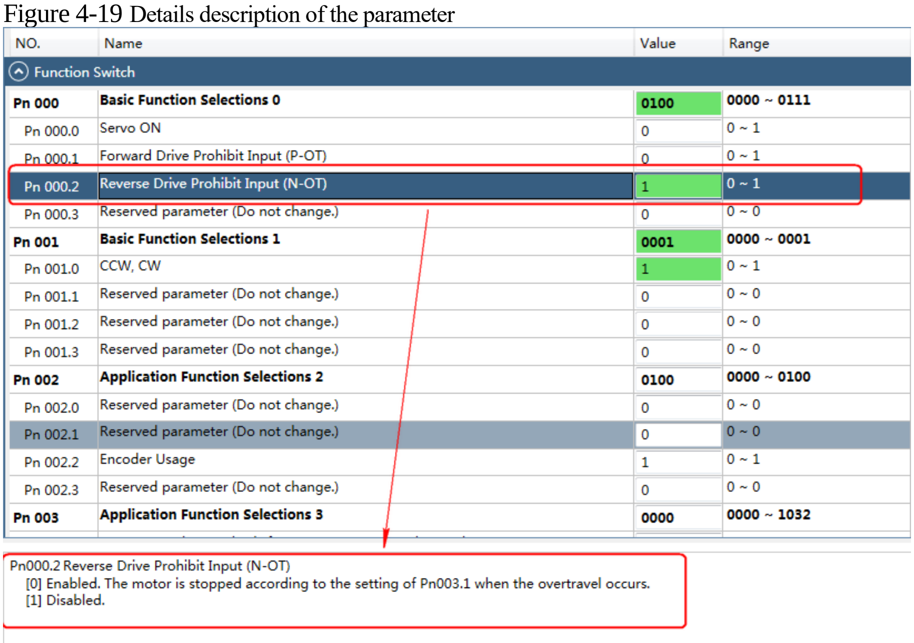
When the parameters have been uploaded from the device, you can modify them on the **Value** column. If a value has been modified, the background of the textbox can be changed, as shown in Figure 4-18.

Figure 4-18 Display after editing parameters



You can refer to the description displayed on the underside of the parameter list for the parameter modification.

Figure 4-19 Details description of the parameter



NO.	Name	Value	Range
Function Switch			
Pn 000	Basic Function Selections 0	0100	0000 ~ 0111
Pn 000.0	Servo ON	0	0 ~ 1
Pn 000.1	Forward Drive Prohibit Input (P-OT)	0	0 ~ 1
Pn 000.2	Reverse Drive Prohibit Input (N-OT)	1	0 ~ 1
Pn 000.3	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 001	Basic Function Selections 1	0001	0000 ~ 0001
Pn 001.0	CCW, CW	1	0 ~ 1
Pn 001.1	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 001.2	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 001.3	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 002	Application Function Selections 2	0100	0000 ~ 0100
Pn 002.0	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 002.1	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 002.2	Encoder Usage	1	0 ~ 1
Pn 002.3	Reserved parameter (Do not change.)	0	0 ~ 0
Pn 003	Application Function Selections 3	0000	0000 ~ 1032

Pn000.2 Reverse Drive Prohibit Input (N-OT)
[0] Enabled. The motor is stopped according to the setting of Pn003.1 when the overtravel occurs.
[1] Disabled.

NOTE

Click **Search** input box on the **Edit Parameters** window, and type the keyword you want to search. The keyword, including **NO**, **Name**, **Value**, **Range**, **Default**, **Unit**, as well as description of each parameter.

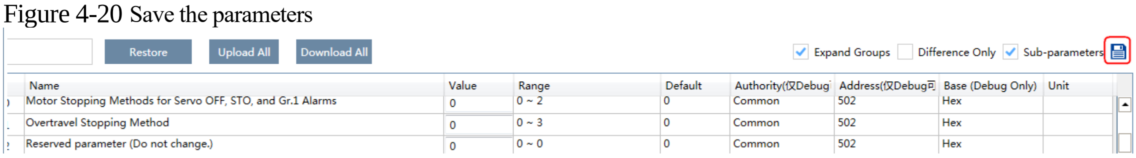
If you want to search multiple items at once, add one or more space between keywords that lists all the parameters that match any of the keywords.

Save Parameters

Follow the below procedure to save the current settings as an offline file into the PC.

Step 1 Click in the **Edit Parameters** window.

Figure 4-20 Save the parameters



Name	Value	Range	Default	Authority(仅Debug	Address(仅Debug可	Base (Debug Only)	Unit
Motor Stopping Methods for Servo OFF, STO, and Gr.1 Alarms	0	0 ~ 2	0	Common	502	Hex	
Overtravel Stopping Method	0	0 ~ 3	0	Common	502	Hex	
Reserved parameter (Do not change.)	0	0 ~ 0	0	Common	502	Hex	

Step 2 Choose the desired files in the **Save As** dialog box.

Step 3 Click **Save**.

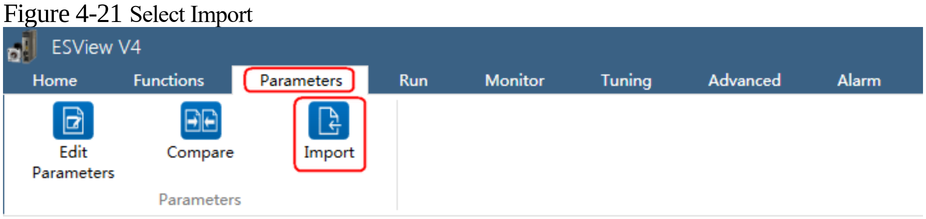
----End

Import Parameters

You can fulfill Import function, importing the offline parameters file into the online Drive.

Step 1 Select **Parameters** > **Import** in the **Menu Bar** of the ESView V4 main windows.

Figure 4-21 Select Import

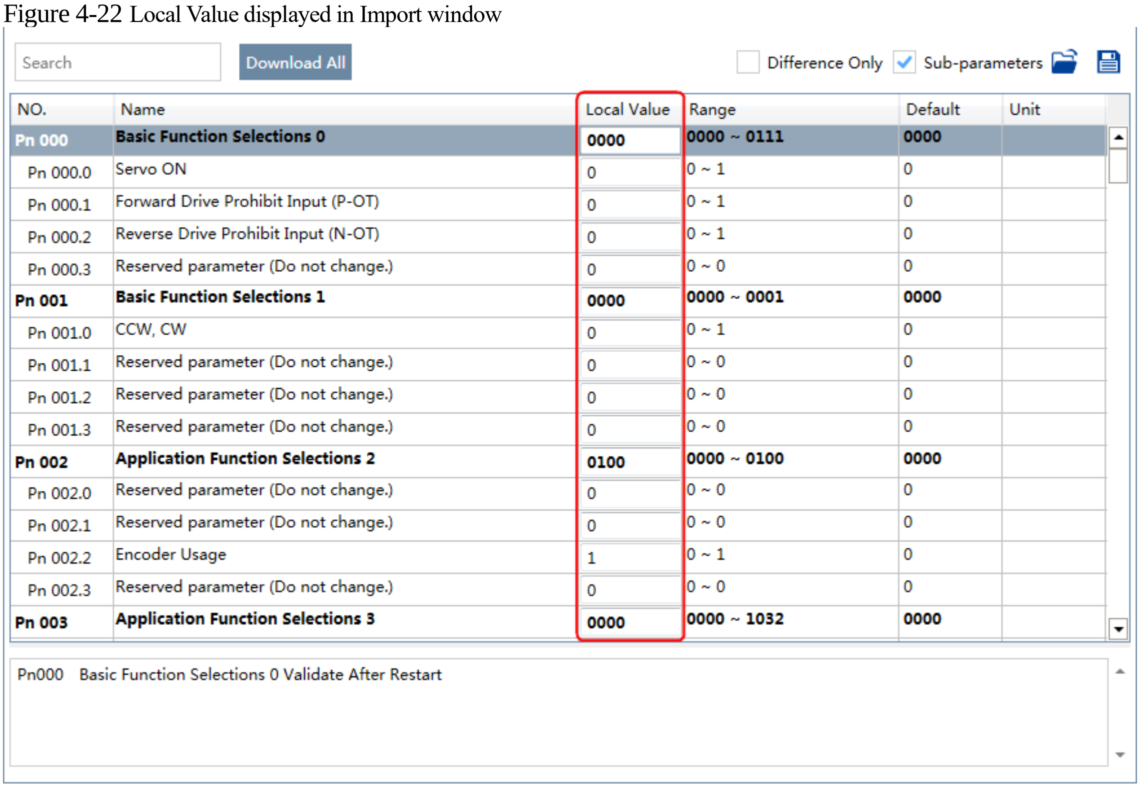


Step 2 Select a proper offline parameter file (**.esvpa*) in the pop-up **Open** dialog box.

Step 3 The **Import** window will be displayed in **Function Display Area**.

And, the **Local Value** in the offline parameters file are filled into the parameter list.

Figure 4-22 Local Value displayed in Import window



NO.	Name	Local Value	Range	Default	Unit
Pn 000	Basic Function Selections 0	0000	0000 ~ 0111	0000	
Pn 000.0	Servo ON	0	0 ~ 1	0	
Pn 000.1	Forward Drive Prohibit Input (P-OT)	0	0 ~ 1	0	
Pn 000.2	Reverse Drive Prohibit Input (N-OT)	0	0 ~ 1	0	
Pn 000.3	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 001	Basic Function Selections 1	0000	0000 ~ 0001	0000	
Pn 001.0	CCW, CW	0	0 ~ 1	0	
Pn 001.1	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 001.2	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 001.3	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 002	Application Function Selections 2	0100	0000 ~ 0100	0000	
Pn 002.0	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 002.1	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 002.2	Encoder Usage	1	0 ~ 1	0	
Pn 002.3	Reserved parameter (Do not change.)	0	0 ~ 0	0	
Pn 003	Application Function Selections 3	0000	0000 ~ 1032	0000	

Step 4 Before importing parameters into the Drive, you can edit and download the parameters.

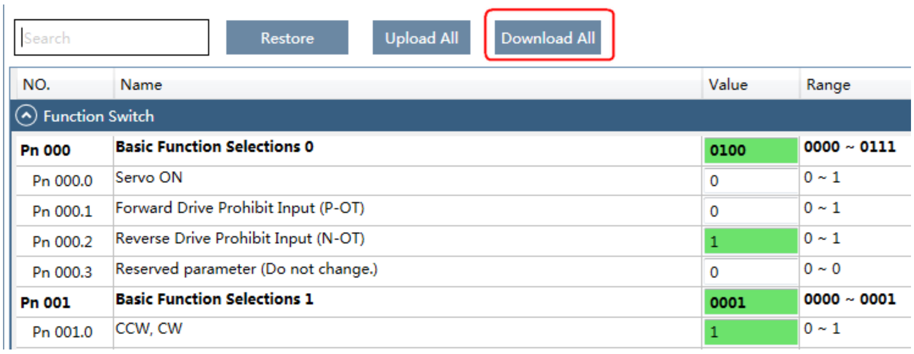
----End

Download Parameters

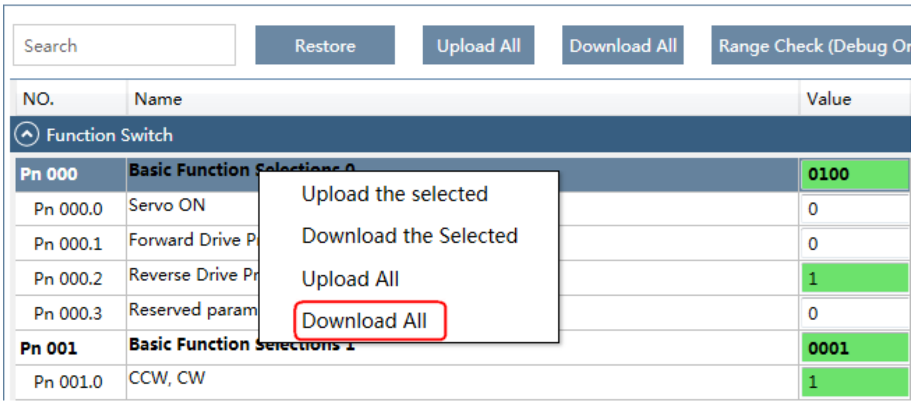
- Download All

  In order to write all parameters of the parameters list into the Drive, you can:

  – Click **Download All** in the **Edit Parameters** window.

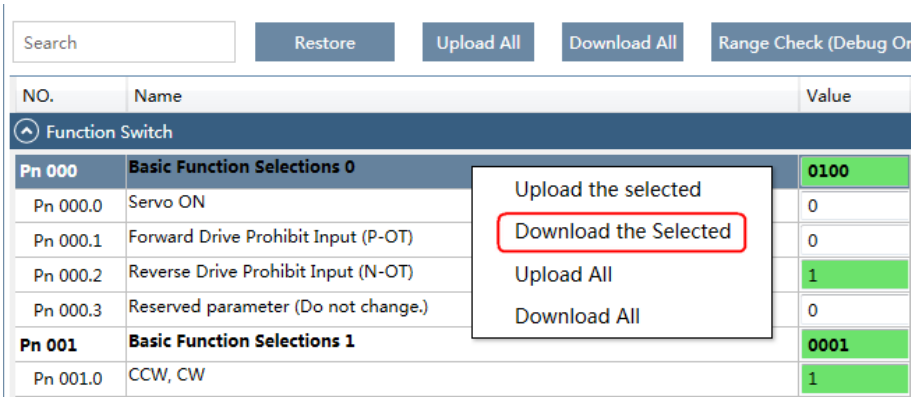


  – Right-click the parameters list where cannot be edited, and select **Download All** in the pop-up menu.



- Download the Selected

  Drag the mouse to select the desired parameters, or you can hold **Ctrl** key and click the desired parameter, and then right-click a selected parameter, and select **Download the Selected** in the pop-up menu.



CAUTION

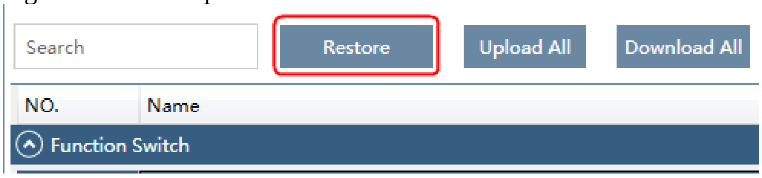
You can only fulfill the Download Parameter function in **Online Operation**. If a warning dialog box **Unable to download the parameters** is displayed, check the connection between PC and the Drive.

Restore Parameters

CAUTION	Make sure that it is necessary to restore the parameters as default setting before fulfilling the **Restore Parameters** function.

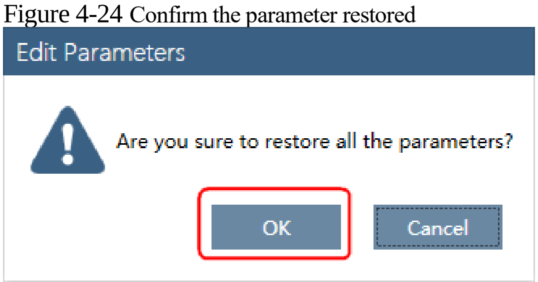
Step 1 Click **Restore** in the **Edit Parameters** window.

Figure 4-23 Restore parameters



Step 2 Read the content on the warning dialog box and click **OK**.

Figure 4-24 Confirm the parameter restored



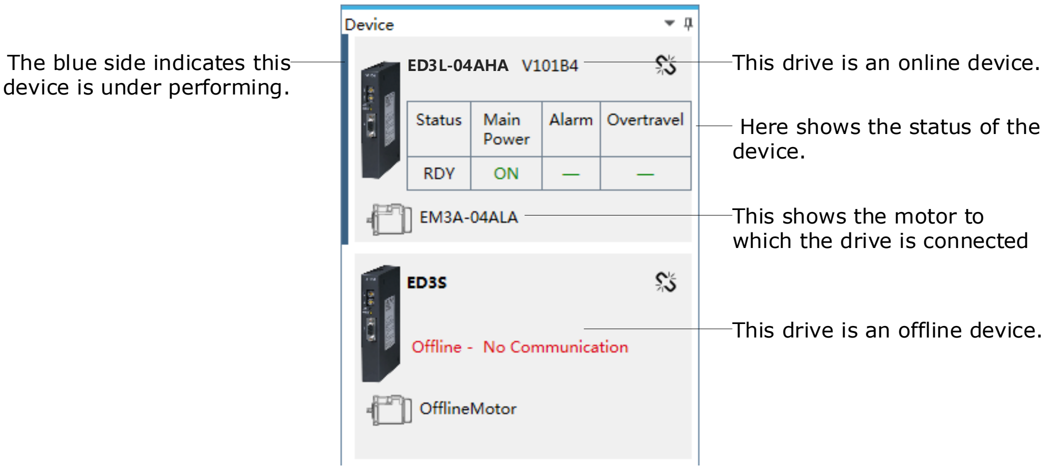
Step 3 *ESView V4* will send the **Restore Parameters** command to the Drive, and then the Drive will execute the **Restore Parameters**.

----End

4.2.4 Monitor

Device Status

The **Device** list can display all the device you had connected or created (including online and offline), and their basic status.

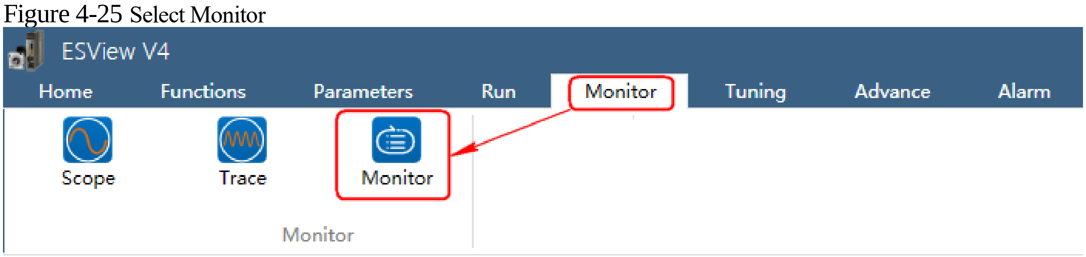


IO Monitor

Use the **Monitor** function for displaying the main parameters of the device and the I/O signal information.

Step 1 Select **Monitor** > **Monitor** in the **Menu Bar** of the *ESView V4* main windows.

Figure 4-25 Select Monitor

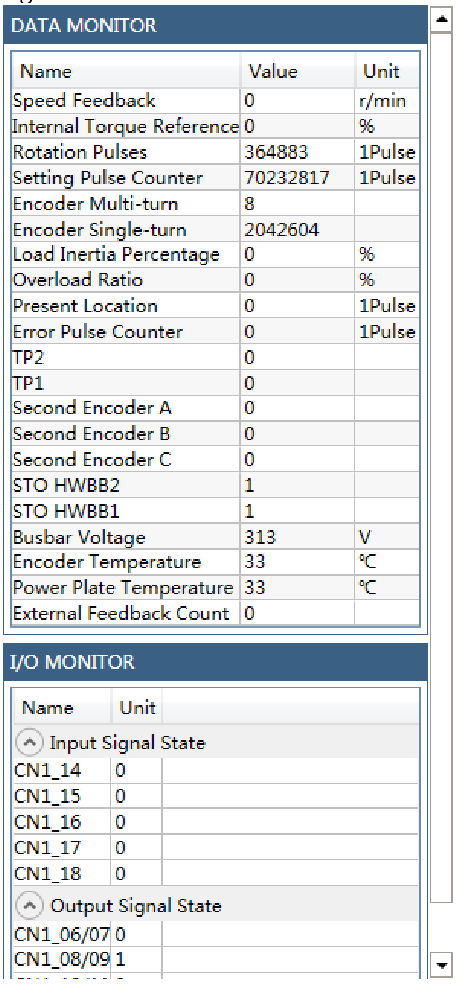


NOTE

You can also move the cursor upon **Monitor** on the right side of the main window of *ESView V4* and stay for a while, the **Monitor List** will be displayed.

Step 2 The **Monitor List** will display the information of **DATA MONITOR** and **I/O MONITOR**.

Figure 4-26 Monitor List



DATA MONITOR

Name	Value	Unit
Speed Feedback	0	r/min
Internal Torque Reference	0	%
Rotation Pulses	364883	1Pulse
Setting Pulse Counter	70232817	1Pulse
Encoder Multi-turn	8	
Encoder Single-turn	2042604	
Load Inertia Percentage	0	%
Overload Ratio	0	%
Present Location	0	1Pulse
Error Pulse Counter	0	1Pulse
TP2	0	
TP1	0	
Second Encoder A	0	
Second Encoder B	0	
Second Encoder C	0	
STO HWBB2	1	
STO HWBB1	1	
Busbar Voltage	313	V
Encoder Temperature	33	℃
Power Plate Temperature	33	℃
External Feedback Count	0	

I/O MONITOR

Name	Unit
Input Signal State	
CN1_14	0
CN1_15	0
CN1_16	0
CN1_17	0
CN1_18	0
Output Signal State	
CN1_06/07	0
CN1_08/09	1

----End

Chapter 5 STO

5.1 Overview

This product has the "Safe Torque Off" (STO) function in accordance with IEC 61800-5-2, which is equivalent to the uncontrolled stop (stop category 0) according to IEC 60204-1, which can protect workers from dangerous movements of moving parts of machinery and reduce the risk when using machinery.STO

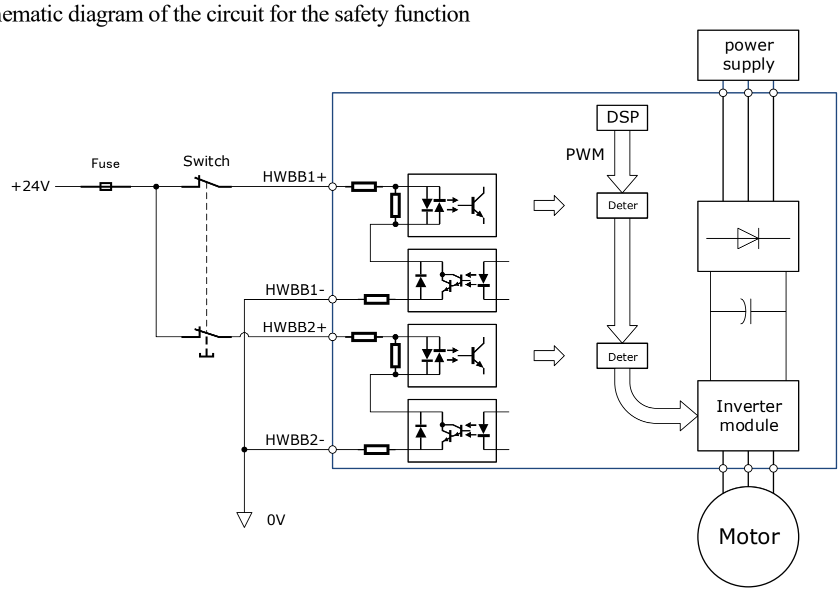
The function provides a way to prevent the drive from generating torque in the motor, and the safety function of the motor output torque is turned off by the safety input signal by forcibly turning off the drive signal of the power transistor inside the driver.

STO does not provide galvanic isolation, so it is not equivalent to the "safe shut-off" function of IEC 60204-1, which means that a driver in the STO state may still have dangerous voltages at its motor terminals.

Functional block diagram

The operation of the safety function circuit is shown in Figure 5-1。

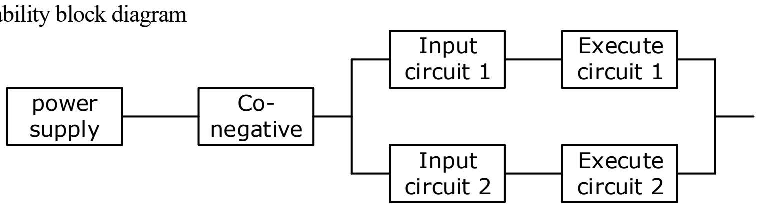
Figure 1-1 Schematic diagram of the circuit for the safety function



【Illustrate】
When the switch is closed, HWBB1 and HWBB2 are ON, and the signal blocking circuit allows the PWM signal to pass through, that is, the torque output is allowed;
When the switch is off, HWBB1 or HWBB2 is OFF, and the signal blocking circuit does not allow PWM signals to pass, that is, the torque output is turned off.

The reliability block diagram is shown in Figure 5-2。

Figure 1-1 Reliability block diagram



Features

STO safety features include the following:

- The safe state refers to the shutdown of all PWM signals of the hardware, causing the motor torque to turn off.
- The system structure is: single channel + dual channel (1oo1 + 1oo2).
- STO operates in demanding operating modes with SC3 system capability.
- PFH can reach 0.018% of the entire safety loop, that is, 1.8*10-11.
- The MTTFd per channel is 3184 years
- Follows IEC 61508-6:2010 with 0 MRT and MTTR.
- Total failure rate λ = 355.80 fit; Safe failure rate λS = 283.38 fit; Dangerous failure rate λDD = 71.69 fit; No dangerous failure rate λDU = 0.73 fit.
  Note: The failure rate unit 1 fit (failures in time) = 1*10-9 h-1, that is, the device fails once in 109 working hours.
- Safety class SIL3 (IEC 62061: 2015) and performance class PLe in category Cat.4 (ISO 13849-1: 2015).
- In accordance with IEC 61508:2010 and IEC 62061:2015, the SFF of single channel (1oo1) is not less than 99%, and the SFF of dual channel section (1oo2) is not less than 90%.
- Follows ISO 13849-1: 2015 with a DC of not less than 99%.
- The response time to enable STO does not exceed 30ms.
  The response time of the STO is the time interval from when the STO signal is triggered and when the PWM signal is turned off.
- (*) When HFT=0, the diagnostic test interval is less than 20ms;
  When HFT > 0, the diagnostic test interval is less than 1h.
- (*) Following the definition of DS in IEC61326-3-1, the motor will stop within 200ms.
- Following ISO 13849-1: 2015, the CCF score is better than 65 points.
- (*) All detected faults will cause the drive to enter a safe state.
- (* In a single channel, the diagnostic test interval + fault reaction time < 30ms.
- (*) Input signal filtering time definition: When the input signal remains low for more than 2ms, the HWBB1 and HWBB2 signals will be set to OFF and the driver will enter a safe state.

Note

In order to prevent the accumulation of faults, it is necessary to confirm the loss of function at regular intervals based on the risk assessment of the machinery or device. Regardless of the safety level of the system, the safety confirmation test is carried out at least once every 20 years. The inspection items mainly include the items with (*) added to the above characteristics.

Risk

The plant manufacturer is responsible for all residual risks associated with the risk assessment. The following are the residual risks associated with STO function. The Company shall not be liable for any damage, injury, etc. caused by residual risks.

警告

- The STO function only shuts down the torque output of the motor and does not cut off the physical connection between the drive and the motor, so there is a risk of electric shock. Do not touch the terminal blocks while they are live.
- For components used on safety circuits, use products that have been certified for safety or meet safety specifications.
- Starting the STO function will turn off the torque output of the motor, and it should be ensured that the servo motor does not operate due to external forces or other influences.
- When replacing the drive, verify that the new product and the previously used product are the same model. Before running the system after installation, be sure to confirm the performance of the feature.
- Please conduct a risk assessment of the machinery or plant as a whole.
- Be sure to supply the STO input signals (HWBB1, HWBB2) from a common power supply. If the power supply is separated, the leakage current may cause the STO function to malfunction and cannot enter the STO cut-off state.
- Use a PELV/SELV switching power supply to power the input and output signals of the STO function.

Alarm description

If an A.30 (STO module disconnection) or A.31 (STO hardware circuit failure) alarm occurs on the drive, it means that the STO function circuit may have been damaged and should be troubleshooted before using the STO function.

Alarm number	The name of the alarm	Description
A30	The STO module is disconnected	HWBB1 or HWBB2 is disconnected for more than 10s, and the STO function should be used after checking the wiring and troubleshooting.
A31	STO hardware circuit failure	The STO function circuit may have been damaged, and the STO function should be used after troubleshooting.

Applicable standards

The standards followed by the STO function are shown in the table below.

Project	Standard
EMC Directive	• IEC 61800-3: 2017 • IEC 61000-4: 2017 • IEC 61326-3-1: 2017 • IEC 61800-5-2: 2016 Illustrate: The environment category is the second environment and the device category is C2.
Low voltage directive	• EN 61800-5-1: 2007 + AMD1:2017
Functional safety	• IEC 61800-5-2: 2016 • IEC 60204-1: 2016 • IEC 61508: 2010 • IEC 62061: 2015 • ISO 13849-1: 2015

Project	Standard
Environmental requirements	• IEC 60068-2-1: 2007 • IEC 60068-2-2: 2007 • IEC 60068-2-6: 1995 • IEC 60068-2-14: 1984 • IEC 60068-2-27: 1987 • IEC 60068-2-78: 2001 • IEC 61800-2: 2015 • IEC 61800-5-1:2007 + AMD1:2016

5.2 Environmental Description

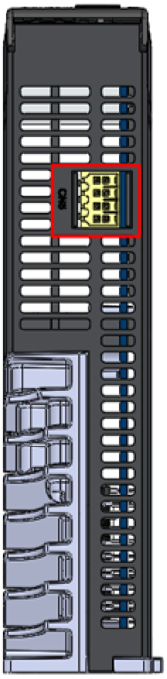
project	Illustrate	
Working environment	temperature	• When used with a single device:-5℃～55℃ • When multiple devices are installed snugly：-5℃～40℃
	humidity	5%~95%RH（No condensation、No freezing）
Storage environment	temperature	-20℃～85℃
	humidity	5%~95%RH（No condensation、No freezing）
elevation	≤1000m（rated）	
IP rating	IP20	
The degree of contamination	II	
Overvoltage rating	III	
Insulation withstand voltage	Input to output: 2.7 kVAC Input to ground: 2.0 kVAC	
Insulation resistance	50 MΩ and above	

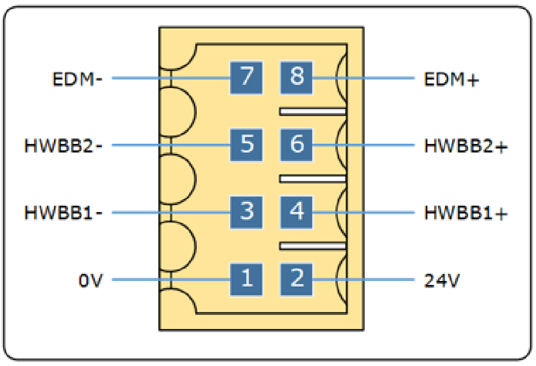
note

- To avoid the risk of crosstalk from the signal cable, separate the power interface cable from the signal cable or use other mitigation methods.
- It is not recommended to use this product in common low-voltage power supply systems.

5.3 Port Definition

Terminal arrangement





Signal description

warn

- Use a PELV/SELV switching power supply to power the input and output signals of the STO function.
- External signals should comply with the invalid current principle.

Pins	name	Illustrate	function
1	0V	24V power supply	When not connected to safety devices, it is used to short-connect HWBB1 and HWBB2 and cannot be used to power external devices.
2	24V		
3	HWBB1-	HWBB1 Input	HWBB1 signal or HWBB2 signal is OFF, STO function will be enabled.
4	HWBB1+		
5	HWBB2-	HWBB2 Input	
6	HWBB2+		
7	EDM-	Peripherals monitor output	When the HWBB1 signal or HWBB2 signal is OFF, the EDM is set to ON.
8	EDM+		

Signal specifications

The input specifications for HWBB1 signals (CN6-3, -4) and HWBB2 signals (CN6-5, -6) are as follows:

project	characteristic	remark
Internal impedance	3.3 kΩ	–
Operating voltage range	24V±20%	V_{H_min} = 17.6 V; V_{L_max} = 4 V

The electrical characteristics of the EDM (CN6-7, -8) output signal are as follows:

Item	Characteristics	Description
Maximum allowable voltage	35 VDC	–
Maximum allowable current	80 mA DC	–
Maximum pressure drop at ON	1.0 V	At a current of 80mA, the voltage between EDM+~EDM-
Maximum latency	5 ms	Time from HWBB1, HWBB2 to EDM

5.4 Function Description

5.4.1 Peripheral monitoring（EDM）

Peripheral device monitoring (EDM) is a circuit that monitors whether the STO function is working properly, and please connect it with feedback such as safety devices.

The logical relationship between EDM signal, HWBB1 signal and HWBB2 signal is shown in Table 5-1.

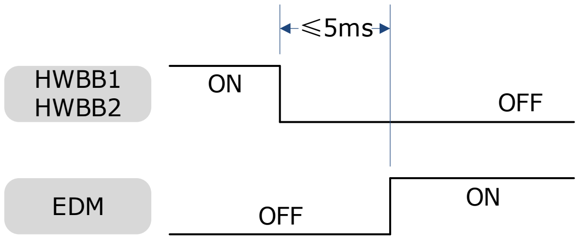
Table 5-2 Logical relationship between EDM and HWBB1 and HWBB2

Signal	logic			
HWBB1	ON	ON	OFF	OFF
HWBB2	ON	OFF	ON	OFF
EDM	OFF	OFF	OFF	ON

警 告

The EDM signal is not a safe output and should not be used for purposes other than monitoring STO functions.

When the STO function is enabled by setting the input signals HWBB1 and HWBB2 to OFF, the EDM output signal will be built into ON at 5ms when the safety function is operating normally.



5.4.2 SAF state

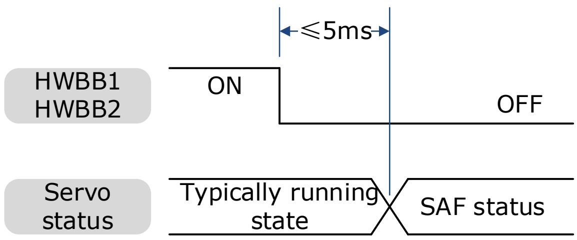
After turning off the servo motor torque output using the STO function, the servo operating status will change to "SAF", and the digital tube on the operation panel will display:

The logical relationship between the SAF state and the HWBB1 signal and HWBB2 signal is shown in Table 5-2.

The logical relationship between the servo state and HWBB1 and HWBB2

project	logic			
HWBB1 signal	ON	ON	OFF	OFF
HWBB2 signal	ON	OFF	ON	OFF
Servo status	–	alarm	alarm	SAF

When the STO function is enabled by setting the input signals HWBB1 and HWBB2 to OFF, the power to the motor is cut off within 5ms.



The safety input signal may contain L pulses for self-diagnosis of safety equipment, and it should be ensured that the L pulse does not exceed 1ms, otherwise it may be treated as an OFF signal and enter a safe state.

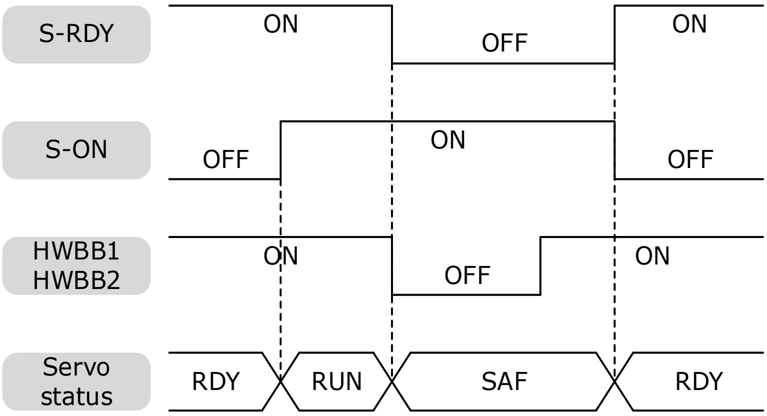
Note

The STO function can only be reset after both the HWBB1 signal and the HWBB2 signal are set to ON.

5.4.3 About servo preparation (S-RDY) signals

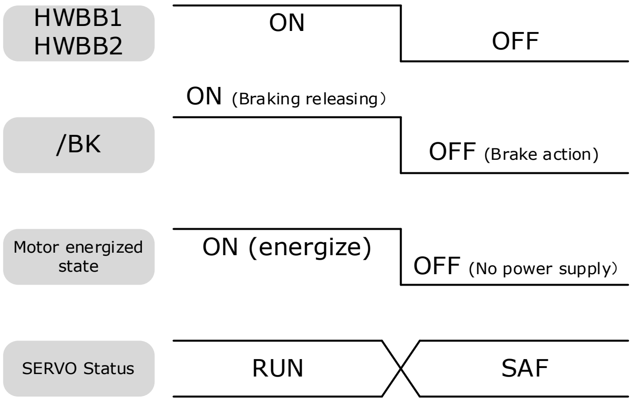
In the SAF state, the servo prepares the S-RDY signal to OFF.

If the HWBB1 and HWBB2 signals are set to ON and the servo is OFF, the servo preparation S-RDY signal will be set to ON, and the servo will enter the servo preparation state.



5.4.4 About the brake control output (/BK) signal

When the STO function is enabled, the brake control output (/BK) signal is set to OFF (brake action). At this point, the motor will immediately enter a power-on state and Pn506 (servo OFF waiting time) is invalid.



5.4.5 About the stop method

When the STO function is enabled, the motor stops running by inertia when the servo enters the SAF state.

5.4.6 About the deviation counter clearing method

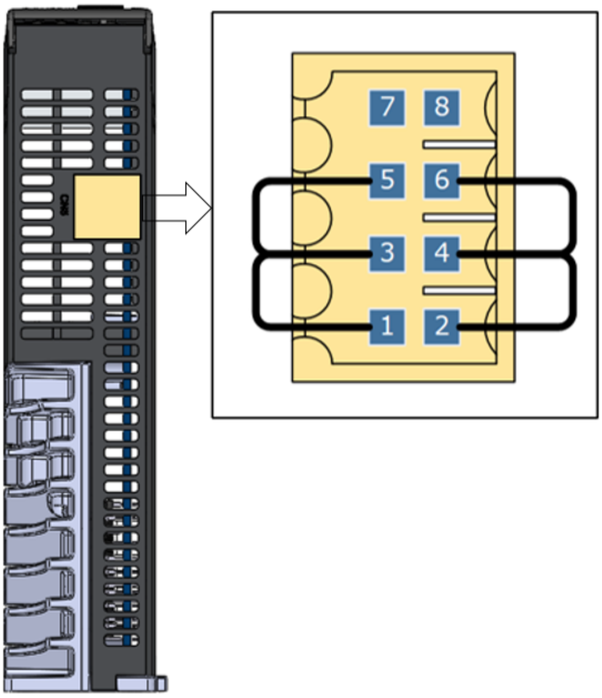
When the STO function is enabled, when the servo enters the SAF state, the deviation counter is cleared according to the setting of Pn004.1 (deviation counter clearing method).

parameter	Setpoint	Zeroing method	Effective time
Pn004.1	0	The deviation counter clears when the servo enters the SOFF or SAF state	Reboot
	2	The deviation counter clears when the servo enters the SOFF, SAF state, or overtravel state	

5.5 Connection of Security Devices

5.5.1 When security devices are not connected

If you do not need to connect a security device, you should keep the secure port connector plugged into the secure interface CN6 and the short-connect setting on the connector in factory condition.



Note

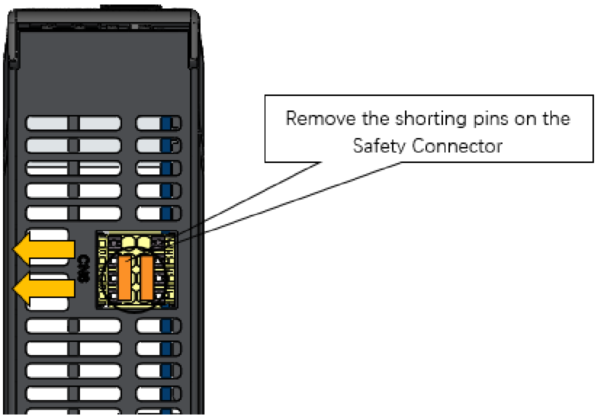
If the short wiring plug on the safety port connector is removed without connecting the safety device, the servo will enter the SAF state and will not supply current to the motor and will not output motor torque. At this point, the digital tube in the operation panel will display "SAF".

5.5.2 When connecting a security device

<u>Remove the secure jumper connector</u>

Follow the method shown in Figure 5-3， Remove the secure jumper connector from the secure device connection port (CN6).

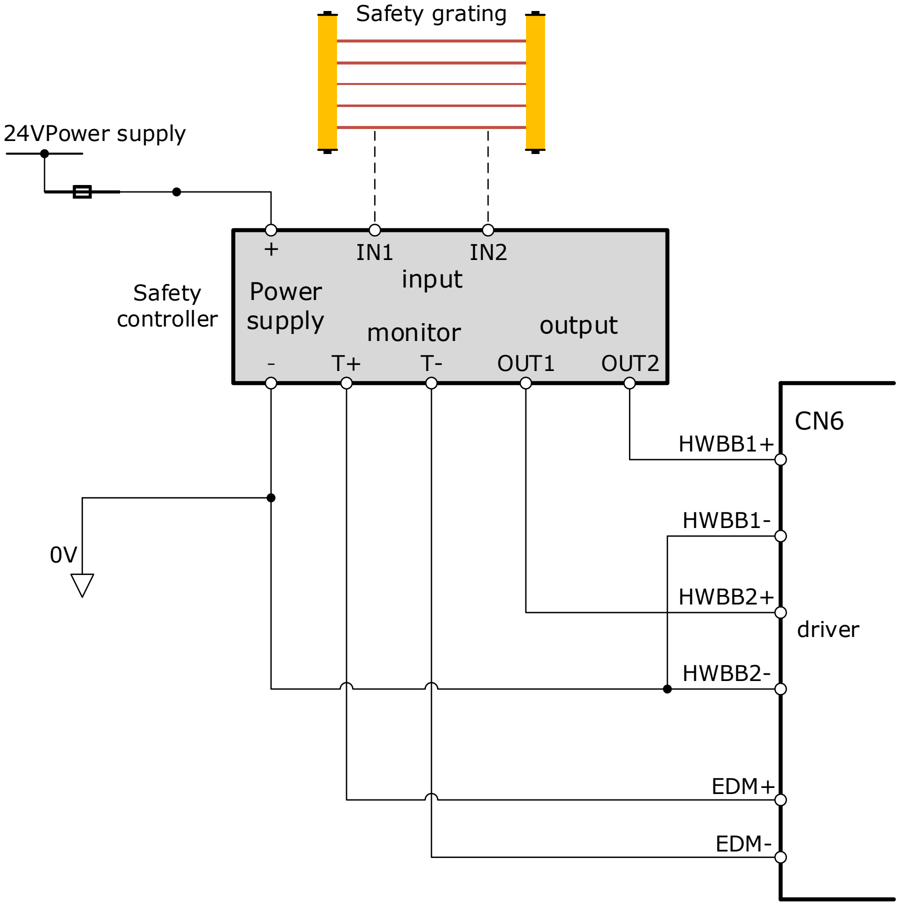
Figure 1-1 Schematic diagram of removing the safety jumper connector



Connect security devices

Follow the wiring example shown in Figure 5-4 to connect the safety device to the port (CN6) for the connection of the safety device.

Figure 1-2 Wiring example of a safety controller



Note: When wiring, use an armored cable to protect the HWBB1+ and HWBB2+ from short circuits.
EDM signals are used at the common-emitter output. When wiring, make sure that current flows from EDM+ to EDM-.

Under normal circumstances, when the safety light barrier is blocked, the HWBB1 and HWBB2 signals are OFF at the same time, and the EDM signal is ON, entering the safe state. If the safety light barrier is not blocked, the HWBB1 and HWBB2 signals enter an actionable state after ON.

Verify security function

After start-up, maintenance, drive replacement or wiring of the unit, be sure to perform the following tests to verify the safety function (it is recommended to document and retain the verification results).

- Make sure that when the HWBB1 and HWBB2 signals are set to OFF, "SAF" is displayed on the operator panel and the motor stops.
- Monitor the ON/OFF status of HWBB1 and HWBB2 signals.

If the ON/OFF status of the signal is inconsistent with the display of Un006, the following factors must be considered：

- The external device is malfunctioning
- The external wiring is disconnected or short-circuited
- The drive has failed

Please find out the cause and take appropriate action.

Troubleshooting

Either of the input signals HWBB1 or HWBB2 is set to OFF， The servo will enter the SAF state, and if another signal is still ON within 10s, an alarm of "A.30 (safety function input signal out of synchronization)" will be generated. At this point, the following factors must be considered:

- The circuit or equipment used to input the HWBB1 and HWBB2 signals may be faulty.
- The cable to the input signal has been disconnected.

Please find out the cause and take appropriate action.

5.6 Usage Procedure

Taking the wiring of the safety controller shown in Figure 5-4 as an example, follow the steps below to use the STO function.

1. Prepare the equipment for maintenance.
2. Stop motor operation and turn off SON signal.
3.The security grating is blocked.
4. The HWBB1 and HWBB2 signals are set to OFF, and the servo enters SAF state.
5. Maintenance personnel can start the operation and leave after the operation is finished.
6. Safety grating recovery.
7. Servo exits SAF state, turn on SON signal and run motor.

Chapter 6 Application Functions

6.1 Power Supply

The main circuit and control circuit of the Drive can be operated with AC power input. When AC power input is selected, single- phase or three phase power input can be used. You shall to set the parameter Pn007.1 and Pn007.3 (use AC power input) according to the applicable power supply.

Parameter	Setting	Meaning	When Enabled
Pn007.1	0	Use a single-phase AC power supply.	After restart
	1 [Default]	Use a three-phase AC power supply. **NOTE**: This setting is invalid for the Drive power from 50W to 400W.	
	2	Dc (valid for rated power ⩾0.75kW only)	
Pn007.3	0	AC power supply frequency is 50Hz.	
	1	AC power supply frequency is 60Hz.	

An alarm A.24 (Main Circuit Power Supply Wiring Error) may be occurred if the setting of Pn007.1 be consonant with not match the applicable power supply.

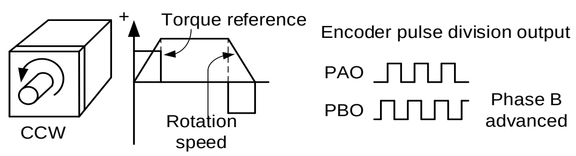

warn

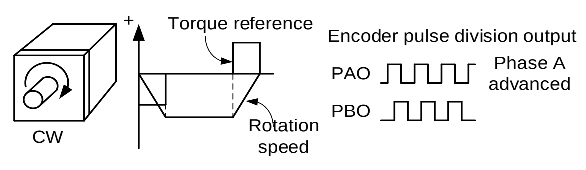
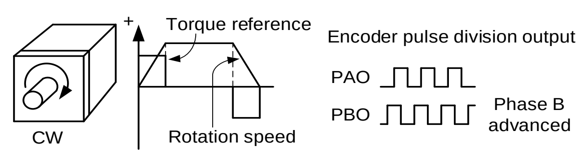
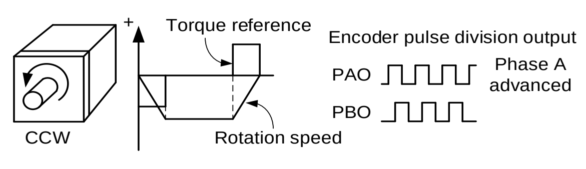
- When using AC power supply and DC power supply to connect to the driver, please make a terminal connection.
  Ac power supply should be connected to the L1/L2/L3 terminals and L1C/L2C terminals of the driver.
- DC power supply should be connected to the B1/decile terminal and one terminal and L1C/L2C terminal of the driver.
- Before using the DC power input, please be sure to set Pn007.1=2 before entering the main loop to avoid burning the internal components of the driver.
- When the DC power supply is input, set the fuse on the power supply wiring.
- No regeneration is performed when using the DC power input, so please perform regenerative energy treatment on the power supply side.

6.2 Motor Rotation Direction

You can reverse the direction of Motor rotation by changing the setting of Pn001.0.

The default setting for Forward Rotation is counterclockwise (CCW) as viewed from the Drive end.

Parameter	Setting	Reference	Diagram
Pn001.0	0: CCW	Forward Reference	

Parameter	Setting	Reference	Diagram
		Reverse Reference	
	1: CW	Forward Reference	
		Reverse Reference	

NOTE: The torque reference and Motor speed in the above table indicate the tracking waveform in ESViewV4.

6.3 Overtravel Limit

6.3.1 Function Description

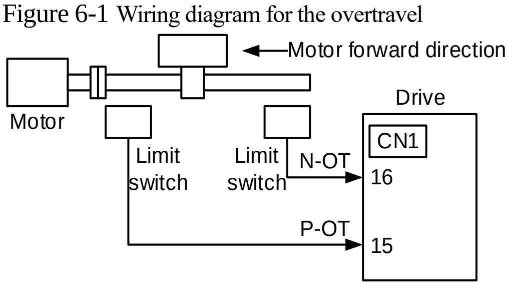
Overtravel is a safety function of the Drive that forces the Motor to stop in response to a signal input from a limit switch that is activated when a moving part of the machine exceeds the safe range of movement.

The overtravel signals include the P-OT (Forward Drive Prohibit) and the N-OT (Reverse Drive Prohibit) signals.

You use the P-OT and N-OT signals to stop the machine by installing limit switches at the positions where you want to stop the machine that is operated by the Motor.

An example of wiring for the P-OT signal and the N-OT signal is shown in Figure 6-1.

Figure 6-1 Wiring diagram for the overtravel



Using the overtravel function is not necessary for rotating applications such as rotary tables and conveyors. No wiring for overtravel input signals is required.

CAUTION	■ To prevent accidents that may result from contact faults or disconnections, use normally closed limit switches. Moreover, never change the default settings of the polarity of the overtravel signals (P-OT and N-OT). ■ When using the Motor on a vertical axis, the workpiece may fall in the overtravel condition. To prevent this, always set the zero clamp after stopping with Pn003.1=2.

6.3.2 Connecting the Overtravel Signal

To use the overtravel function, connect the following overtravel limit switch input signal terminals.

Type	Name	Pin	Setting	Meaning
Input	P-OT	CN1-15	ON	Forward run allowed. Normal operation status.
			OFF	Forward run prohibited. Forward overtravel.
	N-OT	CN1-16	ON	Reverse run allowed. Normal operation status.
			OFF	Reverse run prohibited. Reverse overtravel.

6.3.3 Enabling/Disabling the Overtravel Signal

Parameters can be set to disable the overtravel signal. If the parameters are set, there is no need to wire the overtravel input signal.

Parameter	Setting	Meaning	When Enabled
Pn000.1	0 [Default]	Inputs the Forward Drive Prohibited (P-OT) signal from CN1-16. [Default]	After restart
	1	Disables the Forward Drive Prohibited (P-OT) signal. (Always allow forward rotation)	
Pn000.2	0 [Default]	Inputs the Reverse Drive Prohibited (N-OT) signal from CN1-15. [Default]	
	1	Disables the Reverse Drive Prohibited (N-OT) signal. (Always allow reverse rotation)	

In addition, you can disable the overtravel limit function by not set the values **1** and **2** to parameter Pn509 (not allocate the P-OT signal and N-OT signal).

6.4 Motor Stopping Methods

You can use the following methods to stop the Motor when the servo is turned OFF, an alarm (Gr.1 or Gr.2) occurs, in Safe state or overtravel occurs.

Stop method	Meaning
Stopping by dynamic brake	The electric circuits are internally connected to stop the Motor quickly.
Coasting to a stop	The Motor stops naturally due to friction during operation.
Reverse brake	Emergency stop torque is used to decelerate the Motor to a stop.
Do not stop	Regards Alarms as the Warnings, and the Motor will not be stopped.

Also, you can let the Motor enter the following states after the Motor stops.

State after Stopping	Meaning
Coasting	The Drive does not control the Motor (The machine will move in response to a force from the load).
Dynamic Brake (DB)	The electric circuits are internally connected to hold the Motor.
Zero clamping	A position loop is created and the Motor remains stopped at a position reference of 0. (The current stop position is held.)
Operation	The state in which the Drive continues to control the Motor.

6.4.1 Motor Stop Methods for Gr.1 Alarms, Safety State and Servo OFF

You can select the Motor stopping methods for Gr.1 Alarms occur, in Safe state or Servo OFF by setting the parameter Pn003.0.

Parameter	Setting	Stop Method	After Stopping	When Enabled
Pn003.0	0 [Default]	Stopping by dynamic brake	Coasting	After restart
	1	Stopping by dynamic brake	Dynamic Brake	
	2	Coasting to a stop	Coasting	

6.4.2 Motor Stop Methods for Overtravel

You can select the Motor stopping methods for overtravel occurs by setting the parameter Pn003.1.

Parameter	Setting	Stop Method	After Stopping	When Enabled
Pn003.1	0 [Default]	Stopping by dynamic brake	Coasting	After restart
	1	Stopping by dynamic brake	Dynamic Brake	
	2	Reverse brake	Zero clamping	
	3	Reverse brake	Coasting	

NOTE

The speed reference is set to 0 during the reverse brake, so that the soft stat function is unavailable. In addition, you shall set a reverse brake torque for stopping the Motor (Pn405).

6.4.3 Motor Stop Methods for Gr.2 Alarms

You can select the Motor stopping methods for Gr.2 Alarms occur by setting the parameter Pn004.0.

Parameter	Setting	Stop Method	After Stopping	When Enabled
Pn004.0	0 [Default]	Stop by dynamic brake	Coasting	After restart
	1	Stop by dynamic brake	Dynamic Brake	
	2	Coast to a stop	Coast	
	3	Reverse brake	Dynamic Brake	
	4	Reverse brake	Coast	
	5	Do not stop, regard as a warning	Operation	

NOTE

Even if set the parameter Pn004.0 to 5 (Do not stop, regard as a warning), you need to manually reset the system after troubleshooting.

6.4.4 Reverse Brake Torque Limit Setting

If Pn004.0 is set to 3 or 4, the Motor will be decelerated to a stop using the torque set in Pn405 as the maximum torque.

Parameter	Name	Range	Unit	Default	When Enabled
Pn405	Reverse Brake Torque Limit	0 to 350	%	300	Immediately

NOTE

- This setting is a percentage of the rated torque.
- The default setting is 300%. This setting is large enough to allow you to operate the Motor at the maximum torque. However, the maximum stop torque that you can actually use is the maximum torque of the Motor.

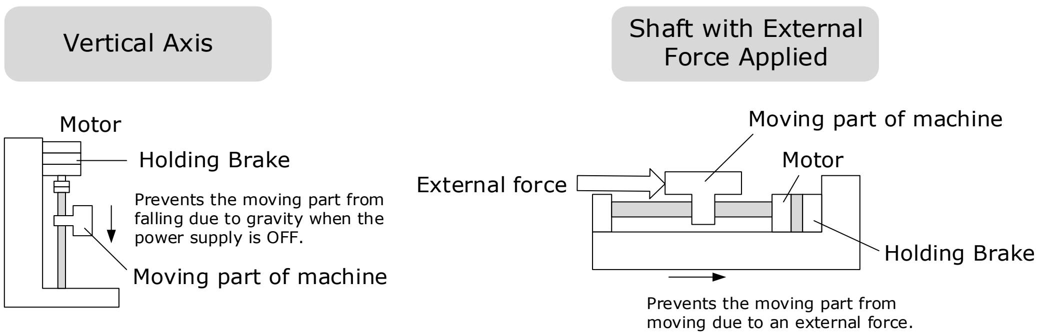
6.5 Holding Brake

6.5.1 Function Description

A holding brake is used to hold the position of the moving part of the machine when the Drive is turned OFF so that moving part does not move due to gravity or an external force.

You can use the brake that is built into a Motor with a Brake, or you can provide one on the machine.

The holding brake is used in the following cases.

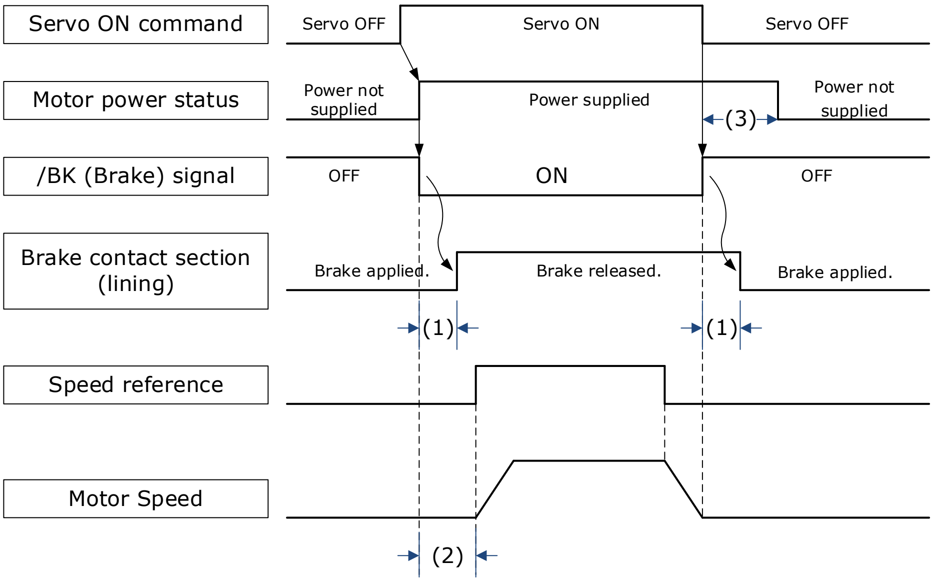


IMPORTANT

The brake built into a Motor with a Brake is a de-energization brake. It is used only to hold the Motor and cannot be used for braking. Use the holding brake only to hold a Motor that is already stopped.

6.5.2 Brake Operating Sequence

You must consider the time required to release the brake and the time required to brake to determine the brake operation timing, as described below.



(1): The brake delay times for Motors with Holding Brakes.
(2): Before you output a reference from the host controller to the Drive, wait for at least 50 ms plus the time required to release the brake after you send the S-ON command.
(3): Use Pn506 (Servo OFF Waiting Time), Pn507 (Brake Enable Speed Threshold), and Pn508 (Brake Enable Waiting Time) to set the timing of when the brake will operate and when the servo will be turned OFF.

NOTE

- Time Required to Release Brake: The time from when the /BK (Brake) signal is turned ON until the brake is actually released.
- Time Required to Brake: The time from when the /BK (Brake) signal is turned OFF until the brake actually operates.

6.5.3 /BK (Brake) Signal

The /BK signal is turned OFF (to operate the brake) when the Servo is turned OFF or when an alarm is detected. You can adjust the timing of brake operation (i.e., the timing of turning OFF the /BK signal) with the Servo OFF Waiting time (Pn506).

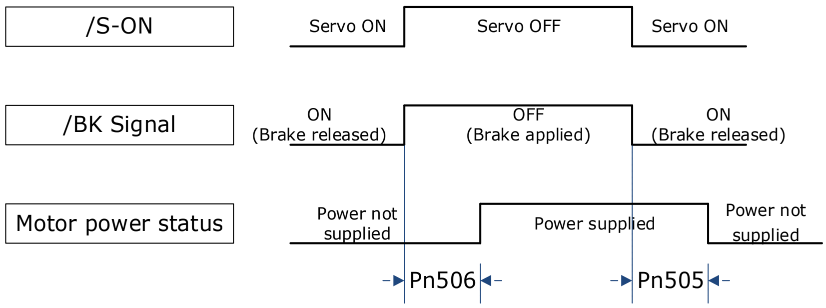
Type	Signal	Pin	Signal Status	Meaning
Output	/BK	Allocated by Pn511	ON	Releases the brake.
			OFF	Activates the brake.

The /BK signal is not allocated in default setting, set its allocation in Pn511.

Parameter	Setting	+ Pin	- Pin	Meaning
Pn511.0	4	CN1-6	CN1-7	The /BK signal is output from CN1-6 and CN1-7.
Pn511.1	4	CN1-10	CN1-11	The /BK signal is output from CN1-10 and CN1-11.

6.5.4 Output Timing of /BK Signal when Motor is Stopped

When the Motor is stopped, the /BK signal turns OFF as soon as the S-OFF (Servo OFF) command is received. Use the servo OFF delay time (Pn506) to change the timing to turn OFF power supply to the Motor after the S-OFF command is input.



Parameter	Name	Range	Unit	Default	When Enabled
Pn505	Servo ON Waiting Time	-2000 to 2000	ms	0	Immediately
Pn506	Servo OFF Waiting Time	0 to 500	10ms	0	Immediately

NOTE

- Set Pn505 as a positive value, when S-ON command is received, the /BK signal will be output first, and then power supplied to the Motor after waiting for this setting.
- Set Pn505 as a negative value, when S-ON command is received, power supplied to the Motor immediately, and then output the /BK signal after waiting for this setting.

When the Motor is used to control a vertical axis, the machine moving part may move slightly due to gravity or an external force.

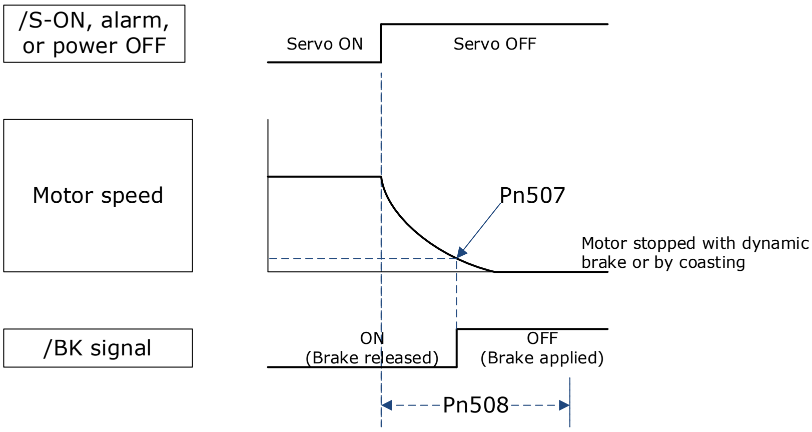
You can eliminate this slight motion by setting the servo OFF delay time (Pn506) so that power supply to the Motor is stopped after the brake is applied.

IMPORTANT

Power supply to the Motor will be stopped immediately when an alarm occurs, regardless of the setting of this parameter. The machine moving part may move due to gravity or an external force before the brake is applied.

6.5.5 Output Timing of /BK Signal when Motor is operating

If an alarm occurs or S-OFF command is received while the Motor is operating, the Motor will start stopping and the /BK signal will be turned OFF. You can adjust the timing of /BK signal output by setting the Brake Enable Waiting Time (Pn508).



The /BK signal goes to H level (brake ON) when either of the following conditions is satisfied:

- When the Motor speed falls below the level set in Pn507 after the power to the Motor is turned OFF.
- When the time set in Pn508 is exceeded after the power to the Motor is turned OFF.

Parameter	Name	Range	Unit	Default	When Enabled
Pn507	Brake Enable Speed Threshold	10 to 100	1rpm	100	Immediately
Pn508	Brake Enable Waiting Time	10 to 100	10ms	50	Immediately

6.6 Encoder Setting

6.6.1 Absolute Encoder Selection

Absolute encoders are fitted on motors with an encoder type of L; e.g. EM3A-02A**L**A211. These encoders require a battery supply to retain the absolute encoder data when the Drive power is removed.

With a system that uses an absolute encoder, the host controller can monitor the current position. Therefore, it is not necessary to perform an origin return operation when the power supply to the system is turned ON.

There are two types of encoders for the Motors. The usage of the encoder is specified in Pn002.2.

Parameter	Setting	Meaning	When Enabled
Pn002.2	0 [Default]	Use the encoder as an absolute encoder.	After restart
	1	Use the encoder as an incremental encoder.	

IMPORTANT

The default setting of the Drive uses an absolute encoder. If the Motor encoder is an incremental encoder, an A47 alarm or an A48 alarm will occur when the Drive is first powered up.
In this case, set Pn002.2=1 and restart the Drive.

6.6.2 Encoder Alarm Resetting

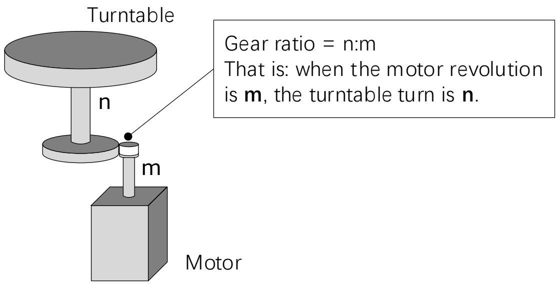
If alarm A.47 or A.48 occurs, replace the battery as soon as possible. After replacing the battery, perform the operation **Absolute encoder alarm reset** and **Fn010 (Absolute encoder multi-turn reset**.

For details about replacing the battery, see the section 3.5.3 Battery Case Connection.

6.6.3 Multiturn Limit Setting

The multiturn limit is used in position control for a turntable or other rotating body.

For example, consider a machine that moves the turntable shown in the following diagram in only one direction.

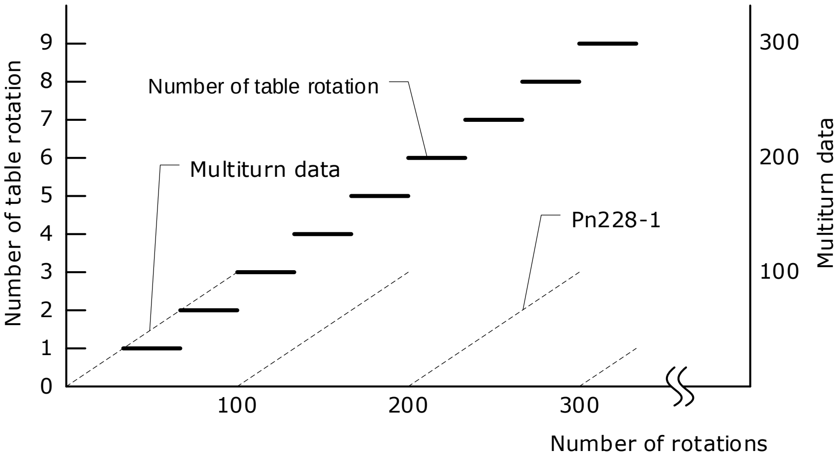


Because the turntable moves in only one direction, the upper limit to the number of revolutions that can be counted by an absolute encoder will eventually be exceeded.

The multiturn limit is used in cases like this to prevent fractions from being produced by the integral ratio of the number motor revolutions and the number of turntable revolutions.

For a machine with a gear ratio of n:m, as shown above, you can set Pn228 as **m**, and the value of m - 1 will be the setting for the multiturn limit setting.

The relationship between the number of turntable revolutions and the number of motor revolutions is shown in the following figure.



Parameter	Name	Range	Unit	Default	When Enabled
Pn228	Multiturn limit	0 to 65535	1 rev	10	After restart

Note: This parameter is enabled when you use an absolute encoder.

The data will change as shown below when this parameter is set to anything other than the default setting.

- If the motor operates in the reverse direction when the multiturn data is 0, the multiturn data will change to the value set in (Pn228-1).
- If the motor operates in the forward direction when the multiturn data is at the value set in (Pn228-1), the multiturn data will change to 0.

NOTE

The multiturn data will always be 0 in the following cases. It is not necessary to reset the absolute encoder in these cases.

- When you use a single-turn absolute encoder
- When you set Pn002.2 = 1 (Use the encoder as an incremental encoder)

6.7 I/O Signal Allocations

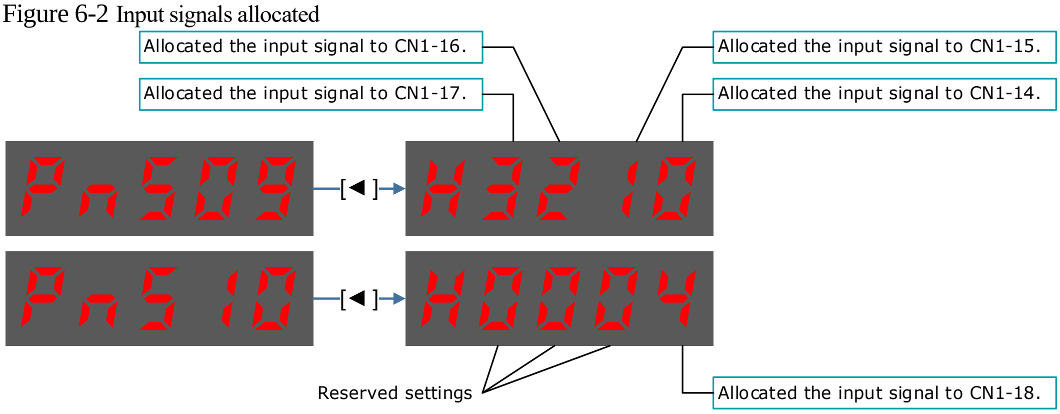
Functions are allocated to the pins on the I/O signal connector (CN1) in advance. You can change the allocations and the polarity for some of the connector pins. Function allocations and polarity settings are made with parameters.

6.7.1 Input Signal Allocations

Allocation Description

The I/O signal connector (CN1) on the Drive provides five pins (points) for allocating the input signals, corresponding to the sub-parameters of Pn509 and Pn510, as is shown in Figure 6-2.

Figure 6-2 Input signals allocated



IMPORTANT

- If you allocate two or more signals to the same input circuit, a logical OR of the inputs will be used and all of the allocated signals will operate accordingly. This may result in unexpected operation.
- Since the pins have priority, only the highest priority pin is in effect if a signal is repeatedly allocated to multiple pin. The priority of the pins is arranged from high to low as follows:
  CN1-18 → CN1-17 → CN1-16 → CN1-15 → CN1-14

Default Input Signals

Table 6-1 lists the input signals that can be allocated and their corresponding values. Set the sub-parameters of Pn509 and Pn510 to use the following values, which means that they are allocated to the corresponding pins.

Table 6-1 Default Input signals

Signal	Name	Value
S-ON	Servo ON Input Signal	0
P-OT	Forward Drive Prohibit Input Signal	1
N-OT	Reverse Drive Prohibit Input Signal	2
P-CL	Forward External Torque Limit Input Signal	3
N-CL	Reverse External Torque Limit Input Signal	4
G-SEL	Gain Selection Input Signal	5
HmRef	Homing Input Signal	6
Remote	Remoted IO Input Signal	7
EXT1	Probe TouchProbe enter 1	8
EXT2	Probe TouchProbe enter 2	9

Table 5-2 Specification of 400V Input Signals

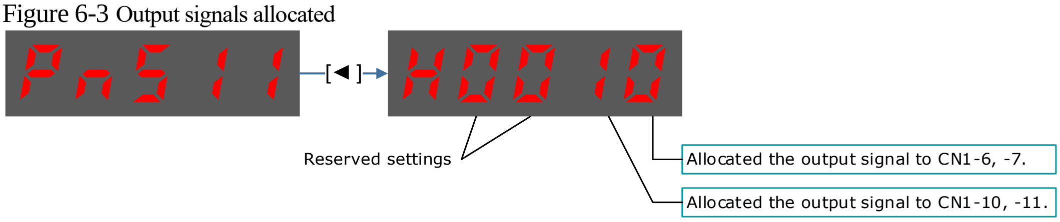
Input Signal	Name	Assigned Value
S-ON	Servo ON	0
P-CON	Forward Drive Prohibited	1
P-OT	Reverse Drive Prohibited	2
N-OT	Forward Torque External Limiting Input	3
N-CL	Reverse Torque External Limiting Input	4
G-SEL	Gain Switching Input	5
HmRef	Homing Signal	6
Remote	Remote IO Input	7
EXT1	Probe TouchProbe Input 1	8
EXT2	Probe TouchProbe Input 2	9

6.7.2 Output Signal Allocations

Allocation Description

The I/O signal connector (CN1) on the Drive provides three group of pins (points) for allocating the output signals, corresponding to the parameter Pn511, as is shown in Figure 6-3.

Figure 6-3 Output signals allocated



IMPORTANT

If you allocate more than one signal to the same output circuit, a logical OR of the signals will be output.

Default Output Signals

0 lists the output signals that can be allocated and their corresponding values. Set the parameter Pn511 to use the following values, which means that they are allocated to the corresponding pins.

Table 5-3 Default Output signals

Signal	Name	Value
COIN/VCMP	Positioning Completion Output Signal or Speed Coincidence Detection Output Signal	0
TGON	Rotation Detection Output Signal	1
S-RDY	Servo Ready Output Signal	2
CLT	Torque Limit Detection Output Signal	3
BK	Brake Output Signal	4
PGC	Motor C-pulse Output Signal	5
OT	Overtravel Output Signal	6
RD	Motor Excitation Output Signal	7
TCR	Torque Detection Output Signal	8
Remote0	Remoted IO Output Signal 0	A
Remote1	Remoted IO Output Signal 1	B

Assignment example

An example of replacing a Servo Ready Output (S-RDY) signal assigned to CN1-12, 13 with a Speed Detection Output (TGON) signal assigned to CN1-10, 11 is shown below.

Before replacement	Pn511 = H − 2 1 −
After replacement	Pn509 = H − 1 2 −

6.8 Torque Limit

You can limit the torque that is output by the Motor.

There are four different ways to limit the torque. These are described in the following table.

Limit Method	Outline	Reference
Internal Torque Limits	The torque is always limited with the setting of a parameter.	6.8.1
External Torque Limits	The torque is limited with an input signal from the host station.	6.8.2
Limiting torque with Profinet command	The torque is limited with the settings of objects 60E0h (PosTorLimit) and 60E1h (NegTorLimit) in Profinet command.	
Limiting torque with /CLT output signal	The torque is limited by the output signal /CLT (Allocated by Pn511).	–

NOTE

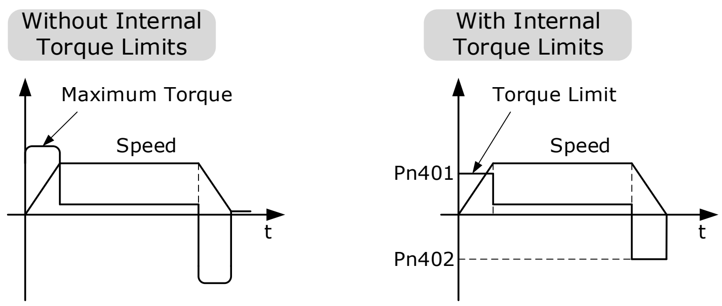
If you set a value that exceeds the maximum torque of the Motor, the torque will be limited to the maximum torque of the Motor.

6.8.1 Internal Torque Limits

If you use internal torque limits, the maximum output torque will always be limited to the specified forward torque limit (Pn401) and reverse torque limit (Pn402).

Parameter	Name	Range	Unit	Default	When Enabled
Pn401	Forward Internal Torque Limit	0 to 350	%	300	Immediately
Pn402	Reverse Internal Torque Limit	0 to 350	%	300	Immediately

If the setting of Pn401 or Pn402 is too low, the torque may be insufficient for acceleration or deceleration of the Motor.



6.8.2 External Torque Limits

You can limit the torque only when required by the operating conditions of the machine by turning a signal ON and OFF.

You can use this for applications such as stopping on physical contact, or holding a workpiece with a robot.

External Torque Limit Reference Signals

The /P-CL (Forward External Torque Limit) and /N-CL (Reverse External Torque Limit) signals are used as the external torque limit reference signals. The /P-CL signal is used for the forward torque limit and the /N-CL signal is used for the reverse torque limit.

Type	Signal	Pin	Signal Status	Meaning
Input	/P-CL	Allocated by Pn509 or Pn510	ON (closed)	Applies the forward external torque limit. The torque is limited to the smaller of the settings of Pn401 and Pn403.
			OFF (open)	Cancels the forward external torque limit. The torque is limited to the setting of Pn403.
Input	/N-CL		ON (closed)	Applies the reverse external torque limit. The torque is limited to the smaller of the settings of Pn402 and Pn404.
			OFF (open)	Cancels the reverse external torque limit. The torque is limited to the setting of Pn404.

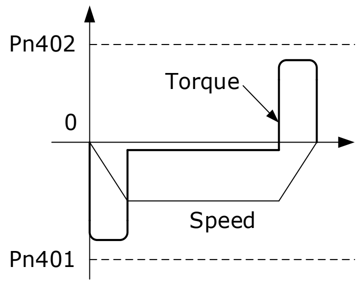
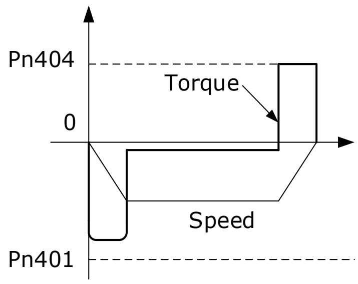
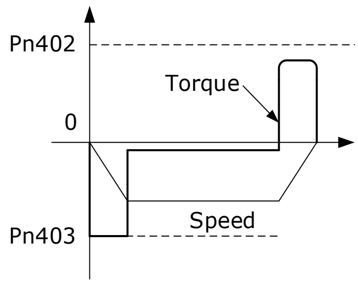
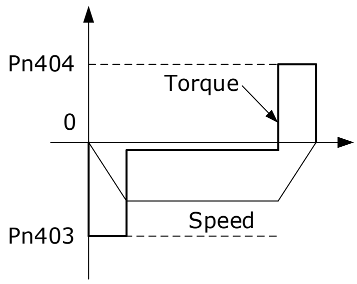
Setting the Torque Limits

If the setting of Pn401 (Forward Torque Limit), Pn402 (Reverse Torque Limit), Pn403 (Forward External Torque Limit), or Pn404 (Reverse External Torque Limit) is too low, the torque may be insufficient for acceleration or deceleration of the Motor.

Parameter	Name	Range	Unit	Default	When Enabled
Pn401	Forward Internal Torque Limit	0 to 350	%	300	Immediately
Pn402	Reverse Internal Torque Limit	0 to 350	%	300	Immediately
Pn403	Forward External Torque Limit	0 to 350	%	100	Immediately
Pn404	Reverse External Torque Limit	0 to 350	%	100	Immediately

Changes in the Output Torque for External Torque Limits

The following table shows the changes in the output torque when the internal torque limit is set to 300%. In this example, the Motor direction is set to Pn001.0=0 (Use CCW as the forward direction).

/PCL	/NCL	
	H Level	L Level
H Level		
L Level		

Limiting torque with /CLT output signal

This following describes the /CLT signal, which indicates the status of limiting the Motor output torque.

Type	Signal	Pin	Signal Status	Meaning
Output	/CLT	Allocated by Pn511	ON (closed)	The Motor output torque is being limited.
			OFF (open)	The Motor output torque is not being limited.

6.9 SEMI F47 Function

The SEMI F47 function detects an A.D1warning (Undervoltage Warning) and limits the output current if the DC main circuit power supply voltage to the Drive drops to a specified value or lower because the power was momentarily interrupted or the main circuit power supply voltage was temporarily reduced.

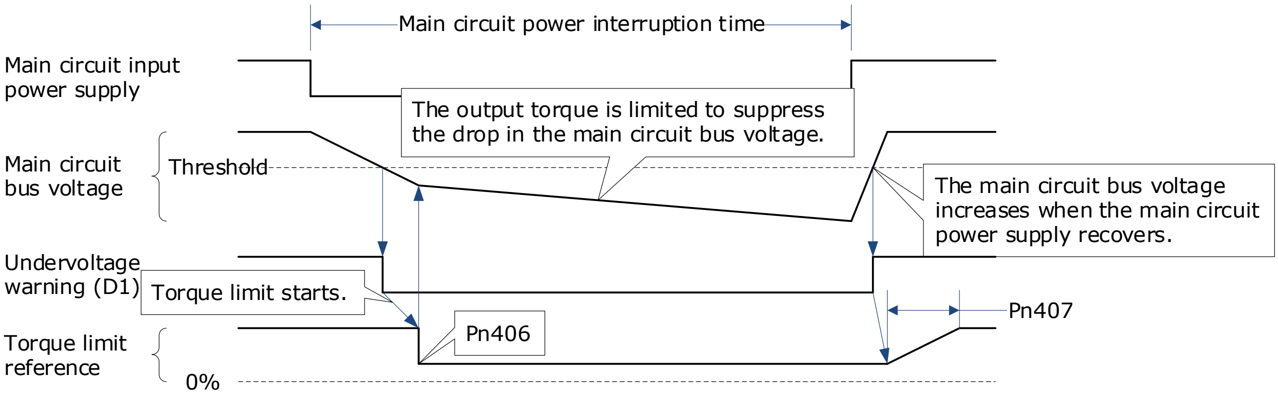
This function complies with the SEMI F47 standards for semiconductor manufacturing equipment.

You can combine this function with the Momentary Power Interruption Hold Time (Pn538) to allow the Motor to continue operating without stopping for an alarm or without recovery work even if the power supply voltage drops.

You can set Pn007.2=1 for slow down the ramp rate of the bus voltage when an undervoltage occurs, allowing the system to run longer. In addition, you can set the Torque Limit at Main Circuit Voltage Drop

(Pn407), which is a relative percentage of Pn401 (Forward Internal Torque Limit) or Pn402 (Reverse Internal Torque Limit).

The Drive controls the torque limit for the set time (Pn407) after the Undervoltage warning is cleared.



Parameter	Name	Range	Unit	Default	When Enabled
Pn538	Momentary Power Interruption Hold Time	0 to 50	1 cycle	1	Immediately
Pn407	Torque Limit at Main Circuit Voltage Drop	0 to 100	%	50	Immediately
Pn408	Release Time for Torque Limit at Main Circuit Voltage Drop	0 to 1000	ms	100	Immediately

IMPORTANT

- This function handles momentary power interruptions for the voltage and time ranges stipulated in SEMI F47. An uninterruptible power supply (UPS) is required as a backup for momentary power interruptions that exceed these voltage and time ranges.
- Set the host controller or Drive torque limit so that a torque reference that exceeds the specified acceleration torque will not be output when the power supply for the main circuit is restored.
- For a vertical axis, do not limit the torque to a value that is lower than the holding torque.
- This function limits torque within the range of the Drive’s capability for power interruptions. It is not intended for use under all load and operating conditions. Set the parameters while monitoring operation on the actual machine.
- You can set the momentary power interruption hold time to increase the amount of time from when the power supply is turned OFF until power supply to the Motor is stopped. To stop the power supply to the Motor immediately, use the Servo OFF command.

Chapter 7 PROFINET Communication

7.1 Introduction

PROFINET IO is a real-time protocol based on Ethernet. Used as an advanced network in industrial automation applications.

PROFINET IO focuses on data exchange for programmable controllers. A complete PROFINET IO network includes the following devices:

- IO controller： The typical one is PLC, which is used to control the whole system
- IO equipment： A distributed IO device (e.g., encoder, sensor)， Control via IO controller
- IO detector： HMI (human-machine interface) or personal computer, used for diagnosis or debugging

PROFINET provides two types of real-time communication， PROFINET IO RT (real-time) and PROFINET IO IRT (isochronous real-time)。The real-time channel is used for the transmission of IO data and alarms。

In the PROFINET IO RT channel， Real-time data is transmitted via priority Ethernet frames。There are no special hardware requirements。Based on this priority, its cycle time can reach 4 ms。 The PROFINET IO IRT channel is suitable for transmitting data with more precise timing requirements。Its cycle time can be up to 2 ms, but requires the support of IO devices and switches with special hardware。

All diagnostic and configuration data is transmitted over non-real-time (NRT) channels。The TCP/IP protocol is used。Therefore, there is no definite cycle, and the cycle may exceed 100 ms。

7.2 upported Packets

ED3L PN supports standard and Siemens messages in speed control mode and basic locator control mode。Secondary packets must be used together with primary packets。From the point of view of the driving device， The received process data is the receiving word, and the process data to be sent is the sending word. The detailed description is shown in the following table:

message	Maximum number of PZDS (one PZD = one word)	
	Receive word	Send word
Standard message 1	2	2
Standard message 3	5	9
SIEMENS Message 102	6	10
SIEMENS Message 111	12	12
SIEMENS Message 105	10	10
SIEMENS Message 750 （Auxiliary message）	3	1

Auxiliary messages are intended only for use with the primary message and cannot be used alone

Telegrams for speed control mode

<table>
<tr><th>message</th><th colspan="2">1</th><th colspan="2">3</th><th colspan="2">102</th><th colspan="2">105</th></tr>
<tr><td>Application level</td><td colspan="2">1</td><td colspan="2">1 , 4</td><td colspan="2">1 , 4</td><td colspan="2">4</td></tr>
<tr><td>PZD1</td><td>STW1</td><td>ZSW1</td><td>STW1</td><td>ZSW1</td><td>STW1</td><td>ZSW1</td><td>STW1</td><td>ZSW1</td></tr>
<tr><td>PZD2</td><td>NSOLL_A</td><td>NIST_A</td><td rowspan="2">NSOLL_B</td><td rowspan="2">NIST_B</td><td rowspan="2">NSOLL_B</td><td rowspan="2">NIST_B</td><td rowspan="2">NSOLL_B</td><td rowspan="2">NIST_B</td></tr>
<tr><td>PZD3</td><td></td><td></td></tr>
<tr><td>PZD4</td><td></td><td></td><td>STW2</td><td>ZSW2</td><td>STW2</td><td>ZSW2</td><td>STW2</td><td>ZSW2</td></tr>
<tr><td>PZD5</td><td></td><td></td><td>G1_STW</td><td>G1_ZSW</td><td>MOMRED</td><td>MELDW</td><td>MOMRED</td><td>MELDW</td></tr>
<tr><td>PZD6</td><td></td><td></td><td></td><td rowspan="2">G1_XIST1</td><td>G1_STW</td><td>G1_ZSW</td><td>G1_STW</td><td>G1_ZSW</td></tr>
<tr><td>PZD7</td><td></td><td></td><td></td><td></td><td rowspan="2">G1_XIST1</td><td rowspan="2">XERR</td><td rowspan="2">G1_XIST1</td></tr>
<tr><td>PZD8</td><td></td><td></td><td></td><td rowspan="2">G1_XIST2</td><td></td></tr>
<tr><td>PZD9</td><td></td><td></td><td></td><td></td><td rowspan="2">G1_XIST2</td><td rowspan="2">KPC</td><td rowspan="2">G1_XIST2</td></tr>
<tr><td>PZD10</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

The message used for basic locator control mode

<table>
<tr><th>message</th><th colspan="2">111</th></tr>
<tr><td>Application level</td><td colspan="2">3</td></tr>
<tr><td>PZD1</td><td>STW1</td><td>ZSW1</td></tr>
<tr><td>PZD2</td><td>POS_STW1</td><td>POS_ZSW1</td></tr>
<tr><td>PZD3</td><td>POS_STW2</td><td>POS_ZSW2</td></tr>
<tr><td>PZD4</td><td>STW2</td><td>ZSW2</td></tr>
<tr><td>PZD5</td><td>OVERRIDE</td><td>MELDW</td></tr>
<tr><td>PZD6</td><td rowspan="2">MDI_TARPOS</td><td rowspan="2">XIST_A</td></tr>
<tr><td>PZD7</td></tr>
<tr><td>PZD8</td><td rowspan="2">MDI_VELOCITY</td><td rowspan="2">NIST_B</td></tr>
<tr><td>PZD9</td></tr>
<tr><td>PZD10</td><td>MDI_ACC</td><td>FAULT_CODE</td></tr>
<tr><td>PZD11</td><td>MDI_DEC</td><td>WARN_CODE</td></tr>
<tr><td>PZD12</td><td>user</td><td>user</td></tr>
</table>

user configures the user-defined function for packet 111。

Auxiliary message

When using 750 messages, the motor accelerates uncontrollably if any of the following settings are made:

- Set the upper torque limit to a negative value via PZD M_LIMIT_POS
- The lower torque limit is set to a positive value via PZD M_LIMIT_NEG

message	750	
Application level	--	
PZD1	M_ADD1	M_ACT
PZD2	M_LIMIT_POS	
PZD3	M_LIMIT_NEG	

7.3 I/O Data signal

Signal	Description	Receive word/send word	Data type	Calibration
STW1	Control word 1	Receive word	U16	-
STW2	Control word 2	Receive word	U16	-
ZSW1	Status word 1	Send word	U16	-
ZSW2	Status word 2	Send word	U16	-
NSOLL_A	Speed set A	Receive word	I16	4000 hex ≙Rated speed
NSOLL_B	Speed set value B	Receive word	I32	40000000 hex ≙ Rated speed
NIST_A	The actual speed is A	Send word	I16	4000 hex ≙Rated speed
NIST_B	The actual speed is B	Send word	I32	40000000 hex ≙ Rated speed
G1_STW	Encoder 1 Control word	Receive word	U16	-
G1_ZSW	Encoder 1 status word	Send word	U16	-
G1_XIST1	Encoder 1 Actual position 1	Send word	U32	-
G1_XIST2	Encoder 1 Actual position 2	Send word	U32	-
MOMRED	Torque reduction	Receive word	I16	4000 hex ≙ Maximum torque
MELDW	Message word	Send word	U16	-
KPC	Position controller gain factor	Receive word	I32	-
XERR	Position deviation	Receive word	I32	-
MDI_TARPOS	MDI position	Receive word	I32	1 hex ≙1LU
MDI_VELOCITY	MDI velocity	Receive word	I32	1 hex ≙1000LU/min
MDI_ACC	MDI acceleration	Receive word	I16	4000 hex ≙100%
MDI_DEC	MDI decelerates	Receive word	I16	4000 hex ≙100%

Signal	Description	Receive word/send word	Data type	Calibration
XIST_A	actual value of position is A	Send word	I32	1 hex ≙1LU
OVERRIDE	Position velocity multiplier	Receive word	I16	4000 hex ≙100%
FAULT_CODE	Error code	Send word	U16	
WARN_CODE	Warning code	Send word	U16	
M_ADD1	Additional torque	Receive word	I16	4000 hex ≙ Maximum torque
M_LIMIT_POS	Positive limit of torque	Receive word	I16	4000 hex ≙ Maximum torque
M_LIMIT_NEG	Negative torque limit	Receive word	I16	4000 hex ≙ Maximum torque
M_ACT	Actual torque	Send word	I16	4000 hex ≙ Maximum torque

7.4 Control Word Definition

7.4.1 STW1 Control Word (for Packets 1 and 3)

Note: STW1.10 must be set to 1 to allow PLC control of the drive.

Signal	Description
STW1.0	= ON (can enable pulse) 0 = OFF1(Brake by ramp function generator, eliminate pulse, ready to be switched on)
STW1.1	1 = no OFF2 (enable) 0 = OFF2 (immediately eliminate pulse and disable connection)
STW1.2	1 = no OFF3 (enable) 0 = OFF3 (Brake by OFF3 ramp p1135, eliminate pulse and disable switching)
STW1.3	1 = Allow to run (pulse can be enabled) 0 = Disable run (cancel pulse)
STW1.4	1 = running condition (slope function generator can be enabled) 0 = Disable ramp function generator (set the output of ramp function generator to zero)
STW1.5	1 = continue ramp function generator 0 = Freeze ramp function generator (freeze ramp function generator output)
STW1.6	1 = Enable setting 0 = disallow Settings (Set input to zero for ramp function generator)
STW1.7	= 1.Response fault
STW1.8	reserve

Signal	Description
STW1.9	reserve
STW1.10	1 = Controlled by PLC
STW1.11	reserve
STW1.12	reserve
STW1.13	reserve
STW1.14	reserve
STW1.15	reserve

7.4.2 STW1 Control Word (for Packets 102 and 105)

Note: When packet 105 is used, STW1.4, STW1.5, and STW1.6 are disabled.

Signal	Description
STW1.0	= ON（Pulse can be enabled） 0 = OFF1（Brake by ramp function generator, eliminate pulse, ready to be switched on）
STW1.1	1 = no OFF2 (enable) 0 = OFF2 (immediately eliminate pulse and disable connection)
STW1.2	1 = no OFF3 (enable) 0 = OFF3 (Brake by OFF3 ramp p1135, eliminate pulse and disable switching)
STW1.3	1 = Allow to run (pulse can be enabled) 0 = Disable run (cancel pulse)
STW1.4	1 = running condition (slope function generator can be enabled) 0 = Disable ramp function generator (set the output of ramp function generator to zero)
STW1.5	1 = continue ramp function generator 0 = Freeze ramp function generator (freeze ramp function generator output)
STW1.6	1 = Enable setting 0 = disallow Settings (Set input to zero for ramp function generator)
STW1.7	= 1.Response fault
STW1.8	reserve
STW1.9	reserve
STW1.10	1 = Controlled by PLC
STW1.11	1 = ramp function generator in effect
STW1.12	1 = Open the lock brake unconditionally
STW1.13	reserve
STW1.14	1 = Closed-loop torque control in effect 0 = Closed-loop speed control takes effect
STW1.15	reserve

7.4.3 STW1 Control Word (for Message 111)

Signal	Description

STW1.0	= ON (can enable pulse) 0 = OFF1 (Brake by ramp function generator, eliminate pulse, ready to be switched on)
STW1.1	1 = no OFF2 (enable) 0 = OFF2 (immediately eliminate pulse and disable connection)
STW1.2	1 = no OFF3 (enable) 0 = OFF3 (Brake by OFF3 ramp p1135, eliminate pulse and disable switching)
STW1.3	1 = Allow to run (pulse can be enabled) 0 = Disable run (cancel pulse)
STW1.4	1 = Do not refuse to perform the task 0 = Reject task (Perform ramp descent at maximum speed reduction)
STW1.5	1 = The task is not suspended 0 = Suspend task execution
STW1.6	0-1 Rising edge = Activate task
STW1.7	0-1 Rising edge = Answer the fault
STW1.8	1 = StartJOG1 0 = turn off JOG1
STW1.9	1 = StartJOG2 0 = Disable JOG2
STW1.10	1 = Controlled by PLC
STW1.11	1 = Start back to zero 0 = Stop return to zero
STW1.12	reserve
STW1.13	reserve
STW1.14	reserve
STW1.15	reserve

7.4.4 STW2 Control Words (for messages 1, 3, 111)

Signal	Description
STW2.0	reserve
STW2.1	reserve
STW2.2	reserve
STW2.3	reserve
STW2.4	reserve
STW2.5	reserve
STW2.6	reserve
STW2.7	reserve
STW2.8	1= Run to fixed block
STW2.9	reserve
STW2.10	reserve
STW2.11	reserve
STW2.12	Master station life symbol, bit 0

Signal	Description
STW2.13	Master station life symbol, bit 1
STW2.14	Master station life symbol, bit 2
STW2.15	Master station life symbol, bit 3

7.4.5 STW2 Control word (for packets 102 and 105)

Signal	Description
STW2.0	reserve
STW2.1	reserve
STW2.2	reserve
STW2.3	reserve
STW2.4	1 = Ignore the ramp function generator
STW2.5	reserve
STW2.6	1 = Speed controller integrator forbidden
STW2.7	reserve
STW2.8	1= Run to fixed block
STW2.9	reserve
STW2.10	reserve
STW2.11	reserve
STW2.12	Master station life symbol, bit 0
STW2.13	Master station life symbol, bit 1
STW2.14	Master station life symbol, bit 2
STW2.15	Master station life symbol, bit 3

7.4.6 POS_STW1 Control word (for message 111)

Signal	Description
POS_STW1.0	reserve
POS_STW1.1	reserve
POS_STW1.2	reserve
POS_STW1.3	reserve
POS_STW1.4	reserve
POS_STW1.5	reserve
POS_STW1.6	reserve
POS_STW1.7	reserve
POS_STW1.8	1= absolute positioning 0= relative positioning
POS_STW1.9	reserve
POS_STW1.10	reserve
POS_STW1.11	reserve
POS_STW1.12	reserve
POS_STW1.13	reserve
POS_STW1.14	reserve
POS_STW1.15	1= MDI Select

7.4.7 POS_STW2 Control word (for message 111)

Signal	Description
POS_ STW2.0	reserve
POS_ STW2.1	reserve
POS_ STW2.2	reserve
POS_ STW2.3	reserve
POS_ STW2.4	reserve
POS_ STW2.5	reserve
POS_ STW2.6	reserve
POS_ STW2.7	reserve
POS_ STW2.8	reserve
POS_ STW2.9	reserve
POS_ STW2.10	reserve
POS_ STW2.11	reserve
POS_ STW2.12	reserve
POS_ STW2.13	reserve
POS_ STW2.14	1= Activate the soft limit switch 0= Turn off the soft limit switch
POS_ STW2.15	reserve

7.5 Definition of the Status word

7.5.1 ZSW1 Status Word (for Packets 1 and 3)

Signal	Description
ZSW1.0	1 = Servo on and ready
ZSW1.1	1 = Ready to run
ZSW1.2	1 = Run Enable
ZSW1.3	1 = A fault exists
ZSW1.4	1 = Free parking invalid (OFF2 invalid)
ZSW1.5	1 = Free parking invalid (OFF3 invalid)
ZSW1.6	1 = The connection ban takes effect
ZSW1.7	1 = Alarm exists
ZSW1.8	1 = The deviation of the speed set value from the actual value is within the t_off (closing time) tolerance
ZSW1.9	1 = Control request
ZSW1.10	1 = The comparative value that reaches or exceeds f or n
ZSW1.11	reserve
ZSW1.12	reserve
ZSW1.13	reserve
ZSW1.14	reserve
ZSW1.15	reserve

7.5.2 ZSW1 Status word (Used for packets 102 and 105

Signal	Description
ZSW1.0	1 = Servo on and ready
ZSW1.1	1 = Ready to run
ZSW1.2	1 = Run Enable
ZSW1.3	1 = A fault exists
ZSW1.4	1 = Free parking invalid (OFF2 invalid)
ZSW1.5	1 = Fast stop invalid (OFF3 invalid)
ZSW1.6	1 = The connection ban takes effect
ZSW1.7	1 = Alarm exists
ZSW1.8	1 = The deviation of the speed set value from the actual value is within the t_off (closing time) tolerance
ZSW1.9	1 = Control request
ZSW1.10	1 = The comparative value that reaches or exceeds f or n
ZSW1.11	reserve
ZSW1.12	reserve
ZSW1.13	reserve
ZSW1.14	Closed loop torque control in effect
ZSW1.15	reserve

7.5.3 ZSW1 status word (for message 111)

Signal	Description
ZSW1.0	1 = Servo on and ready
ZSW1.1	1 = Ready to run
ZSW1.2	1 = Run Enable
ZSW1.3	1 = A fault exists
ZSW1.4	1 = Free parking invalid (OFF2 invalid)
ZSW1.5	1 = Fast stop invalid (OFF3 invalid)
ZSW1.6	1 = The connection ban takes effect
ZSW1.7	1 = Alarm exists
ZSW1.8	1 = the following error within the tolerance
ZSW1.9	1 = Control request
ZSW1.10	1 = The target position has been reached
ZSW1.11	1 = The reference point has been set
ZSW1.12	0-1 Rising edge = Active positioning, moving task confirmed
ZSW1.13	1 = The drive is stopped
ZSW1.14	reserve
ZSW1.15	reserve

7.5.4 ZSW2 Status Word (For Packets 1, 3, and 111)

Signal	Description
ZSW2.0	reserve
ZSW2.1	reserve
ZSW2.2	reserve
ZSW2.3	reserve
ZSW2.4	reserve
ZSW2.5	reserve

Signal	Description
ZSW2.6	reserve
ZSW2.7	reserve
ZSW2.8	1= Run to fixed block
ZSW2.9	reserve
ZSW2.10	reserve
ZSW2.11	reserve
ZSW2.12	Slave station life symbol, bit 0
ZSW2.13	Slave station life symbol, bit 1
ZSW2.14	Slave station life symbol, bit 2
ZSW2.15	Slave station life symbol, bit 3

7.5.5 ZSW2 status words (for messages 102, 105)

Signal	Description
ZSW2.0	reserve
ZSW2.1	reserve
ZSW2.2	reserve
ZSW2.3	reserve
ZSW2.4	1= ramp function generator is not activated
ZSW2.5	1= Open the lock
ZSW2.6	1= Speed controller integrator forbidden
ZSW2.7	reserve
ZSW2.8	1= Run to fixed block
ZSW2.9	reserve
ZSW2.10	reserve
ZSW2.11	reserve
ZSW2.12	Slave station life symbol, bit 0
ZSW2.13	Slave station life symbol, bit 1
ZSW2.14	Slave station life symbol, bit 2
ZSW2.15	Slave station life symbol, bit 3

7.5.6 POS_ZSW1 Status word (for message 111)

Signal	Description
POS_ZSW1.0	reserve
POS_ZSW1.1	reserve
POS_ZSW1.2	reserve
POS_ZSW1.3	reserve
POS_ZSW1.4	reserve
POS_ZSW1.5	reserve
POS_ZSW1.6	reserve
POS_ZSW1.7	reserve
POS_ZSW1.8	reserve
POS_ZSW1.9	reserve
POS_ZSW1.10	1 = JOG function activation
POS_ZSW1.11	1 = return to zero reference point activation
POS_ZSW1.12	reserve

POS_ZSW1.13	reserve
POS_ZSW1.14	reserve
POS_ZSW1.15	1 = MDI is activated 0 = MDI is not activated

7.5.7 POS_ZSW2 Status Word (for Packet 111)

Signal	Description
POS_ZSW2.0	reserve
POS_ZSW2.1	reserve
POS_ZSW2.2	reserve
POS_ZSW2.3	reserve
POS_ZSW2.4	reserve
POS_ZSW2.5	reserve
POS_ZSW2.6	1 = Negative soft limit switch activated 0 = Negative soft limit switch is not activated
POS_ZSW2.7	1 = Forward soft limit switch activated 0 = The forward soft limit switch is not activated
POS_ZSW2.8	reserve
POS_ZSW2.9	reserve
POS_ZSW2.10	reserve
POS_ZSW2.11	reserve
POS_ZSW2.12	reserve
POS_ZSW2.13	reserve
POS_ZSW2.14	reserve
POS_ZSW2.15	reserve

7.5.8 MELDW Status word

<table>
<tr><th>Signal</th><th>Description</th></tr>
<tr><td>MELDW.0</td><td>1 = Slope ascent/descent completed
0 = ramp function generator in effect</td></tr>
<tr><td>MELDW.1</td><td>1 = torque utilization ratio [%] < torque threshold 2</td></tr>
<tr><td>MELDW.2</td><td>1 = | n_act | < 3 (p2161) speed threshold</td></tr>
<tr><td>MELDW.3</td><td>1 = | n_act | speed threshold 2 or less</td></tr>
<tr><td>MELDW.4</td><td>1 = Vdc_min The controller is activated</td></tr>
<tr><td>MELDW.5</td><td>reserve</td></tr>
<tr><td>MELDW.6</td><td>1 = No motor overtemperature alarm</td></tr>
<tr><td>MELDW.7</td><td>1 = No thermal overload alarm is generated for the power unit</td></tr>
<tr><td>MELDW.8</td><td>1 = The deviation of the speed set value from the actual value is within t_on tolerance</td></tr>
<tr><td>MELDW.9</td><td>reserve</td></tr>
<tr><td>MELDW.10</td><td>reserve</td></tr>
<tr><td>MELDW.11</td><td>1 = The controller is enabled</td></tr>
<tr><td>MELDW.12</td><td>1 = Drive ready</td></tr>
<tr><td>MELDW.13</td><td>1 = Pulse enable</td></tr>
<tr><td>MELDW.14</td><td>reserve</td></tr>
<tr><td>MELDW.15</td><td>reserve</td></tr>
</table>

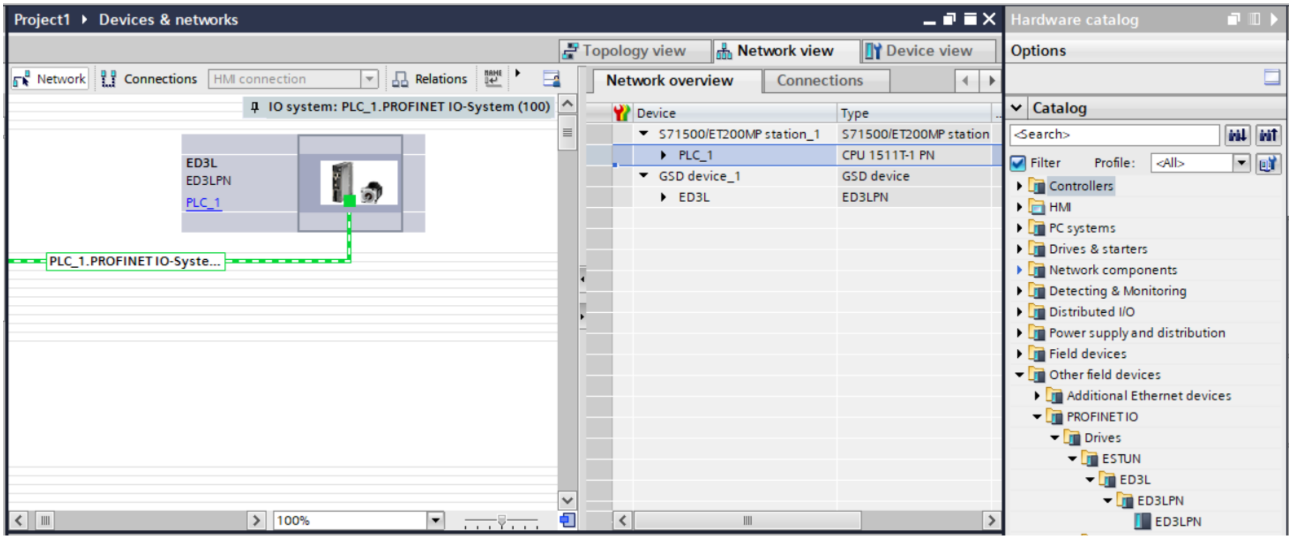
7.6 S7-1500PLC configuration configuration

7.6.1 Example of Message 3 application

Configuration

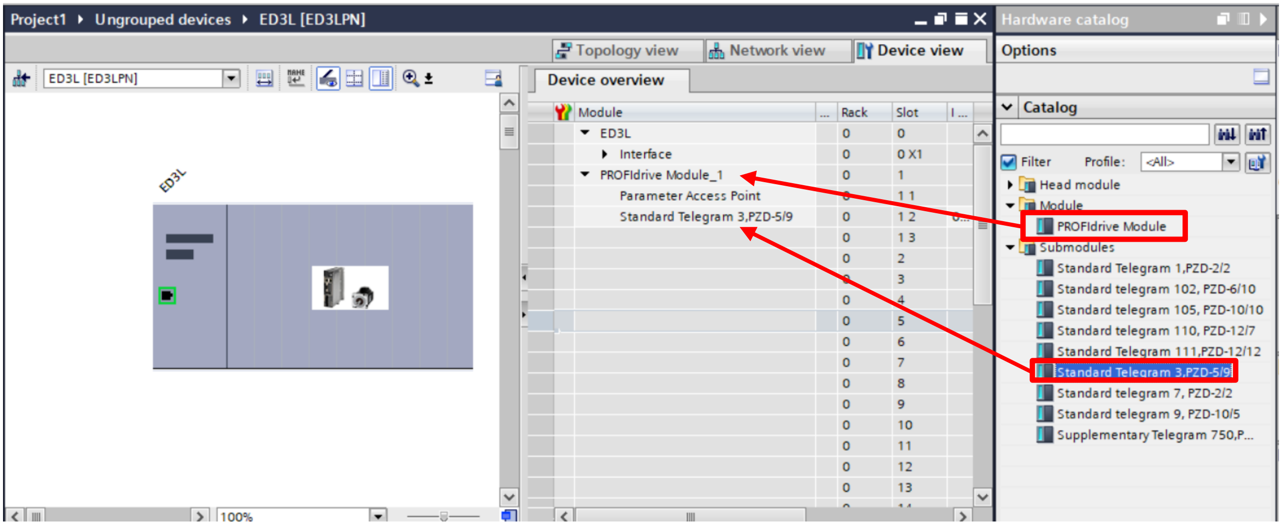
Step 1 Configure the Siemens PLC and ED3LPN servo according to the equipment and wiring used, as shown in the following figure:

Figure 7-1 wiring



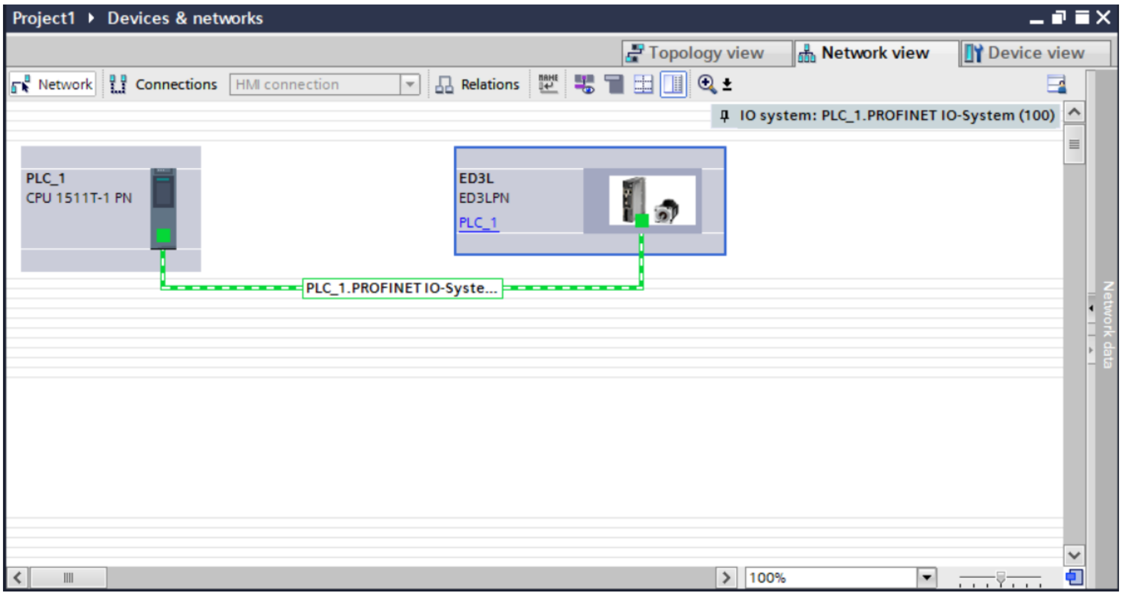
Step 2 Add packet 3, as shown in the following figure:

Figure 7-2 Add packet 3



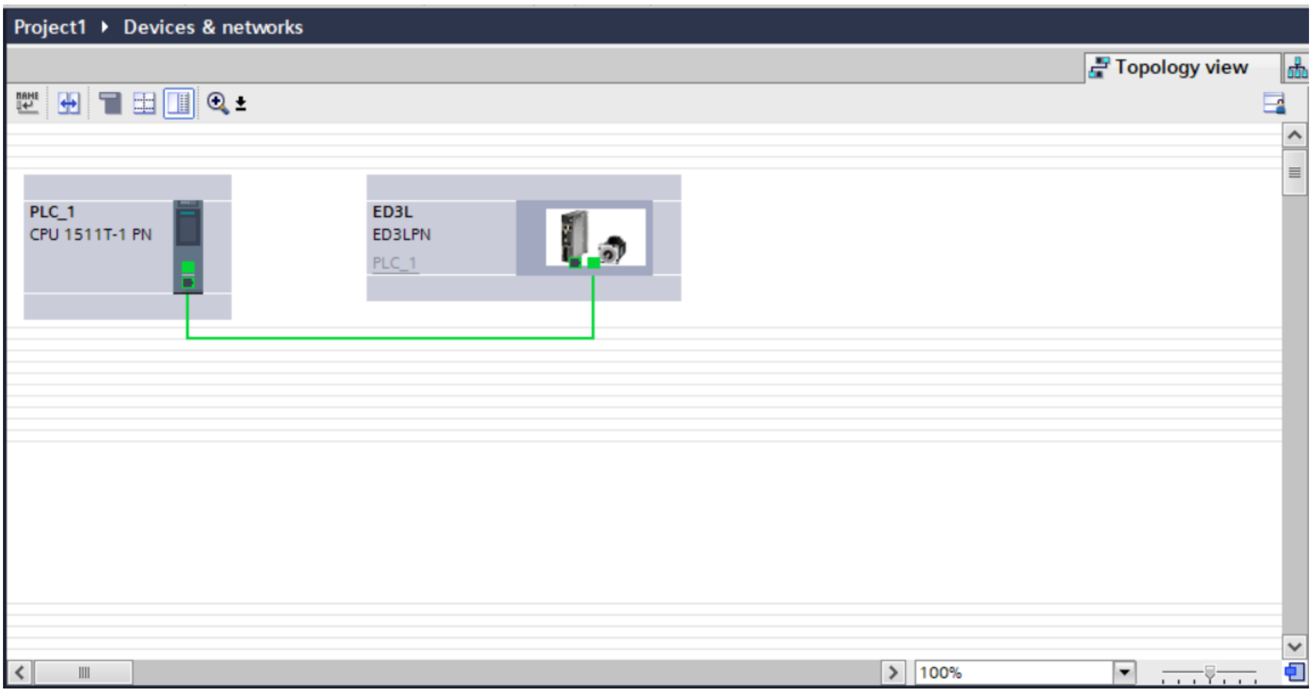
Step 3 Switch to the network view and connect the PLC with the ED3LPN servo, as shown in the following figure:

Figure 7-3 Connection servo



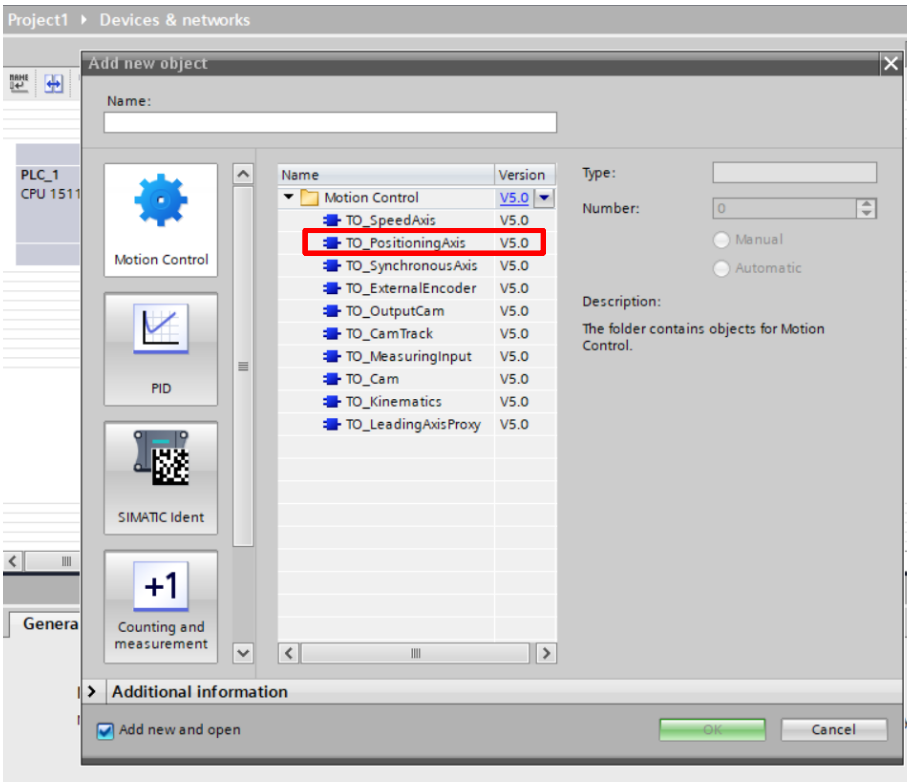
Step 4 Message 3 is used for IRT communication, where a topological connection is required, and the topological connection is consistent with the actual physical connection, and if it is RT communication, there is no need for topological connection.

Figure 7-4 Topology connection



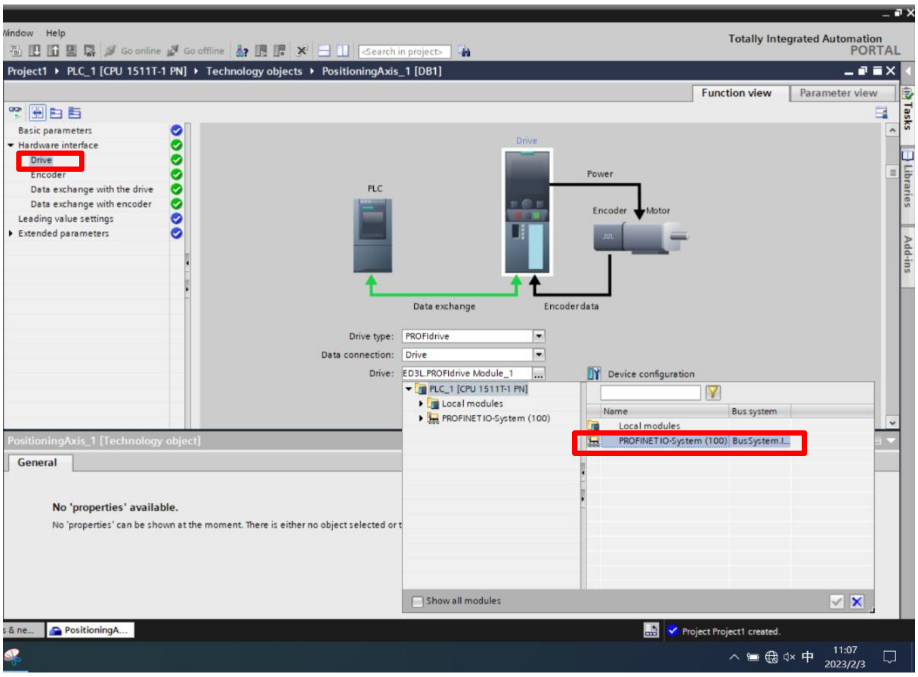
Step 5 Add the axis craft object, as shown in the following figure:

Figure 7-5 Adding Axis Process Objects



Step 6 In Add Axis configuration, the drive selects Message 3, as shown in the following figure:

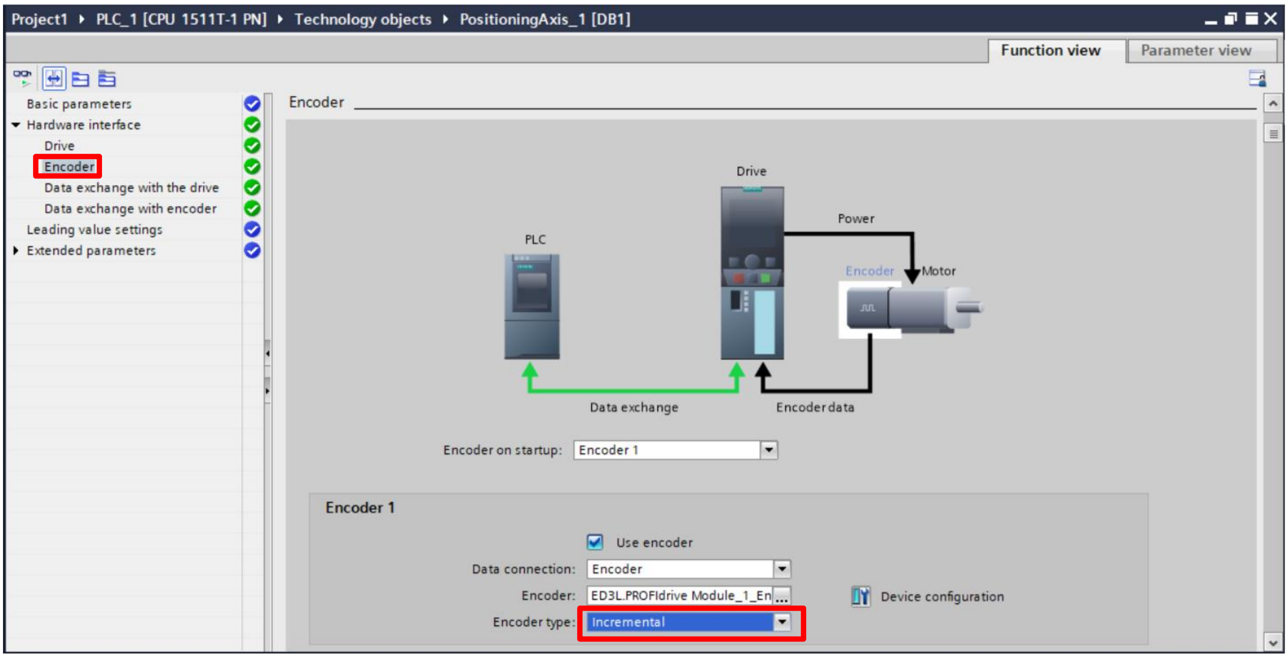
Figure 7-6 Drive unit selection



Configure the encoder type,

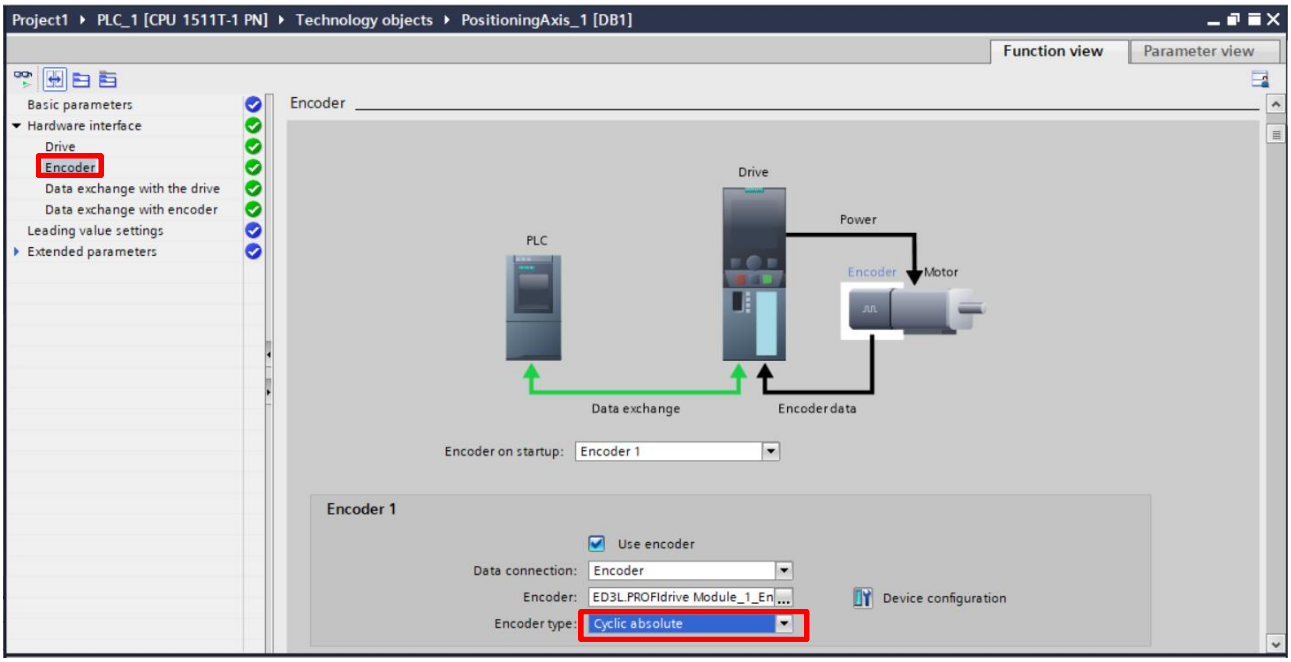
Step 1 : If the encoder used for the motor is incremental or an absolute encoder, but Pn002 is set to 0100, select Incremental for the encoder type, as shown in the following figure:

Figure 7-7 Select the Incremental encoder



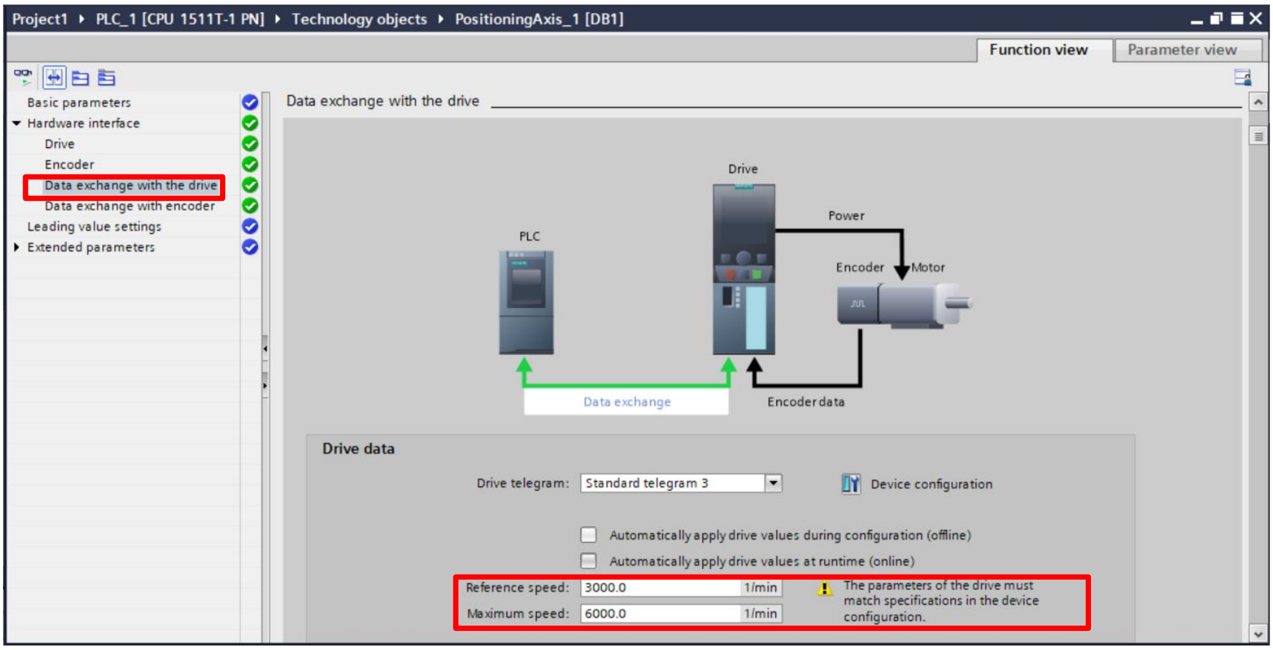
Step 2 If the encoder used is an absolute encoder and Pn002 is set to 0000, select Cyclic Absolute Encoder for the encoder type, as shown in the following figure:

Figure 7-8 Selecting "Cyclic Absolute Encoder"



Step 3 When configuring the parameters for data exchange with the drive, the rated speed and maximum speed of the motor can be referred to, as shown in the figure below:

Figure 7-9 Configure parameters



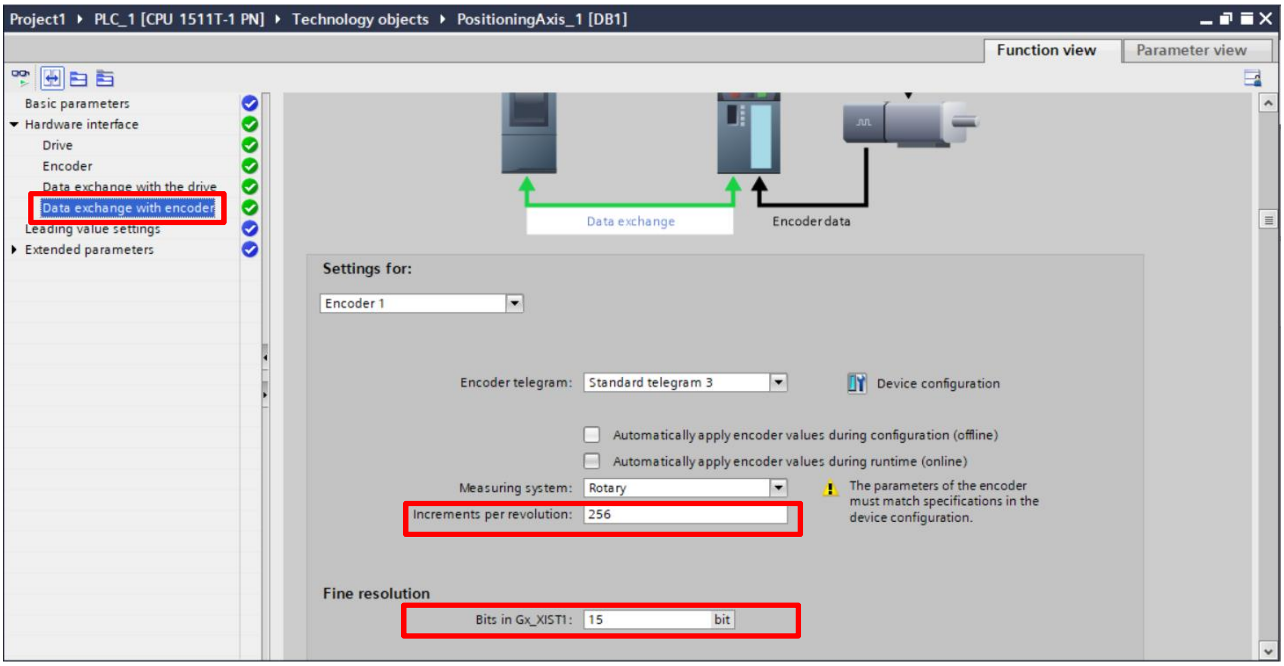
Note: The above picture shows the EM3A-08AFA and EM3J-08AFA configurations

Step 4 When configuring the parameters for data exchange with the encoder, it is configured according to the type of encoder used by the motor.

Incremental encoders

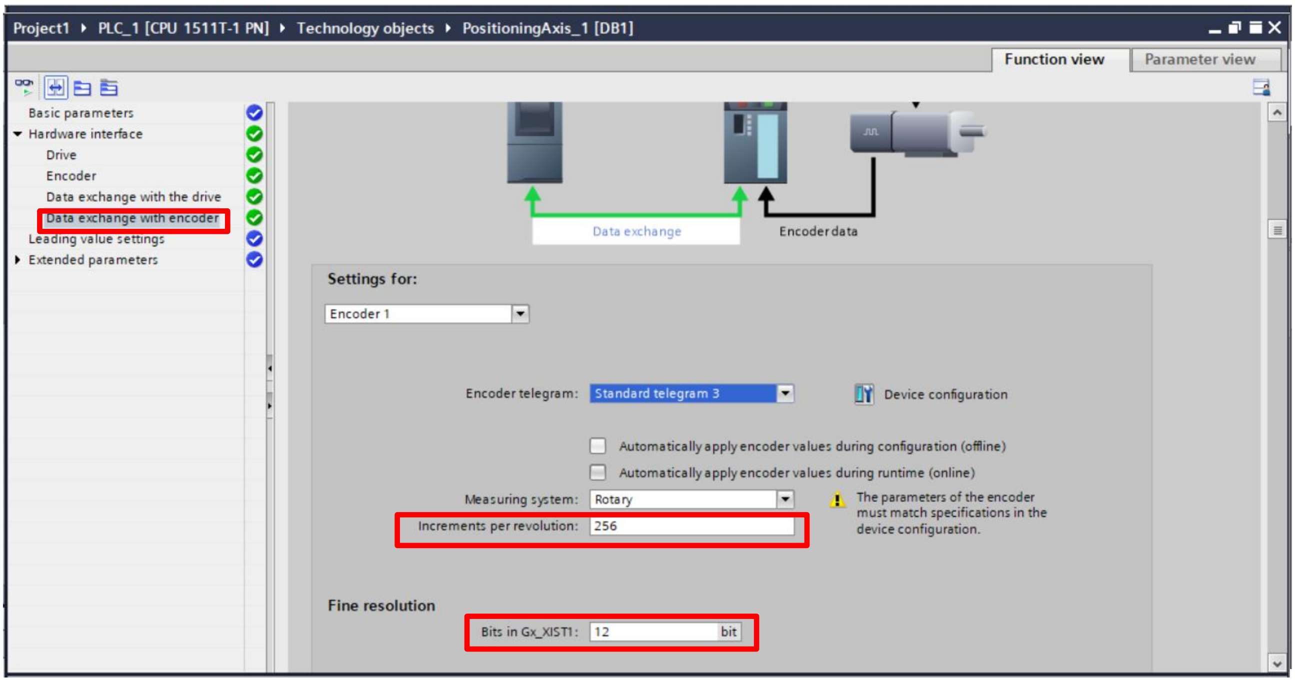
Nikon encoder (23-bit), as shown in the following figure:

Figure 7-10 Nikon encoder (23-bit)



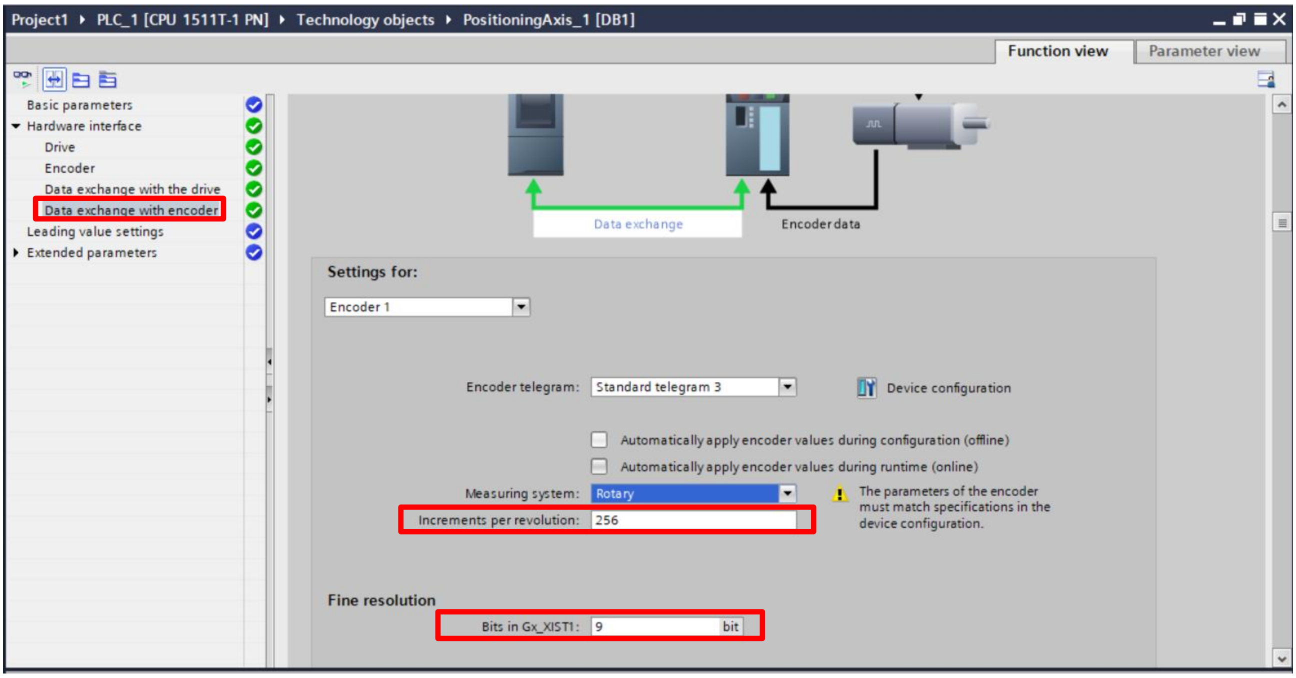
Biss encoder (20-bit), as shown in the following figure:

Figure 7-11 Biss encoder (20-bit)



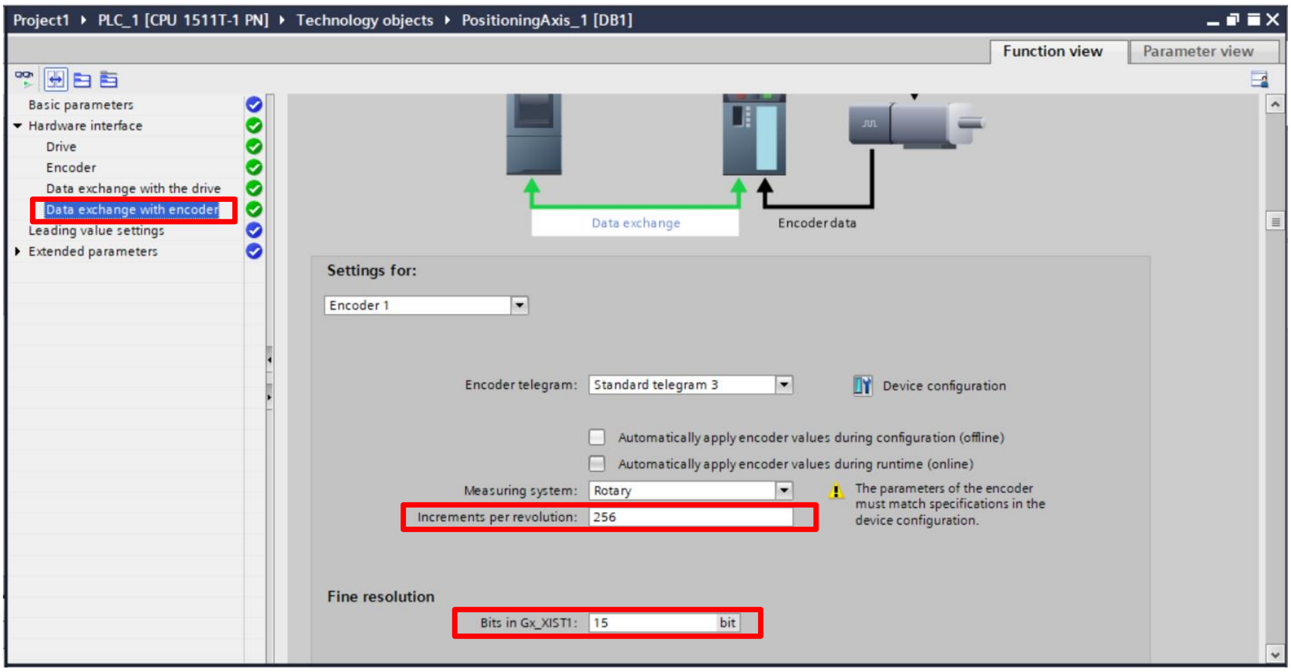
Magnetic encoder (17-bit), as shown in the following figure:

Figure 7-12 Figure 6-12 Magnetic encoder (17-bit)



Tamagawa encoder (23-bit), as shown in the following figure:

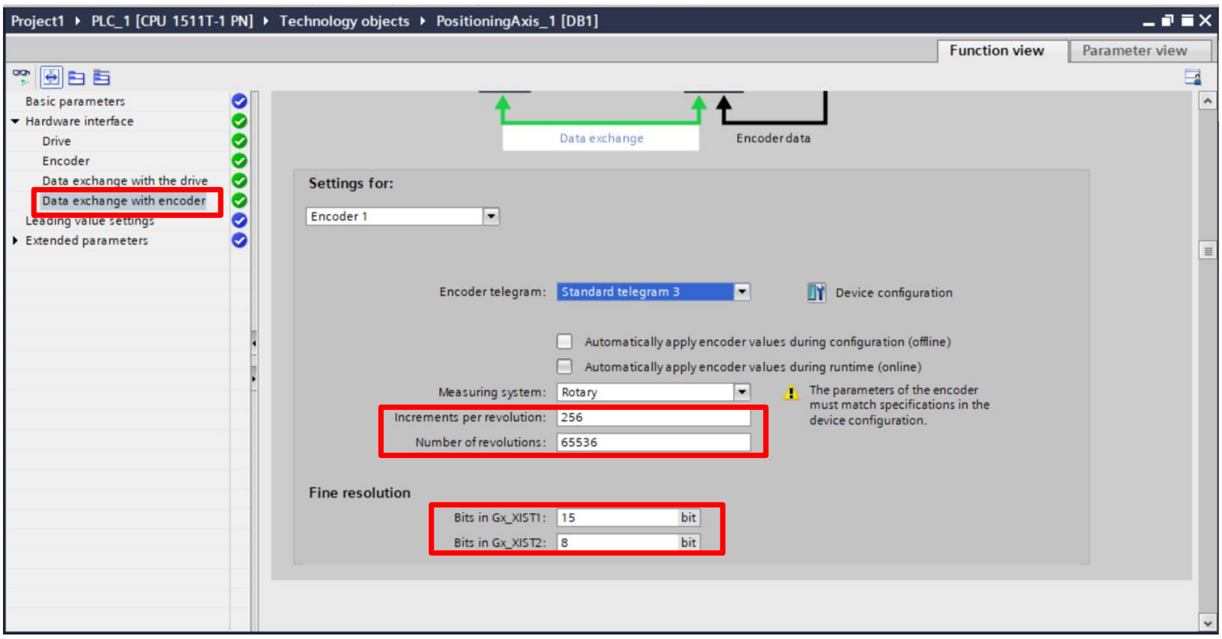
Figure 7-13 Figure 6-13 Tamagawa encoder (23-bit)



Cyclic absolute encoder

Nikon encoder (23-bit), as shown in the following figure:

Figure 7-14 Nikon encoder (23-bit)

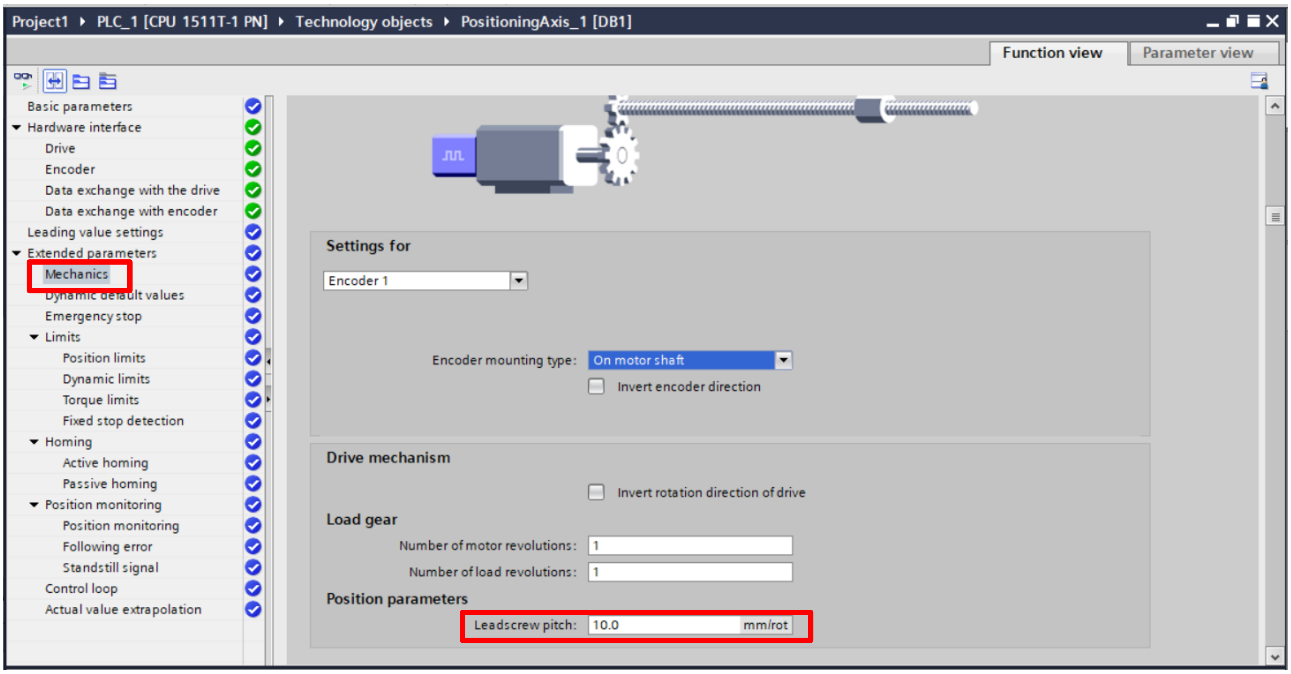


Tamagawa encoder (23-bit), configured with the same Nikon encoder (23-bit):

Configure mechanical parameters,

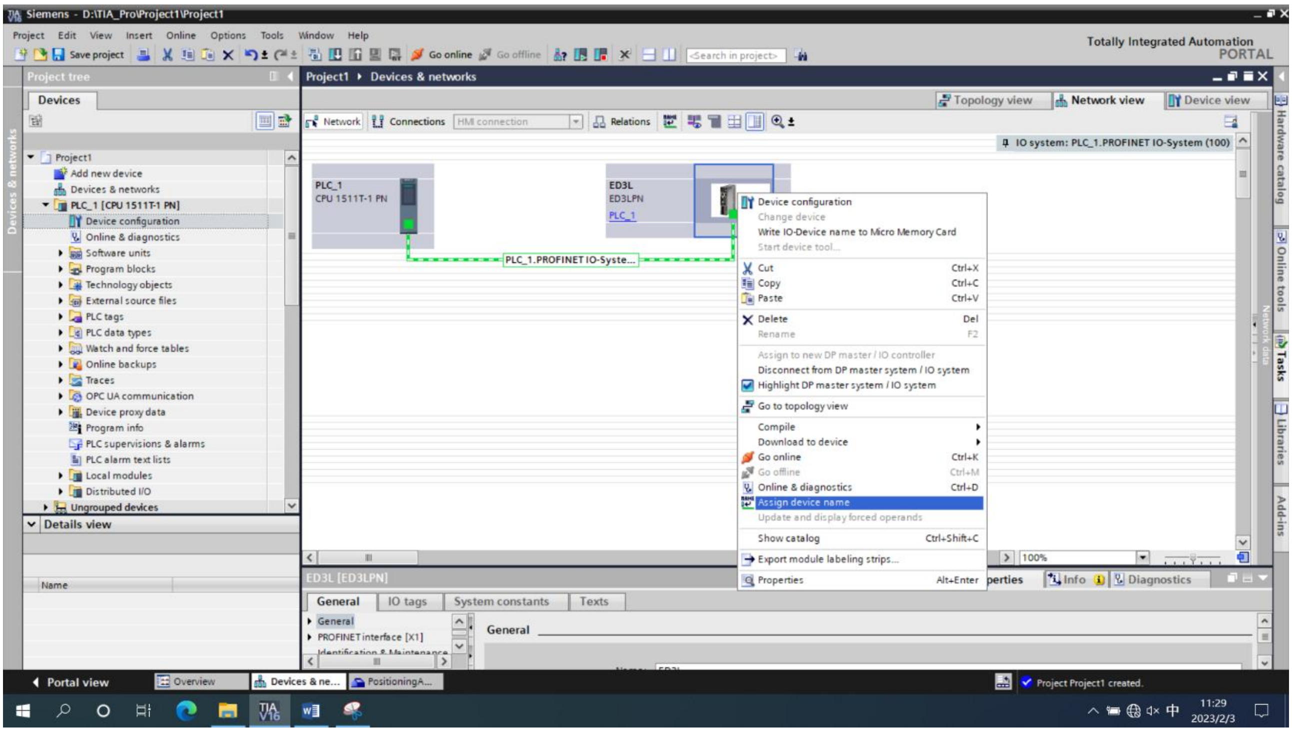
Step 1 Set the mechanical parameters as shown in the following figure:

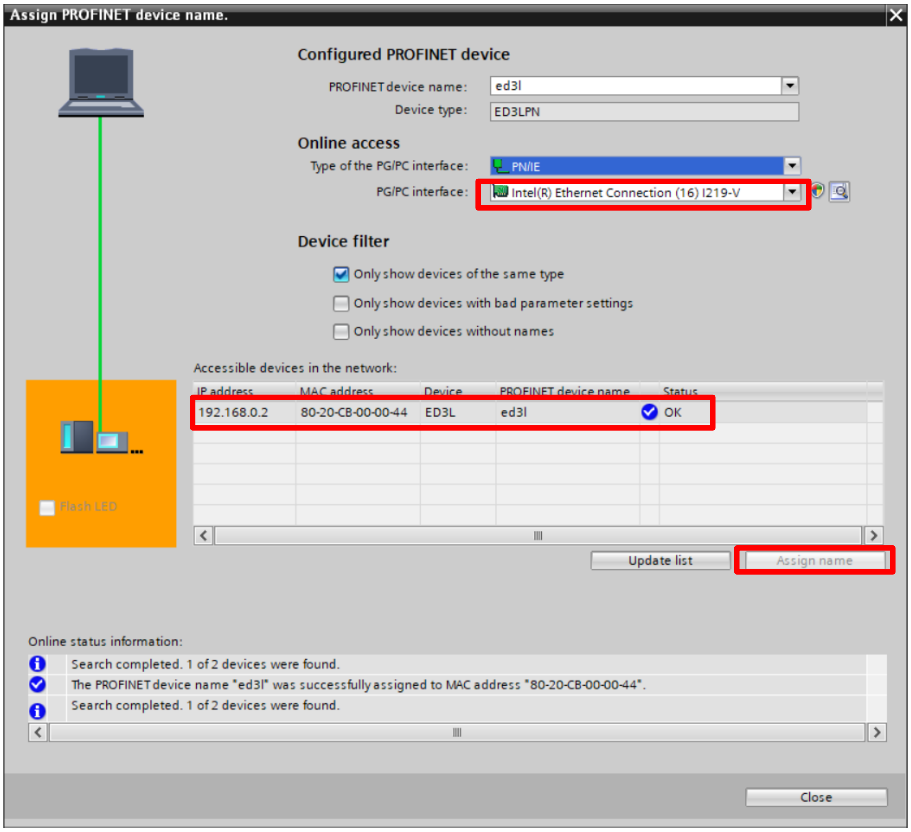
Figure 7-15 Camfer Gure Mechani Karpalametez



Step 2 Return to the network view and assign a name to the device, as shown in the following figure:

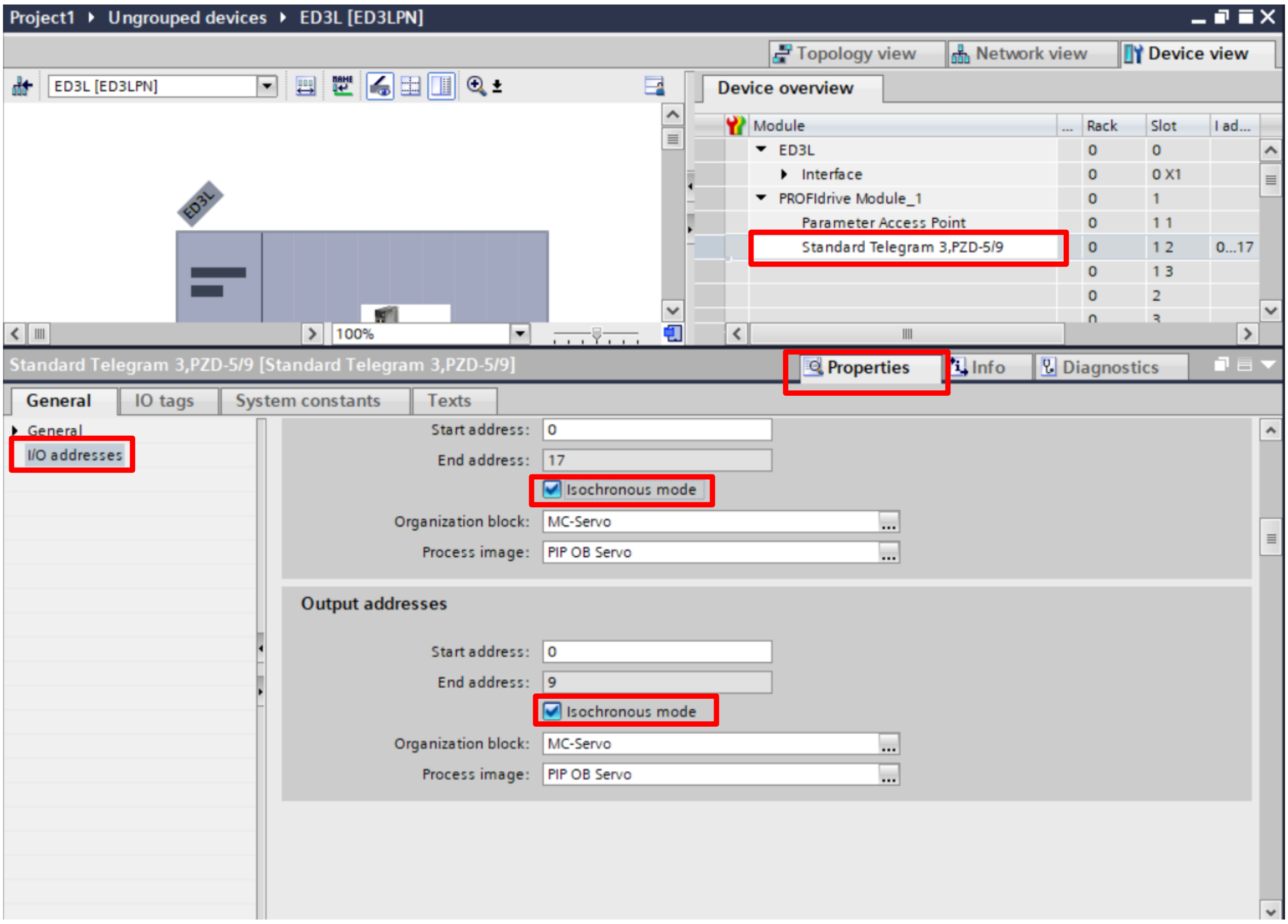
Figure 7-16 Device assignment name

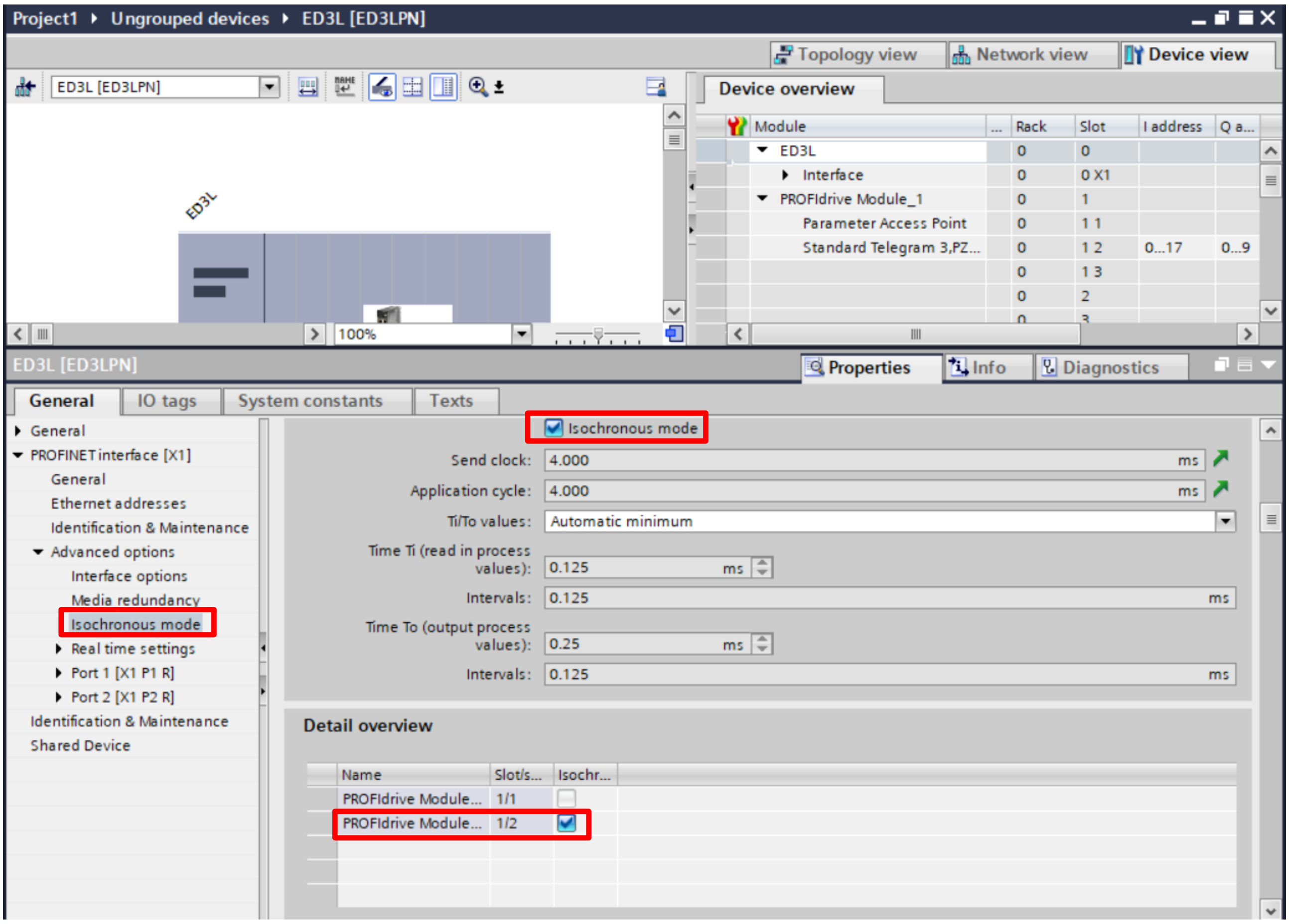




Step 3 Set the isochronous synchronization mode, as shown in the following figure:

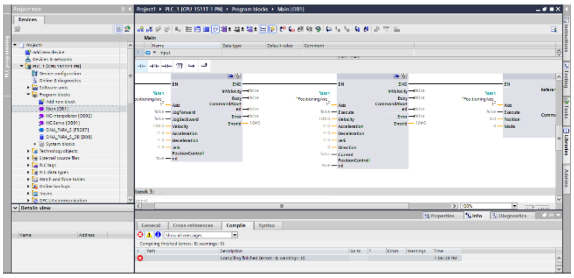
Figure 7-17 Set the isochronous synchronization mode

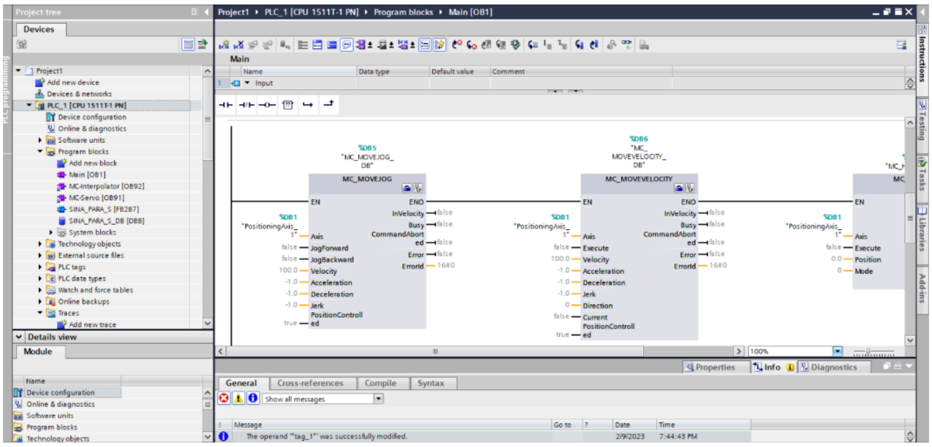


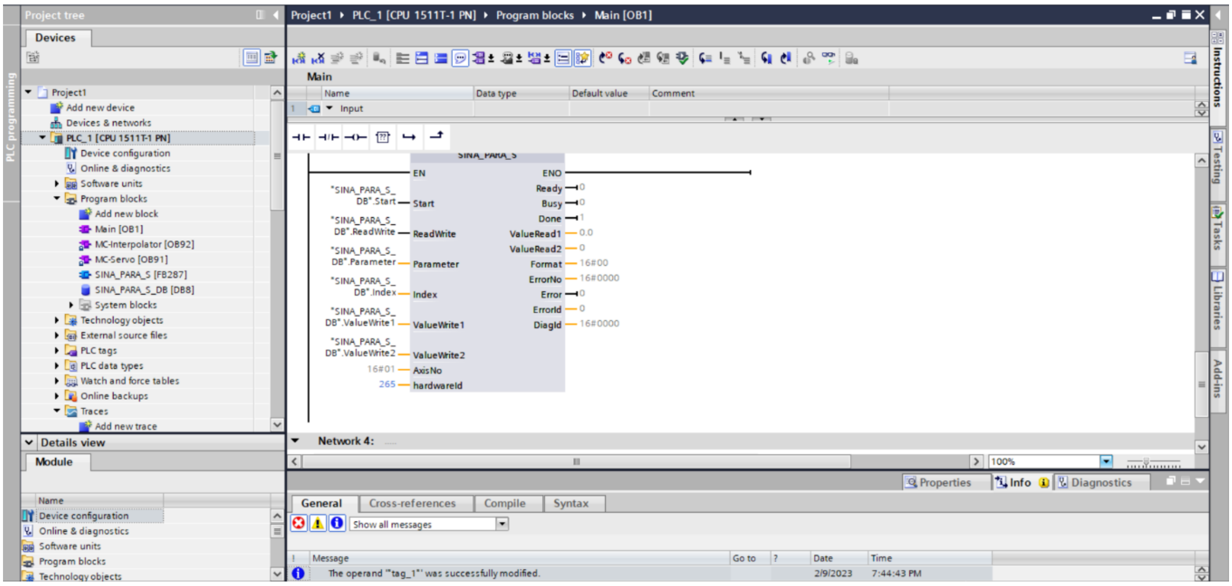


Step 4 Add a motion control module to the project to control the axis process logic, as shown in the following figure:

Figure 7-18 Axis process logic control

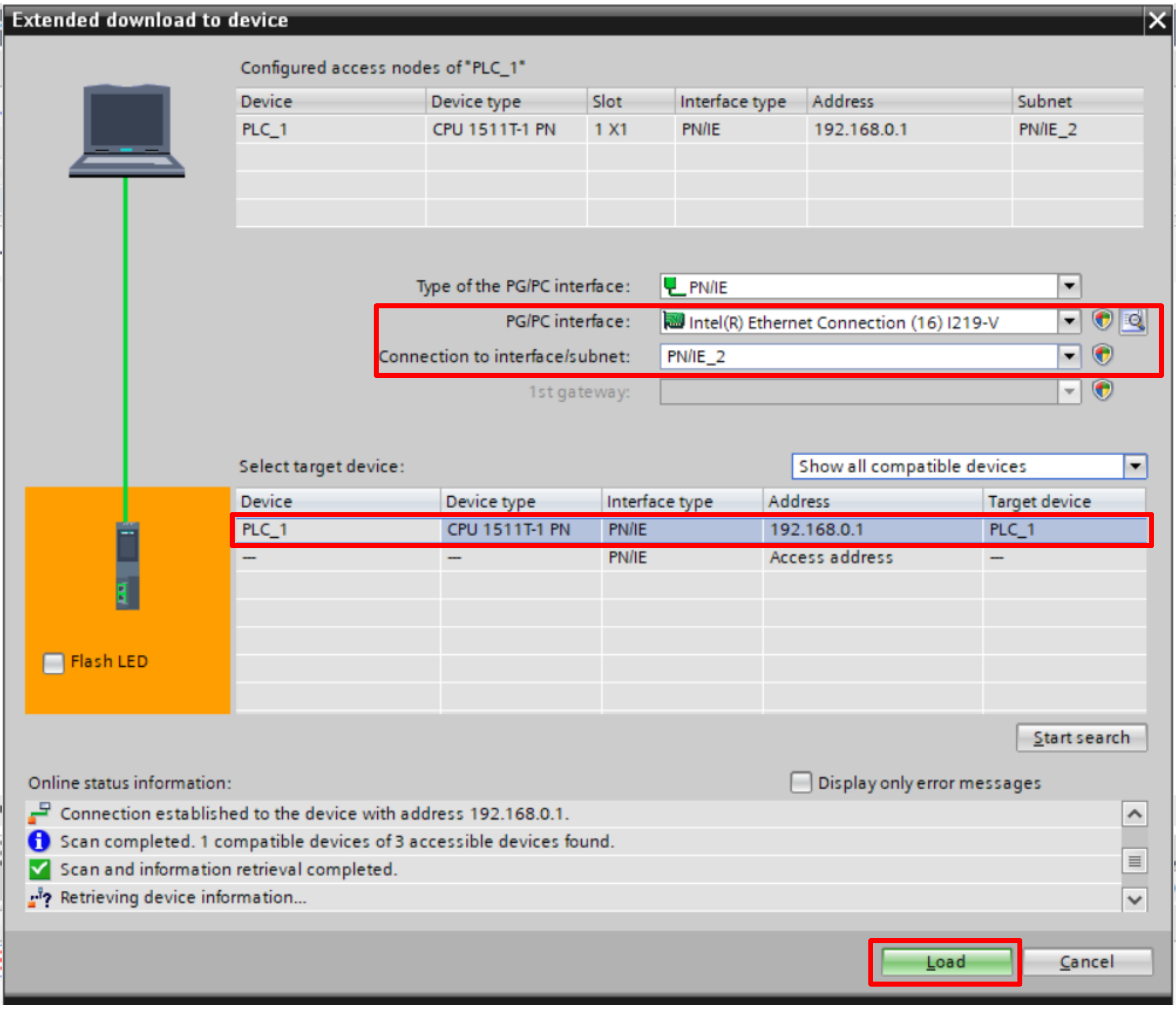






Step 5 Compile and download the program, as shown in the picture below:

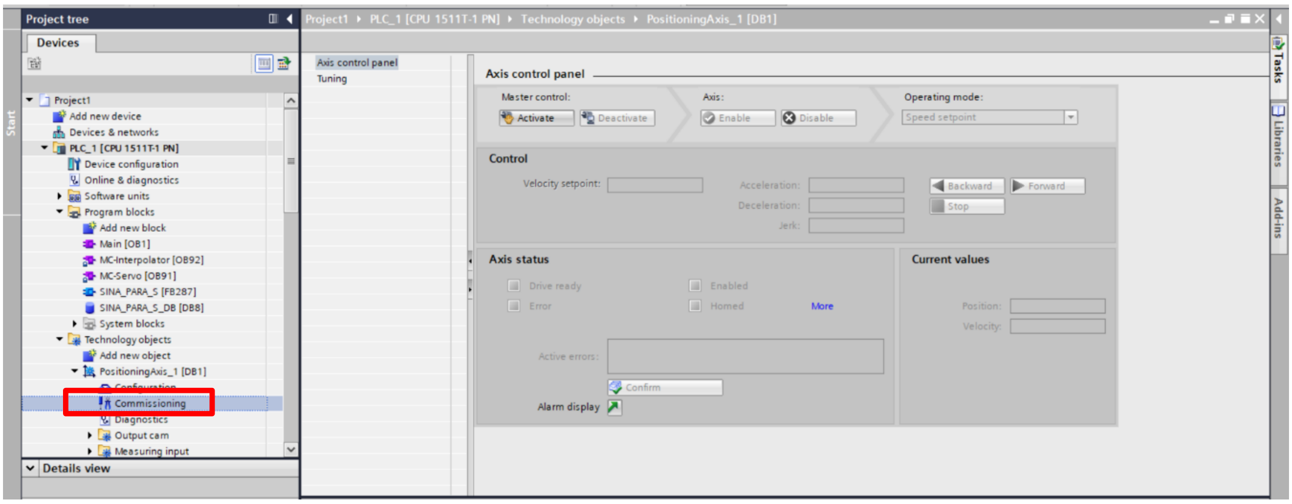
Figure 7-19 Compiling and downloading the program



Shaft debugging

Step 1 he commissioning function of the craft object confirms the correct parameter configuration, as shown in the following figure:

Figure 7-20 Process object debugging function



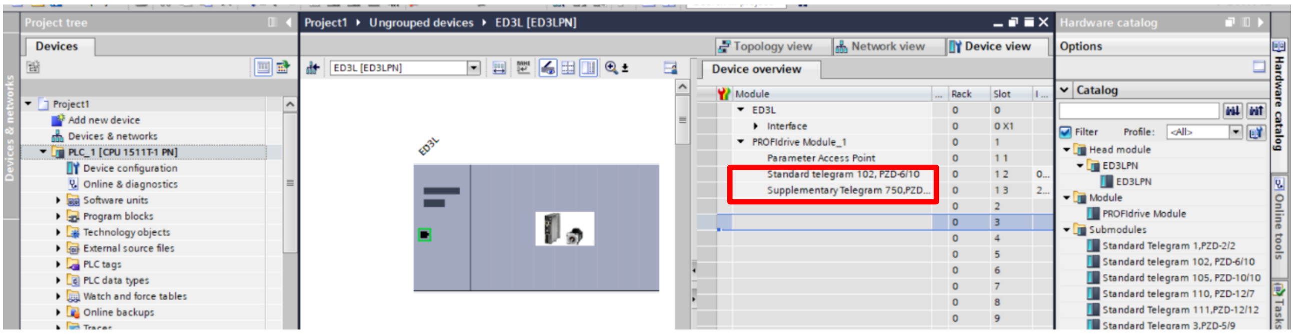
7.6.2 Application Example of Packet 102/105

Compared with message 3, the torque limiting function and torque control function are added, and the rest of the functions are the same as message 3

Torque limiter configuration and application examples

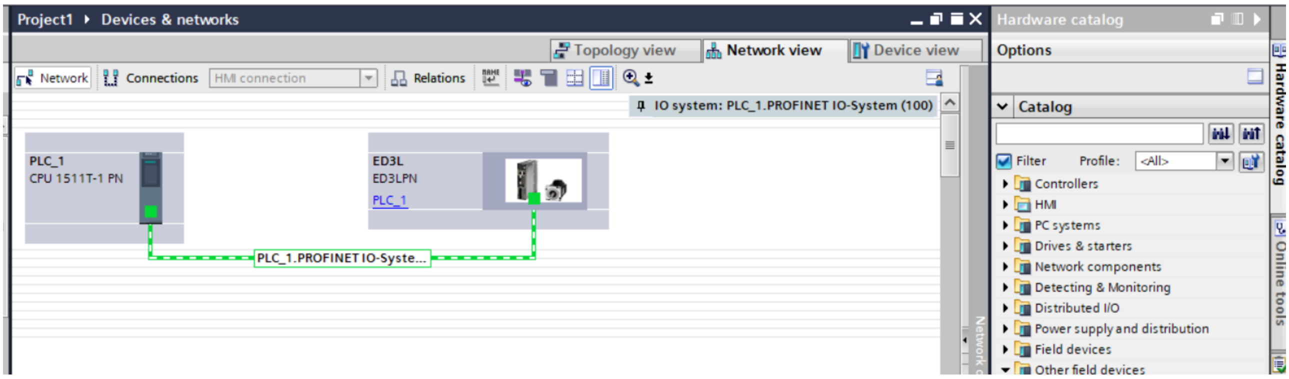
Step 1 Add packets 102 and 750, as shown in the following figure:

Figure 7-21 Add packets 102 and 750



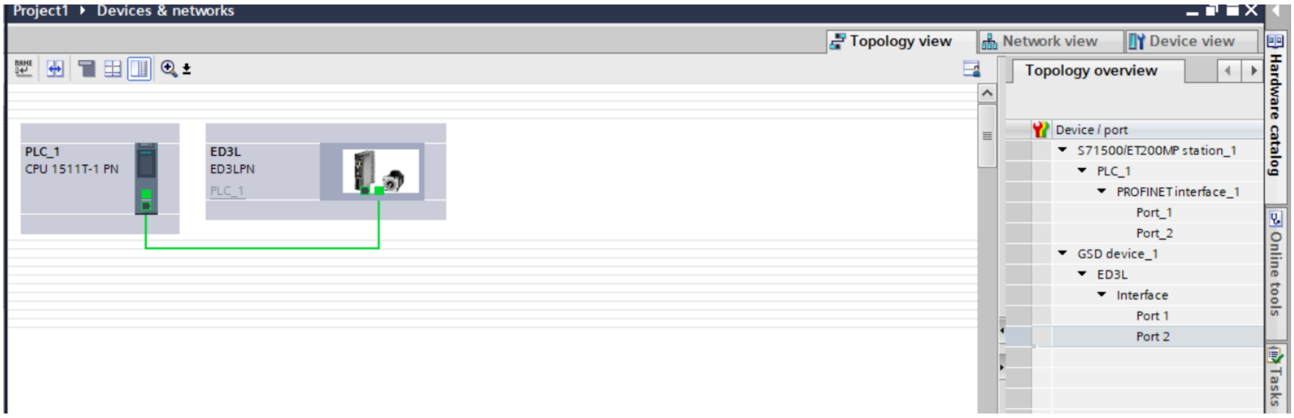
Step 2 Switch to the network view and connect the PLC with the ED3LPN servo, as shown in the following figure:

Figure 7-22 Connect the PLC to the ED3L PN servo



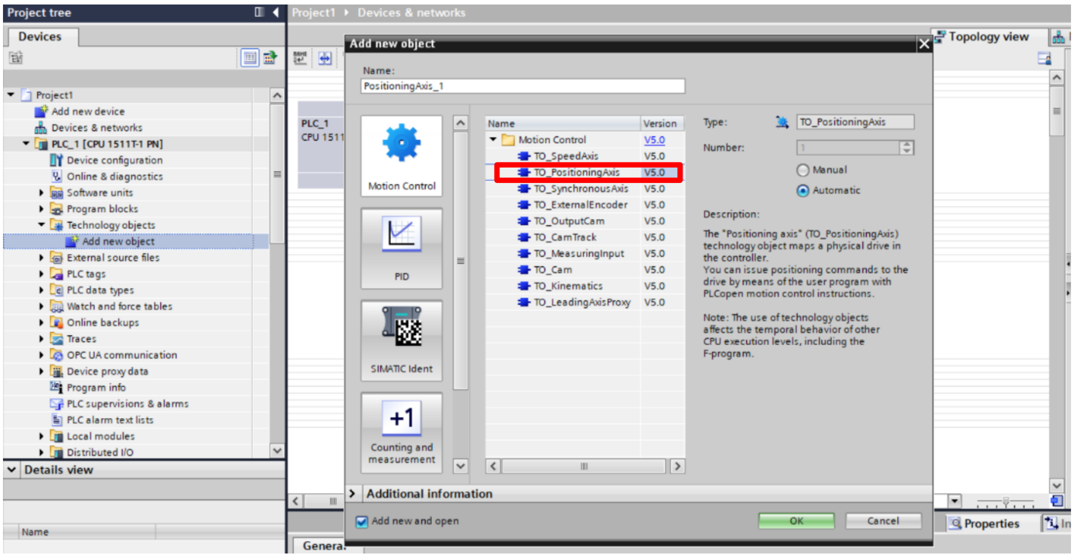
Step 3 Message 102 is used in IRT communication, where a topological connection is required, and the topological connection is consistent with the actual physical connection, as shown in the following figure:

Figure 7-23 Topology connections



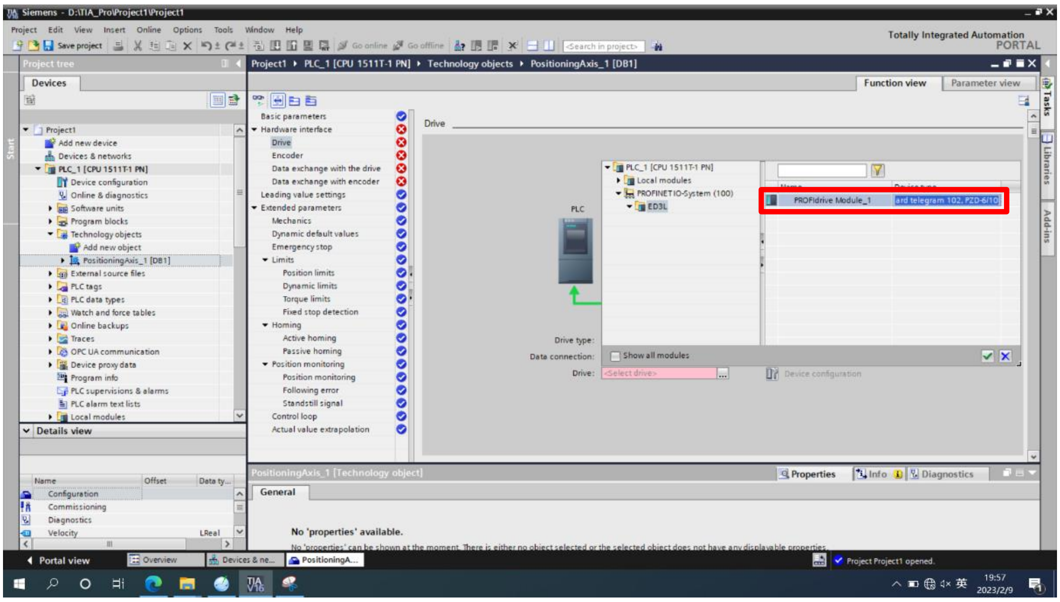
Step 4 Add the axis craft object, as shown in the following figure:

Figure 7-24 Add an axis craft object



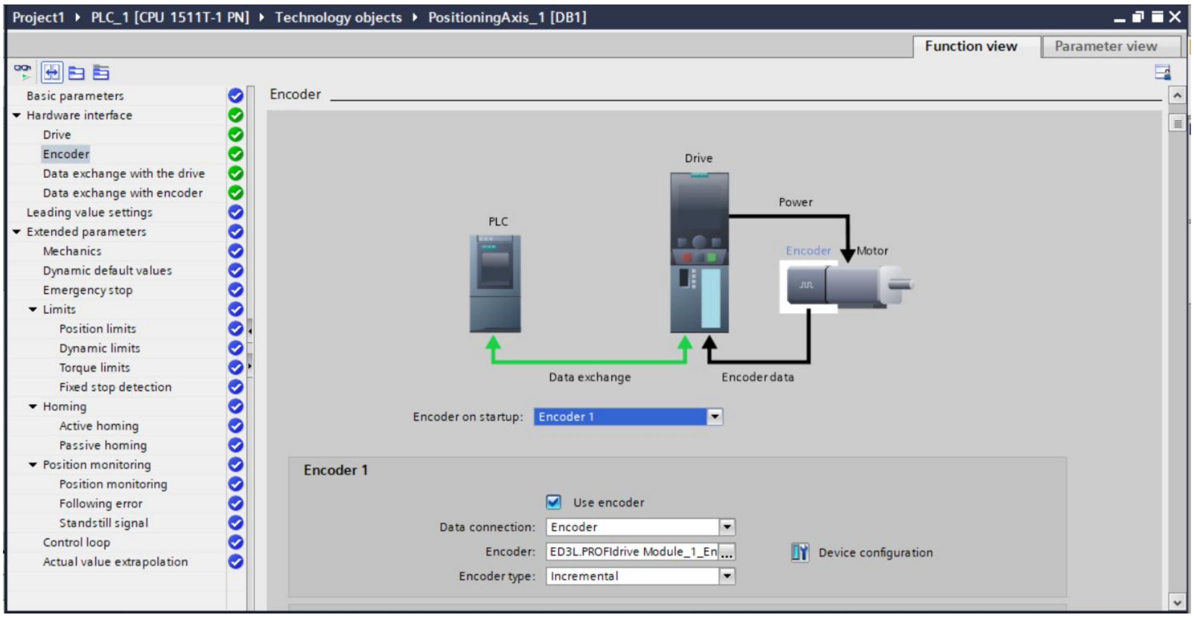
Step 5 In the Add Axis configuration, the drive selects message 102, as shown in the following figure:

Figure 7-25 Adding an axis in the configuration



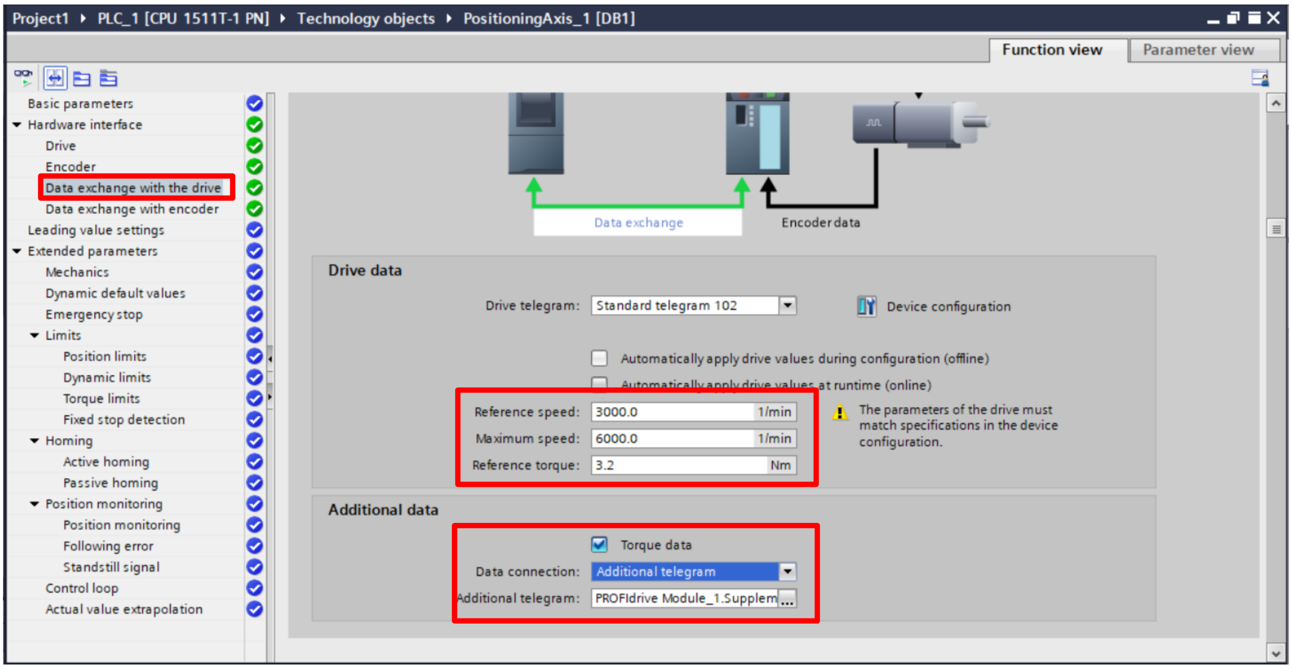
Step 6 The encoder configuration is the same as packet 3

Figure 7-26 Encoder configuration



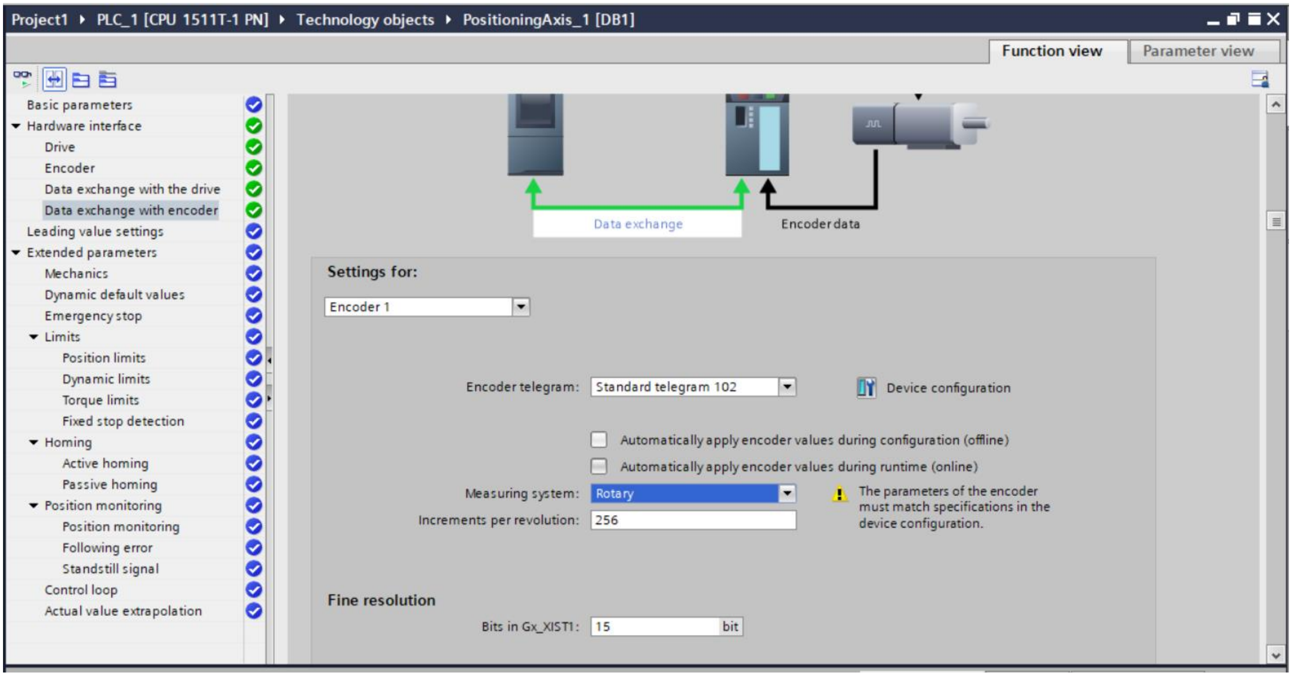
Step 7 Configure data exchange parameters with the drive, the reference torque value is 3 times the servo rated torque, this example applies a 750W motor, its rated torque is 2.39Nm, its reference torque is 2.39x3=7.17Nm, as shown in the figure below:

Figure 7-27 Data exchange parameters



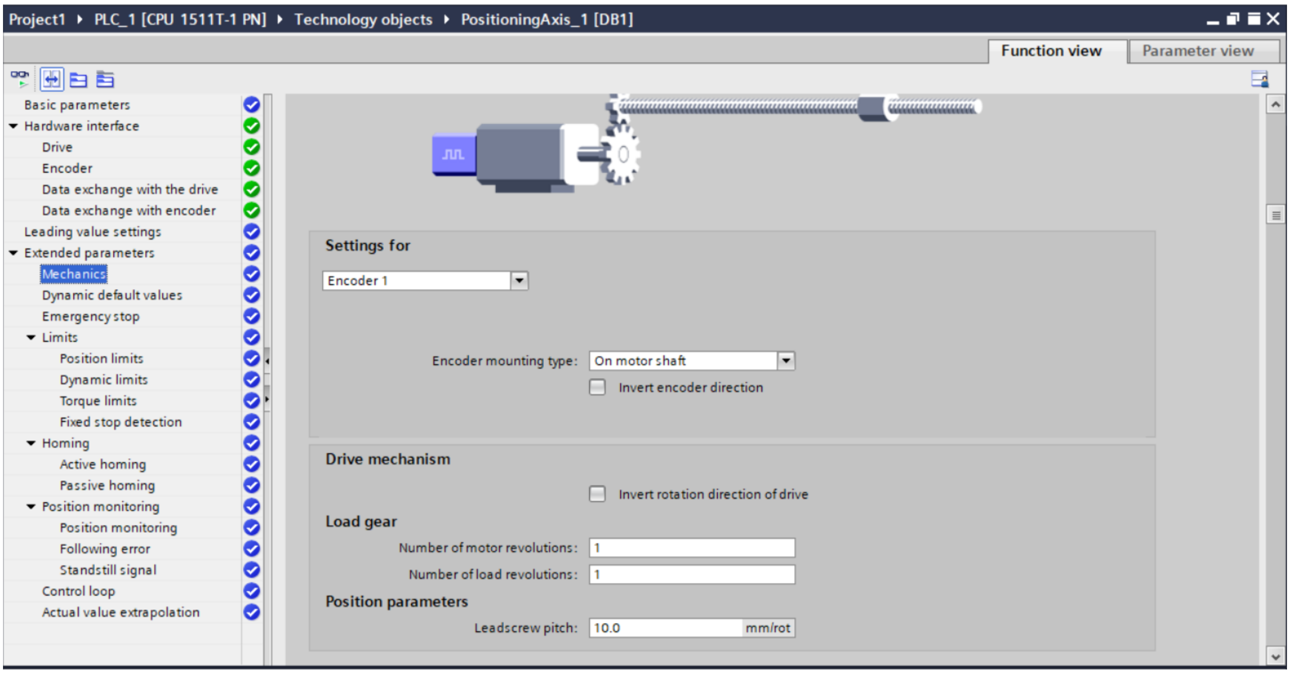
Step 8 Configure data exchange parameters with encoder as in Message 3

Figure 7-28 Configure parameters for data exchange with the encoder



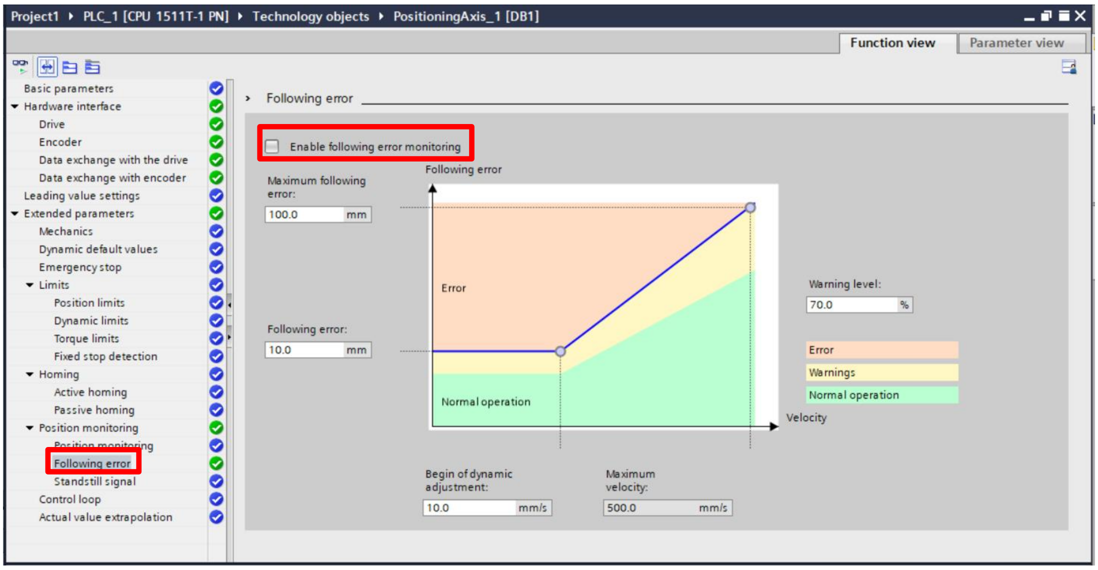
Step 9 Configure the mechanical parameters as shown in the following figure:

Figure 7-29 Setting mechanical parameters



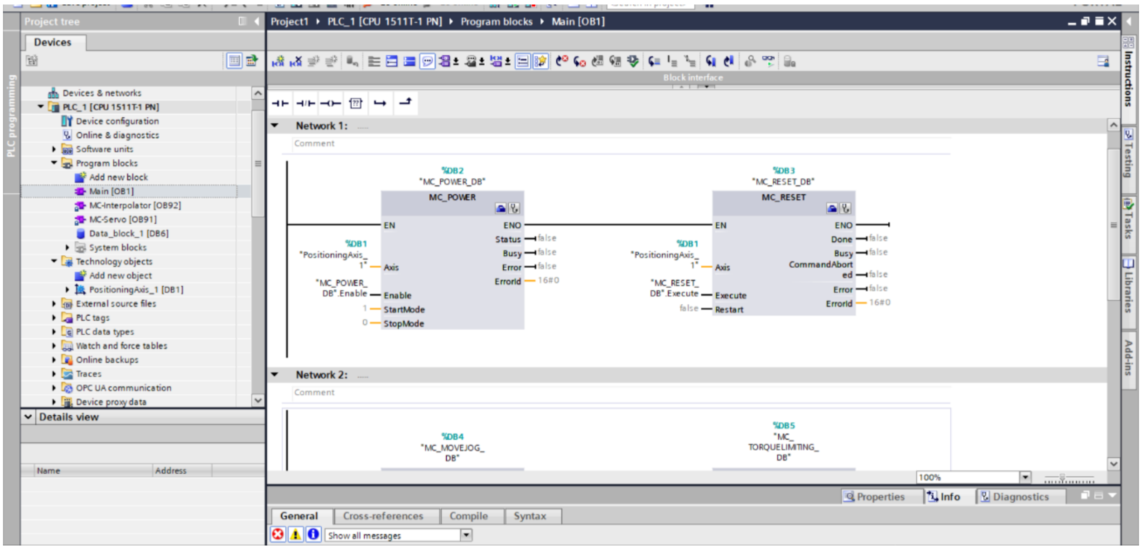
Step 10 Uncheck "Enable following error monitoring", as shown in the figure below:

Figure 7-30 Enabling Follow-up Error monitoring Deselect this option



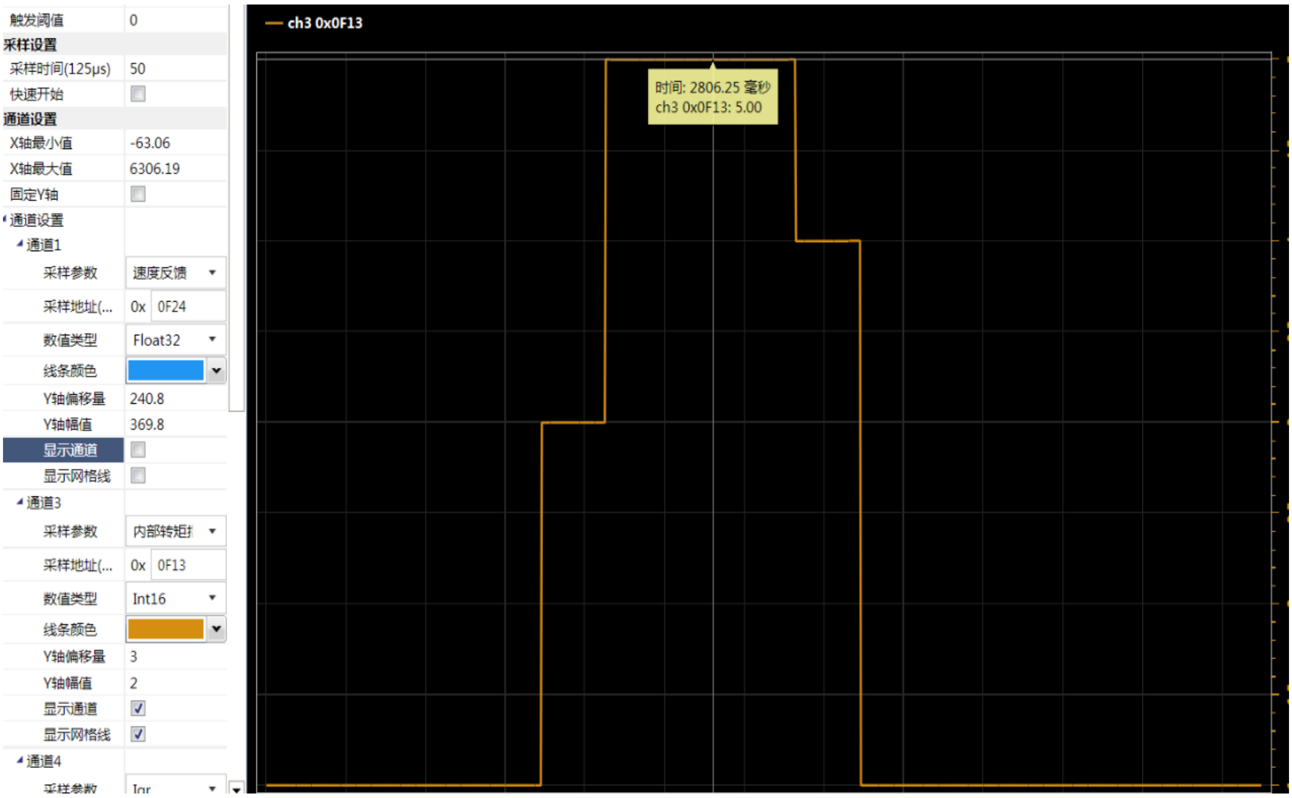
Step 11 Add a motion control module to OB1, as shown in the figure below:

Figure 7-31 Adding a Motion control module



Step 12 Based on the parameters in the figure above, calculate the internal torque command percentage to 0.12/2.39 = 5%, observe the oscilloscope waveform as shown in the following figure:

Figure 7-32 Oscilloscope waveform

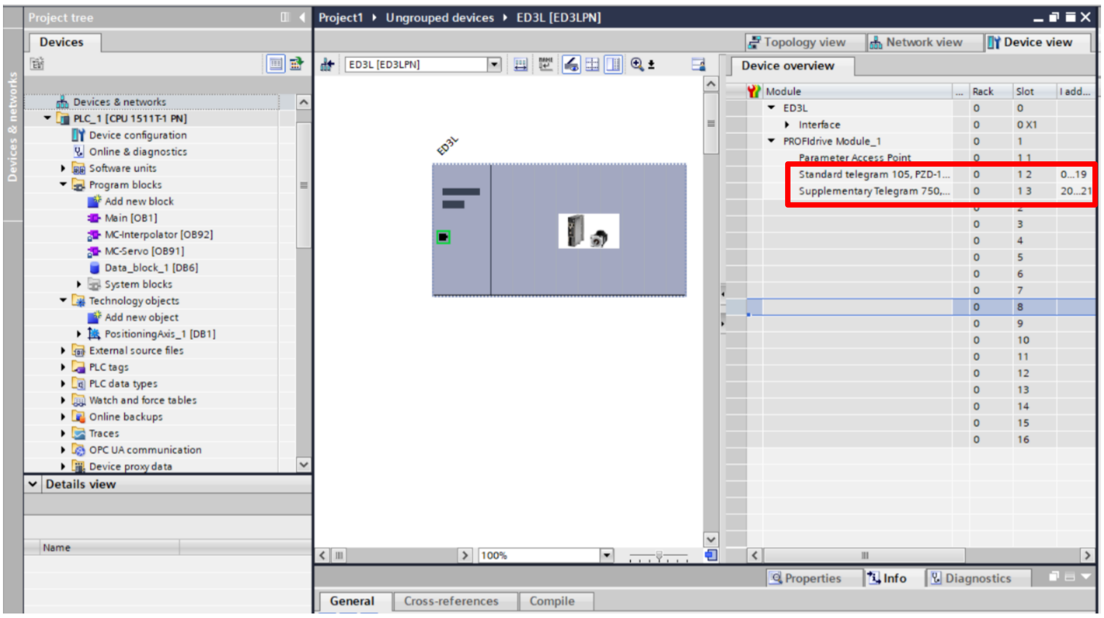


The oscilloscope shows a torque limit of 5% when stalled, and the torque limiting function is active.

Torque control mode configuration and application example

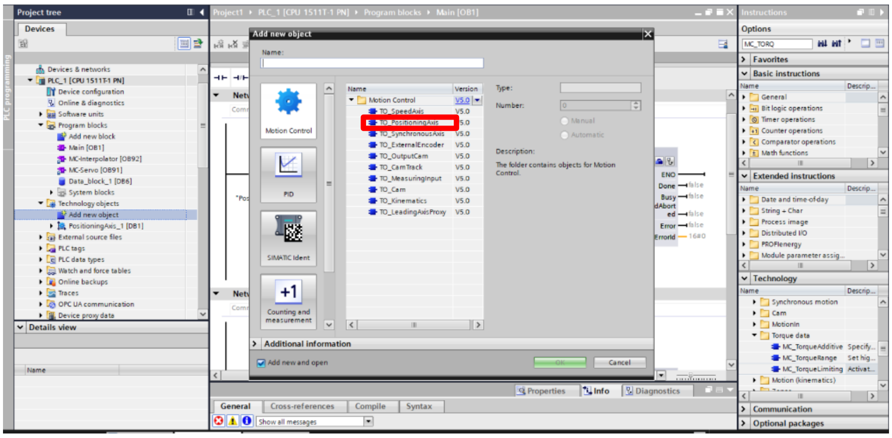
Step 1 Add packets 105 and 750, as shown in the following figure:

Figure 7-33 Add messages 105 and 750



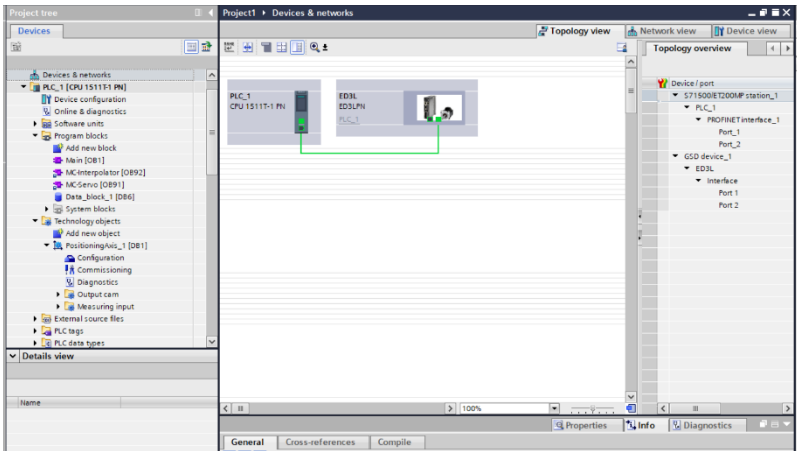
Step 2 Switch to the network view and connect the PLC with the ED3LPN servo, as shown in the following figure:

Figure 7-34 Connect the PLC to the ED3L PN servo



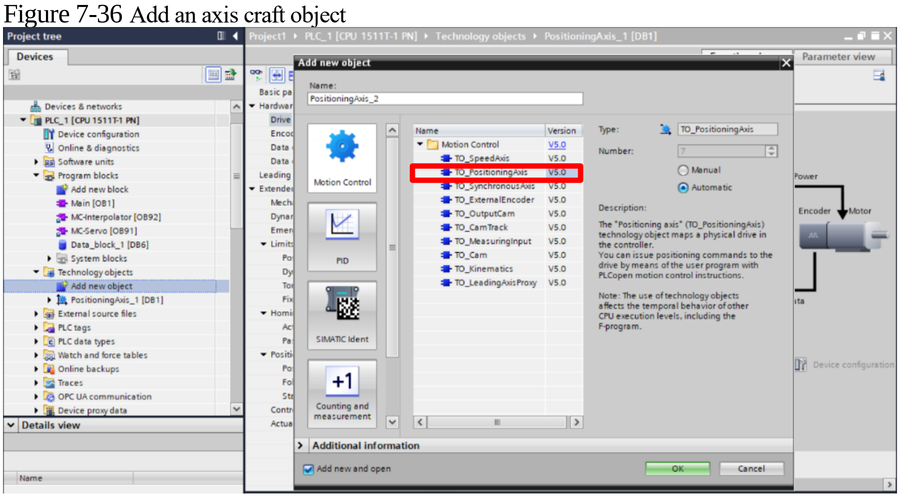
Step 3 Message 105 is used for IRT communication, where a topological connection is required, and the topological connection is consistent with the actual physical connection, as shown in the following figure:

Figure 7-35 Topology connections



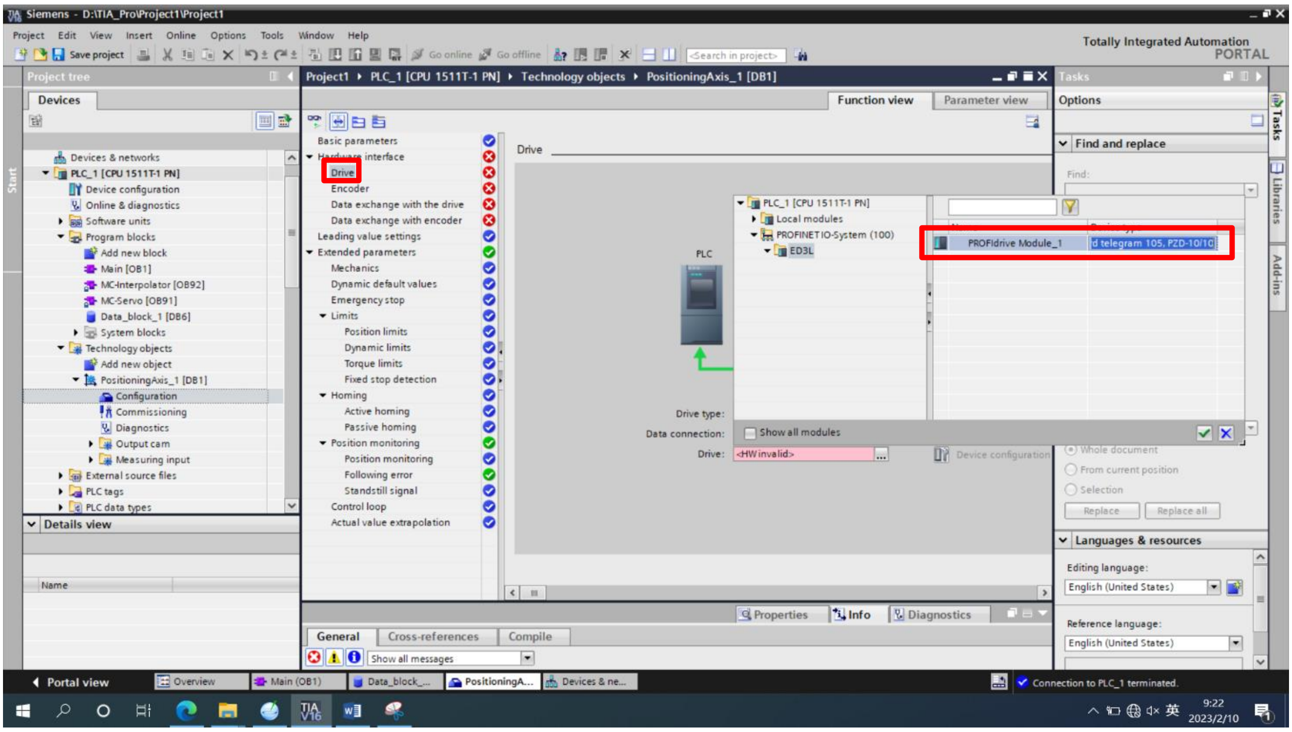
Step 4 Add the axis craft object, as shown in the following figure:

Figure 7-36 Add an axis craft object



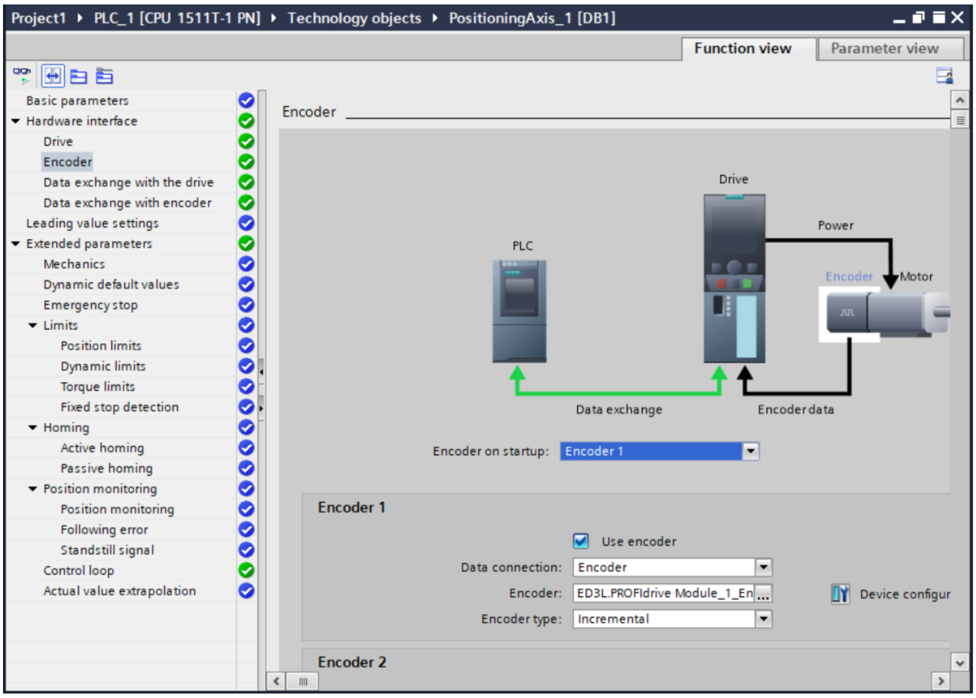
Step 5 In the Add Axis configuration, the drive selects message 105, as shown in the following figure:

Figure 7-37 Selecting Packet 105

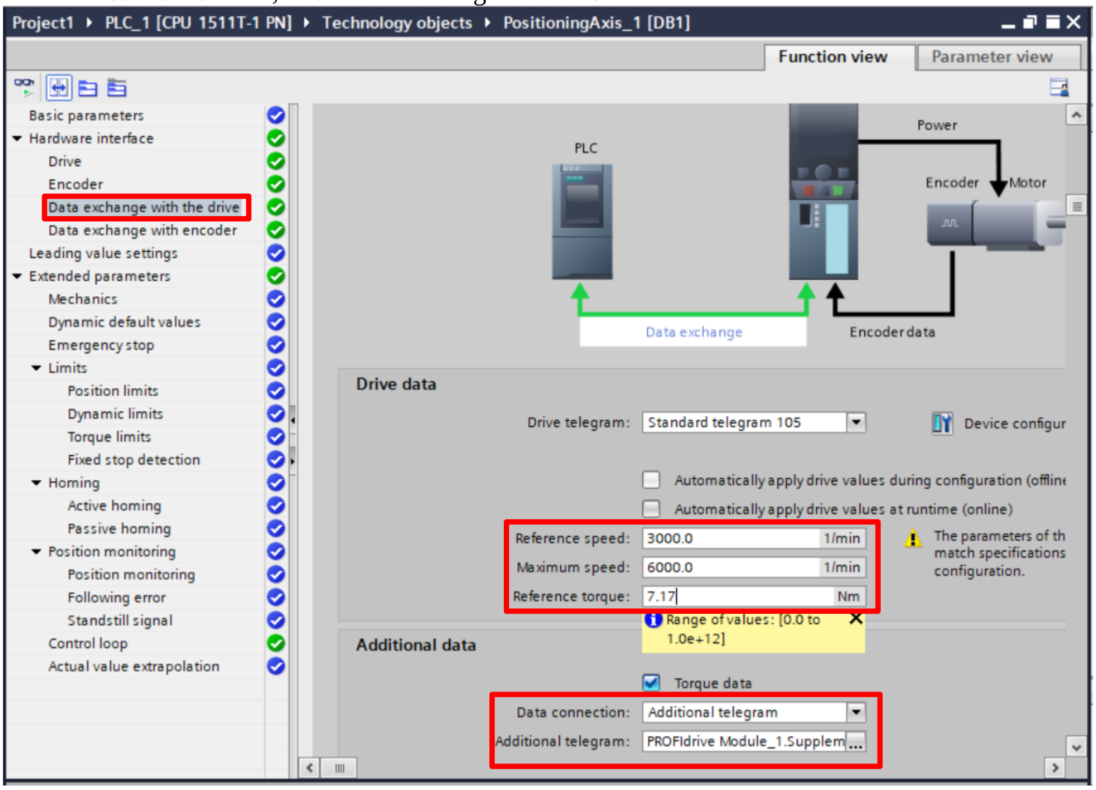


Step 6 The encoder configuration is the same as packet 3

Figure 7-38 Encoder configuration

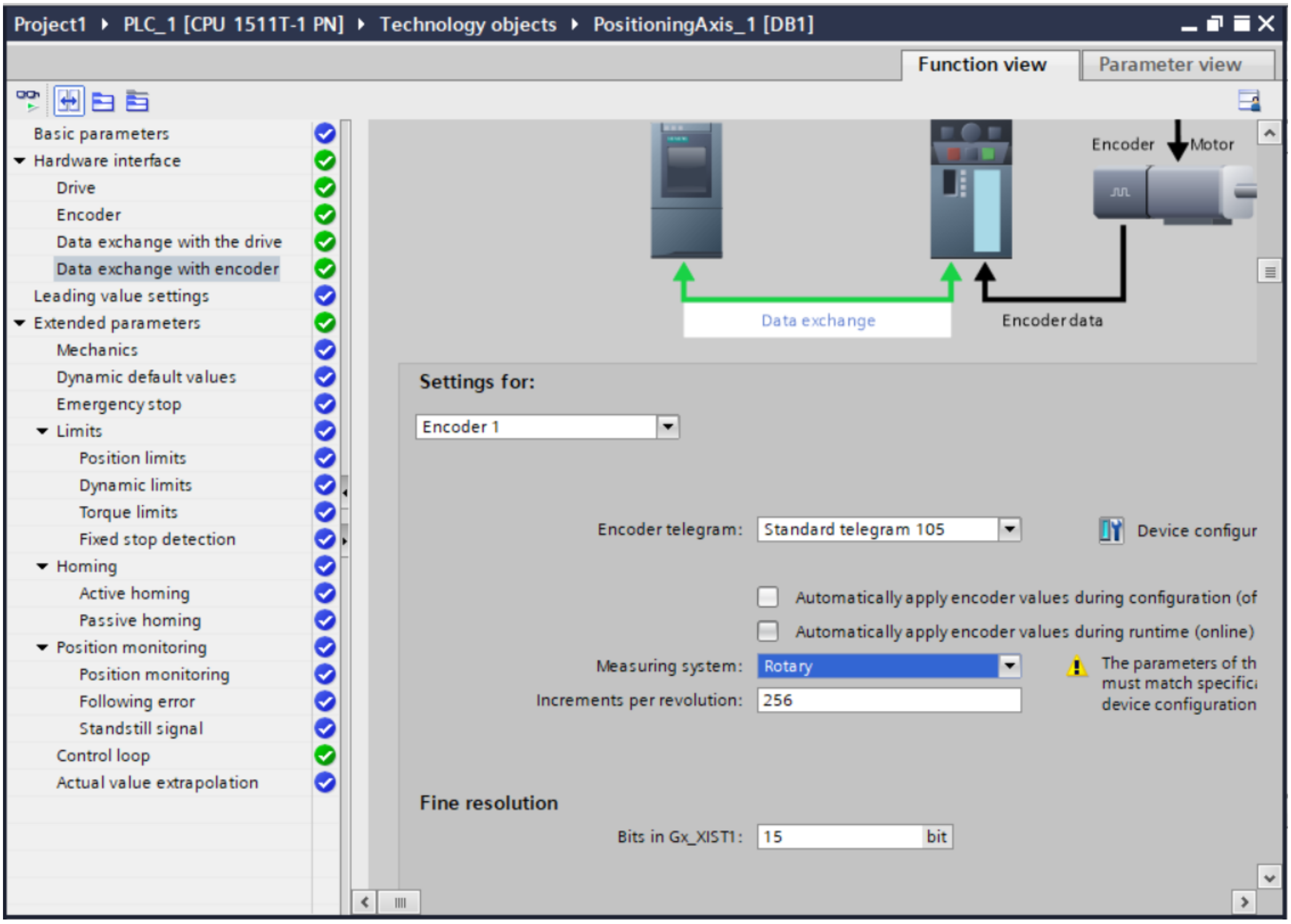


Step 7 Configure data exchange parameters with the drive, the reference torque value is 3 times the servo rated torque, this example applies a 750W motor, its rated torque is 2.39Nm, its reference torque is 2.39x3=7.17Nm, as shown in the figure below:



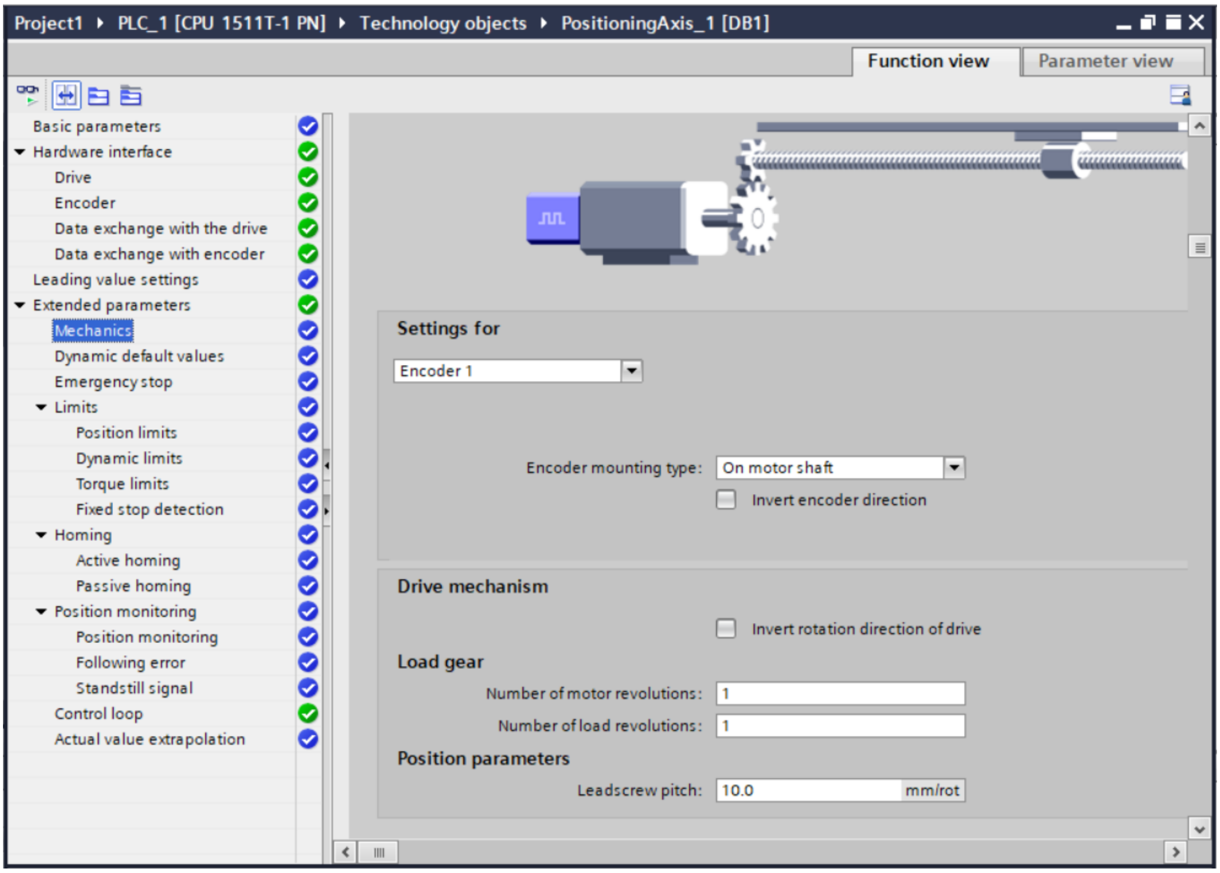
Step 8 Configure data exchange parameters with encoder as in Message 3

Figure 7-39 Data exchange parameters



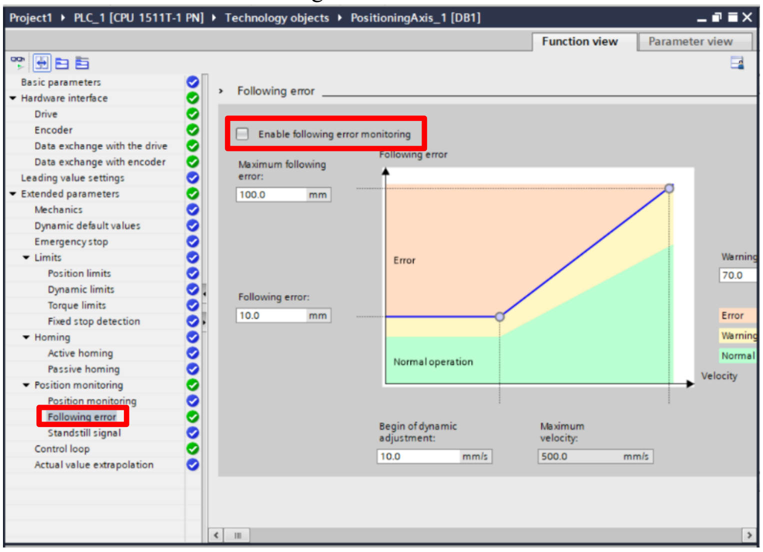
Step 9 Configure the mechanical parameters as shown in the following figure:

Figure 7-40 Setting mechanical parameters



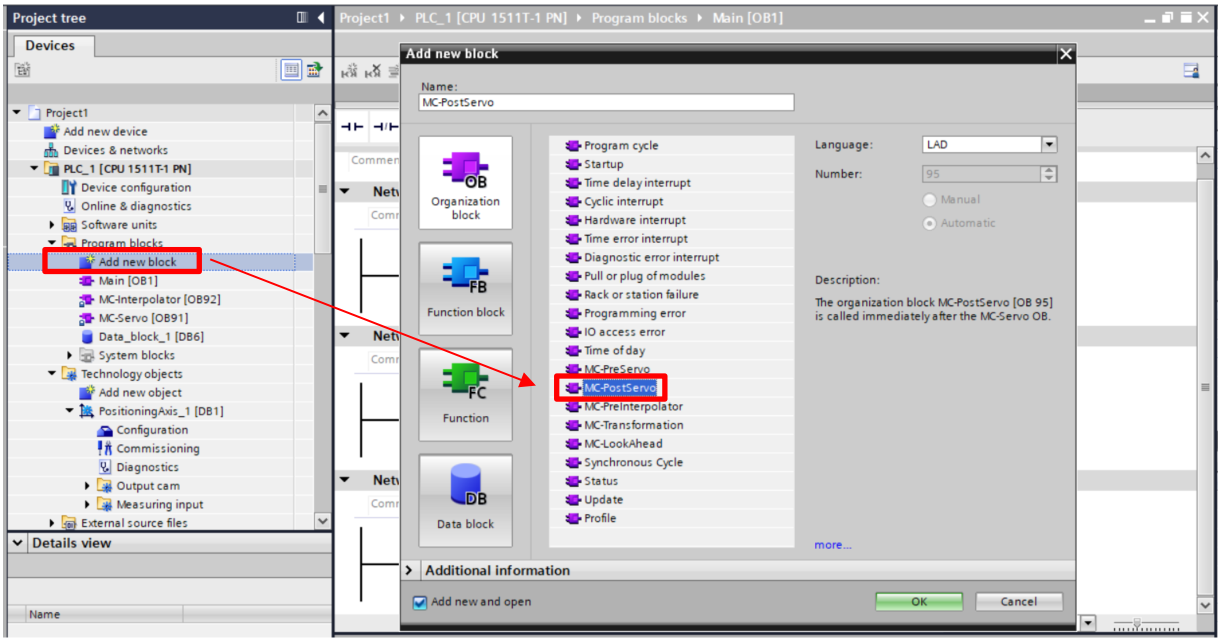
Step 10 Uncheck the Enable error monitoring item, as shown in the following figure:

Figure 7-41 Enable Follow Error Monitoring Deselect



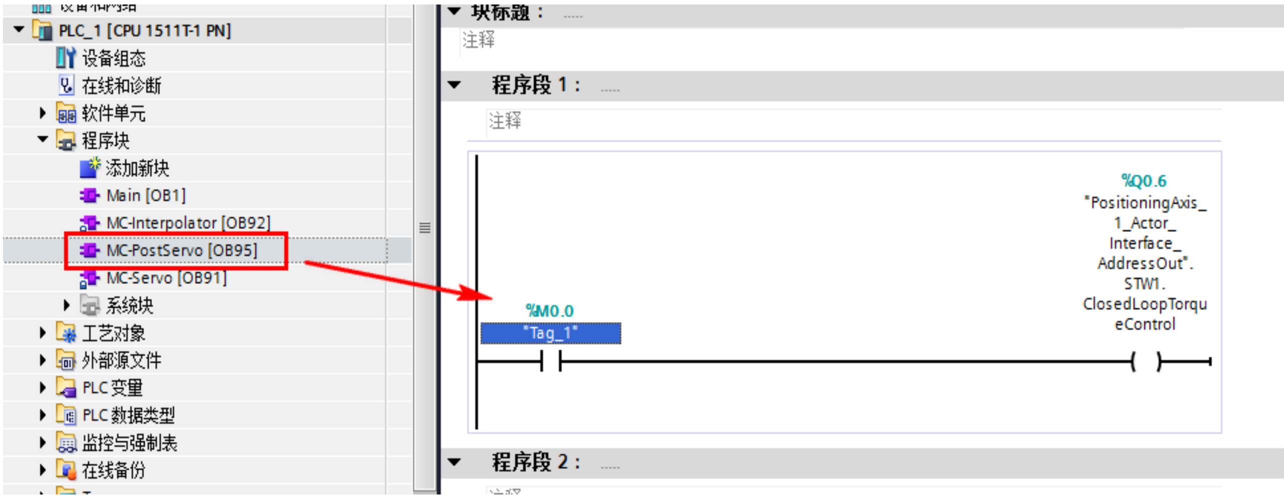
Step 11 Add MC_PostServo function blocks to the program, as shown in the following figure:

Figure 7-42 Add MC_PostServo function blocks



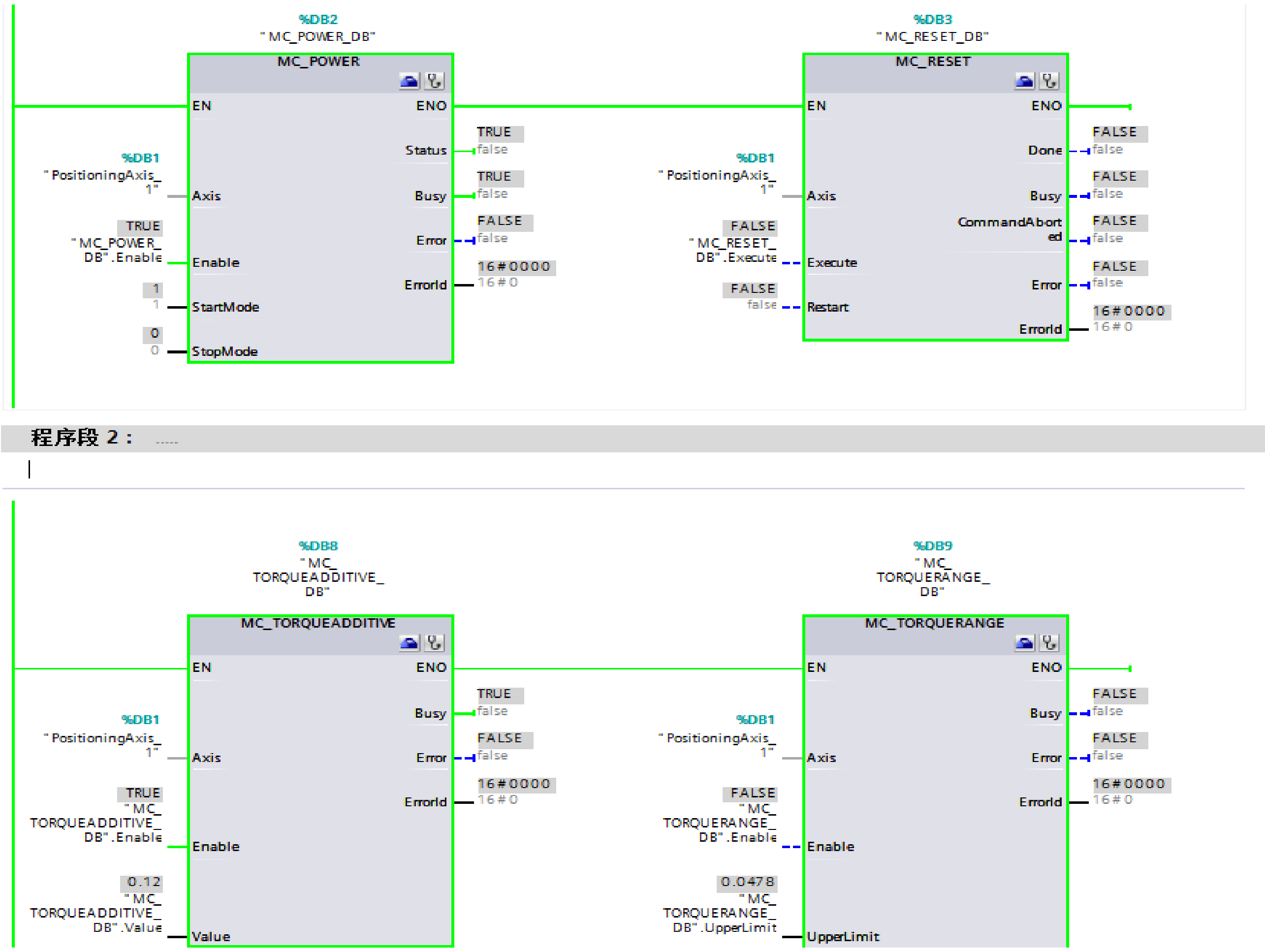
Step 12 Write the closed-loop torque control module switching logic in the MC_PostServo function block, as shown in the following figure:

Figure 7-43 Write closed-loop torque control module switching logic



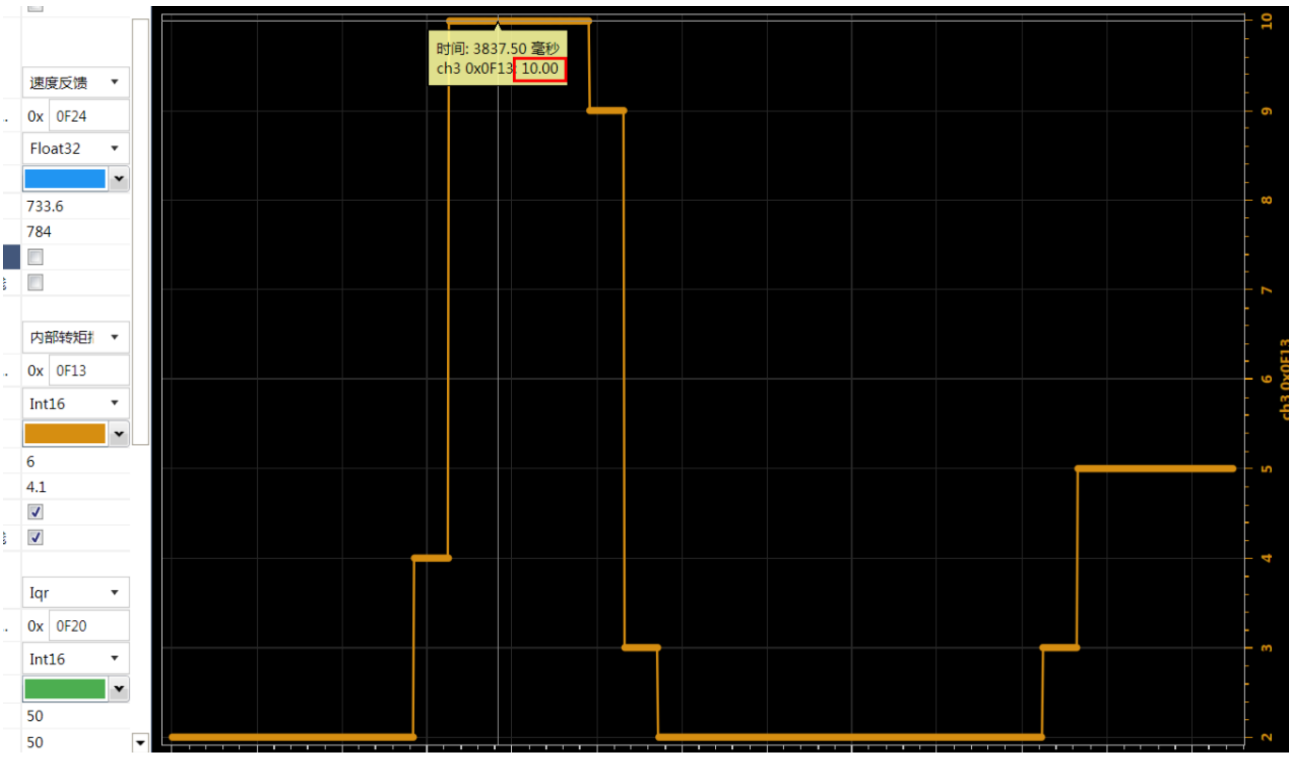
Step 13 2.13 Add the execution block in the OB1 main program, as shown in the following figure:

Figure 7-44 Add an execution block



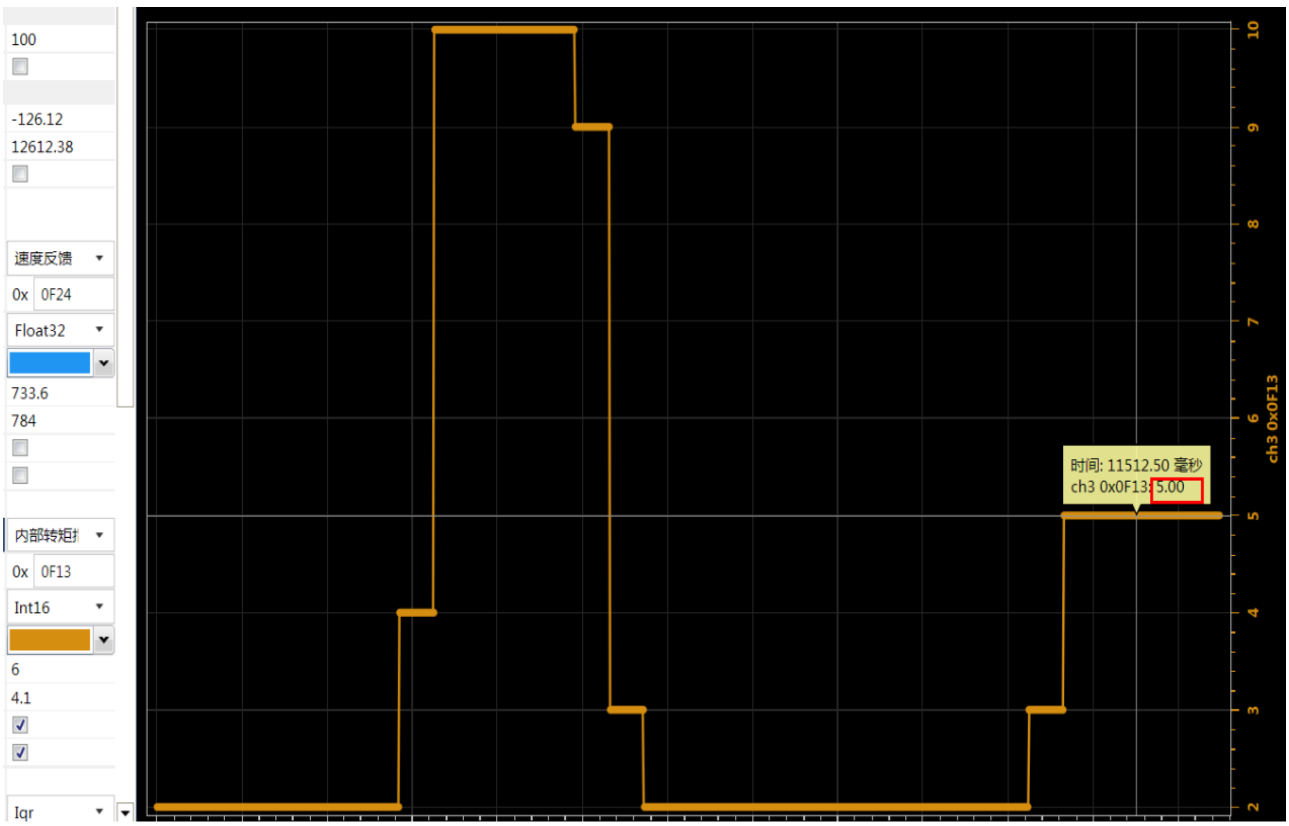
Step 14 Enable torque control, based on the given torque of 0.24Nm in the figure above, calculate the internal torque command percentage as 0.24/2.39 = 10%, which means that the internal torque command percentage when the motor is stalled is 10%, as shown in the following figure:

Figure 7-45 Enable torque control



Step 15 Configure Pn707=1 in the servo to enable the torque limiting function, given the upper torque limit of 0.12, the internal torque command percentage when stalled is 0.12/2.39 = 5%, and the torque limiting is effective, as shown in the following figure:

Figure 7-46 Torque limiting is effective



7.6.3 Message 111 application example

Overview

The PLC implements basic positioning control via the SINA_POS (FB284) in the driver library provided by message 111 and TIA Portal V15.1 drivelib_TIA15.1_V522_sha512.

The current example uses a 23-bit encoder

SINA_POS function block pin

Input signal	Type	Default value	Meaning
ModePos	INT	0	Operation mode: 1 = relative positioning (supported) 2 = Absolute positioning (supported) 3 = Perform location based on Settings (not supported) 4 = back to reference point procedure (supported) 5 = Set back to reference point position (supported) 6 = Run program segment 0-15/63 (G120/S120) (not supported) 7 = Click (supported) 8 = click increment (not supported)
EnableAxis	BOOL	0	Switching instructions: 0 = OFF1, 1 = ON
CancelTraversing	BOOL	1	0 = Reject the active running job, 1 = do not reject
IntermediateStop	BOOL	1	0 = active state running instruction interrupt, 1 = no intermediate stop
Positive	BOOL	0	Positive direction
Negative	BOOL	0	Negative direction
Jog1	BOOL	0	Jog signal source 1
Jog2	BOOL	0	Jog signal source II
FlyRef	BOOL	0	0 = Cancel the active back reference point, 1 = select the active back reference point
AckError	BOOL	0	Fault response
ExecuteMode	BOOL	0	Activate the Run job/Receive Settings/Activate back reference point function
Position	DINT	0[LU]	The position setpoint (in units [LU]) for the operating mode "Direct Setpoint Designation/MDI" or the segment number for the operating mode "Running Segment"
Velocity	DINT	0[LU/min]	Speed applicable to MDI operation mode (unit [1000LU/min])
OverV	INT	100[%]	Speed multiplier effective for all operating modes: 0-199%
OverAcc	INT	100[%]	Effective acceleration rate 0-100%
OverDec	INT	100[%]	Effective speed reduction multiplier 0-100%
ConfigEPos	DWORD	3h	elaborate

Input signal	Type	Default value	Meaning
HWIDSTW (block S7-1200/1500)	HW_IO	0	Set the symbolic name or HW ID on the SIMATIC S7-1200/1500 of the value slot
HWIDZSW (block S7-1200/1500)	HW_IO	0	The symbolic name or HW ID on the SIMATIC S7-1200/1500 of the actual value slot

Output signal	Type	Default value	Meaning
AxisEnabled	BOOL	0	The drive is ready to be switched on
AxisPosOk	BOOL	0	Axis target position has been reached
AxisSpFixed	BOOL	0	1 = Set value fixed
AxisRef	BOOL	0	Set the reference point position
AxisWarn	BOOL	0	Actuated alarm
AxisError	BOOL	0	Drive failure
Lockout	BOOL	0	disconnection
ActVelocity	DINT	0	Current speed (standardized 40000000h = 100% p2000)
ActPosition	DINT	0[LU]	Current position (unit LU)
ActMode	INT	0	The operating mode that is currently active
EPosZSW1	WORD	0	EPos ZSW1 (binary particle matrix) state
EPosZSW2	WORD	0	EPos ZSW2 (binary particle matrix) state
ActWarn	WORD	0	Current alarm number
ActFault	WORD	0	Current fault number
Error	BOOL	0	1 = A group fault exists
Status	INT	0	16#7002: No Trouble - The segment is running 16#8401： Driver failure 16#8402： disconnection 16#8403： The floating back to reference point function cannot be enabled 16#8600： DPRD_DAT error 16#8601： DPWR_DAT error 16#8202： The selected run mode is incorrect 16#8203： The set value parameter is incorrect 16#8204： The selected run program segment number is incorrect
DiagID	WORD	0	Extension communication error → SFB call error

ConfigEPos	Message 111-bit	Default value
位 0	STW1.%X1	1
位 1	STW1.%X2	1
位 2	POS_STW2.%X14	0
位 3	POS_STW2.%X15	0
位 4	POS_STW2.%X11	0
位 5	POS_STW2.%X10	0
位 6	POS_STW2.%X2	0
位 7	STW1.%X13	0
位 8	POS_STW1.%X12	0
位 9	STW2.%X0	0
位 10	STW2.%X1	0
位 11	STW2.%X2	0
位 12	STW2.%X3	0
位 13	STW2.%X4	0
位 14	STW2.%X7	0
位 15	STW1.%X14	0
位 16	STW1.%X15	0
位 17	POS_STW1.%X6	0
位 18	POS_STW1.%X7	0
位 19	POS_STW1.%X11	0
位 20	POS_STW1.%X13	0
位 21	POS_STW2.%X3	0
位 22	POS_STW2.%X4	0
位 23	POS_STW2.%X6	0
位 24	POS_STW2.%X7	0
位 25	POS_STW2.%X12	0
位 26	POS_STW2.%X13	0
位 27	STW2.%X5	0
位 28	STW2.%X6	0
位 29	STW2.%X8	0

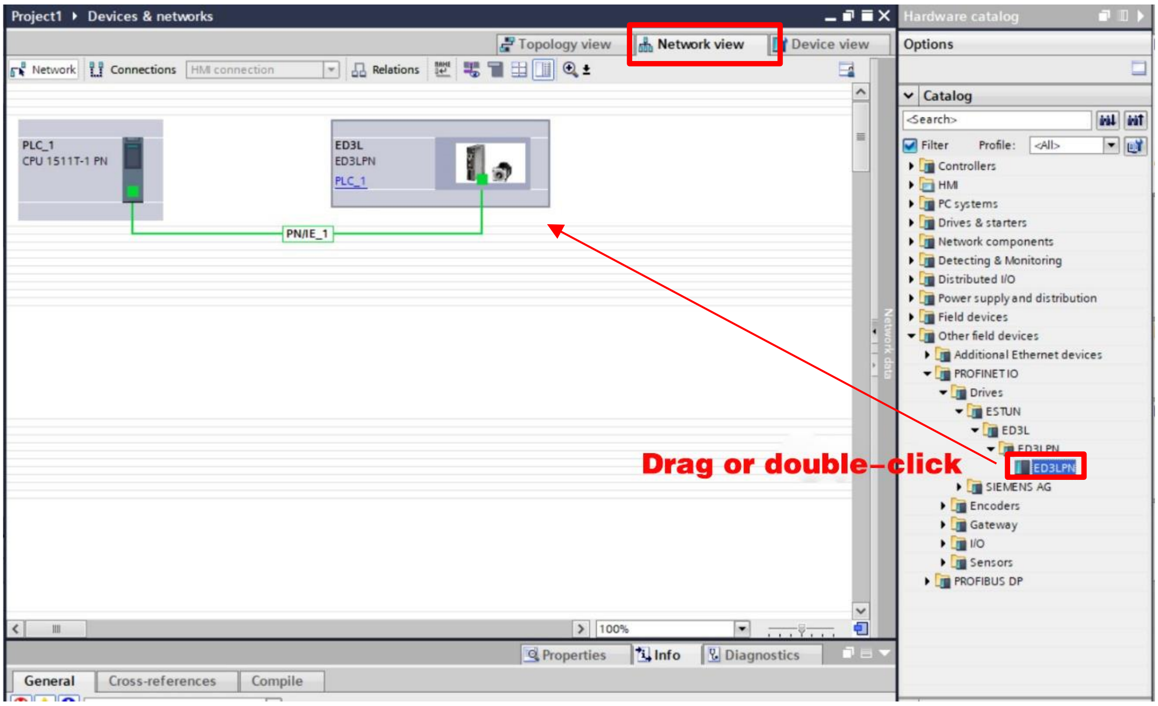
ConfigEPos	Message 111-bit	Default value
位 30	STW2.%X9	0
位 31	预留	0

ED3LPN Device-dependent variable

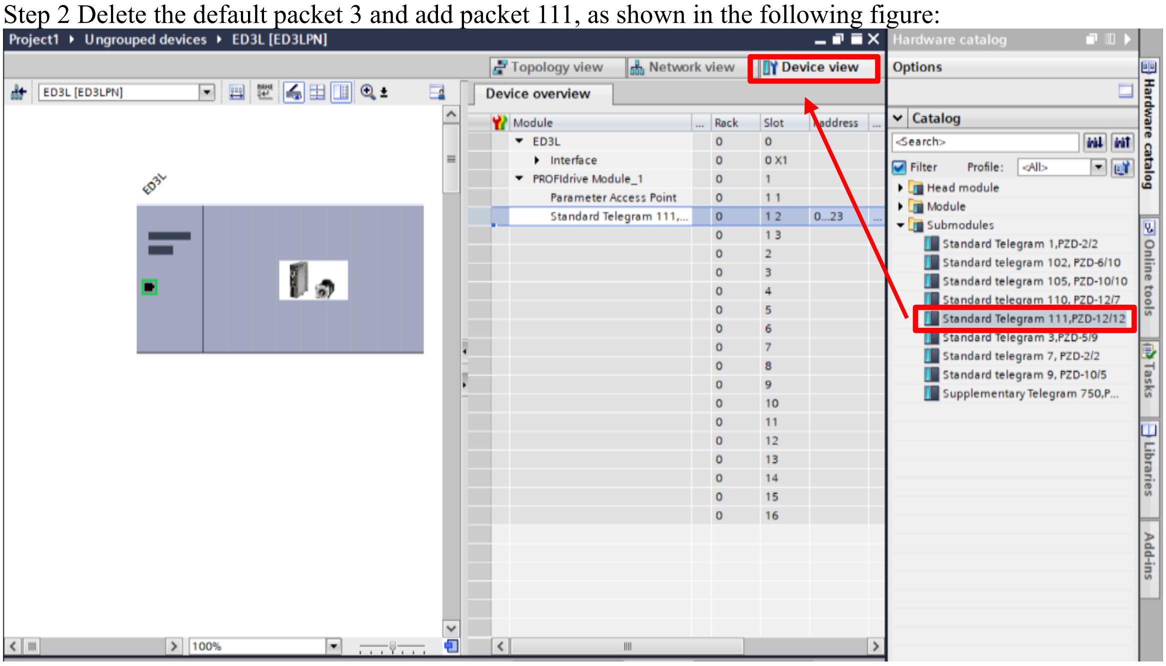
Pn720	Zero-back mode	INT32	RW	–	1～35	1
Pn721	Look for the reference speed	INT32	RW	0.1rpm	1～ 2147483647	1000
Pn722	Find origin velocity	INT32	RW	0.1rpm	1～ 2147483647	100
Pn723	Return to zero acceleration	INT32	RW		0～32767	16384
Pn724	Origin migration	INT32	RW	1 pulse	-2147483648～2147483647	0
Pn725	Electronic gear ratio molecule	INT32	RW	–	1～2^{30}	1
Pn726	Electronic gear score	INT32	RW	–	1～2^{30}	1
Pn730	EPOS maximum acceleration	INT32	RW	1000LU/S2	0～2147483647	100
Pn731	EPOS maximum reduction speed	INT32	RW	1000LU/S2	0～2147483647	100
Pn732	JOG1 speed	INT32	RW	1000LU/min	-40000000～40000000	-500
Pn733	JOG2 speed	INT32	RW	1000LU/min	-40000000～40000000	500
Pn734	Soft limit positive parameter	INT32	RW	LU	-2147483647～2147483647	2147483647
Pn735	Soft limit negative parameter	INT32	RW	LU	-2147483647～2147483647	-2147483647
Pn736	Enable additional torque limiting	INT32	RW	-	0～1	0
Pn738	EPOS reaches the window threshold	INT32	RW	LU	0～2147483647	50
Pn739	EPOS time when the window threshold is reached	INT32	RW	ms	0～2147483647	5

configuration

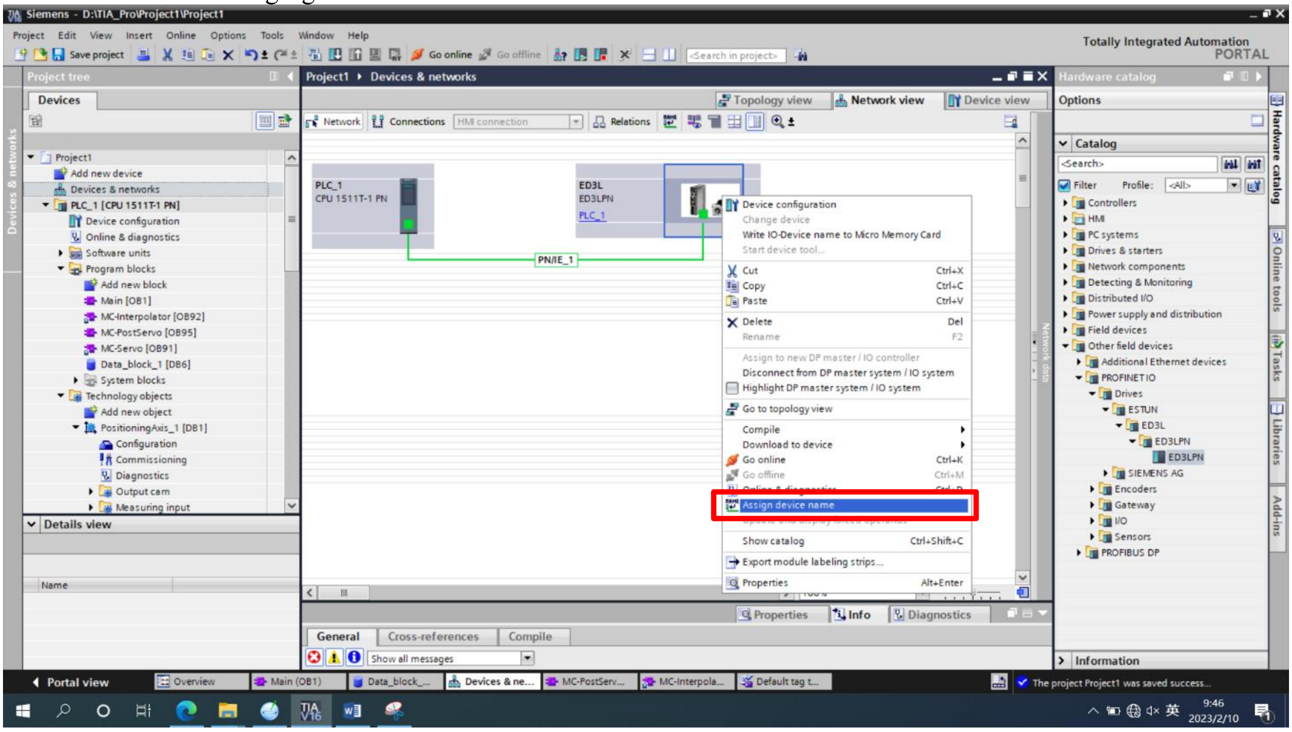
Step 1 Add the ED3LPN device to the network view and establish a network connection with the PLC, as shown in the following figure:

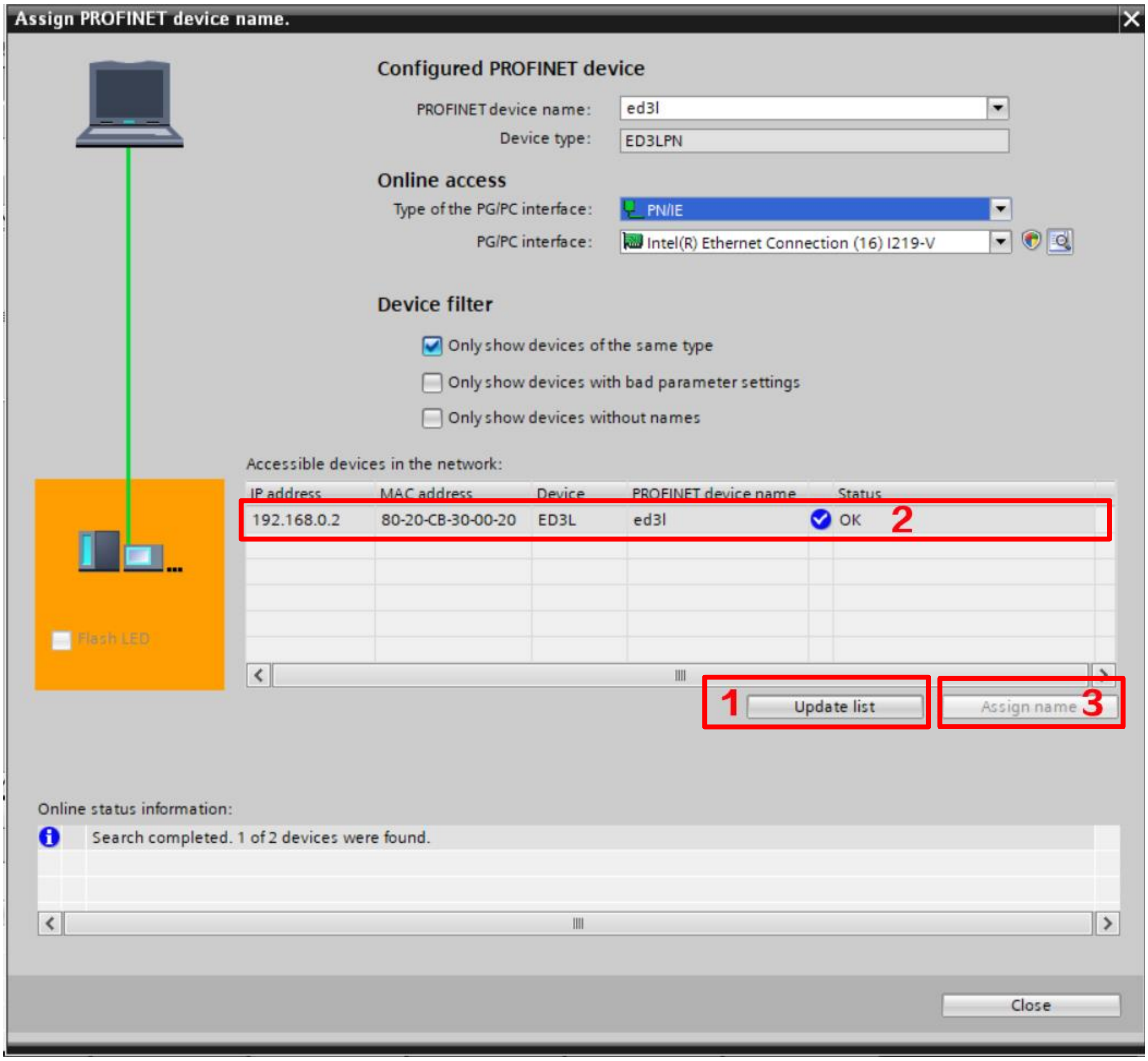


Step 2 Delete the default packet 3 and add packet 111, as shown in the following figure:

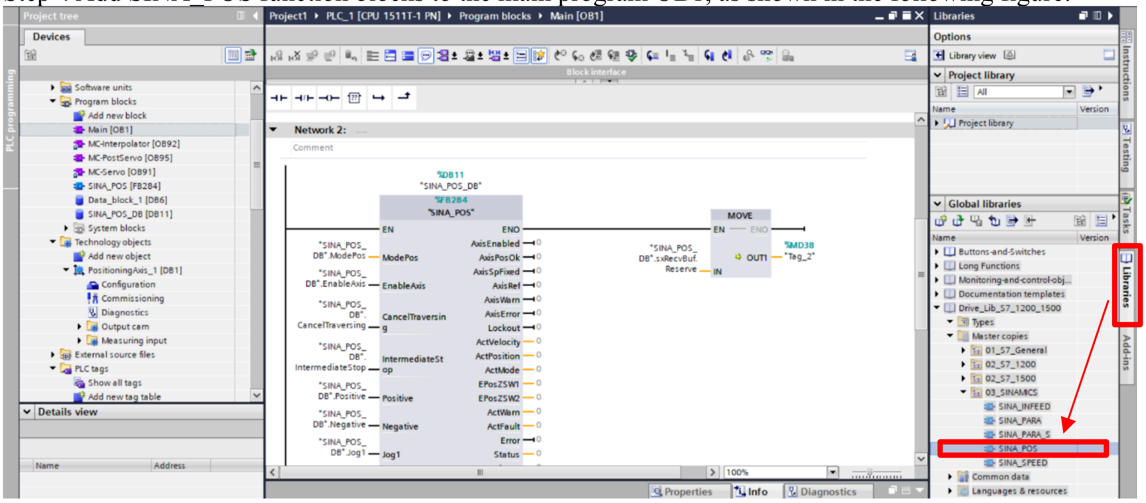


Step 3 Set the name and IP address of the PLC and ED3LPN devices, and the IP address can be automatically assigned, as shown in the following figure:

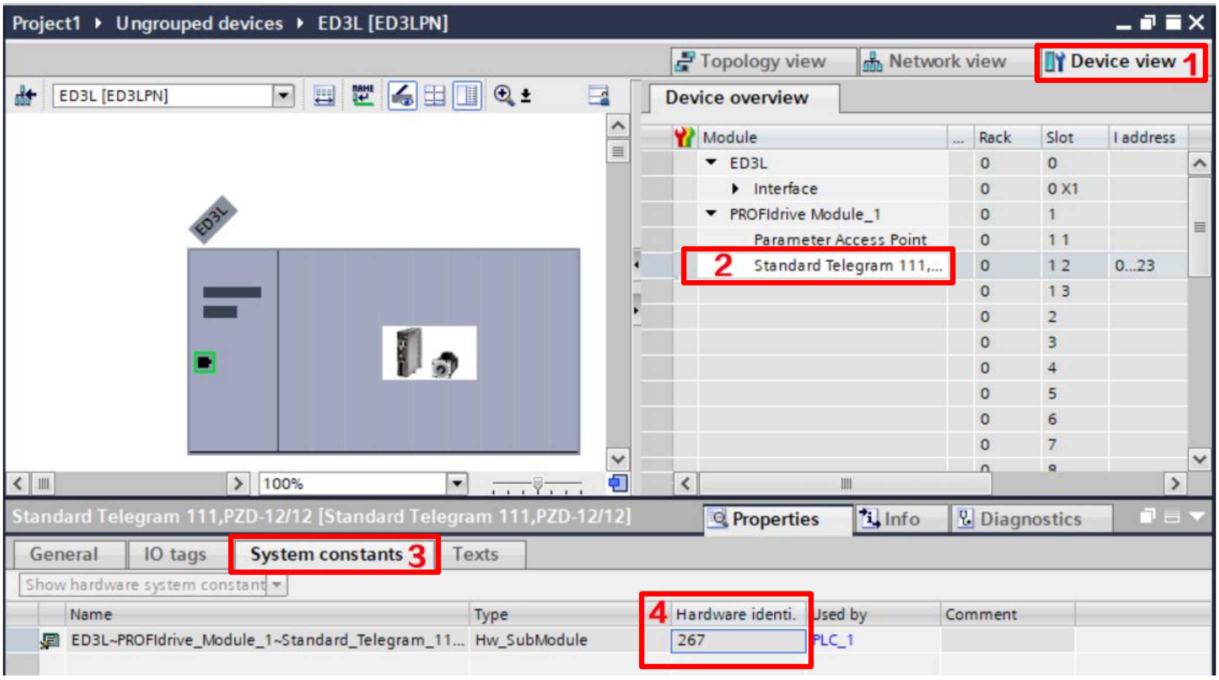




Step 4 Add SINA_POS function blocks to the main program OB1, as shown in the following figure:

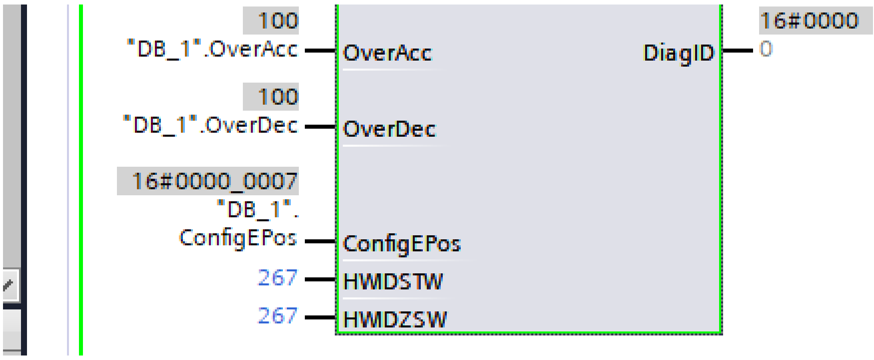


Step 5 Determine the hardware identifier corresponding to the added ED3LPN device, which will be used as the input parameter values of HWIDSTW and HWUDZSW of the SINA_POS function block, as shown in the following figure:



Soft limit function

Step 1 Set the ConfigEPos input pin of the FB284 function block to 0x07, that is, activate the soft limit switch, and the ModePos is 2 (absolute positioning), as shown in the figure below:



Step 2 sets the soft limit range through Pn734 and Pn735, Pn734 is the positive limit value of the soft limit, Pn735 is the negative limit value of the soft limit, the current position is 10000, the parameter settings are shown in the following table;

Servo parameter number	Name	Set value
Pn725	Electronic gear ratio molecule	1047576
Pn726	Electronic gear score	1000
Pn734	Soft limit positive parameter	1000
Pn735	Soft limit negative parameter	-1000

Step 3: Set the input pin position value of the SINA_POS function block to 20000, the target position value is outside the soft limit range [-1000, 1000], and the execution starts the operation, the servo is limited and not executed;

Step 4: Set the input pin Position value of the SINA_POS function block to 500, the target position value is within the soft limit range [-1000, 1000], execute the start run, the servo starts to run, and executes to the 500 position;

Step 5: At this time, set the input pin position value of the SINA_POS function block to 2000, and the target position value is outside the soft limit range [-1000, 1000].

Step 6: Set Pn734 = 10000, Pn735 = -10000, soft limit range to [-10000, 10000], start run again, start the servo run, and execute to the 2000 position.

Return to zero function

Summary:

Set the input pin ModPos=4 of the SINA_POS function block, control the servo system to enter the zero control, the current zero return function of the servo is planned by the servo internally, and the upper computer only provides a control signal that triggers the zero return

Application introduction:

The zeroing function is used to find the mechanical origin and locate the position relationship between the mechanical origin and the mechanical zero point.

- Mechanical origin: a fixed position on the machine, which can correspond to a certain origin switch, and can correspond to the C pulse signal of the motor.
- Mechanical zero: The position of absolute 0 on the machine.

After the origin is successfully returned to zero, the motor stop position is the mechanical origin, and the relationship between the mechanical origin and the mechanical zero can be set by setting Pn724 (origin bias):

Mechanical Origin = Mechanical Zero + Pn724 (Origin Offset)

When Pn724=0, it means that the mechanical origin and the mechanical zero point coincide.

Example of return to zero:

Step 1 Configure the servo parameters as shown in the following table:

Servo parameter number	Name	Set value
Pn509	Input signal distribution port 1	2160 (See Section 10.2 for instructions)
Pn516	The input port signal is negated by 1	0000 (See Section 10.2 for instructions)
Pn725	Electronic gear ratio molecules	8388608
Pn726	Electronic gear score	1000
Pn720	Return to zero mode	1 (See return to zero mode introduction)
Pn721	Return to zero speed value	500
Pn722	Return to zero low speed value	100
Pn723	Return to zero acceleration and deceleration value	16384
Pn724	Return to zero migration	100

Step 2 Start back to zero, the servo looks for N-OT signals at high speed at 500 speed, see Un000 monitoring;

Step 3 Through the display panel, set Pn516 to 1000 to reverse the N-OT signal, and the servo starts the low-speed reverse operation of 100;

Step 4: Through the display panel, set Pn516 to 0000 to cancel the N-OT signal, the servo looks for the first C pulse and stops, and the return to zero ends, at this time the output ActPosition value of FB284 is 100, that is, the return to zero offset value;

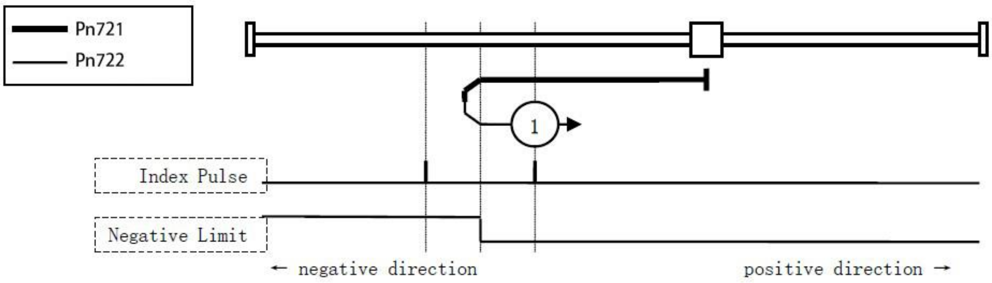
Note: High-speed zero return acceleration and deceleration time = PN721/(PN730*60*1000*(PN723/0x4000)/encoder resolution) seconds

High-speed zero return acceleration and deceleration time = Pn722(Pn730*60*1000*(Pn723/0x4000)/encoder resolution) seconds

Introduction to the zeroing method

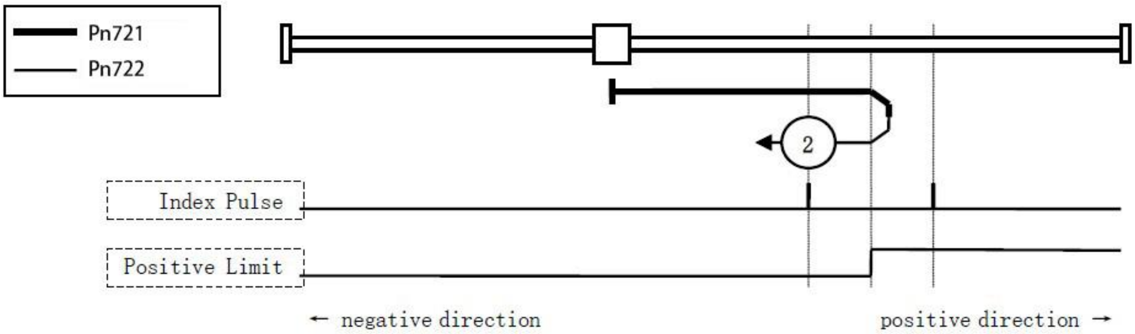
Pn720=1 (using C-pulse and negative limit switch)

The drive first moves quickly in the negative direction, and only decelerates and stops when it reaches the negative limit switch (N-OT); Then the drive returns slowly, looking for the target zero position. The target zero position of this zeroing method is the first C-pulse position of the encoder after leaving the limit switch.



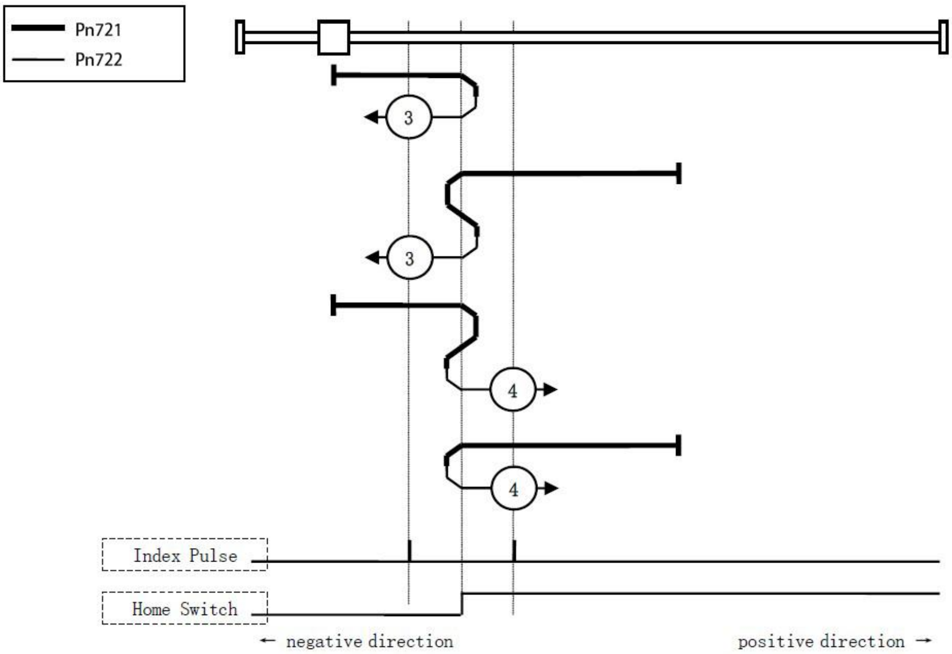
Pn720=2 (using C-pulse and positive limit switch)

The driver first moves in the positive direction quickly, and only decelerates and stops when it reaches the positive limit switch (P-OT); Then the drive returns slowly, looking for the target zero position. The target zero position of this zeroing method is the first C-pulse position of the encoder after leaving the limit switch.



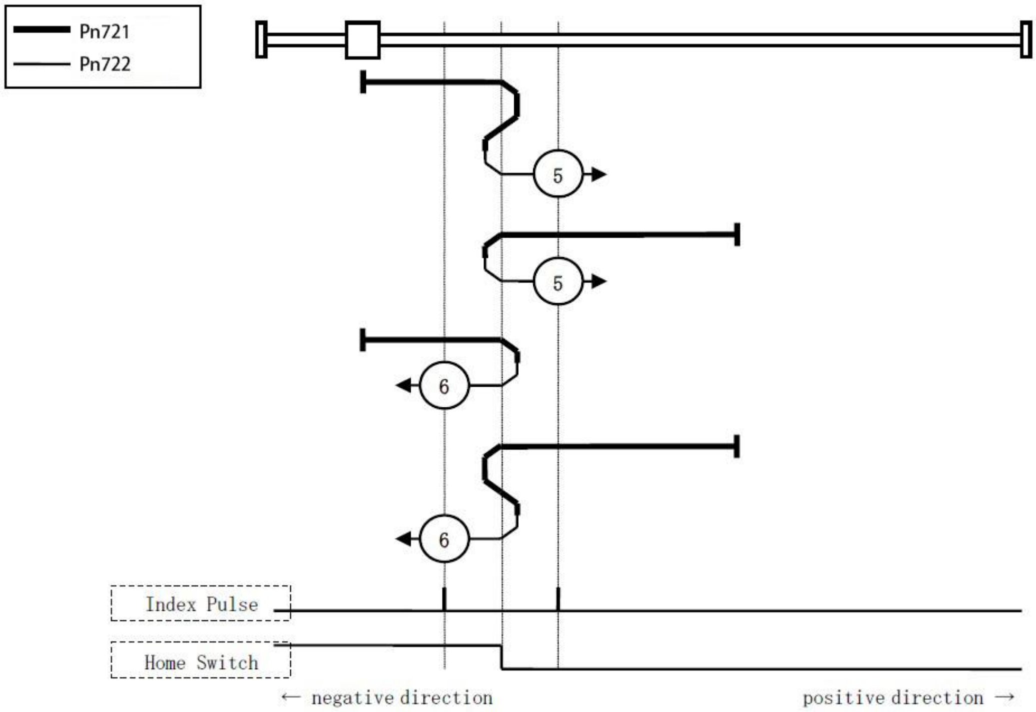
Pn720=3 or 4 (using C pulse and forward reference point switch)

These zero-back modes are for the case that the reference switch is positioned in the positive direction and cleared in the negative direction, that is, the reference switch is installed near the forward end of the motion, and the initial direction movement of the reference switch driver depends on the reference switch state. The target zero position is the first C pulse position to the left or right of the reference point switch.



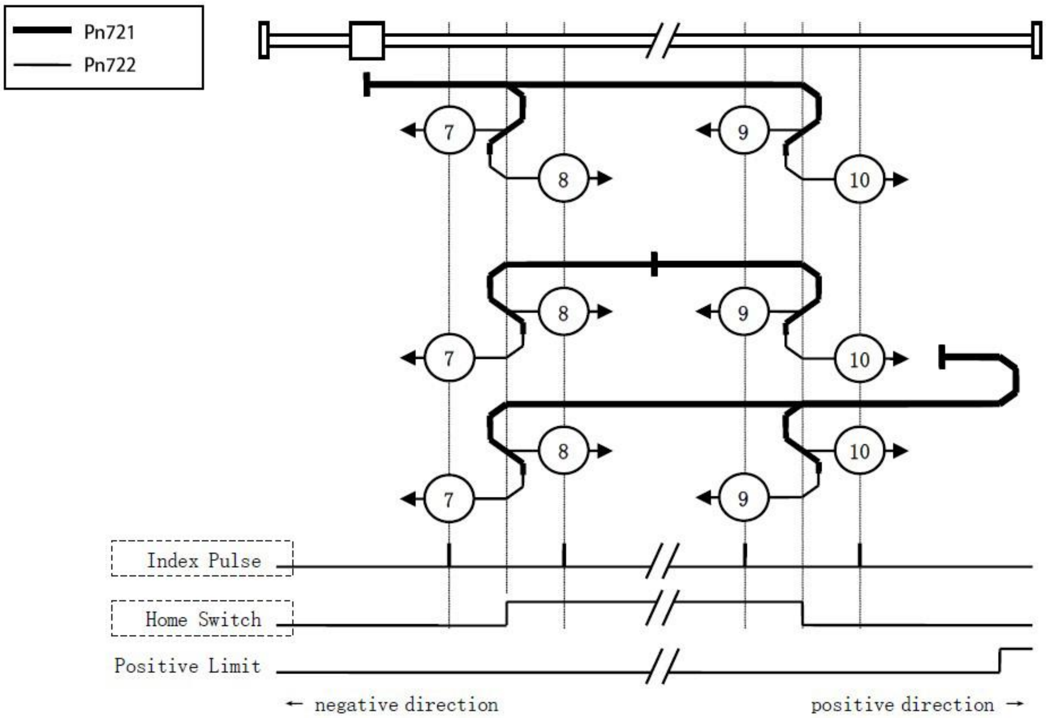
Pn720=5 or 6 (using C pulse and negative reference point switch)

These zero-back modes are for the case where the reference switch is positioned in the negative direction and cleared in the positive direction, that is, the reference switch is installed near the negative end of the motion, and the driver's initial direction movement depends on the reference switch state. The target zero position is the first C pulse position to the left or right of the reference point switch.



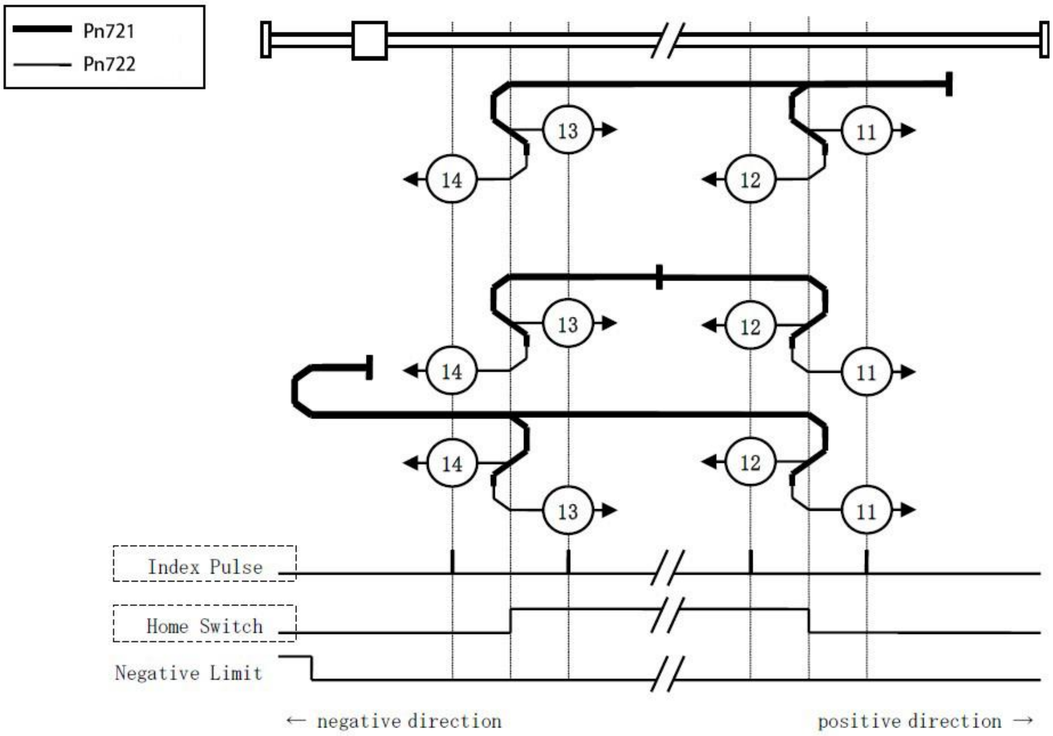
Pn720=7 ~ 10 (using C pulse, reference switch, and positive limit switch)

These zero-back modes are for the case that the reference switch is installed in the middle position of mechanical motion. The zero-back action is carried out according to the reference switch, positive limit switch and C pulse, and the final mechanical origin is the C pulse position near the reference switch.



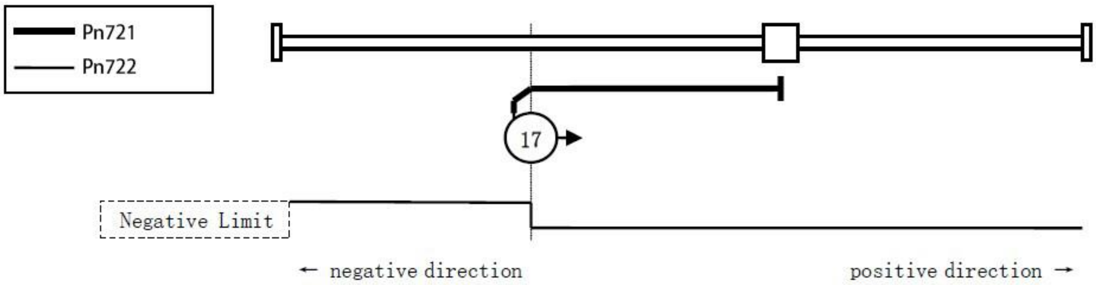
Pn720=11 ~ 14 (using C pulse, reference switch, and negative limit switch)

These zero-back modes are for the case that the reference switch is installed in the middle position of mechanical motion. The zero-back action is carried out according to the reference switch, negative limit switch and C pulse, and the final mechanical origin is the C pulse position near the reference switch.



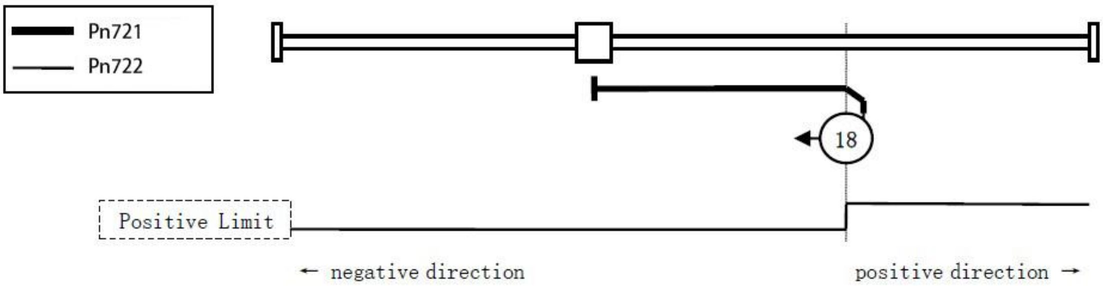
Pn720=17 (negative limit switch)

This return to zero mode is similar to Pn720=1 (using C pulse and negative limit switch), except that the target zero position no longer uses C pulse and relies on the negative limit switch.



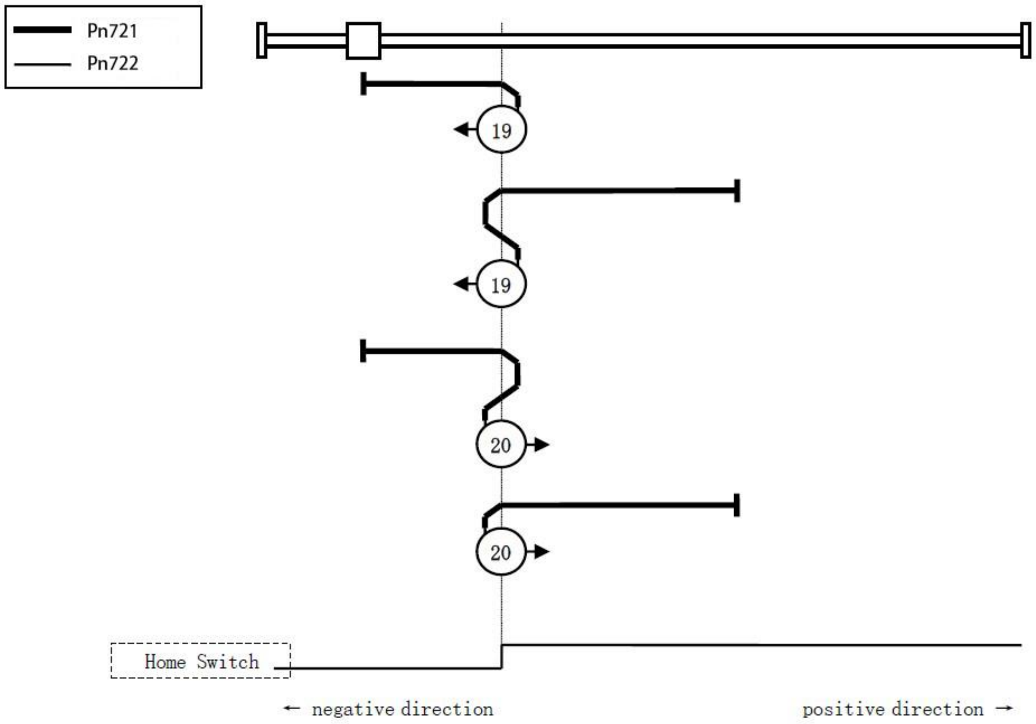
Pn720=18 (negative limit switch)

This return to zero mode is similar to Pn720=2 (using C pulse and positive limit switch), except that the target zero position no longer uses C pulse and relies on the positive limit switch.



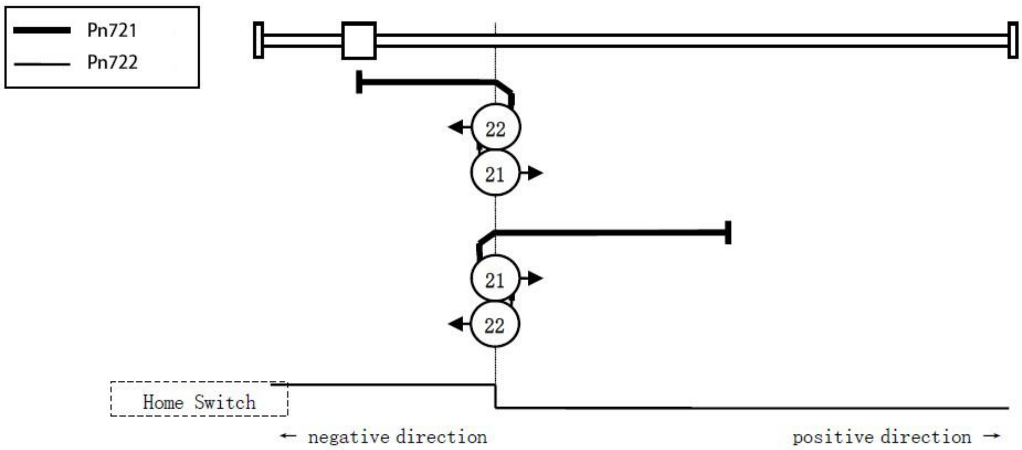
Pn720=19 or 20 (reference switch)

These return to zero modes are similar to Pn720=3 or 4 (using C pulse and forward reference switch), except that the target zero position no longer uses C pulse and relies on the reference switch.



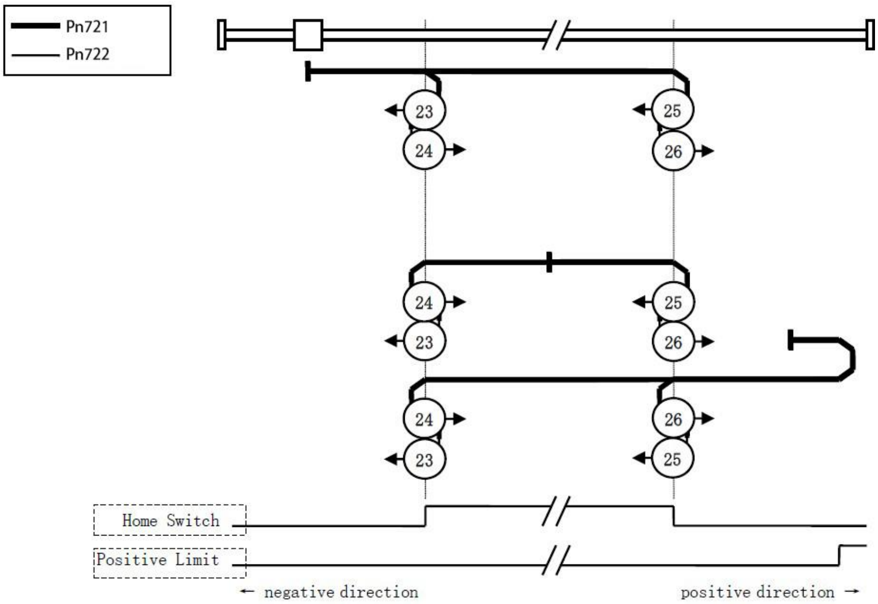
Pn720=21 or 22 (reference switch)

These return to zero modes are similar to Pn720=5 or 6 (using C pulse and negative reference switch), except that the target zero position no longer uses the C pulse and relies on the reference switch.



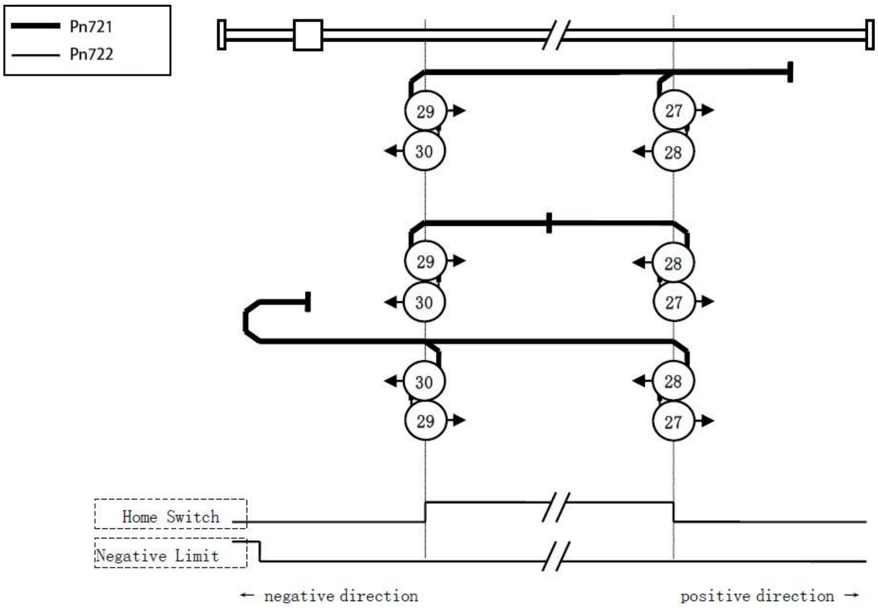
Pn720=23～26

These return to zero modes are similar to Pn720=7 ~ 10 (using C pulse, reference switch and positive limit switch), except that the target zero position no longer uses C pulse and relies on reference switch and positive limit switch.



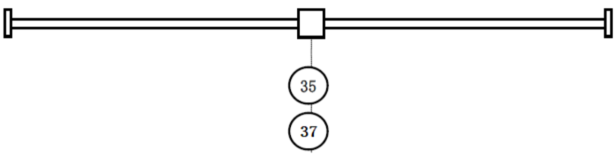
Pn720=27～30

These return to zero modes are similar to Pn720=11 ~ 14 (using C pulse, reference switch and negative limit switch), except that the target zero position no longer uses C pulse, but relies on the reference switch and positive limit switch.



Pn720=35 or 37 (current position is zero)

The current position is system zero.



[Note] When Pn720=37 is set, users are allowed to return to zero when Servo OFF.

Point function

The ModePos input value of FB284 function block is 7, indicating the point function

Step 1 Configure servo JOG parameters, as shown in the following table:

Servo parameter number	Name	Set value
Pn725	Electronic gear ratio molecule	8388608
Pn726	Electronic gear score	1000
Pn732	JOG1 speed	-100
Pn733	JOG2 speed	400

Step 2 Set the FB284 function block input pin ModePos=7

Step 3 Enable the servo and start Jog1. It is observed that the servo speed is -100 in Un000.

Step 4 Shut down Jog1 and start Jog2. In Un000, the servo speed is 400.

Note: Servo Jog1 speed = (Pn732 * 1000 * (Pn725/Pn726))/encoder resolution unit is RPM

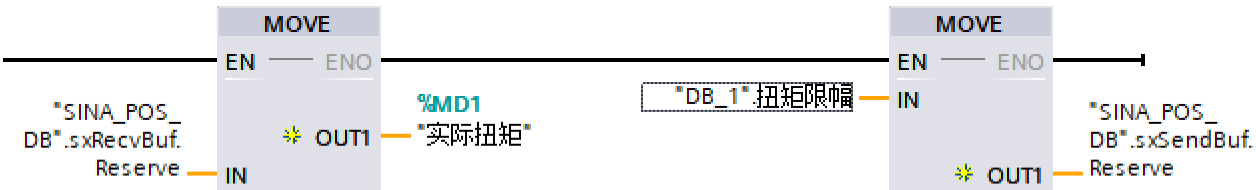
Torque limit and read function

The ModePos input value of FB284 function block is 7, so that the servo is in the point state, which is used to coordinate with the torque limiting function debugging

Procedure Step 1 Set servo torque limiting parameters

Servo parameter number	Name	Set value
Pn736	Enable additional torque limiting	0

Step 2 Torque limiting is set and read by sxSendBuf.Reserve and sxRecvBuf.Reserve of FB284 function block, as shown in the figure below:



Note: The given torque limit of 0~0x4000 corresponds to the rated torque of the servo of 0~300%.

Step 3 According to the point function, enable servo Jog1 and run at the speed of -100. Check that Un003 is -4, and the actual torque read at this time fluctuates around 0xD0. The internal torque instruction percentage calculated according to the actual torque =-0xD0*300/16384 = -3.8, which is basically consistent with the value read by the servo.

Step 4 Input torque limiting variable sxSendBuf.Reserve is 0x80, and the torque instruction percentage is calculated as 0x80*300/16384 = 2.3. At this time, the Un003 of the servo is -2. Basically consistent with the theoretical basis, the feedback sxRecvBuf.Reserve value fluctuates around 0x80.

Step 5 input torque limiting variable sxSendBuf.Reserve is 0x222, the theoretical calculation of torque instruction percentage = 0x222 * 300/16384 = 9.99, at this time the servo Un003 is -4, the motor is blocked, at this time the servo Un003 is -10, which is basically consistent with the theoretical basis, and the feedback sxRecvBuf.Reserve value fluctuates around 0x222;

Relative/absolute positioning control

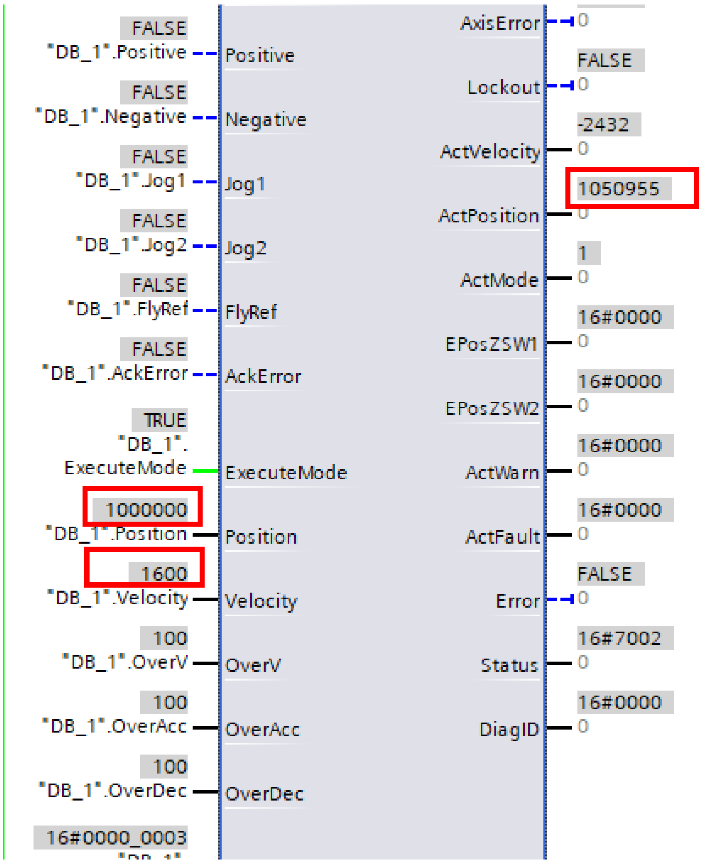
The input pins CancelTraversing and IntermediateStop of FB284 must be set to TRUE when locating control

The ModePos input value of FB284 function block is 1, and the servo is relative positioning control

Procedure Step 1 Set servo control parameters

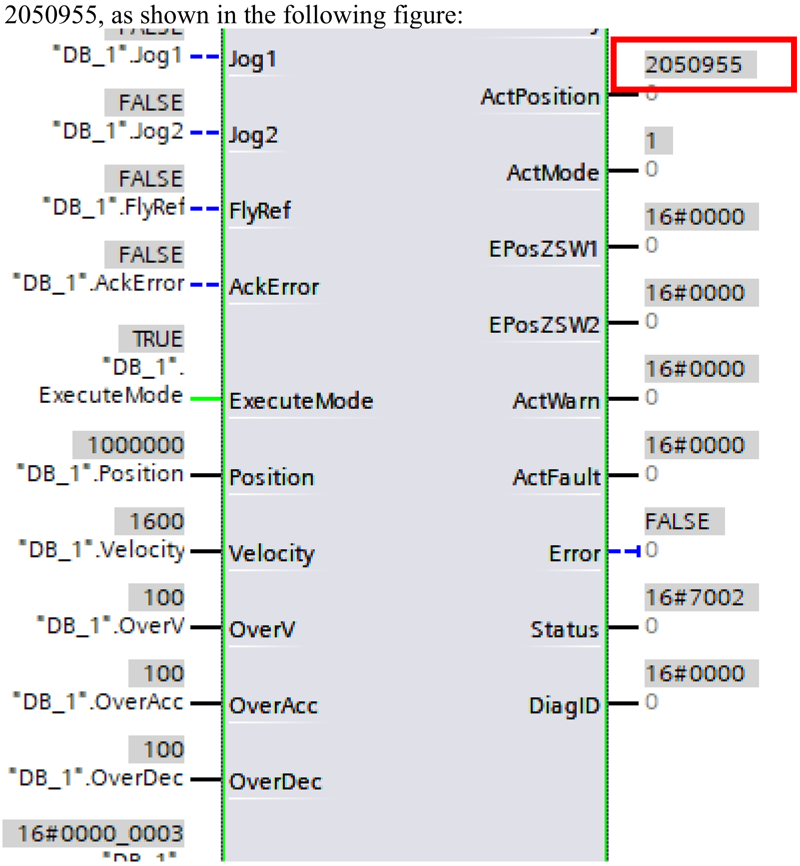
Servo parameter number	Nname	Set value
Pn725	Electronic gear ratio molecule	8388608
Pn726	Electronic gear score	1000
Pn730	EPOS maximum acceleration	100
Pn731	EPOS maximum reduction speed	100

Step 2 Fb284 function block input pin assignment, Position=1000000, Velocity=1600, OverV=100, OverAcc=100, OverDec=100, its actual position ActPosition=1050955, as shown in the figure below.



Step 3 After enabling relative positioning, the servo starts to run, the Un000 of the servo monitoring page is 1600, the theoretical speed of the servo = 1600 * 1000 * (Pn725 / Pn726) / encoder resolution (23-bit encoder) = 1600RPM, the theoretical speed is consistent with the actual speed.

Step 4 The positioning is completed, and its actual position is ActPosition(1050955) + Position(1000000) = 2050955, as shown in the following figure:



Note: Servo theoretical speed =Velocity*1000* (Pn725/Pn726)/encoder resolution RPM

Servo acceleration =Pn730*OverAcc (%) *Pn725/Pn726 LU/S2

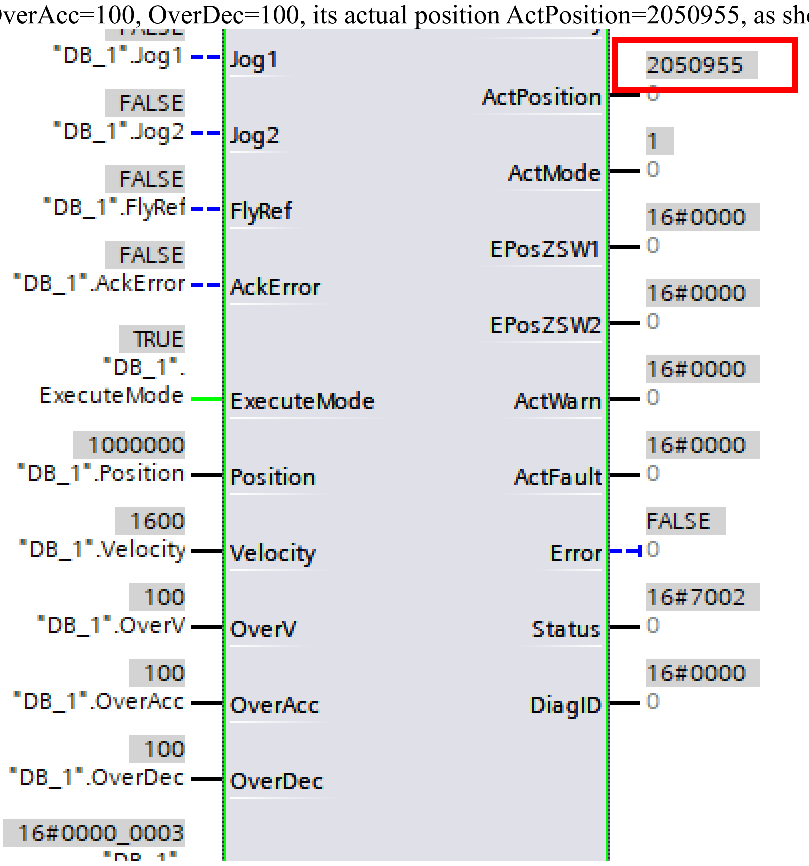
Servo deceleration = Pn731 * OverDec(%) * Pn725 / Pn726 LU / S2

The ModePos input value of FB284 function block is 2, and the servo is absolute positioning control

Procedure Step 1 Set servo control parameters

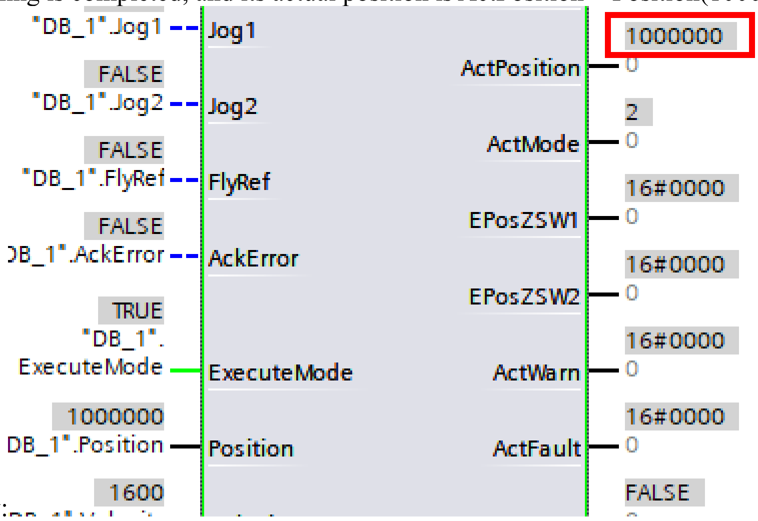
Servo parameter number	Name	Set value
Pn725	Electronic gear ratio molecule	8388608
Pn726	Electronic gear score	1000
Pn730	EPOS maximum acceleration	100
Pn731	EPOS maximum reduction speed	100

Step 2 Fb284 function block input pin assignment, Position=1000000, Velocity=1600, OverV=100, OverAcc=100, OverDec=100, its actual position ActPosition=2050955, as shown in the figure below.



Step 3 After enabling absolute positioning, the servo starts to run, the Un000 of the servo monitoring page is 1600, the theoretical speed of the servo = 1600 * 1000 * (Pn725 / Pn726) / encoder resolution (23-bit encoder) = 1600RPM, the theoretical speed is consistent with the actual speed.

Step 4 The positioning is completed, and its actual position is ActPosition = Position(1000000), as shown in the figure below:



CancelTraversing function

When this function takes effect, that is, CancelTraversing = FALSE, the servo will slow down and stop at the maximum deceleration speed, at this time, the previous input parameters will fail, CancelTraversing = TURE, and the ExecuteMode instruction needs to be executed again.

Note: Servo deceleration = Pn731*1000*Pn725/Pn726 LU/S2

IntermediateStop function

When this function takes effect, that is, IntermediateStop = FALSE, the servo will slow down and stop at the percentage of the maximum deceleration (OverDec), at this time the previous input parameters are still valid, IntermediateStop = TURE, the servo continues to complete the previous positioning control, and does not need to re-execute the ExecuteMode command.

Note: Servo deceleration = Pn731*1000*OverDec(%)*Pn725/Pn726 LU/S2

Continuous position given function

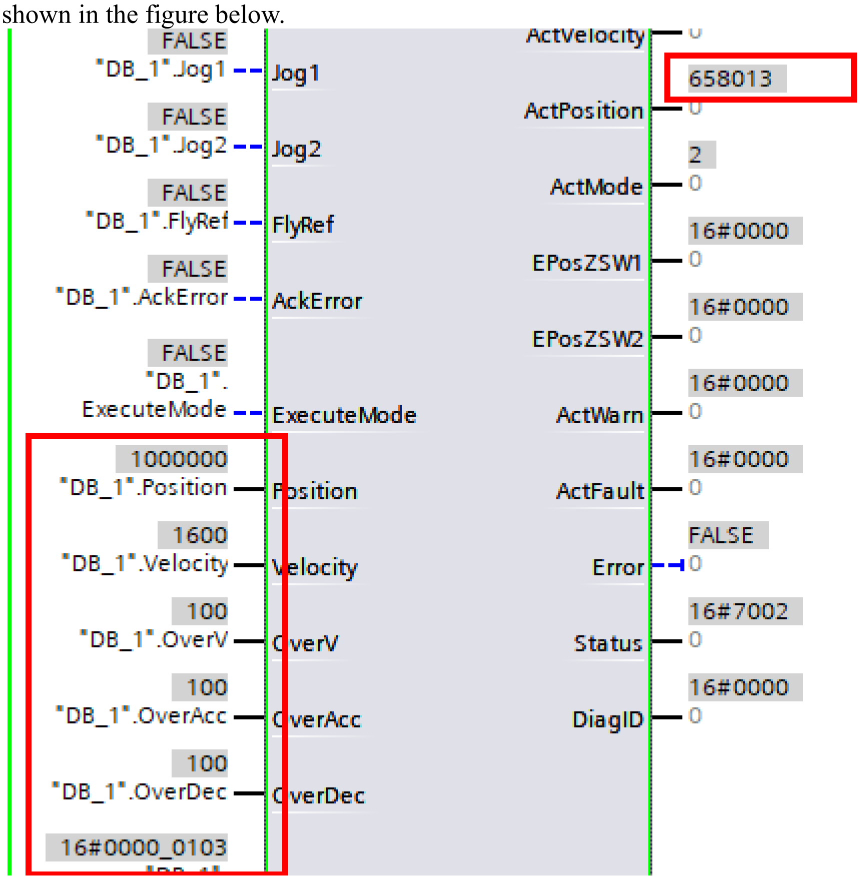
Configure ConfigEPos=0x103, the servo is a continuous position given mode, no need to ExecuteMode rising edge to enable servo movement, just execute EnableAxis servo will immediately execute the FB284 function block input positioning instruction, if the servo input parameters are updated will immediately take effect and execute.

The ModePos input value of FB284 function block is 2, and the servo is absolute positioning control

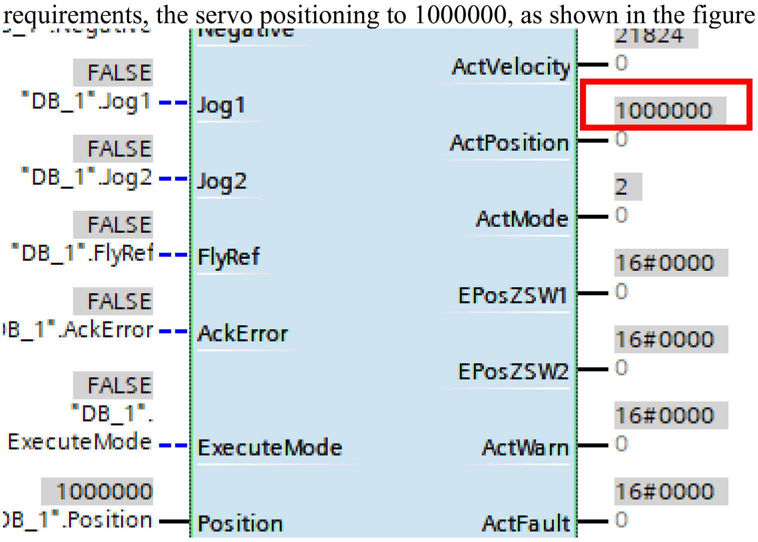
Procedure Step 1 Set servo control parameters

Servo parameter number	Name	Set value
Pn725	Electronic gear ratio molecule	8388608
Pn726	Electronic gear score	1000
Pn730	EPOS maximum acceleration	100
Pn731	EPOS maximum reduction speed	100

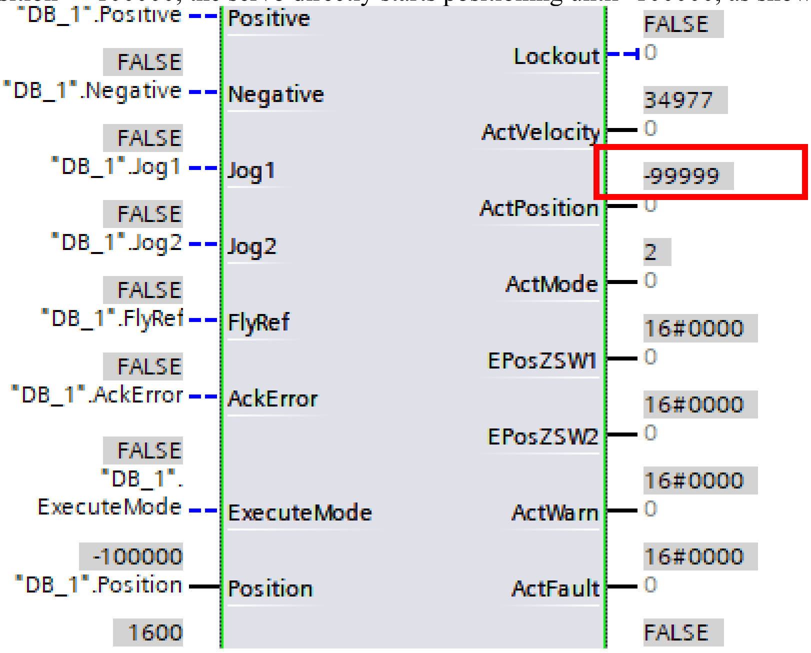
Step 2 Fb284 function block input pin assignment, ConfigEPos=0x103, Position=1000000, Velocity=1600, OverV=100, OverAcc=100, OverDec=100, its actual position ActPosition=658012, as shown in the figure below.



Step 3 EnableAxis = TRUE, the servo starts absolute positioning, according to the absolute positioning requirements, the servo positioning to 1000000, as shown in the figure below:

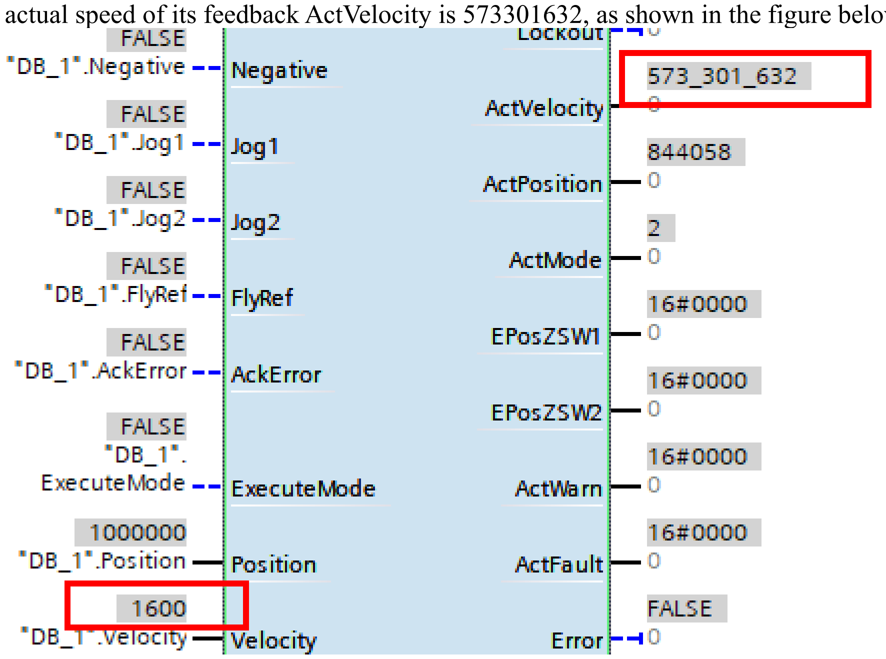


Step 4 Modify Position = -100000, the servo directly starts positioning until -100000, as shown in the following figure:



ActVelocity description

Configure the servo to be positioned at 1600RPM, the servo display panel Un000 is 1600RPM, and the actual speed of its feedback ActVelocity is 573301632, as shown in the figure below:



The calculation relationship between ActVelocity and servo speed is as follows:

Servo speed = ActVelocity* rated speed /0x40000000 RPM

7.7 Application Example of S7-200 Smart Packet 111

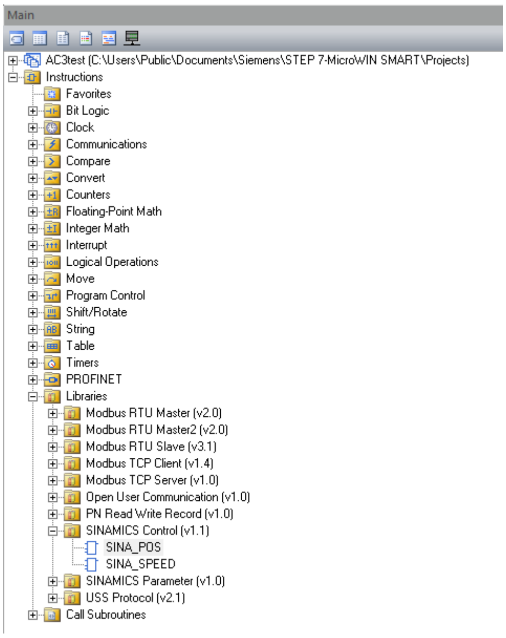
7.7.1 Overview

Before applying S7-200Smart, you need to download and install PLC development and debugging software from Siemens' official website:

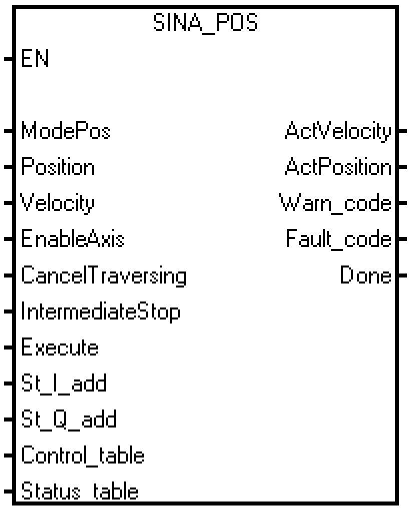
- STEP 7-Micro/WIN SMART V2.6

7.7.2 Overview of Control Modules

1） When using message 111 to implement EPOS position control, the SINA_POS control module is applied in the debugging software. After installing STEP 7-Micro/WIN SMART V2.6, find the SINA_POS control module in the figure below:



SINA_POS Pin



SINA_POS input and output parameters are described in the following table:

Input pin	type	Description
ModePos	INT	Operation mode: 1 = relative positioning (supported)

		2 = Absolute positioning (supported) 3 = Continuous operation mode (at the specified speed) (not supported) 4 = Active return to zero (support) 5 = directly set back to zero (supported) 6 = Run program segment 0 ~ 15 (not supported) 7 = Click at specified speed (supported) 8 = Click at specified distance (not supported)
Position	DINT	Position setting when ModePos=1 or 2 [LU] Program segment number when ModePos=6
Velocity	DINT	Speed set value when ModePos=1, 2, 3 [1000LU/min]
EnableAxis	BOOL	Servo running command: 0 = stop (OFF1) 1 = start
CancelTraversing	BOOL	0 = Cancel the current running task 1 = Do not cancel the current running task
IntermediateStop	BOOL	To pause a task: 0 = Pause the current running task 1 = The current running task is not suspended
Execute	BOOL	The mode of activating the request
St_I_add	DWORD	PROFINET Pointer to the start address of the packet I storage area, for example, &IB128
St_Q_add	DWORD	PROFINET Pointer to the start address of the Q store, for example, &QB128
Control_table	DWORD	Control_table Pointer to the start address, for example &VD8000
Status_table	DWORD	Status_table Pointer to the start address, for example, &VD7500
Output pin	Type	Description
ActVelocity	DWORD	Actual speed (Rated speed of the device in hexadecimal 40000000h)
ActPosition	DWORD	Actual location [LU]
Warn_code	WORD	Device warning code information
Fault_code	WORD	Device fault code information
Done	BOOL	The target position is reached when the operation mode is relative or absolute motion

Control_table Parameter definition

Byte offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	reserve	reserve	AckError Confirmation error	reserve	Jog2 Point 2	Jog1 Point 1	Negative Negative rotation	Positive Forward rotation
1	reserve							
2	OverV：Set speed percentage 0～199%							
3								
4	OverAcc: 0 to 100% acceleration when ModePos=1, 2, or 3							
5								
6	OverDec: The set speed reduction percentage when ModePos=1, 2, or 3 ranges from 0 to 100%							
7								
8	ConfigEpos							
9								
10								
11								

ConfigEpos： This parameter can be used to control the related functions of basic positioning. The corresponding relationship between bits is shown in the following table:

ConfigEPos position	Function description
ConfigEPos.%X0	OFF2 stop
ConfigEPos.%X1	OFF3 stop
ConfigEPos.%X2	Activate the software limit
ConfigEPos.%X3	Activate the hardware limit

ConfigEPos.%X6	Zero switching signal
ConfigEPos.%X7	External block switching
ConfigEPos.%X8	Continuous change of set value when ModPos=2 and 3 (no need to re-trigger)

Note: If a variable is assigned to this in the program, the initial value must be 3 (i.e. ConfigEPos.%X0 and ConfigEPos.%X1 equal to 1)

Status_table Parameter definition

偏移	位 7	位 6	位 5	位 4	位 3	位 2	位 1	位 0
0	reserve	Overrange_Error The entered data is out of range	An error occurred with the AxisError driver	AxisWarn The driver has a warning	Lockout The driver is disconnected	AxisRef has set the reference point	AxisPosOk reaches the target position of the axis	The Axisenabled driver isenabled
1	Error ID：Identify the error type.							
2	Actmode：The currently active running mode							
3								
4	POS ZSW1：POS ZSW1 Status word 1							
5								
6	POS ZSW2：POS ZSW2 Status word 2							
7								

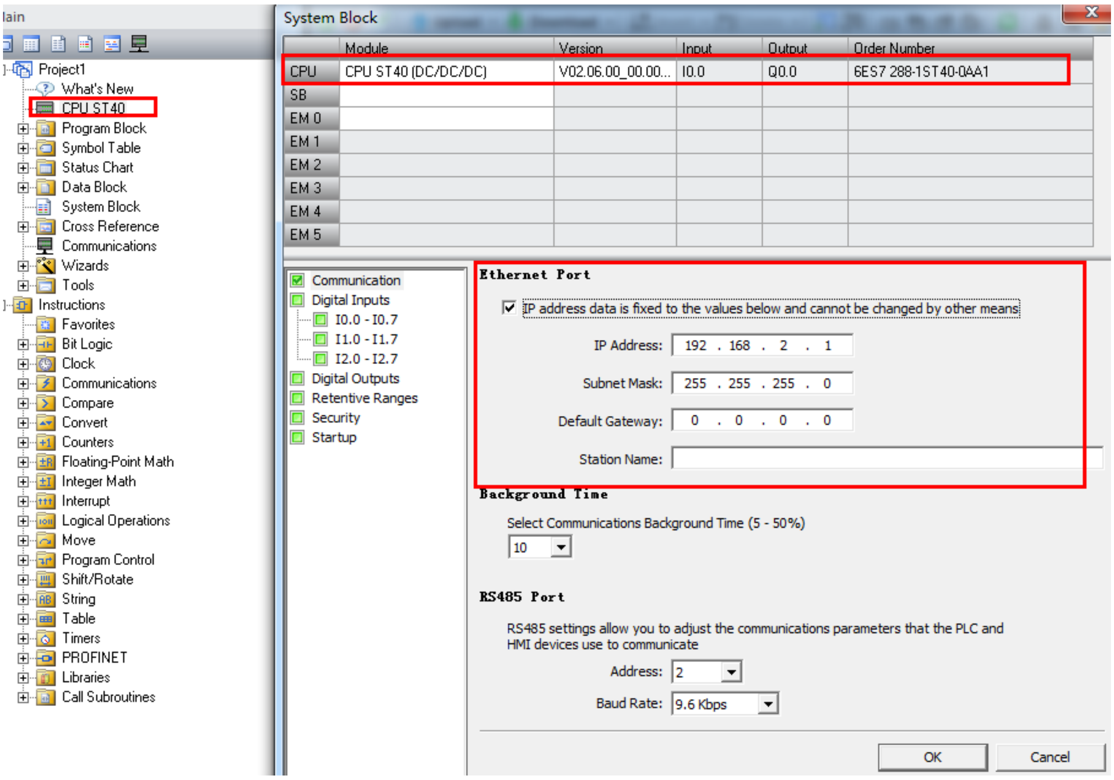
Error ID Error code for parameter

Error code	description
0	error-free
1	A drive error was detected
2	Drive disabled
3	The selected mode is not supported
4	The OverV, OverAcc, and OverDec parameters are out of the supported value range
5	When ModePos=6, the program segment number is out of range

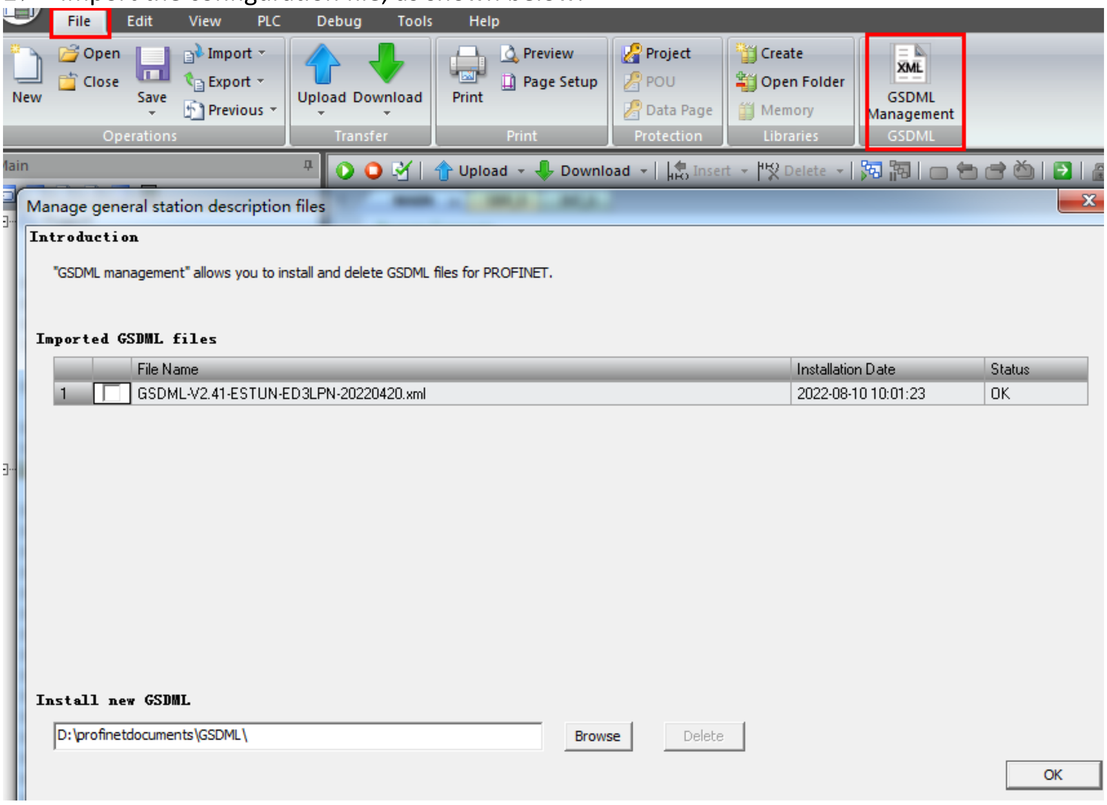
7.7.3 Project Configuration

To configure the S7-200 SMART project, run the STEP 7-Micro/WIN SMART debugging software as follows:

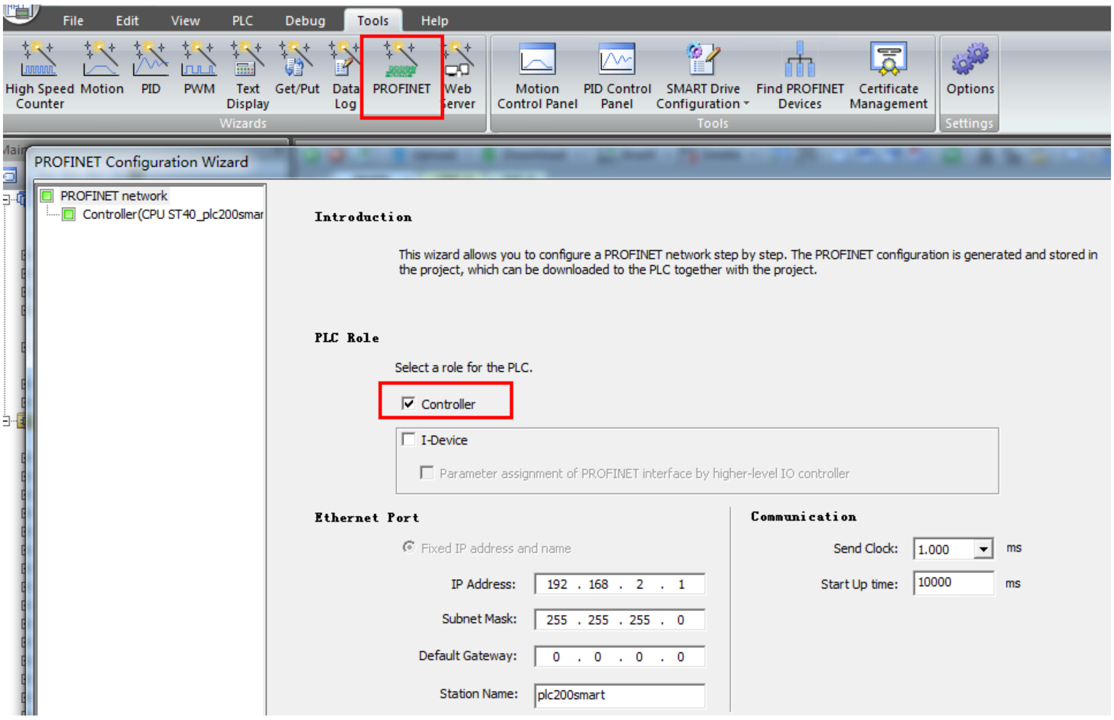
1）Create a new project, select the PLC model to use, and set the IP address, name and other information for PLC. CPU ST40 is used in this paper, as shown in the following figure:



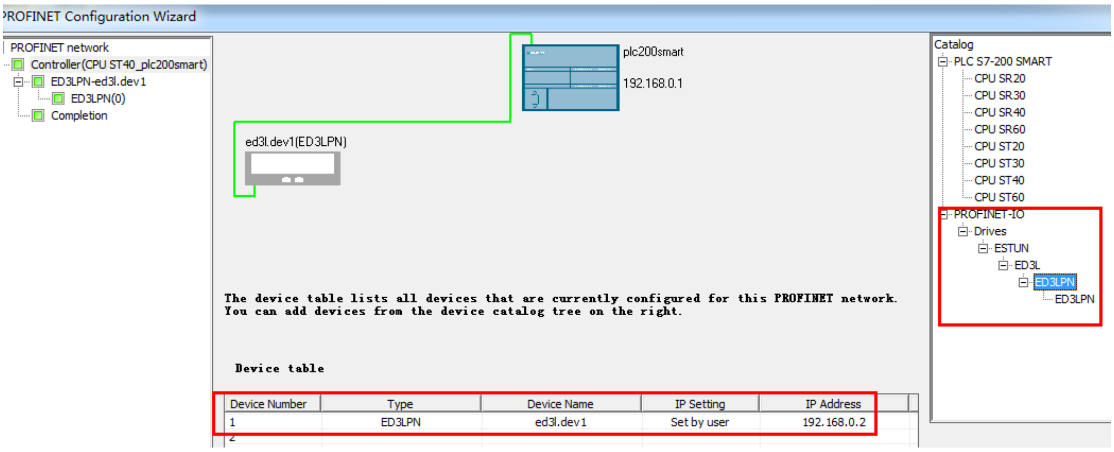
2） Import the configuration file, as shown below:



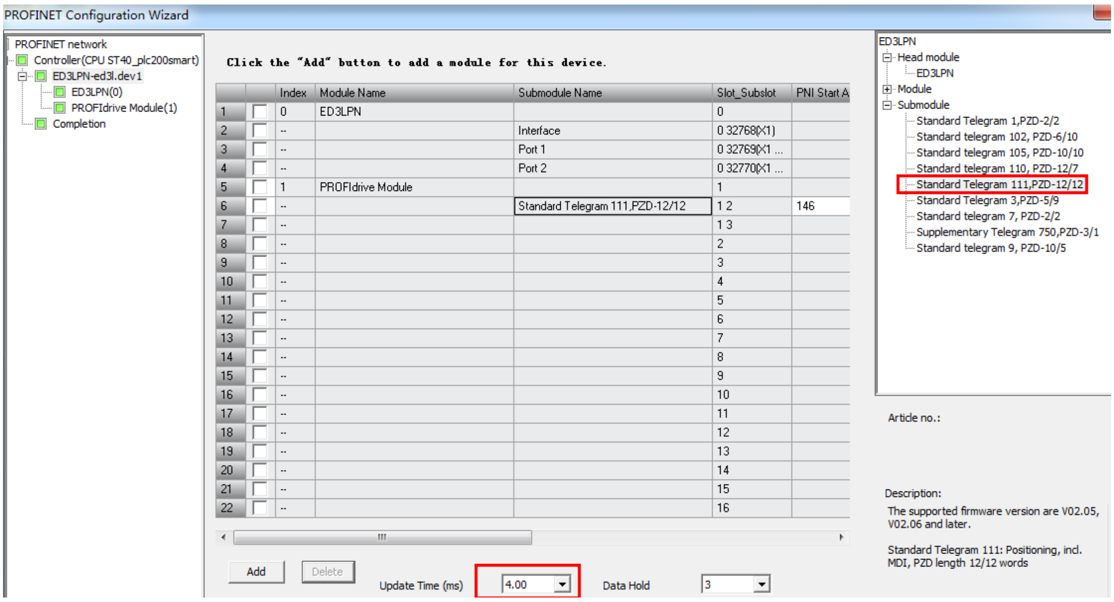
3）Configure the PROFINET communication site and message information through the wizard function. Firstly, select PLC as PROFINET controller and configure the IP address of PLC here. Then click the next button:



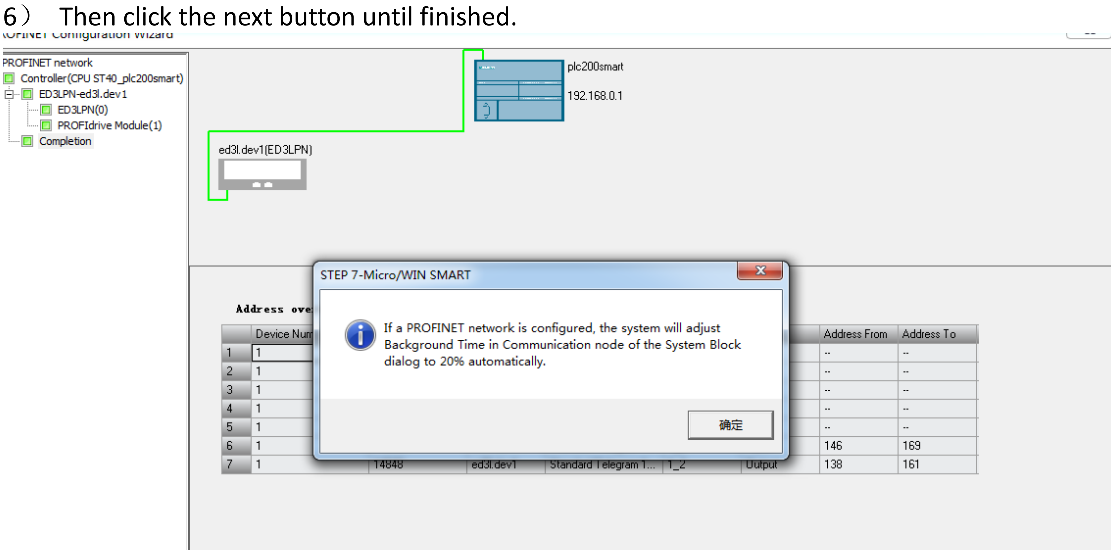
4）Add the ED3LPN server and configure the server's name and IP address. Add the site by clicking the Add button, then click the Next button:



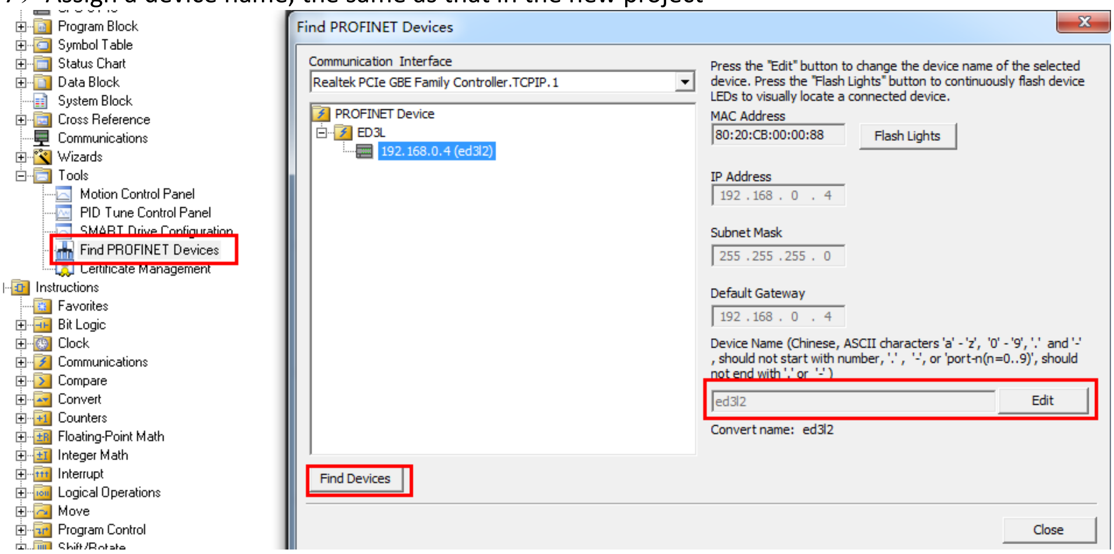
5） Drag message 111 into the module list in the Configuration message view with a minimum update time of 4 ms:



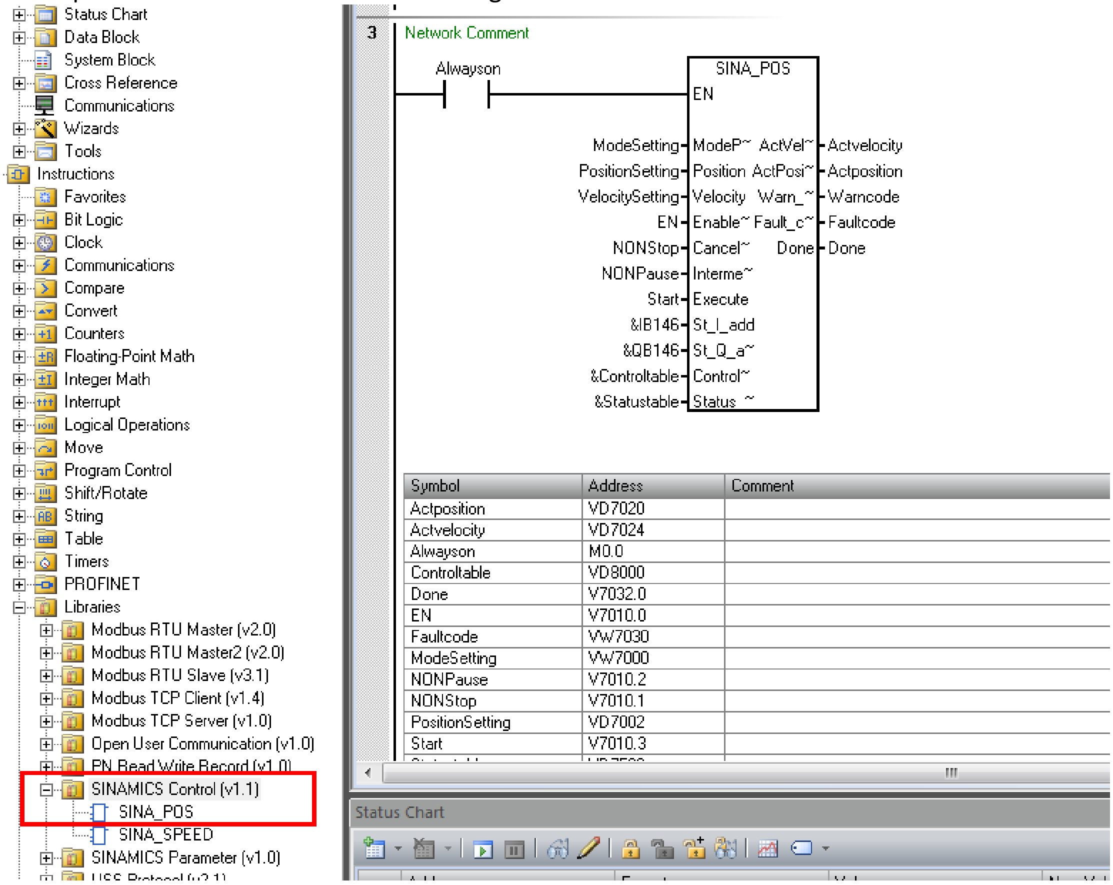
6） Then click the next button until finished.



7）Assign a device name, the same as that in the new project



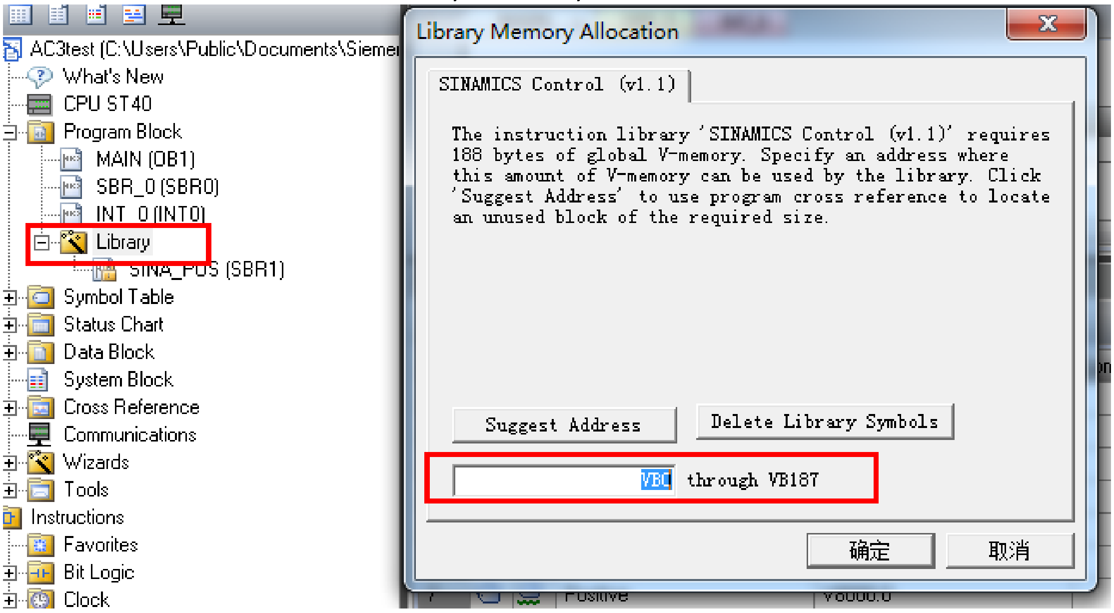
8）In the main program, write the following program. Note that the addresses of St_I_add and St_Q_add must correspond to the IO address of 111 message:



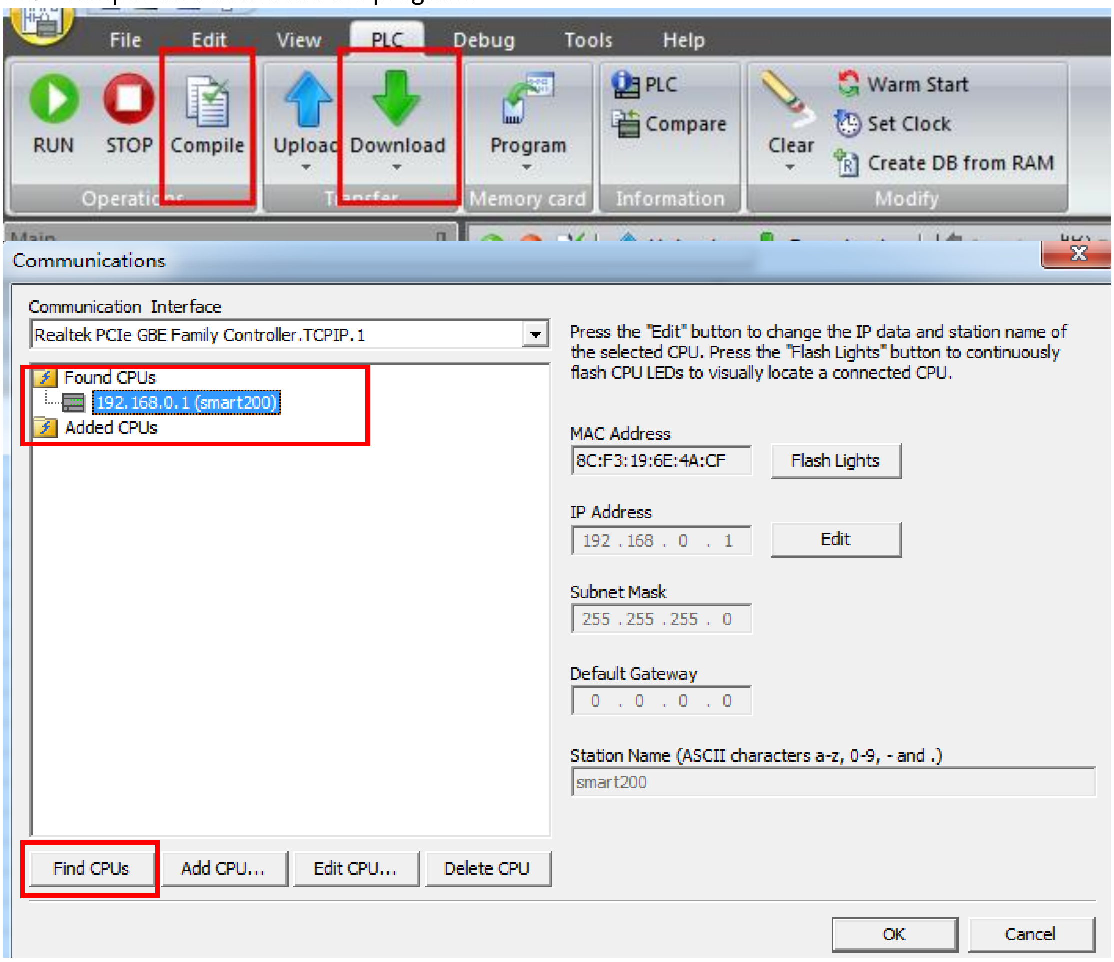
9）The symbol table address definition used in the program is shown below:

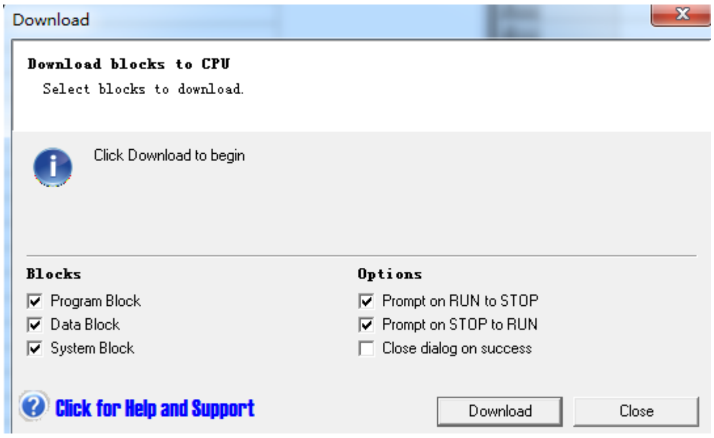
symbol	address
EN	V7010.0
NonStop	V7010.1
NonPause	V7010.2
Start	V7010.3
Done	V7032.0
Positive	V8000.0
Negetive	V8000.1
JOG1	V8000.2
JOG2	V8000.3
ACKError	V8000.5
ErrorID	VB7501
PositionSetting	VD7002
VelocitySetting	VD7006
Actposition	VD7020
Actvelocity	VD7024
Statustable	VD7500
Controltable	VD8000
ConfigEpos	VD8008
ModeSetting	VW7000
Warncode	VW7028
Faultcode	VW7030
OverV	VW8002
OverAcc	VW8004
OverDec	VW8006

10）Allocate the V address area used by the library:

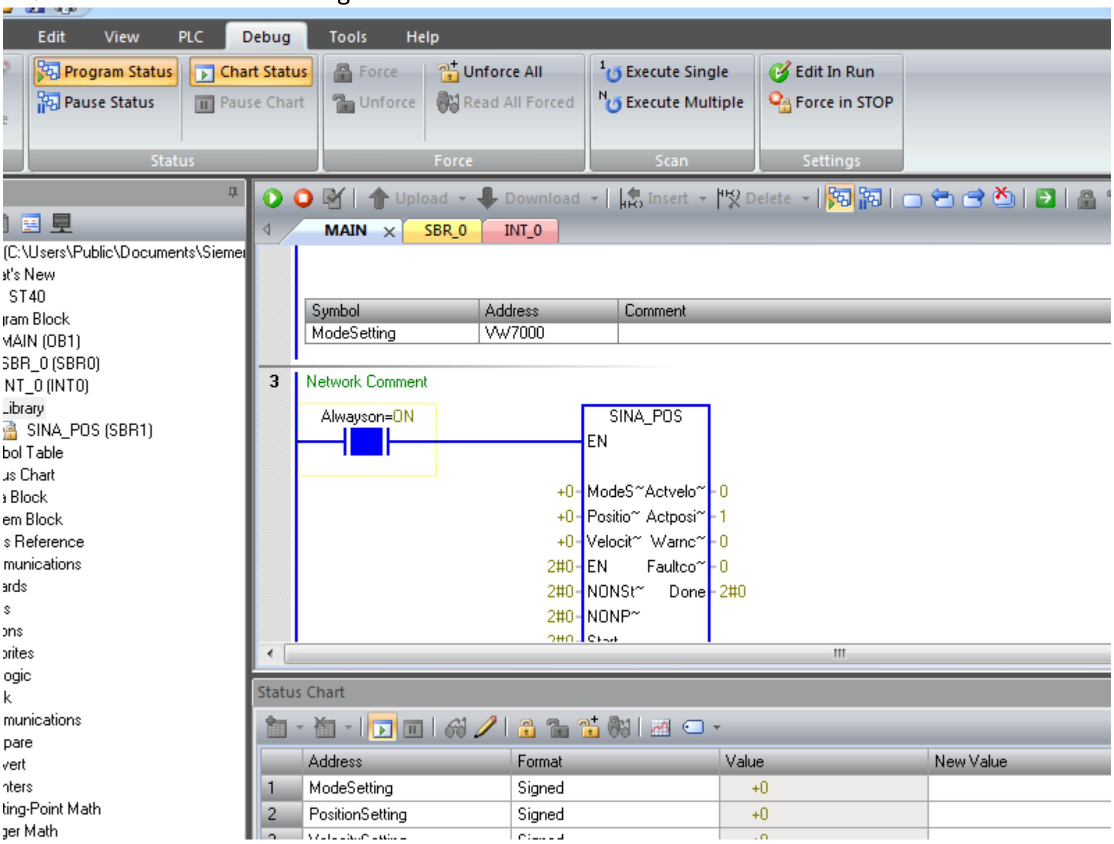


11）Compile and download the program:





12）Related functional testing via status charts:



7.7.4 SINA_POS Function Description

Operating conditions:

1. The axis isenabled by typing EnableAxis = 1. If the driver isenabled properly and there are no errors, then the Axisenabled bit in Status_table is 1.
2. ModePos Enter a running mode.
3. The input signal CancelTraversing, IntermediateStop, must be set to 1 when running EPOS, in Control_table, set "ConfigEpos" to 3, the signal description is as follows:

   1）Setting CancelTraversing=0, the shaft stops at maximum reduction, the working data is discarded, and the running mode can be switched after the shaft stops.

   2）Set IntermediateStop=0 to stop the ramp using the currently set speed reduction value, and the task is maintained. If IntermediateStop=1 is set again, the rear shaft will continue to run, and this can be interpreted as a pause of the shaft. The running mode can be switched after the shaft is stationary.
4. Activate the hardware limit switch

   If the hardware limit switch is used, input ConfigEPos.%X3 into the library instruction SINA_POS to 1 to activate the hardware limit function.

5. Activate the software limit switch
If the software limit switch is used, you need to set the input ConfigEPos.%X2 of the library instruction SINA_POS to 1 to activate the software limit function.

Relative positioning operation mode

Relative positioning operation mode can be realized by driving relative positioning function, which uses ED3LPN servo driven internal position controller to realize relative position control.

Requirements:

- Select ModePos=1 for the running mode
- Axis enable EnableAxis=1
- The shaft does not have to go back to zero or the absolute encoder can be left uncalibrated

Steps:

- Specify the target Position and Velocity by input parameters Position and velocity
- Specify the speed, plus or minus the percentage of speed by input parameters OverV, OverAcc and OverDec
- Run conditions CancelTraversing and IntermediateStop must be set to 1, Jog1 and Jog2 to 0
- In relative positioning, the direction of motion is determined by the positive or negative values set in Position

The current state of the command is activated by the rising edge of Execute or monitored by PosZSW1, PosZSW2 in Status_table, and the AxisPosOK bit of the output Status_table is 1 if the target position is reached. If an error occurs during run, the AxisError in Status_table is at position 1.

Relative positioning operation mode variable assignment, as shown in the following table:

Symbol	Address	Assignment
ModeSetting	VW7000	1
PositionSetting	VD7002	1000
VelocitySetting	VD7006	100
EN	V7010.0	1
NonStop	V7010.1	1
NonPause	V7010.2	1
Start	V7010.3	0→1
OverV	VW8002	100
OverAcc	VW8004	100
OverDec	VW8006	100
ConfigEpos	VD8008	3

Absolute positioning operation mode

Absolute positioning operation mode can be realized by driving absolute positioning function, which uses ED3LPN servo-driven internal position controller to realize absolute position control.

Requirements:

- Run mode: ModePos=2
- Axis EnableAxis=1
- Shaft must have returned to zero or encoder has been calibrated

Steps:

- Enter the parameters Position, Velocity to specify the target position and velocity
- Enter parameters OverV, OverAcc, and OverDec to specify the speed, plus or minus the percentage of the speed
- The run condition CancelTraversing and IntermediateStop must be set to 1 and Jog1 and Jog2 to 0
- In absolute positioning, the system runs to the target position using the shortest path. In this case, the input parameters Positive and Negative must be 0.

The current state of the command is activated by the rising edge of Execute or monitored by PosZSW1, PosZSW2 in Status_table, and the AxisPosOK bit of the output Status_table is 1 if the target position is reached. If an error occurs during run, the AxisError in Status_table is at position 1.

绝对定位运行模式变量赋值，如下表所示：

符号	地址	赋值
ModeSetting	VW7000	2
PositionSetting	VD7002	500
VelocitySetting	VD7006	100
EN	V7010.0	1
NonStop	V7010.1	1
NonPause	V7010.2	1
Start	V7010.3	0→1
OverV	VW8002	100
OverAcc	VW8004	100
OverDec	VW8006	100
ConfigEpos	VD8008	3

Active return to zero

This function allows the shaft to return to zero along the forward or reverse operation according to the preset return to zero speed and way, activating the active return to zero of the drive

Requirements:

- Run mode: ModePos=4
- Axis EnableAxis=1
- The axis is at rest

Steps:

- Enter parameters OverV, OverAcc, and OverDec to specify the speed, plus or minus the percentage of the speed
- Jog1 and Jog2 must be set to 0, and 1 must be set to Positive

The return to zero motion is triggered by the rising edge of Execute and should remain high during the return to zero process. The current status of the activation command is monitored by PosZSW1 and PosZSW2 in Status_table. AxisRef in Status_table is set to 1 after returning to zero. When an error occurs during running, AxisError position 1 in Status_table.

Assign values to the active zero-mode variable, as shown in the following table:

Symbol	Address	Assignment
ModeSetting	VW7000	4
PositionSetting	VD7002	500
VelocitySetting	VD7006	100
EN	V7010.0	1
Start	V7010.3	0→1
OverV	VW8002	100
OverAcc	VW8004	100
OverDec	VW8006	100
ConfigEpos	VD8008	3
Positive	V8000.0	1
Negative	V8000.1	0

Directly set back to zero

This operation mode allows the axis to be set to zero position at any position.

Requirements:

- Run mode: ModePos=5
- The axis may be in the enabled state, but must be in the stationary state when executing mode

Steps:

- Set the zero position of the shaft by executing the rising edge when the shaft is at rest

Directly set the value of the variable back to zero mode, as shown in the following table:

Symbol	Address	Assignment
ModeSetting	VW7000	5
EN	V7010.0	1
Start	V7010.3	0→1
ConfigEpos	VD8008	3
Positive	V8000.0	1
Status_table	VD7500	Status display:V7500.2(AxisRef)=1

Velocity point mode

The point running mode is realized by the Jog jog function of the driver.
Requirements:

- Run mode: ModePos=7
- Axis EnableAxis =1
- The axis is at rest
- The shaft does not have to return to zero or absolute value. The encoder can be left in an uncorrected state

Steps:

- Jog speed is set in the drive, and the OverV parameter of the speed is percentage scaled to the jog speed setting
- Operating conditions CancelTraversing and IntermediateStop are independent of jog operating mode
- Jog1 and Jog2 are used to control the point operation of EPOS, The direction of motion is determined by the point speed set in the drive, The default setting is Jog1 using negative tapping speed, Jog2 uses the Positive point speed, which has nothing to do with the positive and Negative parameters
- The current state of the activation command can be monitored by PosZSW1, PosZSW2 in Status_table, AxisPosOK set to 1 when the jog ends (Jog1 or Jog2=0) when the axis is stationary, and error AxisError position 1 occurs during operation

Assign values to the velocity jog mode variables as shown in the following table:

Symbol	Address	Assignment
ModeSetting	VW7000	7
EN	V7010.0	1
JOG1	V8000.2	1
JOG2	V8000.3	0
OverV	VW8002	100
ConfigEpos	VD8008	3

Torque limiting and reading function

Set Pn736 = 1 to enable torque limiting and reading functions.

1) According to the format of 111 message, the corresponding bytes read by torque limiting and torque are shown as follows:

PZD12	user	user

2）In STEP 7-Micro/WIN SMART, set the start address for sending and receiving packets to 146, as shown in the following figure:

	Submodule Name	Slot_Subslot	PNI Start Ad...	Input Size (B...	PNQ Start A...	Output Size
1		0				
2	Interface	0 32768				
3	Port 1	0 32769				
4	Port 2	0 32770				
5		1				
6	Standard Telegram 111,PZD-12/12	1 2	146	24	146	24
7		1 3				

3）According to the location of user, it can be calculated that the output address of torque limiting is QW168, and the input address of torque reading is IW168. The configuration is shown as follows:

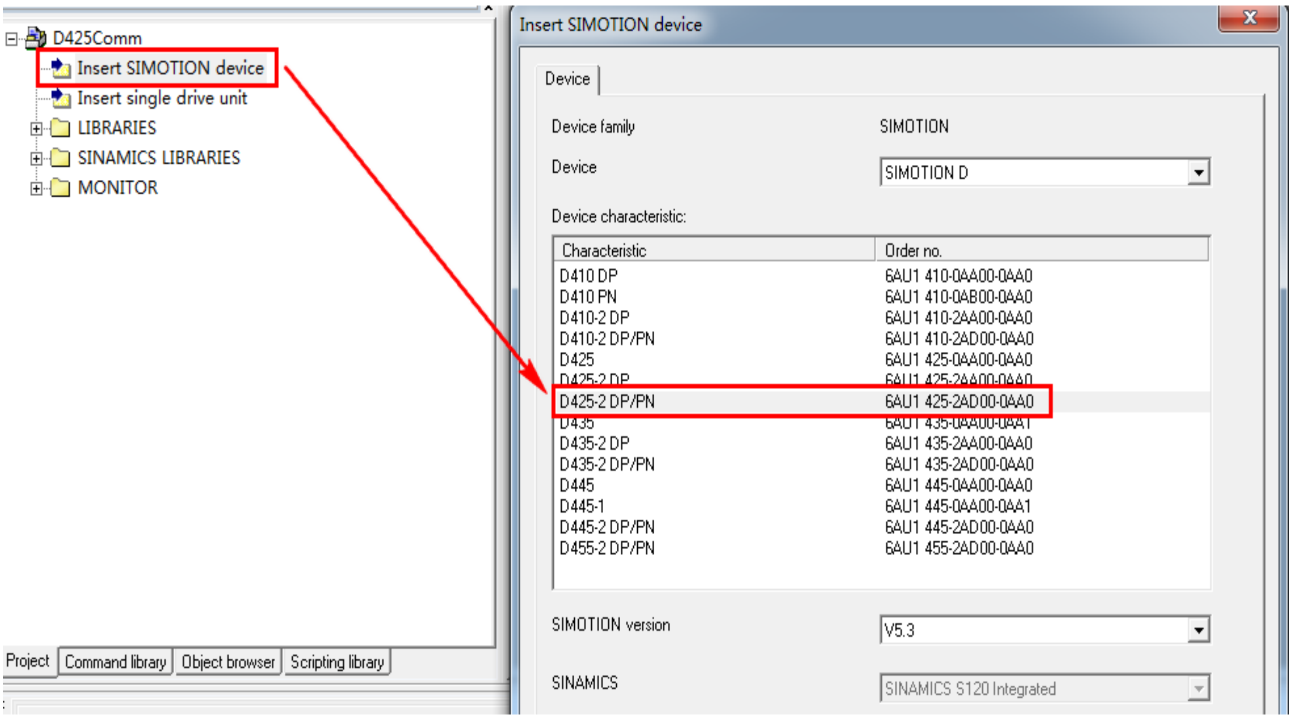
22	QW168	Hexadecimal		
23	IW168	Hexadecimal		

7.8 Simotion D425-2 DP/PN Configuration and Commissioning

7.8.1 Configuring Packet 105 Items

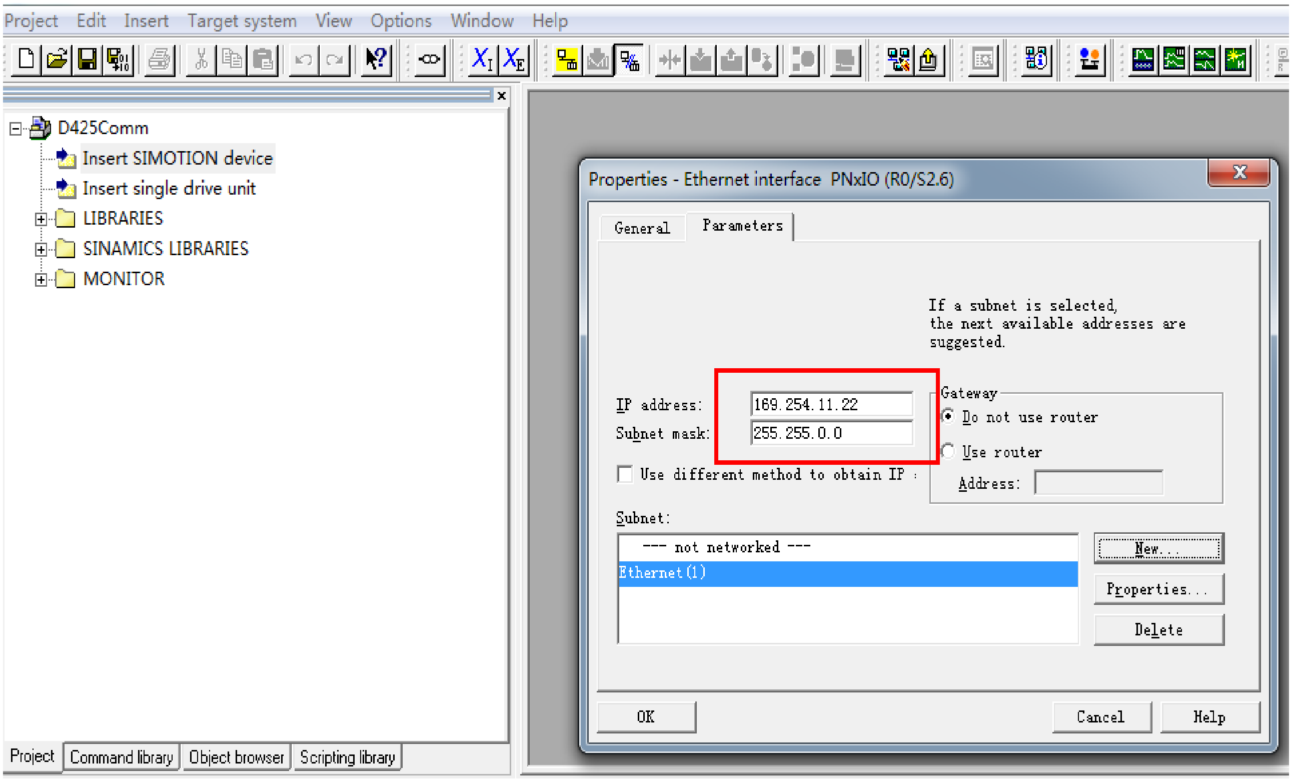
Step 1 Open the Simotion Scout software and insert the SIMOTION device, as shown in the figure.

Figure 7-47 Inserting a SIMOTION device



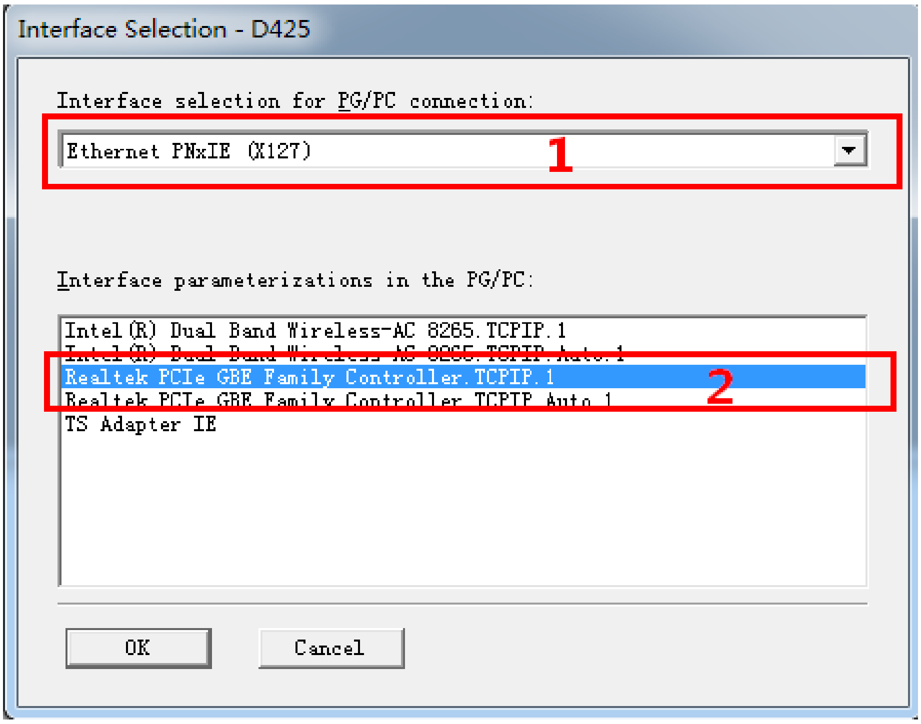
Step 2 Set the IP address and subnet mask of the SIMOTION device.

Figure 7-48 Setting the IP address and subnet mask of the SIMOTION device



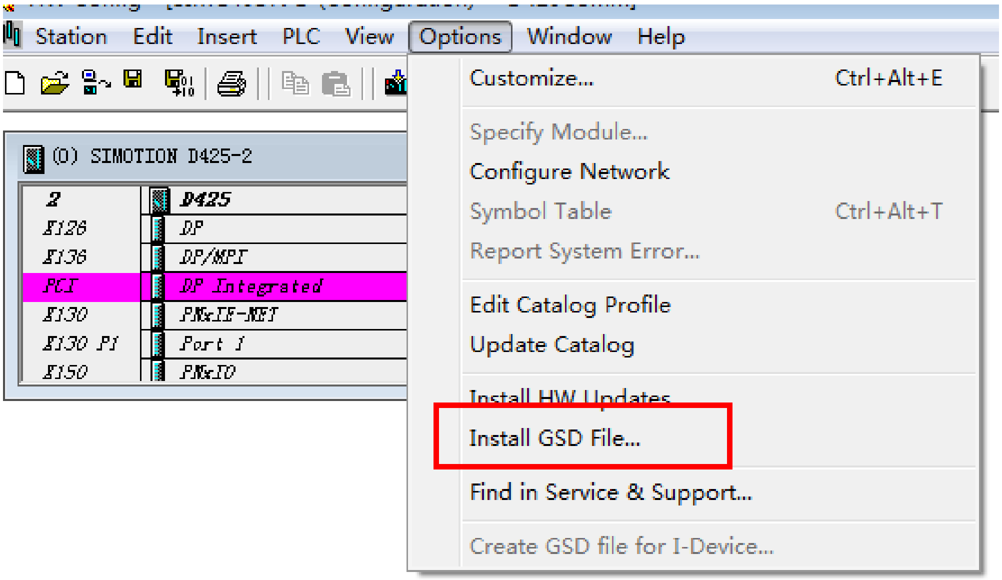
Step 3 Select the D425-2 DP/PN port based on the actual configuration (in this example, it is X127 port (red number 1)), and then select the name of the NIC connecting to the PC (red number 2), as shown in the figure.

Figure 7-49 Selecting network ports



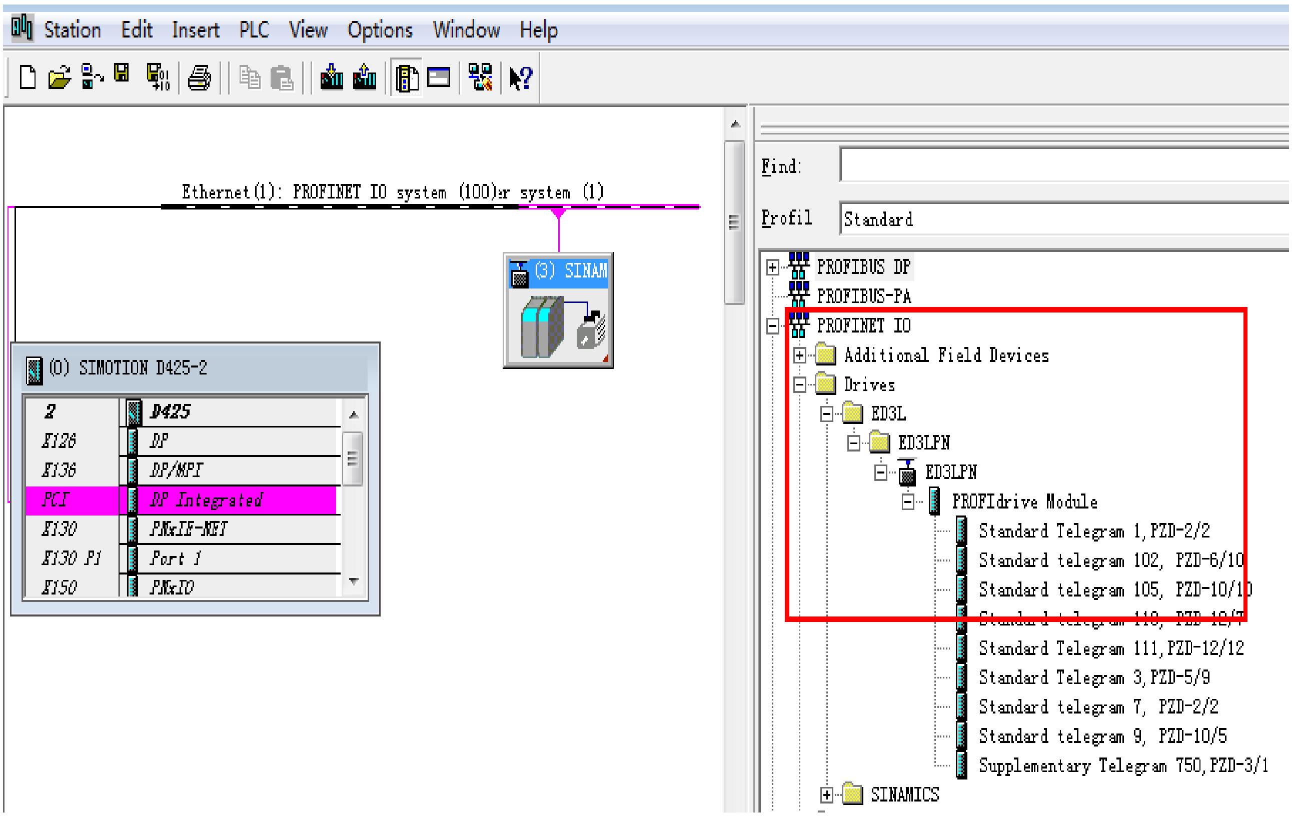
Step 4 Install the GSD file in the configuration, as shown in the figure.

Figure 7-50 Installing the GSD file



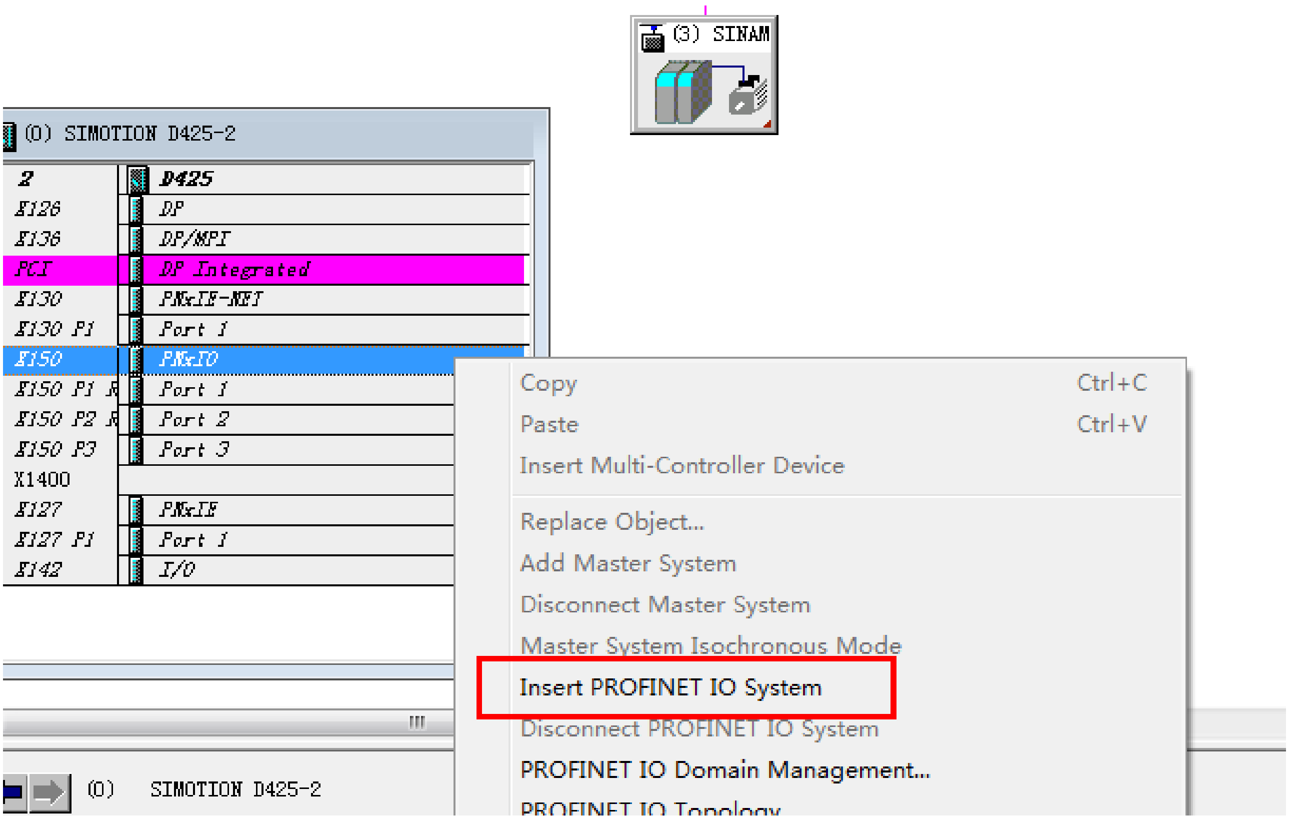
Step 5 After you install the GSD file, you can view the ED3L options and the list of supported packets in the project tree on the right, as shown in the figure.

Figure 7-51 Packet list



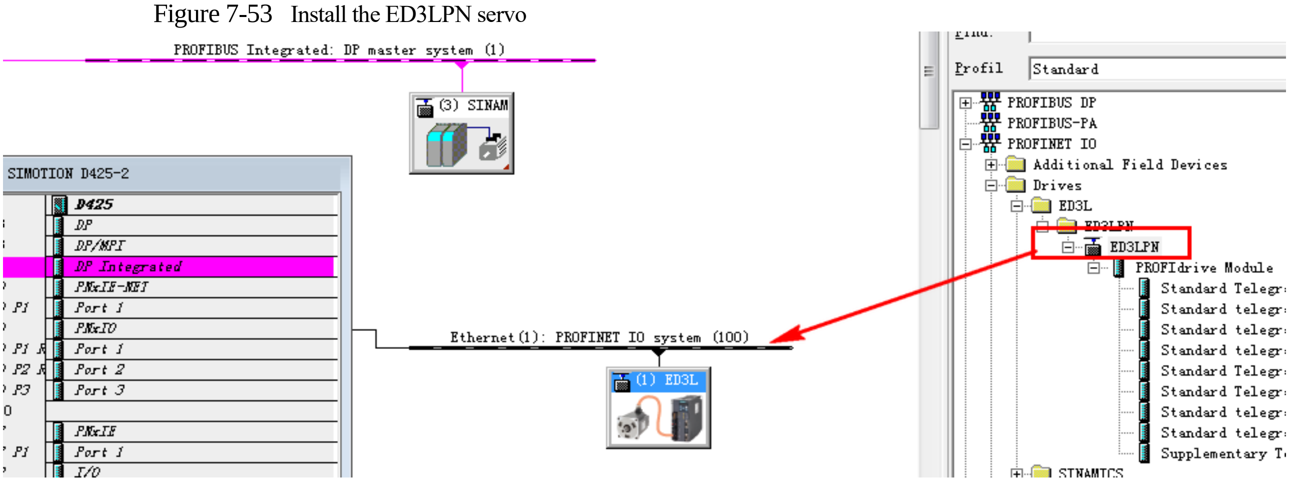
Step 6 Then insert the PROFINET IO system bus as shown in the figure.

Figure 7-52 INSERT THE PROFINET IO SYSTEM



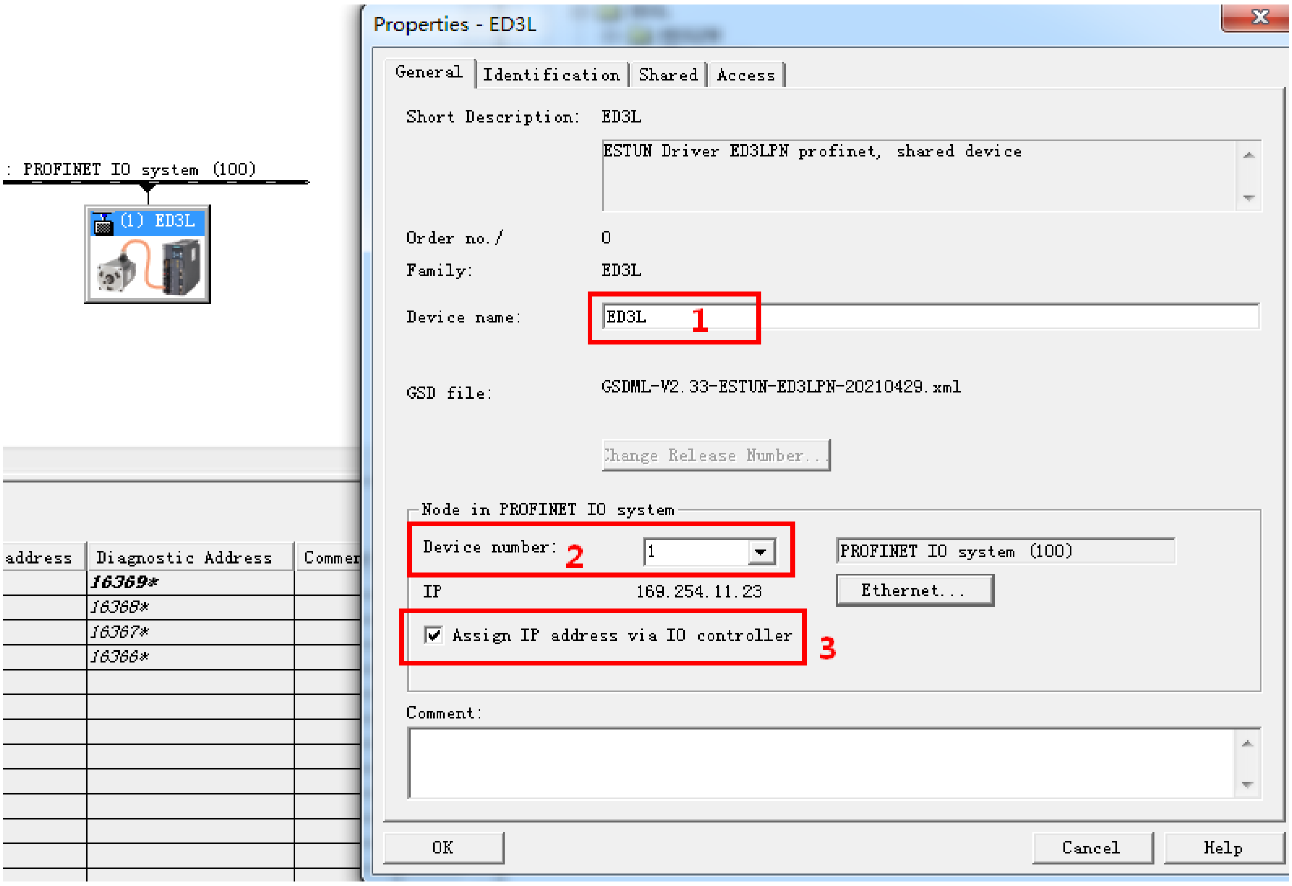
Step 7 Select the ED3LPN module on the right and drag it onto the PROFINET IO system bus as shown.

Figure 7-53 Install the ED3LPN servo



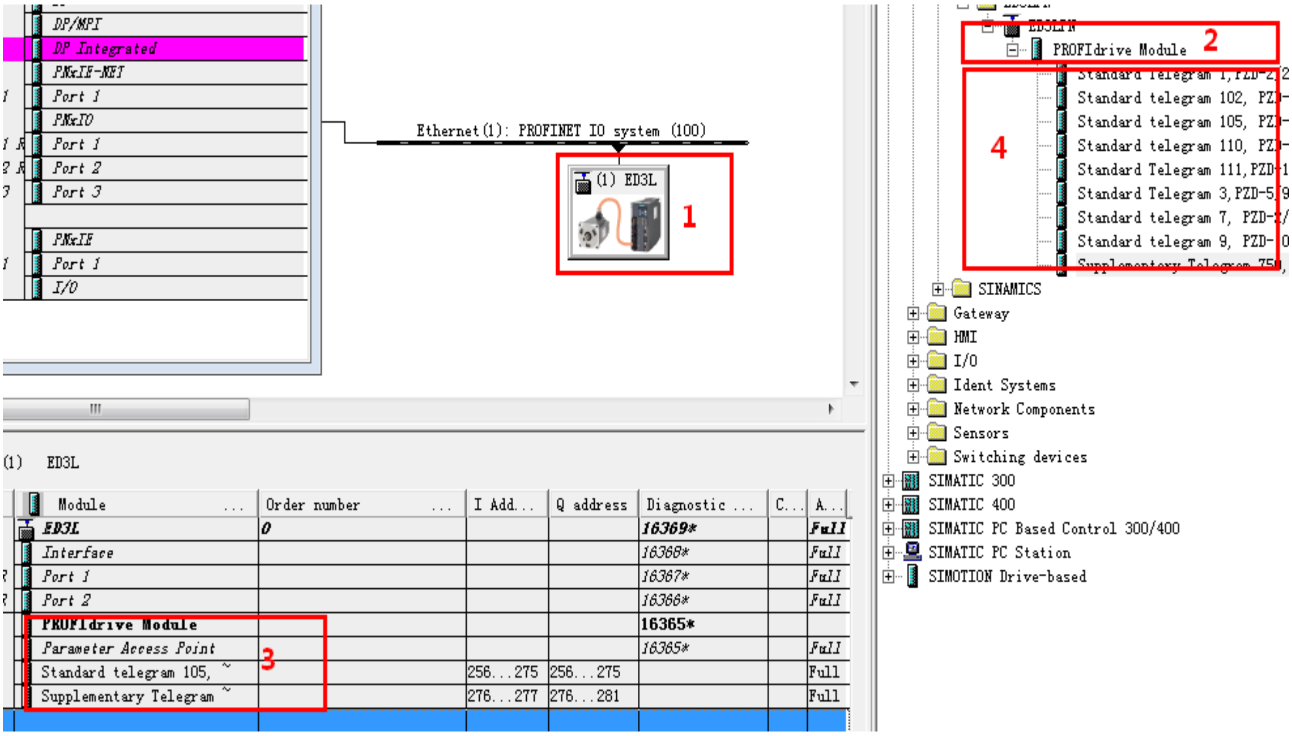
Step 8 Then double-click the ED3L module, set the name and IP address, its default device name is ED3L, the IP address check is shown in red number 3, and its configuration is shown in the figure.

Figure 7-54 Set the device name and IP address



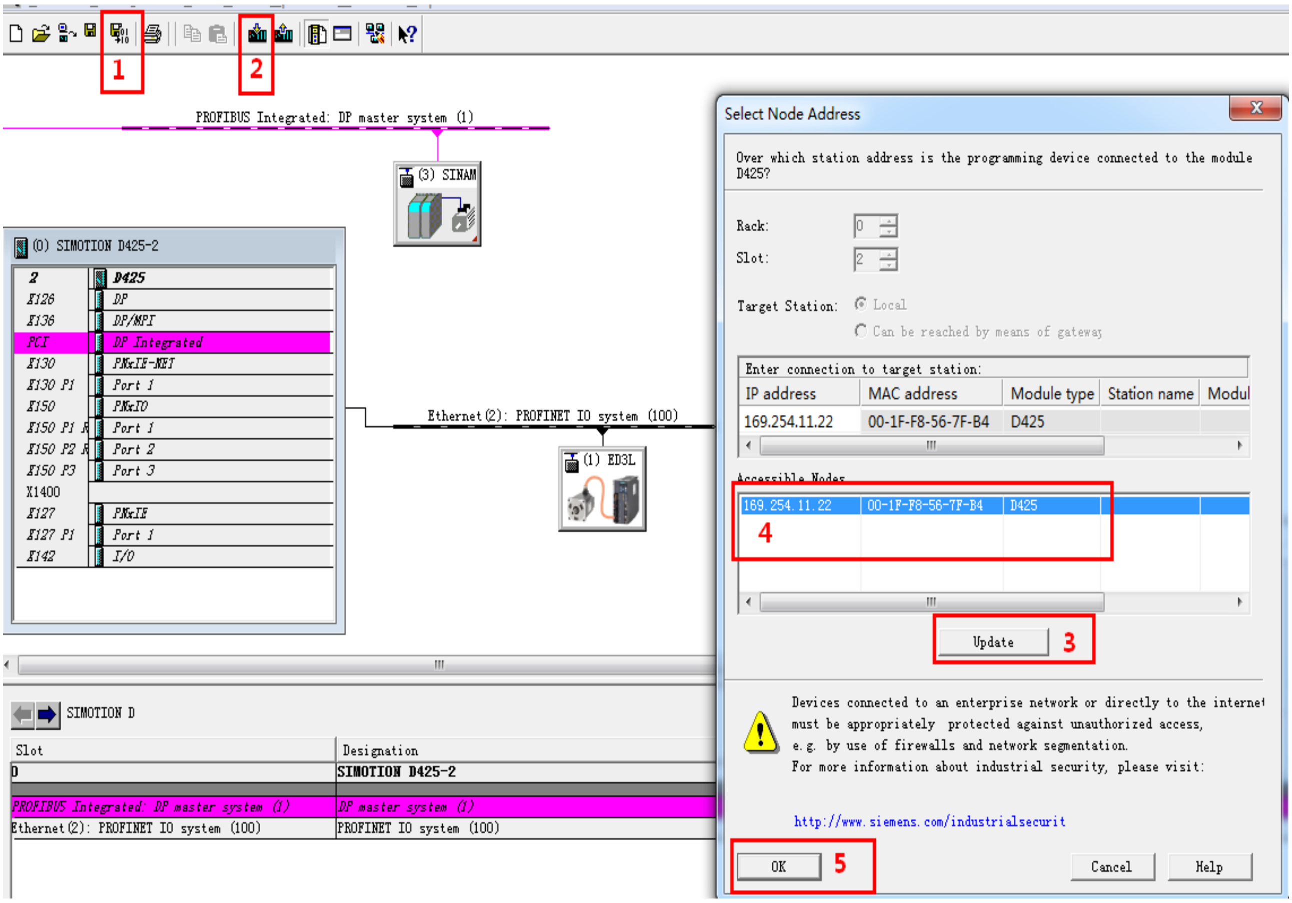
Step 9 Click ED3LPN Modules to add modules and packets in red numerical order.

Figure 7-55 Adding a packet



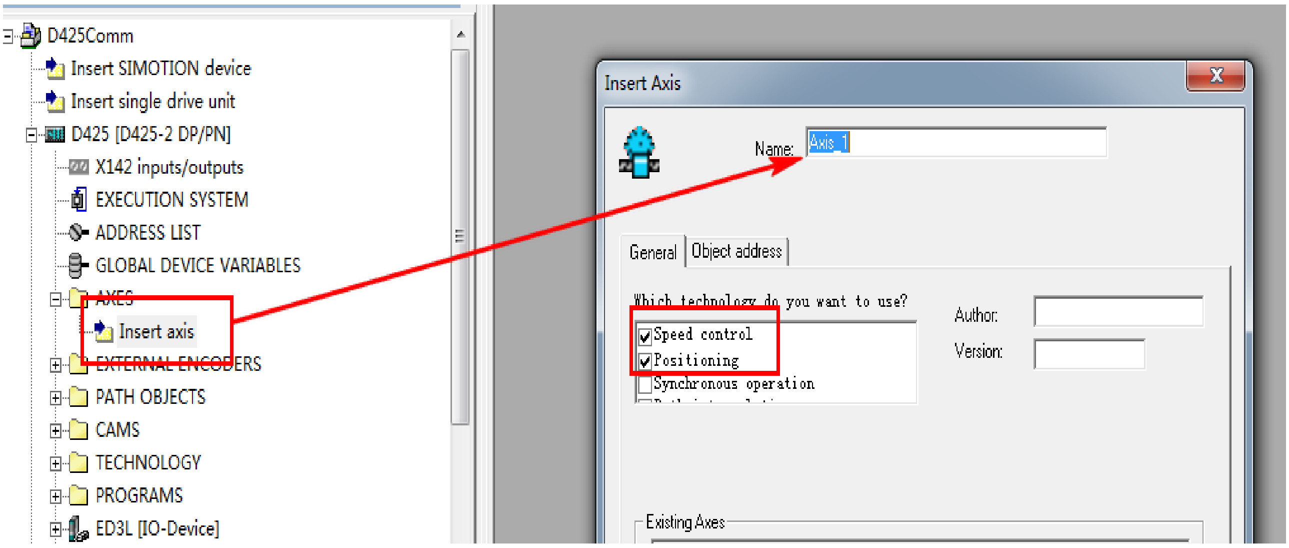
Step 10 The hardware configuration project is then compiled and downloaded, executed in red numerical order, as shown in the figure.

Figure 7-56 Compile and download the hardware configuration



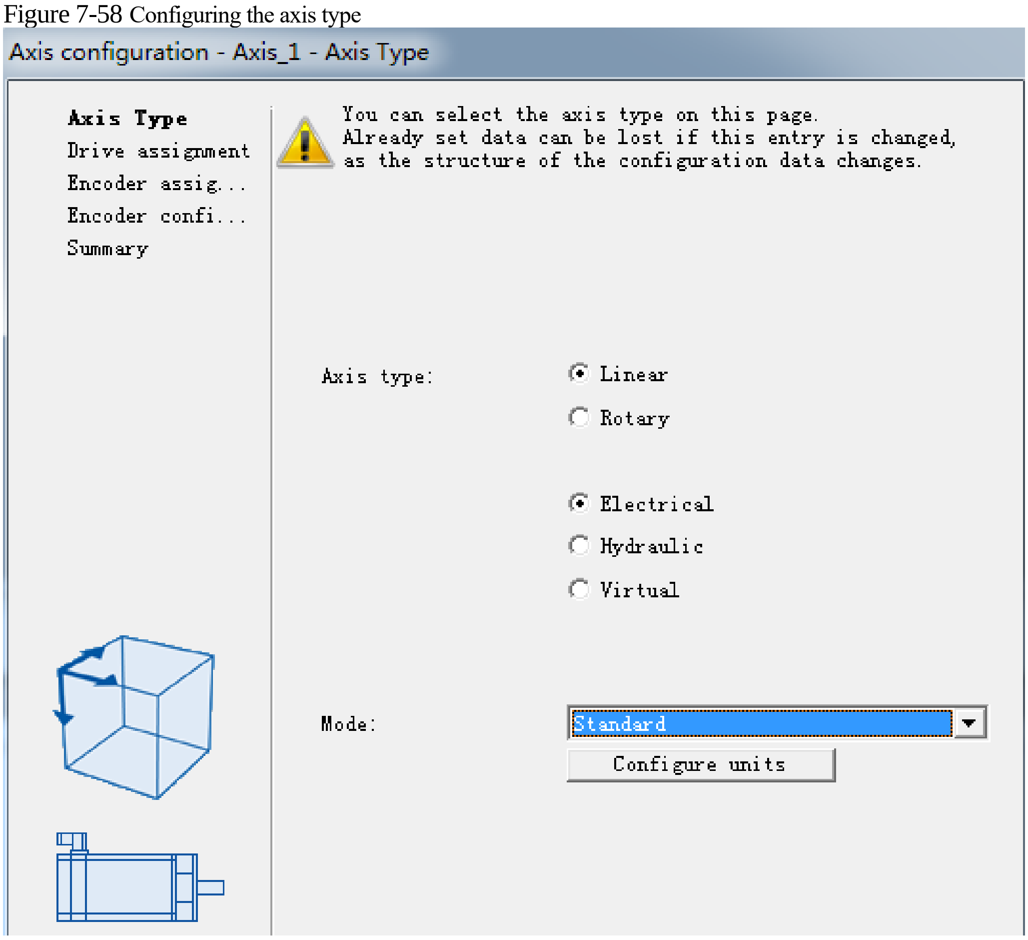
Step 11 Then add the process object, as shown in the figure.

Figure 7-57 Add a new craft object



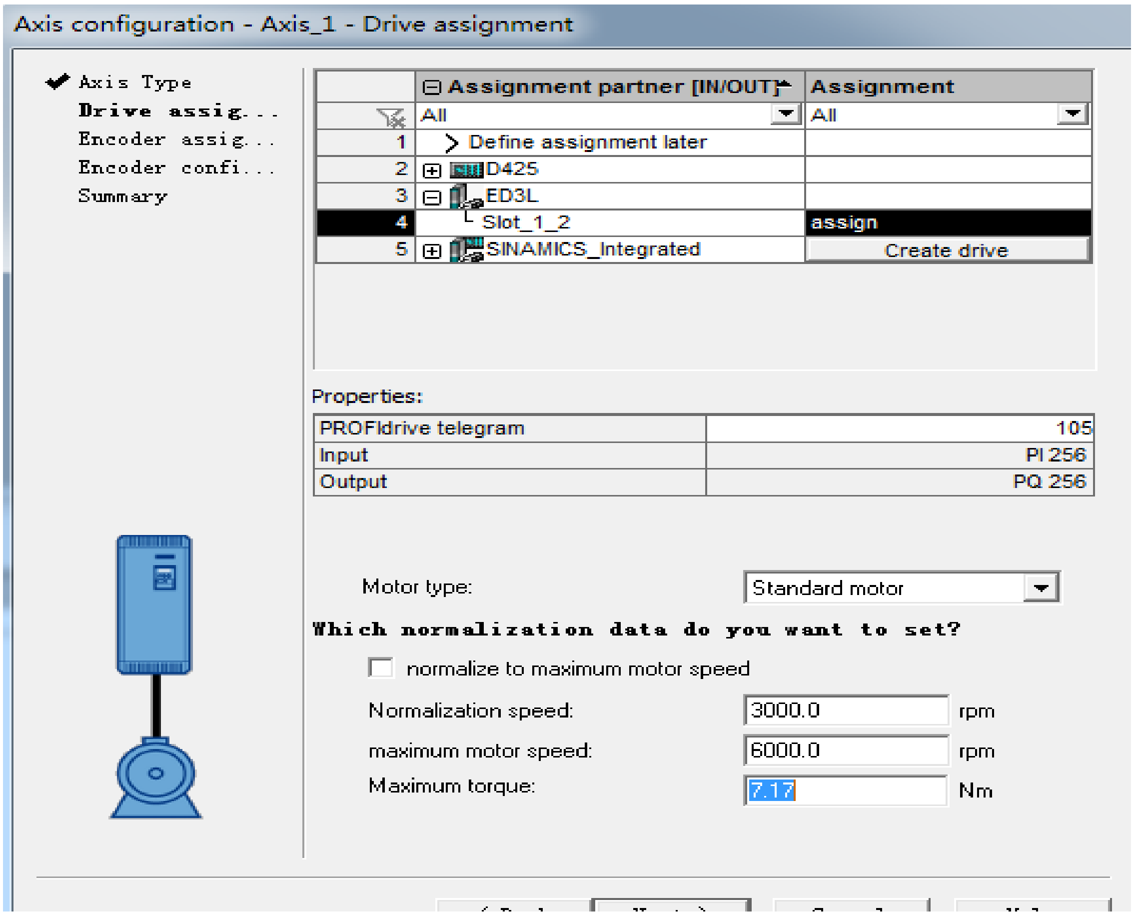
Step 12 Configure the axis type and select it according to the actual working conditions, as shown in the figure.

Figure 7-58 Configuring the axis type



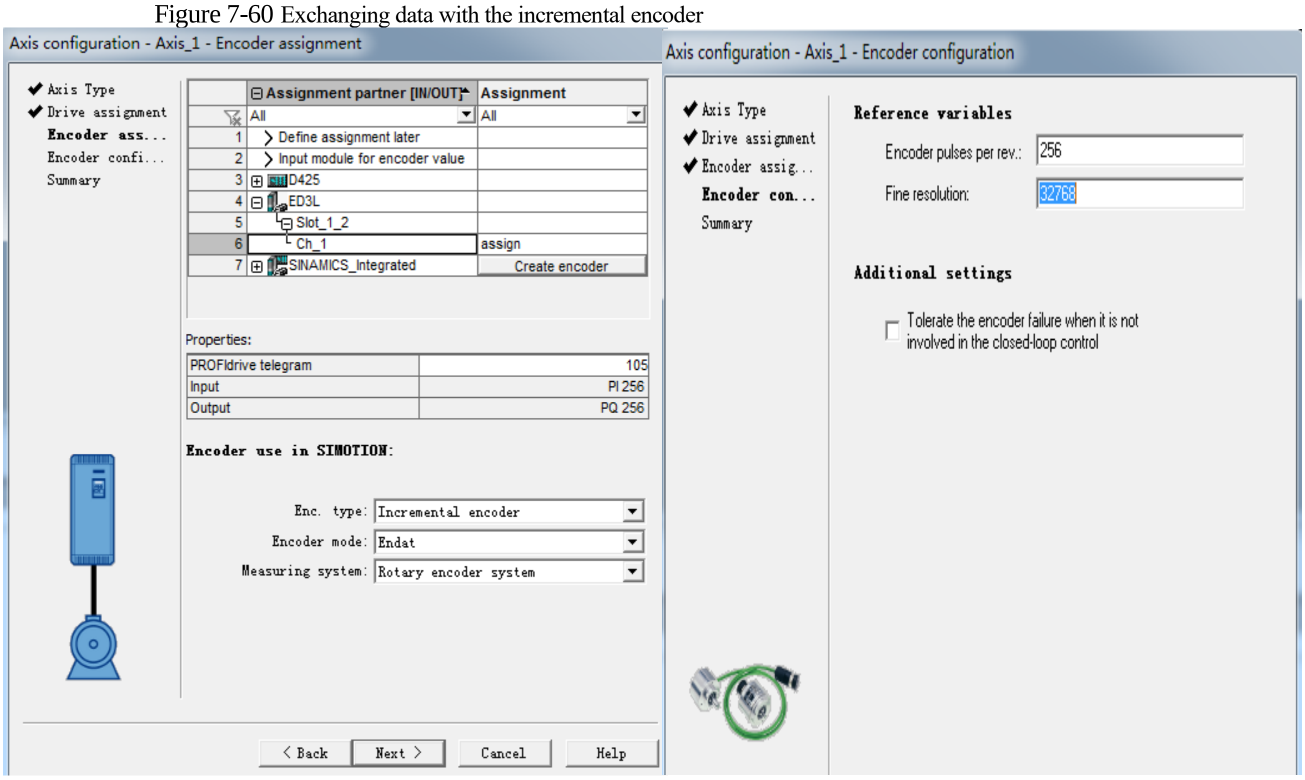
Step 13 Configure the data for the driver to interact with D425-2 DP/PN, as shown in the figure.

Figure 7-59 Exchanging data with the driver



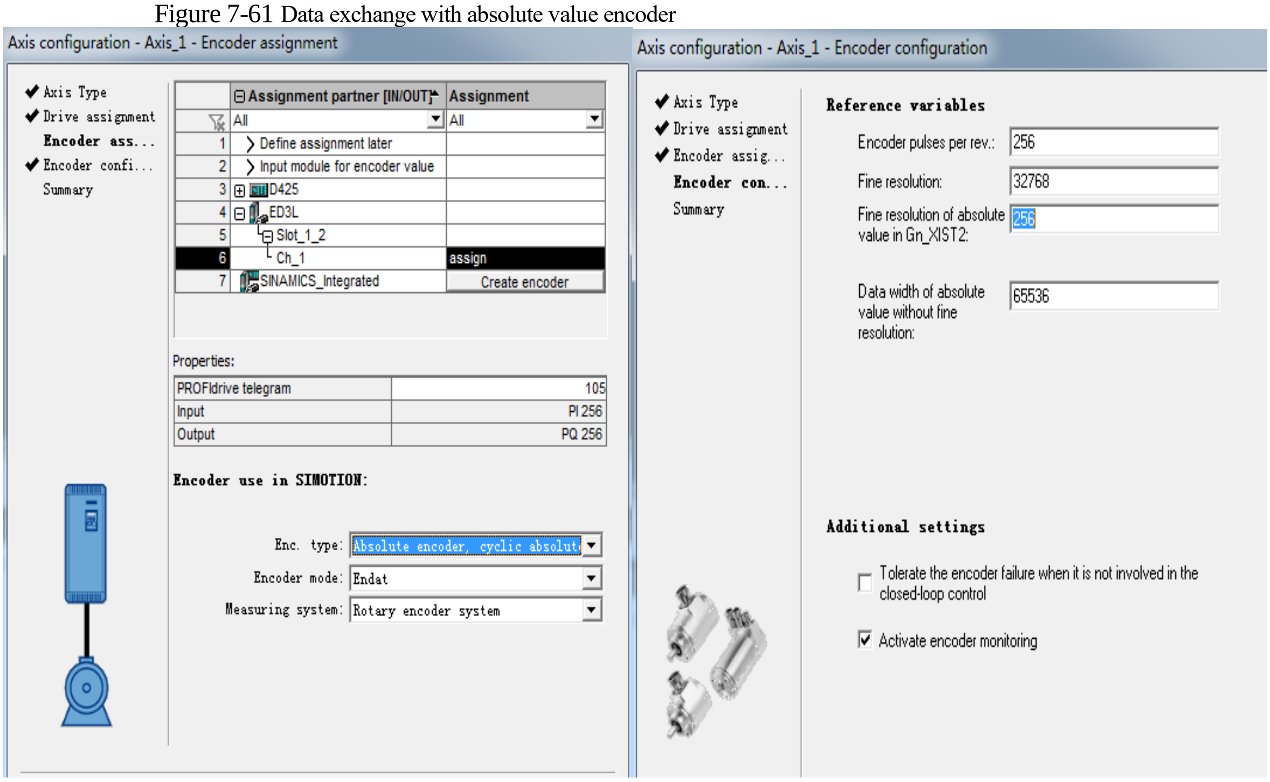
Step 14 Configure the data for the interaction between the encoder and D425-2 DP/PN, and set the data exchange parameter value in the increment mode of the encoder. The encoder type can be seen in the Pn002 value of ED3L. If Pn002 value is 0100, it is the increment encoder, as shown in the figure.

Figure 7-60 Exchanging data with the incremental encoder



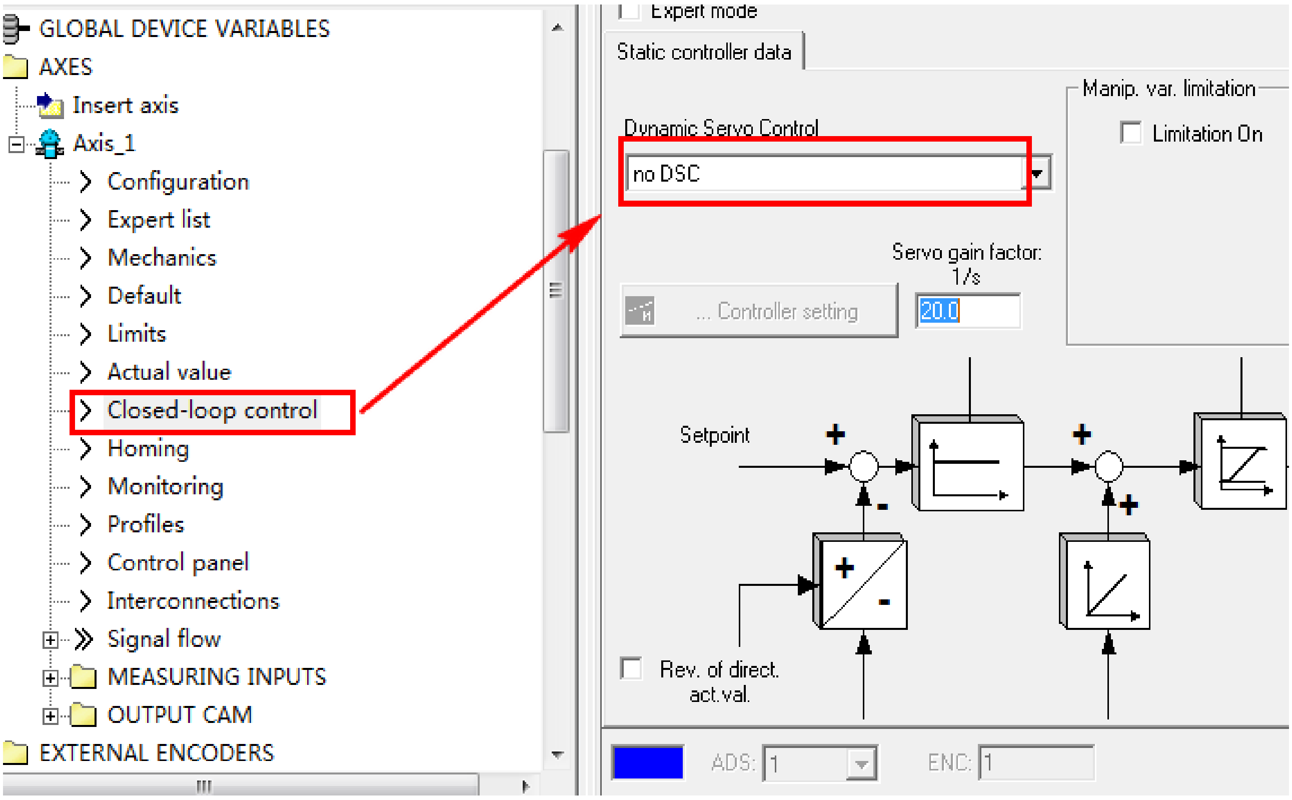
The data exchange parameter value is configured in the absolute value mode of encoder. The encoder type can see the Pn002 value of ED3L. When Pn002 value is 0000, it is the absolute value encoder, as shown in the figure.

Figure 7-61 Data exchange with absolute value encoder



At present, this version does not support the DSC function, so you need to configure the following figure.

Figure 7-62 DSC configuration



Step 15 After adding the process object axis, IRT configuration for communication is started, as shown in the figure.

Figure 7-63 IRT Pattern configuration

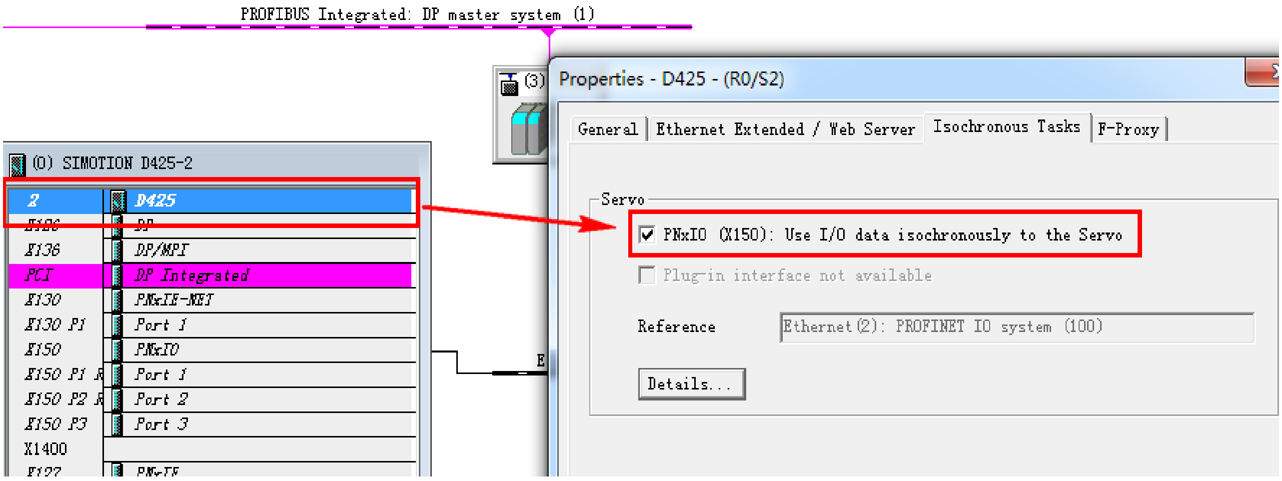


Figure 7-64 Synchronizing primary station configuration

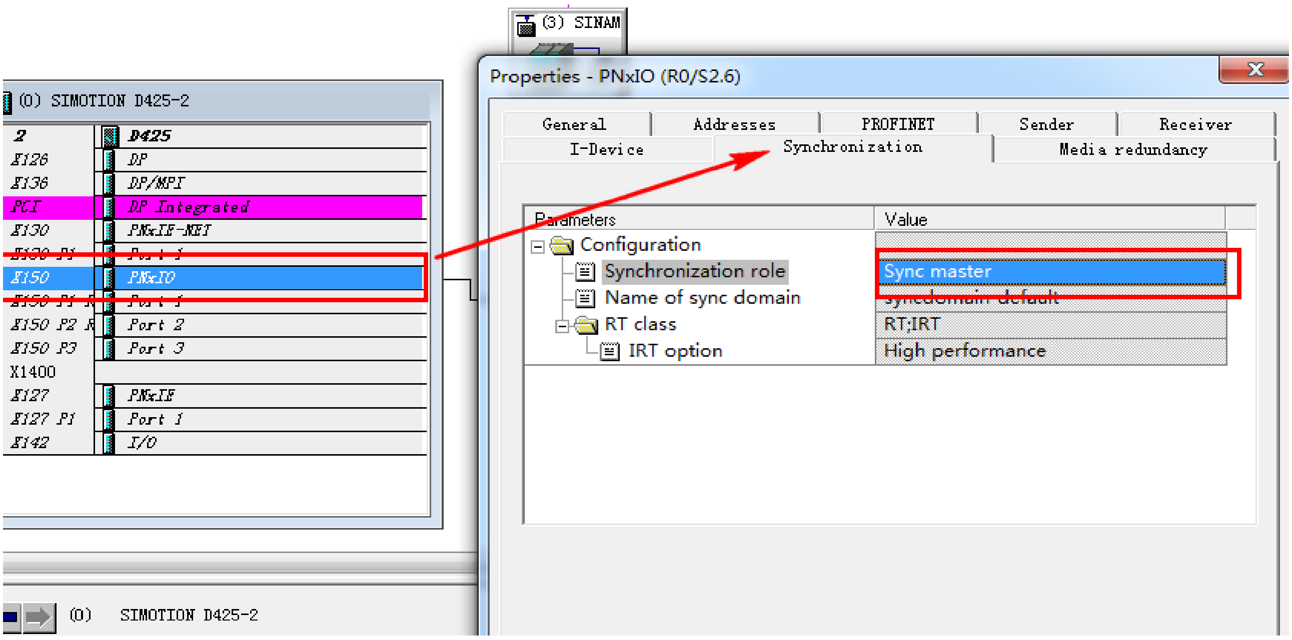
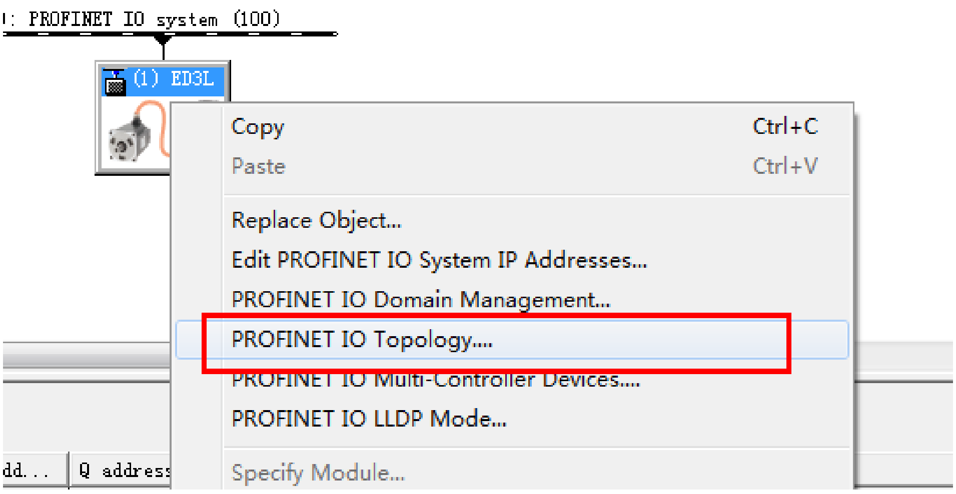


Figure 7-65 Configuring the network topology



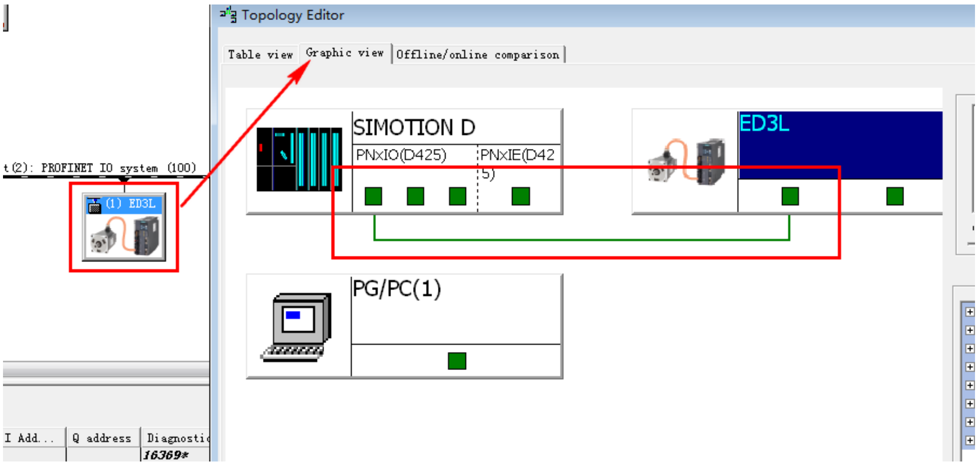
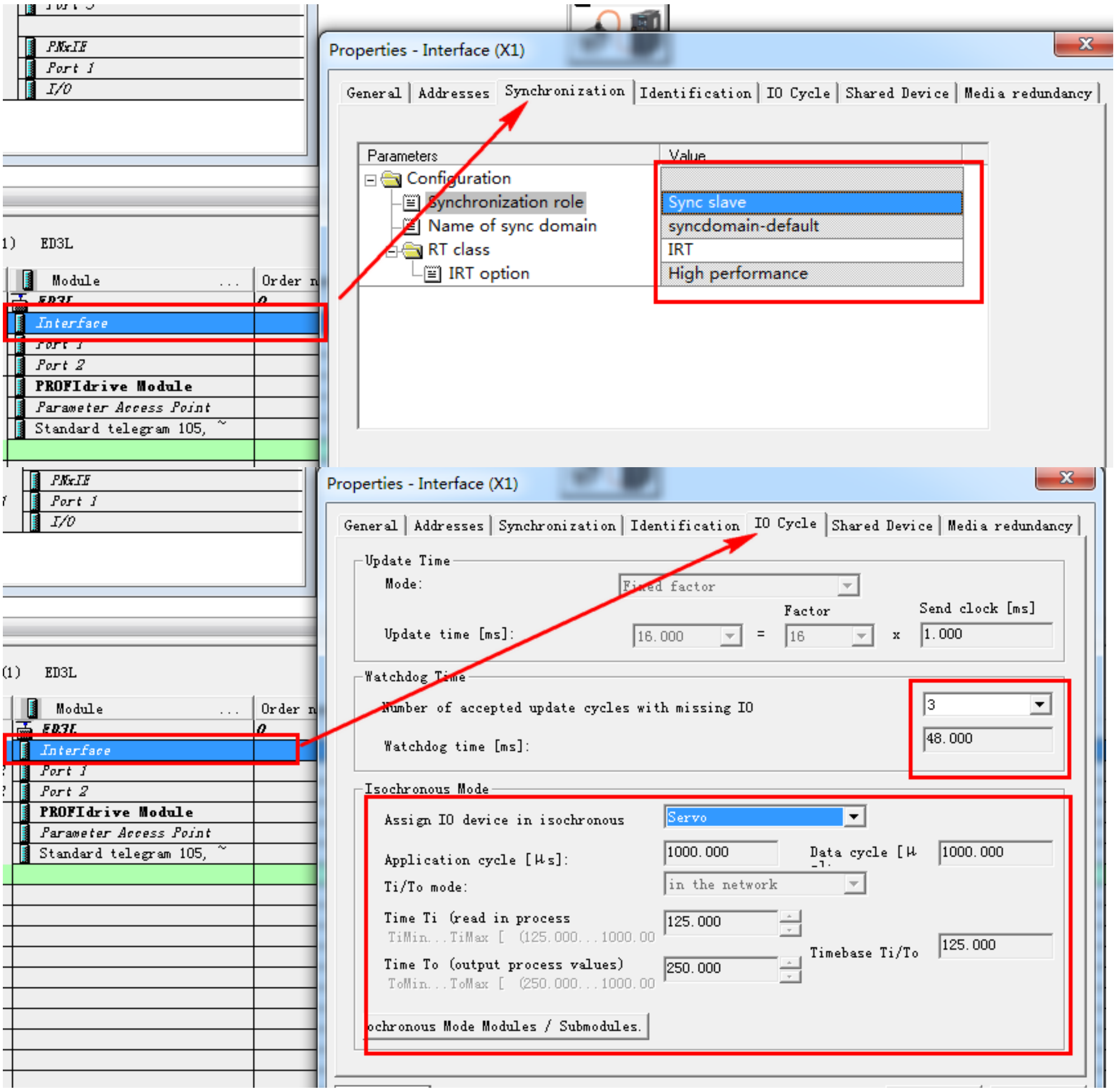
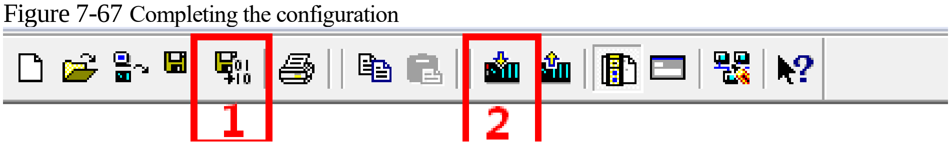


Figure 7-66 Synchronizing slave station configuration



Step 16 After the IRT configuration is completed, compile and download the new hardware configuration, as shown in the figure.

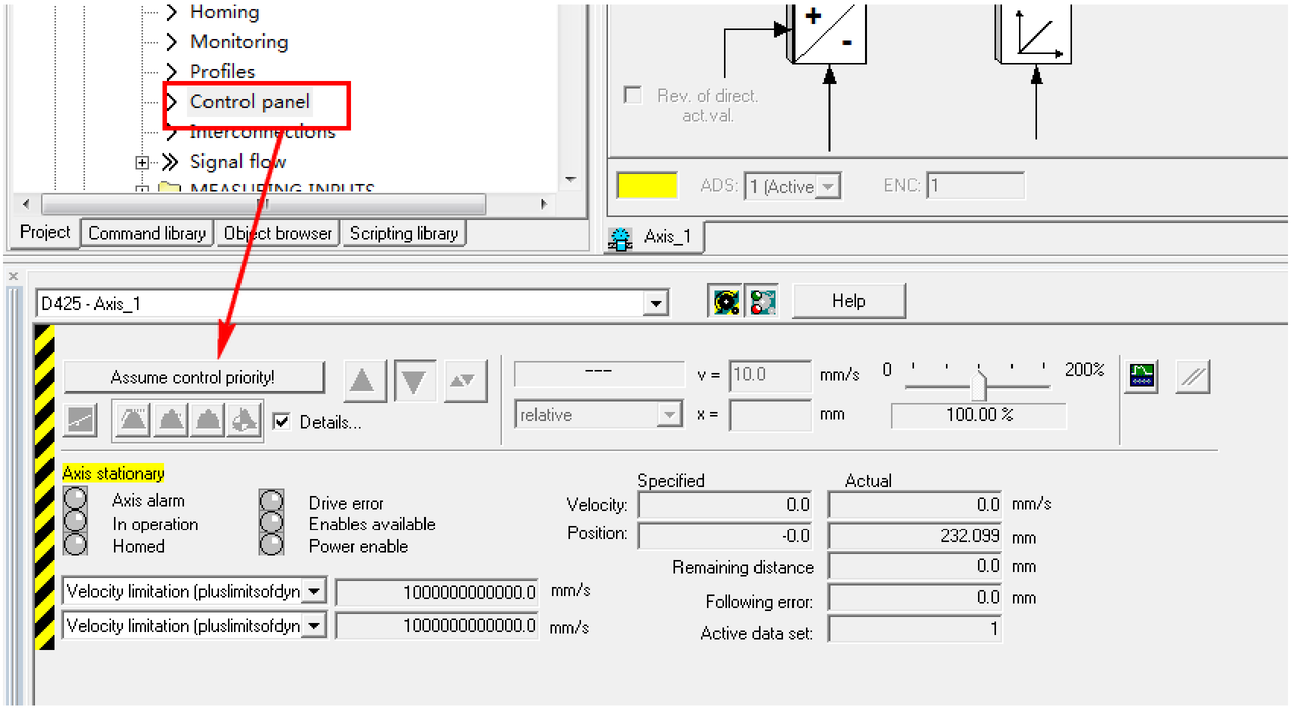
Figure 7-67 Completing the configuration



7.8.2 Debugging

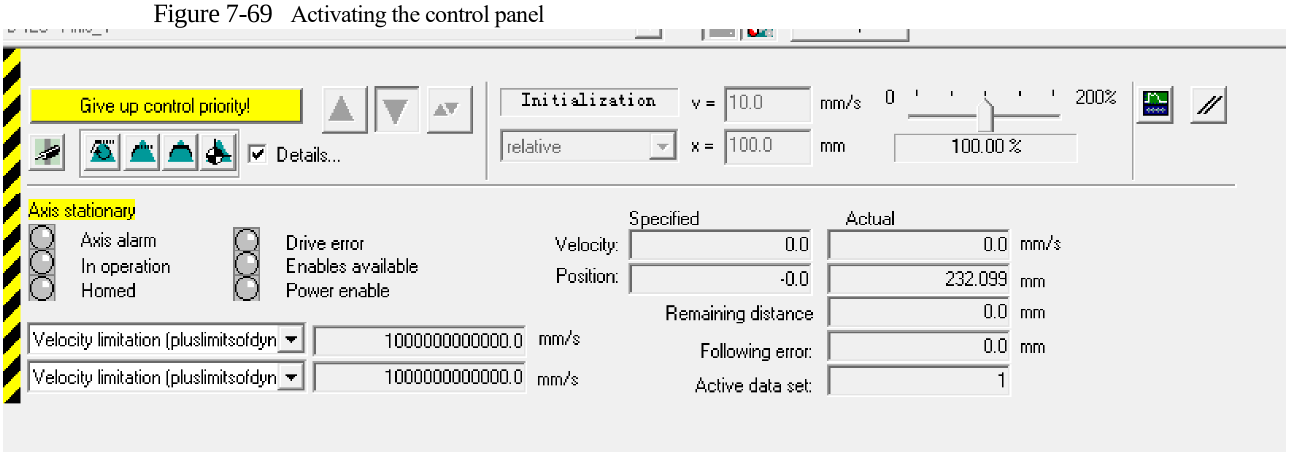
Step 1 Open the control panel, as shown in the figure.

Figure 7-68 Control Panel



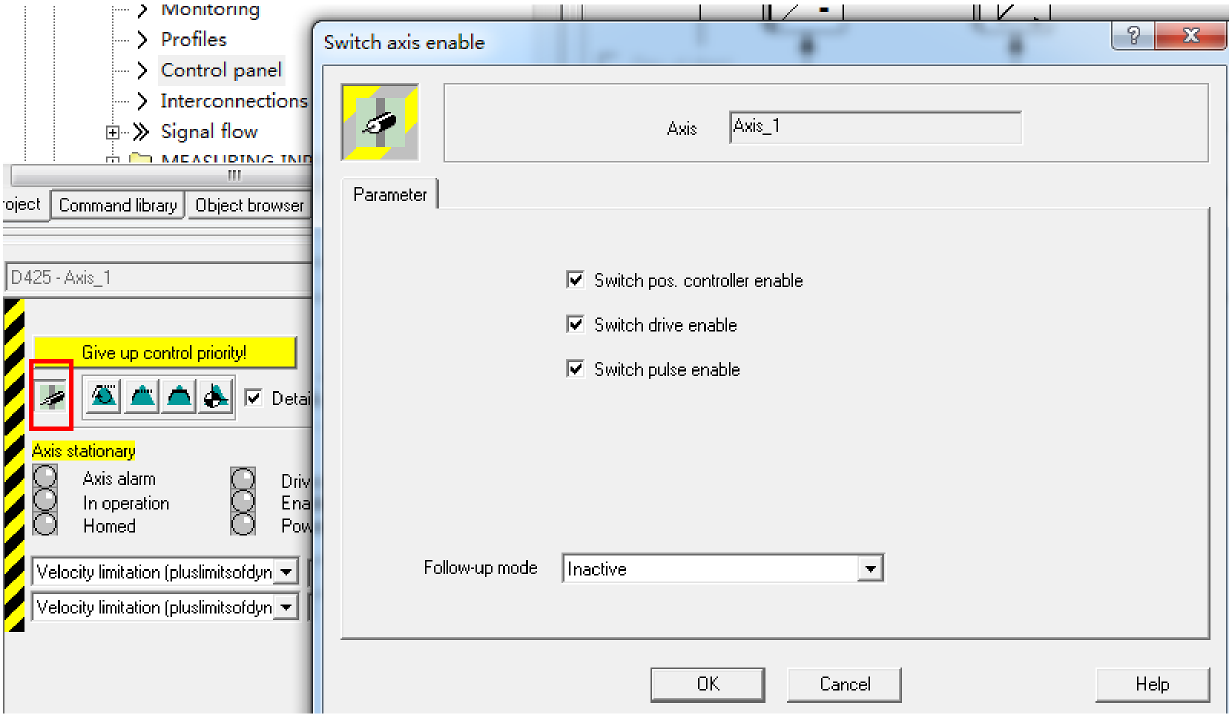
Step 2 ctivate control permissions on the control panel, as shown in the figure.

Figure 7-69 Activating the control panel



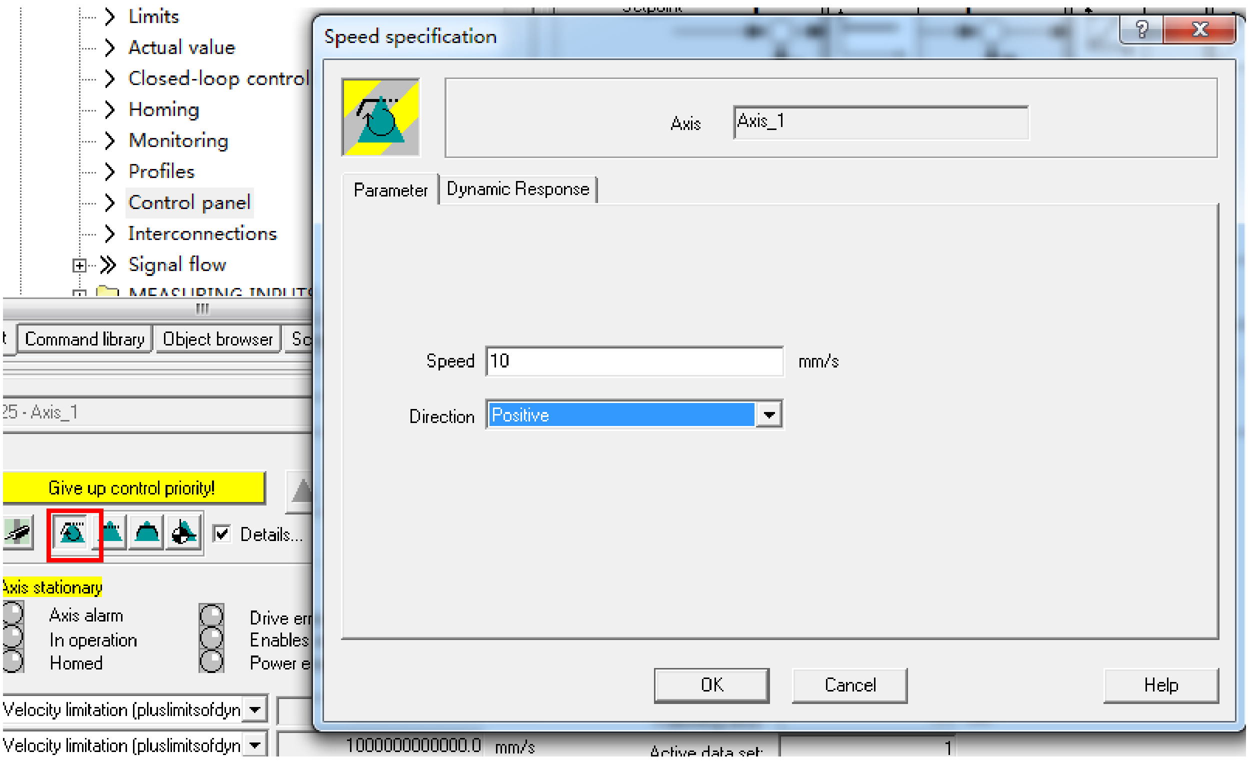
Step 3 Enable the control axis, as shown in the figure.

Figure 7-70 Enabling the control axis



Step 4 Step 4 Select control mode, speed control, position control, return to zero and absolute/relative position control, as shown in the figure for speed control mode.

Figure 7-71 Selecting Control mode



Chapter 8 Trial Operation

8.1 Preparations for Trail Operation

The procedure for trial operation is given below.

Step	Meaning	Reference
1	**Installation** Install the Motor and Drive according to the installation conditions. First, operation is checked with no load. Do not connect the Motor to the machine.	Chapter 2
2	**Wiring and Connections** Wire and connect the Drive. First, Motor operation is checked without a load. Do not connect the CN1 connector on the Drive.	Chapter 3
3	**Confirmations before Trial Operation**	–
4	**Power ON**	–
5	**Resetting the Absolute Encoder** If an absolute encoder is used, it is necessary to reset the absolute encoder.	6.6

8.2 Inspections and Confirmations

To ensure safe and correct trial operation, check the following items before you start trial operation.

- Make sure that the Drive and Motor are installed, wired, and connected correctly.
- Make sure that the correct power supply voltage is supplied to the Drive.
- Make sure that there are no loose parts in the Motor mounting.
- If you are using a Motor with an Oil Seal, make sure that the oil seal is not damaged. Also make sure that oil has been applied.
- If you are performing trial operation on a Motor that has been stored for a long period of time, make sure that all Motor inspection and maintenance procedures have been completed.
- If you are using a Motor with a Holding Brake, make sure that the brake is released in advance. To release the brake, you must apply the specified voltage of 24 VDC to the brake, for details see the section 3.6.4 Holding Brake Wiring.

8.3 Motor Operation without a Load

You use jogging for trial operation of the Motor without a load.

Jogging is used to check the operation of the Motor without connecting the Drive to the host controller. The Motor is moved at the preset jogging speed.

WARNING	■ During jogging, the overtravel function is disabled. ■ Consider the range of motion of your machine when you jog the Motor.

8.3.1 Preparations

Always check the following before you execute jogging.

- The main circuit power supply must be ON.
- There must be no alarms.
- The Servo must not be in Safe State.
- The servo must be OFF.
- The jogging speed must be set considering the operating range of the machine.

8.3.2 Applicable Tools

- Use the Panel Operator of the Drive
- Use the ESView V4 (Recommended)

8.3.3 JOG Operation

Use the Panel Operator of the Drive

Before performing the JOG operation by using the Panel Operator, you shall check and set the relevant parameters properly.

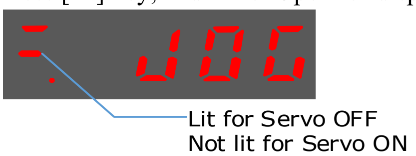
For the method of checking and setting parameters by using the Panel Operator, refers to the section **4.1.4 Parameter Setting Mode**.

Following the below steps to jog the Motor.

Step 1 Press [**M**] key several times to select the Utility Function Mode.

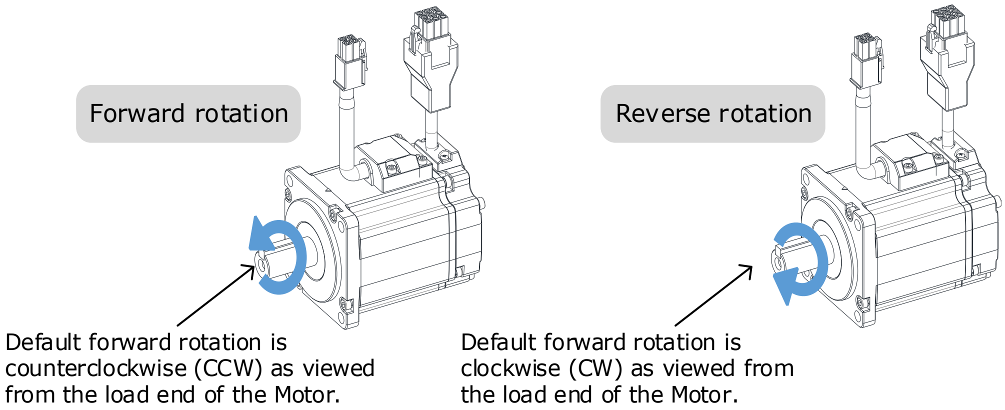
Step 2 Press [▲] key or [▼] key to select the function number Fn002.

Step 3 Press [◄] key, and Panel Operator displays as below.



Step 4 Press [**M**] key to Servo ON (supply power to Motor).
Press [**M**] key again to Servo OFF (not supply power to Motor).

Step 5 Press [▲] key or [▼] key to run the Motor in forward or reverse direction.
Press and hold [▲] key or [▼] key to run the Motor continuously.



NOTE: The rotation direction of the Motor depends on the setting of Pn001.0 (CCW, CW). The figure above shows the default setting.

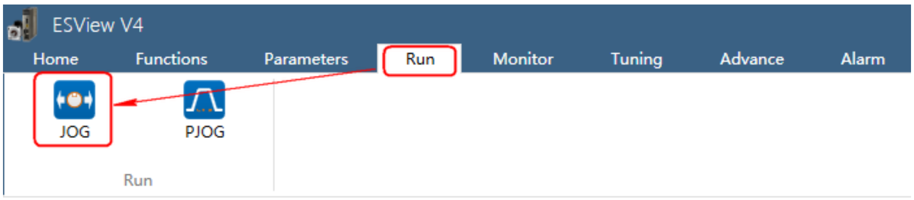
Step 6 Press the [◄] key to return to the display of the Fn002.

----End

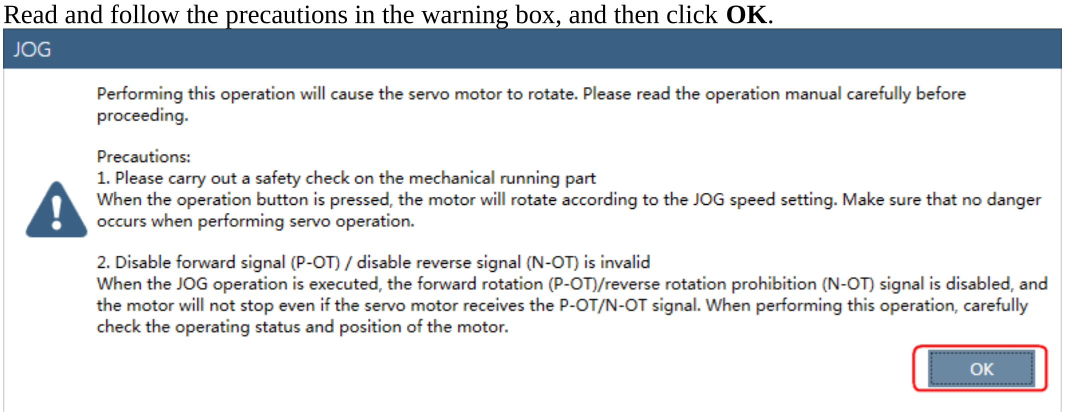
Use the ESView V4

The Motor will operate only while a button is clicked on the *ESView V4*.

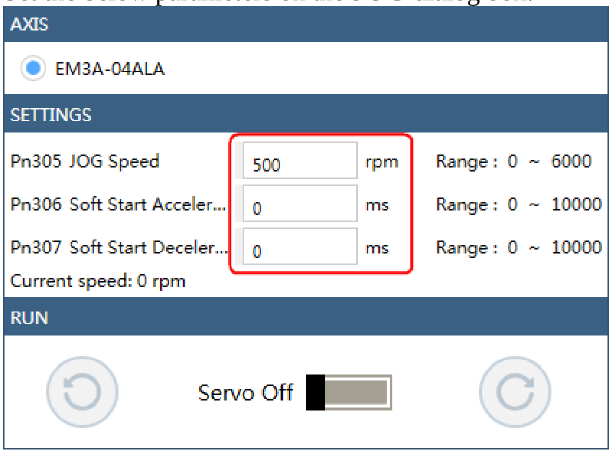
Step 1 Select **Run** > **JOG** in the **Menu Bar** of the *ESView V4* main windows.



Step 2 Read and follow the precautions in the warning box, and then click **OK**.

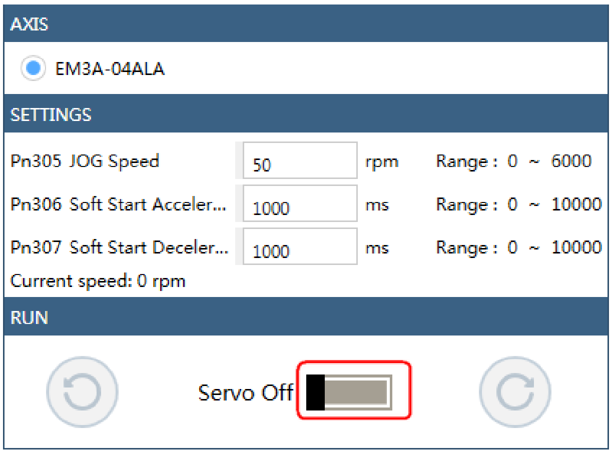


Step 3 Set the below parameters on the **JOG** dialog box.

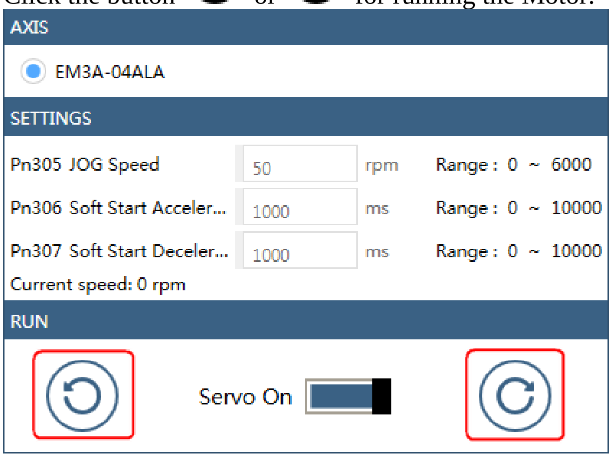


- **Pn305 JOG Speed**: set the speed for jogging the Motor.
- **Pn306 Soft Start Acceleration Time**: set the time it takes for the Motor runs to **JOG speed**.
- **Pn307 Soft Start Deceleration Time**: set the time it takes for the Motor stops from **JOG speed**.

Step 4 Click **Servo Off** / **Servo On** for supplying power to the Motor.



Step 5 Click the button  or  for running the Motor.



Click and hold the button  or  can run the Motor continuously, and the Motor can stop running when you release the button.

----End

8.4 Motor Operation with a Load

8.4.1 Precautions

WARNING

Operating mistakes that occur after the Motor is connected to the machine may not only damage the machine, but they may also cause accidents resulting in personal injury.

IMPORTANT

If you disabled the overtravel function for trial operation of the Motor without a load, enable the overtravel function (P-OT and N-OT signal) before you preform trial operation with the Motor connected to the machine in order to provide protection.

If you will use a holding brake, observe the following precautions during trial operation.

- Before you check the operation of the brake, implement measures to prevent vibration from being caused by the machine falling due to gravity or an external force.
- First check the Motor operation and brake operation with the Motor uncoupled from the machine. If no problems are found, connect the Motor to the machine and perform trial operation again.

Control the operation of the brake with the /BK (Brake) signal output from the Drive.

CAUTION

Failures caused by incorrect wiring or incorrect voltage application in the brake circuit may cause the Drive to fail, damage the Drive, damage the equipment, or cause an accident resulting in death or injury.

Observe the precautions and instructions for wiring and trial operation precisely as described in this manual.

8.4.2 Preparations

Always confirm the following before you perform the trial operation procedure for both the machine and Motor.

- Make sure that the Drive is connected correctly to both the host controller and the peripheral devices.
- Overtravel wiring
- Brake wiring
- Allocation of the /BK (Brake) signal to a pin on the I/O signal connector (CN1)
- Emergency stop circuit wiring
- Host controller wiring

8.4.3 Operation Procedure

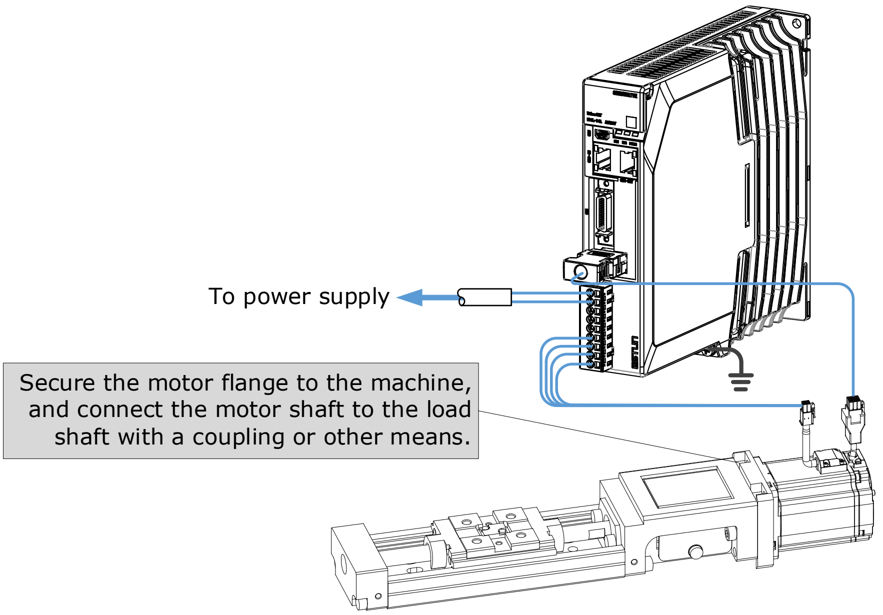
Step 1 Enable the overtravel signals.
Refers to the section 6.3 Overtravel Limit.

Step 2 Make the settings for the protective functions, such as the safety function, overtravel, and the brake.

- For details on overtravel settings, refers to the section 6.3 Overtravel Limit.
- For details on holding brake settings, refers to the section 6.5 Holding Brake.

Step 3 Turn OFF the power supplies to the Drive.
The control power supply and main circuit power supply will turn OFF.

Step 4 Couple the Motor to the machine.



Step 5 Turn ON the power supplies to the machine and host controller and turn ON the control power supply and main circuit power supply to the Drive.

Step 6 Check the protective functions, such overtravel and the brake, to confirm that they operate correctly.

Step 7 If necessary, adjust the servo gain to improve the Motor response characteristics.
The Motor and machine may not be broken in completely for the trial operation. Therefore, let the system run for a sufficient amount of time to ensure that it is properly broken in.

Step 8 For future maintenance, save the parameter settings with one of the following methods.

- Use the ESView V4 to save the parameters as a file.
- Record the settings manually.

This concludes the procedure for trial operation with both the machine and Motor.

----End

8.5 Program Jogging

You can use program jogging to perform continuous operation with a preset operation pattern, travel distance, movement speed, acceleration/deceleration time, waiting time, and number of movements.

You can use this operation when you set up the system in the same way as for normal jogging to move the Motor without connecting it to the host controller in order to check Motor operation and execute simple positioning operations.

8.5.1 Preparations

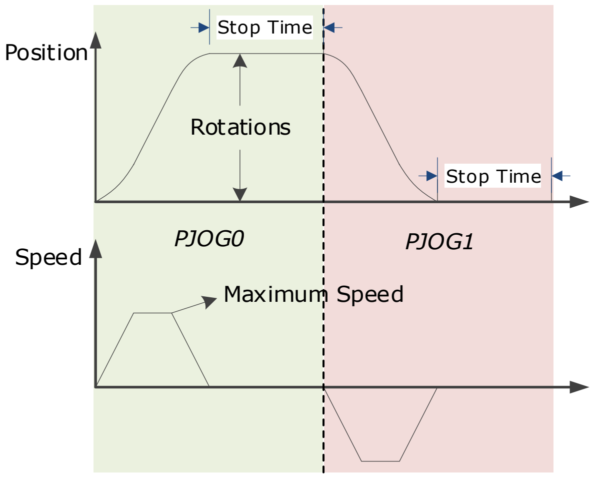
Always check the following before you execute program jogging.

- The parameters must not be written prohibited.
- The main circuit power supply must be ON.
- There must be no alarms.
- The Servo must not be in Safe State.
- The servo must be OFF.
- The range of machine motion and the safe movement speed of your machine must be considered when you set the travel distance and movement speed.
- There must be no overtravel.

8.5.2 Operation Description

Program jogging operation consists of two operation patterns (PJOG0 and PJOG1), you can set their relevant parameters respectively. Figure 8-1 shows an example of position-speed timing diagram in PJOG operation.

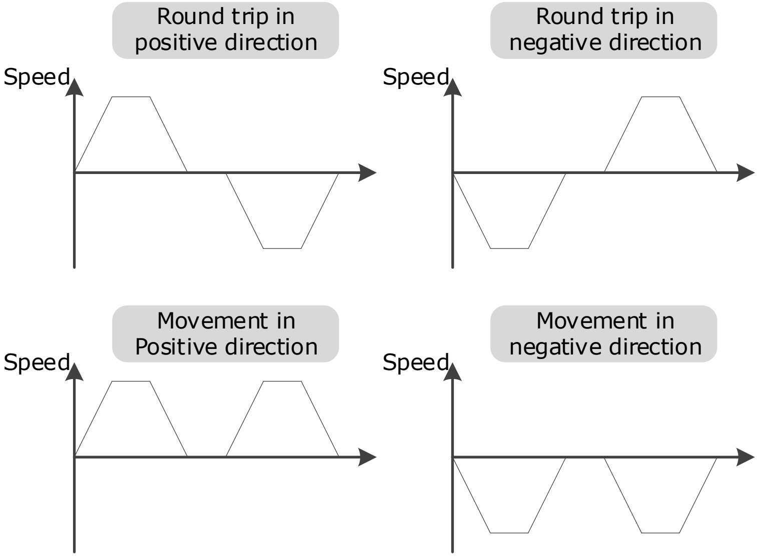
Figure 8-1 Position-speed timing diagram



The Drive will operator the Motor repeatedly according to the parameter settings of the two operation patterns until you stop the program jogging operation manually.

You can set the parameters Pn164 and Pn168 to a negative value for reversing the Motor, so that there are four ways of the operation in the program jogging, as is shown in Figure 8-2.

Figure 8-2 Operation in the program jogging



You shall set the Rotations (Pn164 and Pn168) and Max Speed (Pn165 and Pn169) to a proper value. If the Rotations is set too small or the Max Speed is set too large, it is possible that the maximum speed set cannot be reached. In this case, it is necessary to increase the Rotations or decrease the Max Speed.

8.5.3 Relevant Parameters

Parameter	Name	Range	Unit	Default	When Enabled
Pn164	Turns for PJOG0	-50 to 50	rotation	5	Immediately
Pn165	Max Speed for PJOG0	100 to 3000	rpm	1000	Immediately
Pn166	Acc./Dec. Time for PJOG0	50 to 2000	ms	500	Immediately
Pn167	Stop Time for PJOG0	100 to 10000	ms	1000	Immediately
Pn168	Turns for PJOG1	-50 to 50	rotation	5	Immediately
Pn169	Max Speed for PJOG1	100 to 3000	rpm	1000	Immediately
Pn170	Acc./Dec. Time for PJOG1	50 to 2000	ms	500	Immediately
Pn171	Stop Time for PJOG1	100 to 10000	ms	1000	Immediately

8.5.4 Applicable Tools

- Use the Panel Operator of the Drive
- Use the ESView V4 (Recommended)

8.5.5 Operation Procedure

Use the Panel Operator of the Drive

Before performing the Program Jogging (PJOG) operation by using the Panel Operator, you shall check and set the following parameters properly.

WARNING	Check and set the parameters Pn164 to Pn171 as proper values in advance, and ensure the movable parts have sufficient travel in the forward and reverse directions.

For the method of checking and setting parameters by using the Panel Operator, refers to the section 4.1.4 Parameter Setting Mode.

The following are the steps to run the Motor between the two programmed operation patterns (PJOG0 and PJOG1).

Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn018.

Step 3 Press [◄] key, and Panel Operator displays as below.

Step 4 Press [**M**] key to execute this operation, and Panel Operator displays as below.

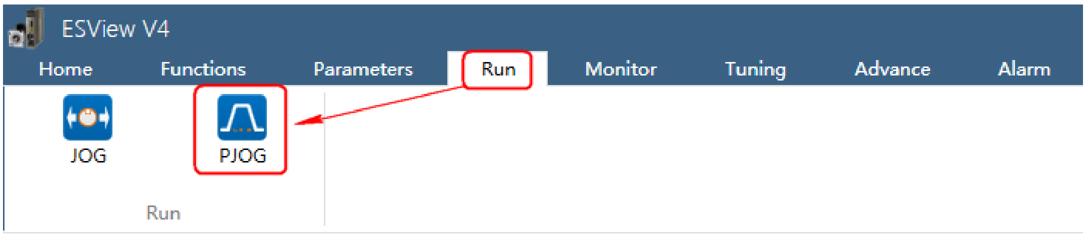
Step 5 Press [◄] key to return to the display of the Fn018.

----End

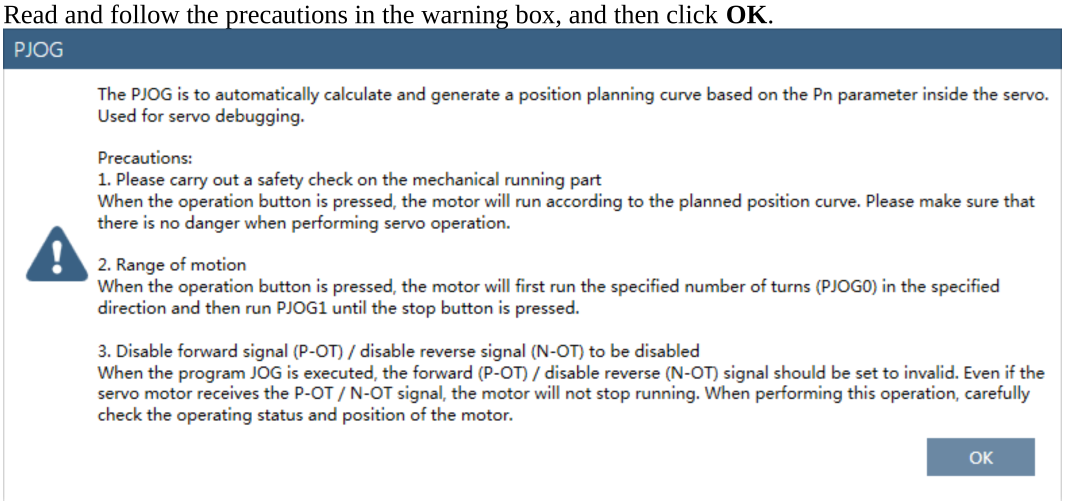
Use the ESView V4

The Motor can be run between the two programmed operation patterns (PJOG0 and PJOG1) by executing PJOG function.

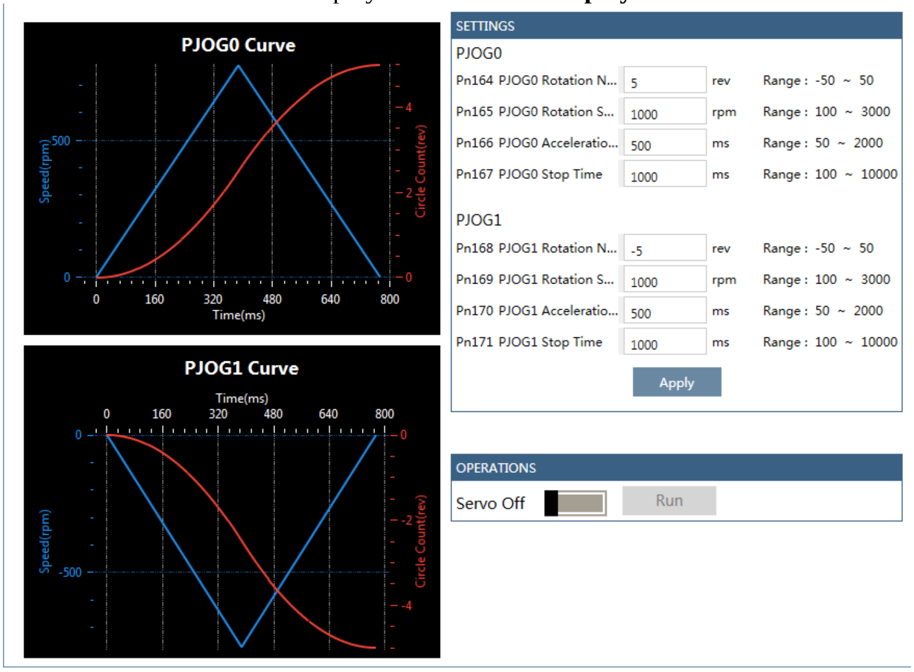
Step 1 Select **Run** > **PJOG** in the **Menu Bar** of the *ESView V4* main windows.



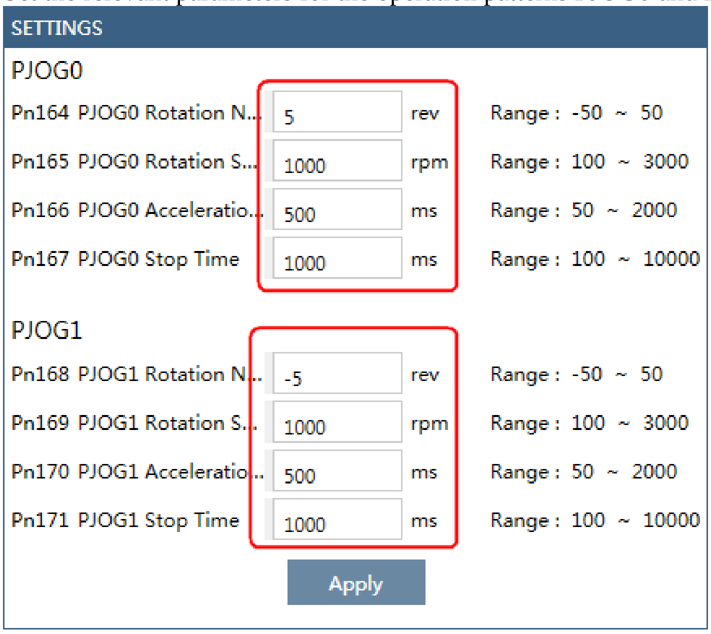
Step 2 Read and follow the precautions in the warning box, and then click **OK**.



Step 3 The **PJOG** window will be displayed in **Function Display Area**.



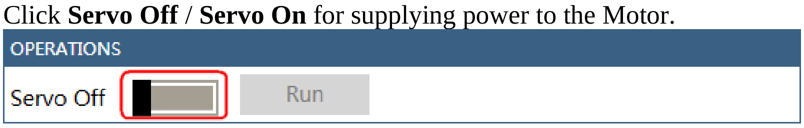
Step 4 Set the relevant parameters for the operation patterns PJOG0 and PJOG1.



- **Rotation Number**: Set the numbers of rotation the Motor will run in the operation pattern PJOG0 or PJOG1.
  NOTE: The Motor can be run in reverse when this parameter is set to a negative value.
- **Rotation Speed**: Set the Motor running speed in the operation pattern PJOG0 or PJOG1.
- **Acceleration/Deceleration Time**: Set the time it takes for the Motor runs to **Rotation Speed** or the Motor stops from **Rotation Speed**.
- **Stop Time**: Set the hold time when the Motor stops running in the operation pattern PJOG0 or PJOG1, and then switches to the other operation pattern.

Step 5 Click **Apply** to complete the settings.

Step 6 Click **Servo Off** / **Servo On** for supplying power to the Motor.



Step 7 Click **Run**.

The Motor will be run between the operation patterns **PJOG0** and **PJOG1**.

Click **Stop** for stopping the Motor running.

The Motor can be stopped when you close *ESView V4* or PJOG window.

----End

Chapter 9 Tuning

9.1 Overview

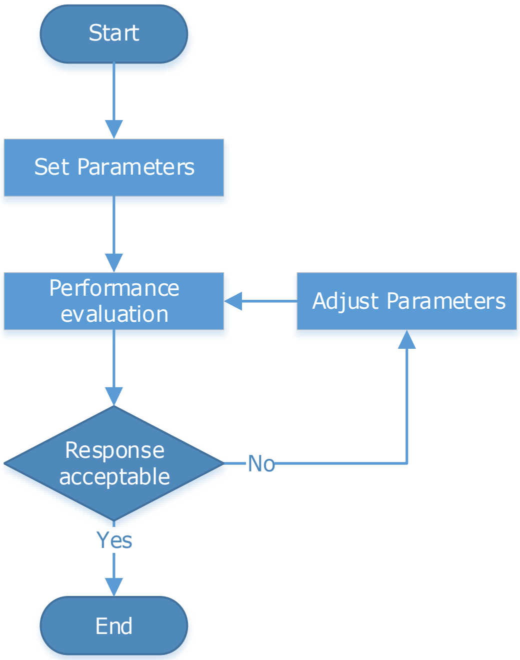
9.1.1 Basic Conception

Tuning is the process of satisfying the servo performance by adjusting the parameters involved in the control law.

Tuning Flow

The process of tuning is usually an iterative process, and Figure 9-1 shows the general flow.

Figure 9-1 General flow



Parameter Classification

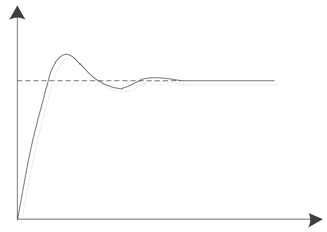
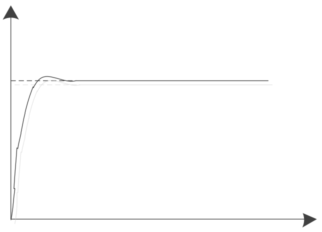
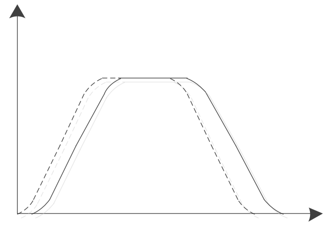
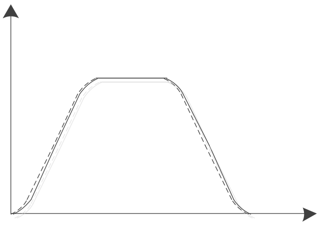
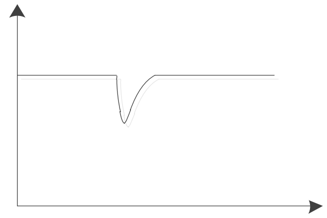
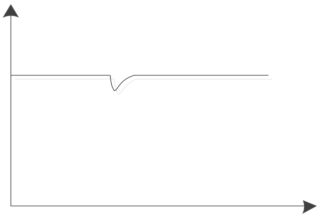
There are two types of parameters in the tuning.

- Function Parameters: refers to some application function selections or switches that may improve Servo performance.
- Adjustment Parameters: increasing or decreasing these parameters may improve Servo performance.

Servo Performance

In general, the indicators used to evaluate Servo performance are bandwidth, response time, overshoot, steady state error, anti-load disturbance, speed ripple fluctuation, torque ripple, and so on. Table 9-1 shows the comparison of the graphics before and after tuning in the example indicators.

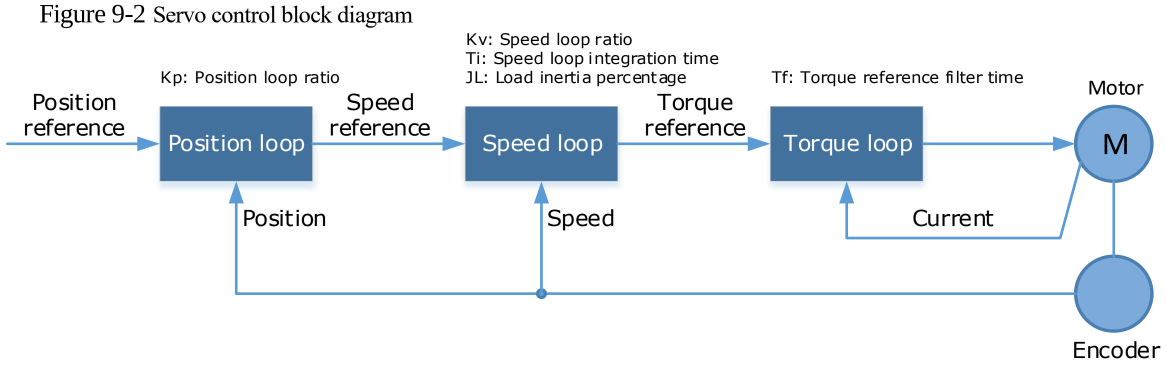
Table 9-1 Comparison of the graphics before and after tuning

Indicator	Before tuning	After tuning
Speed step response		
Position following		
Anti-load disturbance		

9.1.2 Control Block Diagram

It is necessary to learn the Servo control principle and Figure 9-2 shows the Servo control block diagram. The position loop, the speed loop and the torque loop are cascade structures, corresponding to the position control mode, the speed control mode and the torque control mode respectively.

Figure 9-2 Servo control block diagram

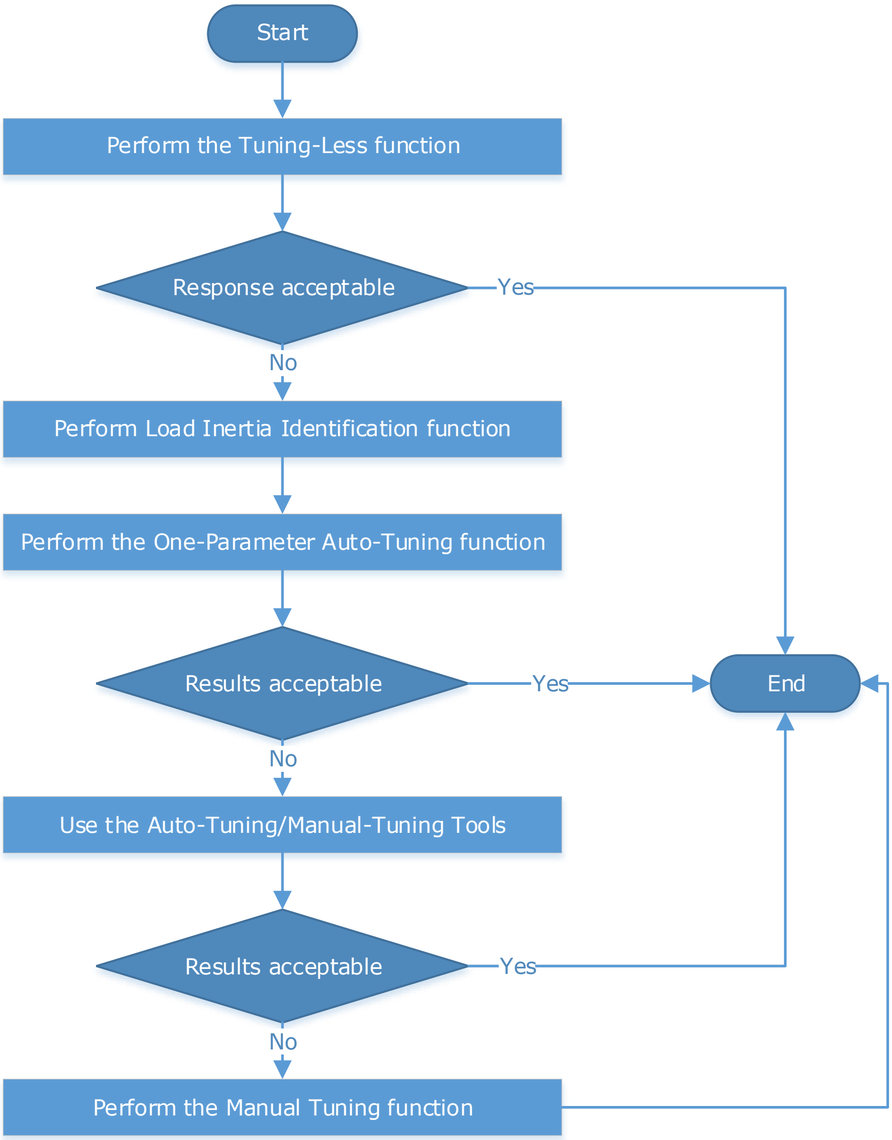


NOTE: only the basic tuning parameters during the tuning are shown in the figure.

9.1.3 Tuning Process

The Drive provides a variety of tuning methods, you can adjust the device according to the process shown in Figure 9-3, in order to obtain the desired Servo performance.

Figure 9-3 Tuning Process



IMPORTANT

It is necessary to perform the tuning operation again if the Motor had been disassembled or the load device had been replaced.

9.1.4 Precautions Before Tuning

- Before performing the tuning operation, make sure the limit function is available.
- Before performing the tuning operation, make sure that an emergency stop can be performed at any time.
- Before performing the tuning operation, you shall set the torque limit according to actual condition.
- Never touch the moving parts during the tuning operation.

9.2 Tuning Modes

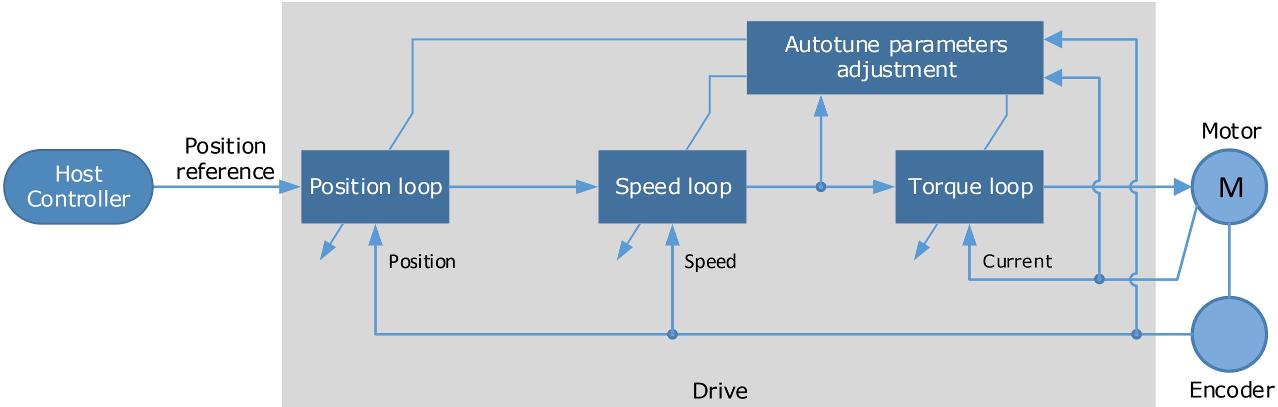
9.2.1 Tuning-Less

Function Description

The tuning-less performs auto-tuning to obtain a stable response regardless of the type of machine or changes in the load. Autotuning is started when the Servo is turned ON.

The tuning-less function uses an Autotune parameters adjustment module that updates the position loop and speed loop parameters in real time based on the servo operating state (position, speed, current). Figure 9-4 shows the block diagram in tuning-less.

Figure 9-4 Block diagram in tuning-less



When using the tuning-less function, the following parameters are automatically adjusted.

Parameter	Adjustment method
Speed Loop Gain	Auto-tuning
Speed Loop Integral Time	Auto-tuning
Position Loop Gain	Auto-tuning
Torque Command Filter Time	Auto-tuning
Load Inertia Percentage	Auto-tuning

NOTE: The parameters will not change automatically in tuning-less function.

Applicated Case

- Applied for that no more than 30 times the load moment of inertia.
- Applied for any rotation speed.

Relevant Parameters

Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	1 [Default]	Set the **Tuning Mode** as **Tuning-less**.	After restart	Function

Application Restrictions

The following functions or applications are not available in the Tuning-less function:

- Gain switch is disabled.
- P/PI Switch is disabled.
- Speed feedback by using observed speed is disabled.
- Load Torque Compensation is disabled.
- Model Following Control Function is disabled.

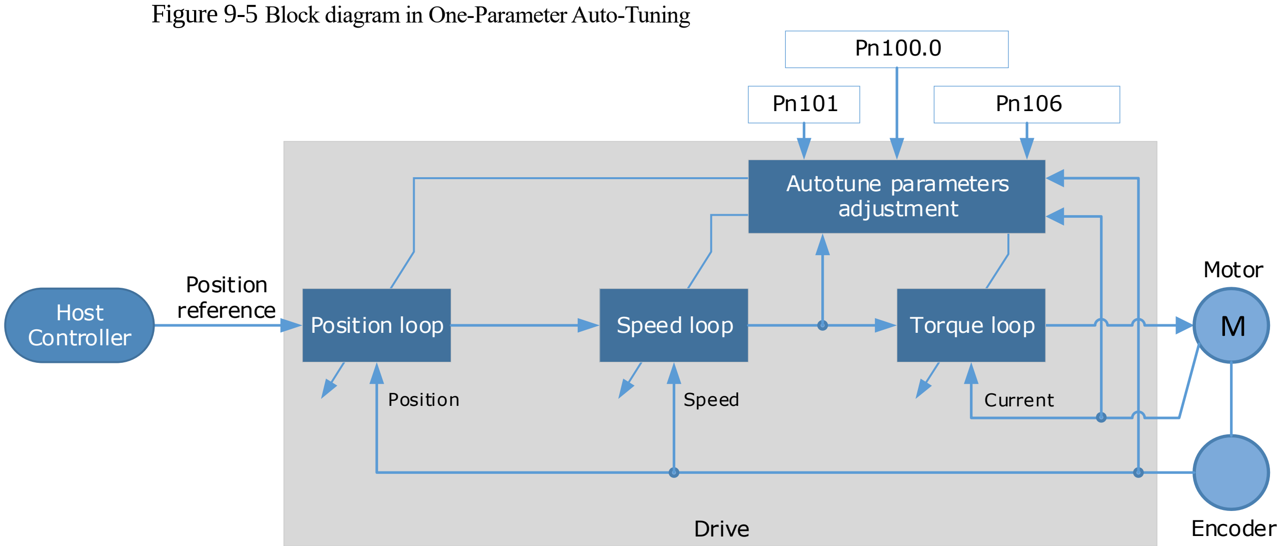
9.2.2 One-Parameter Auto-Tuning

Function Description

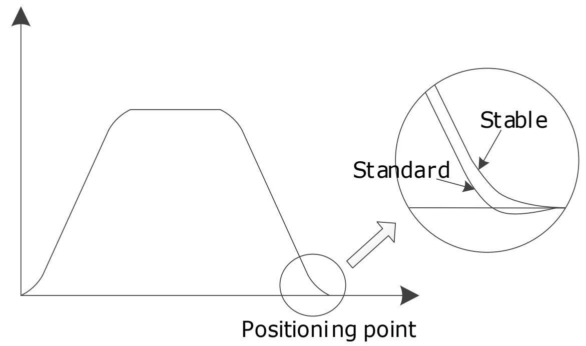
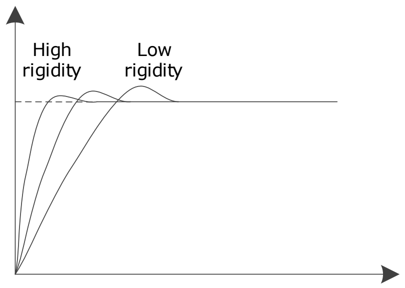
This tuning function is similar to the tuning-less function, using an Autotune parameters adjustment module that updates the position loop and speed loop parameters in real time based on the servo operating state (position, speed, current).

Only the parameter Pn101 (Servo Rigidity) needs to set in One-Parameter Auto-Tuning function, and Figure 9-5 shows the block diagram in One-Parameter Auto-Tuning.

Figure 9-5 Block diagram in One-Parameter Auto-Tuning



Before performing One-Parameter Auto-Tuning, you need to manually set the following parameters:

Parameter	Name	Description
Pn106	Load Inertia Percentage	Properly setting the Load Inertia Percentage is a prerequisite for the One-Parameter Auto-Tuning to obtain a better Servo performance. You can calculate the load inertia percentage (difficult and complex) by yourself, or you can get it by the utility function Fn009 or by ESView V4, certainly, you can directly modify the parameters by the host controller.
Pn100.3	Damping Selection	Select a damping method according to your requirement and application. ● [0] Standard: Short positioning time, but prone to overshoot. ● [1] Stable: Stable positioning, but long positioning time. 
Pn101	Servo Rigidity	The Servo Rigidity determines the response characteristic of the position loop or speed loop. The performance can be improved by increasing the Servo Rigidity, and decrease it if a vibration occurs. The figure below shows the speed step response for different Servo Rigidities: 

When using One-Parameter Auto-Tuning function, the following parameters are automatically adjusted.

Parameter	Adjustment method
Speed Loop Gain	Auto-tuning
Speed Loop Integral Time	Auto-tuning
Position Loop Gain	Auto-tuning
Torque Command Filter Time	Auto-tuning

NOTE: The parameters will not change automatically in tuning-less function.

Compared to Tuning-less, there are some features below in One-Parameter Auto-Tuning:

- Tuning based on a proper load inertia percentage can get a better servo performance.

- The setting of Servo Rigidity can be applied to more operating conditions.

Applicated Case

- Applied for that more than 50 times the load moment of inertia.
- Applied for any rotation speed.

Relevant Parameters

Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	3	Set the **Tuning Mode** as **One-Parameter Auto-Tuning**.	After restart	Function
Pn100.3	0	Set the damping method in **One-Parameter Auto-Tuning** as **Standard**.		
	1	Set the damping method in **One-Parameter Auto-Tuning** as **Stable**.		
Pn101	–	Servo Rigidity	Immediately	Adjustment
Pn106	–	Load Inertia Percentage	Immediately	Adjustment

Application Restrictions

The following functions or applications are not available in One-Parameter Auto-Tuning function:

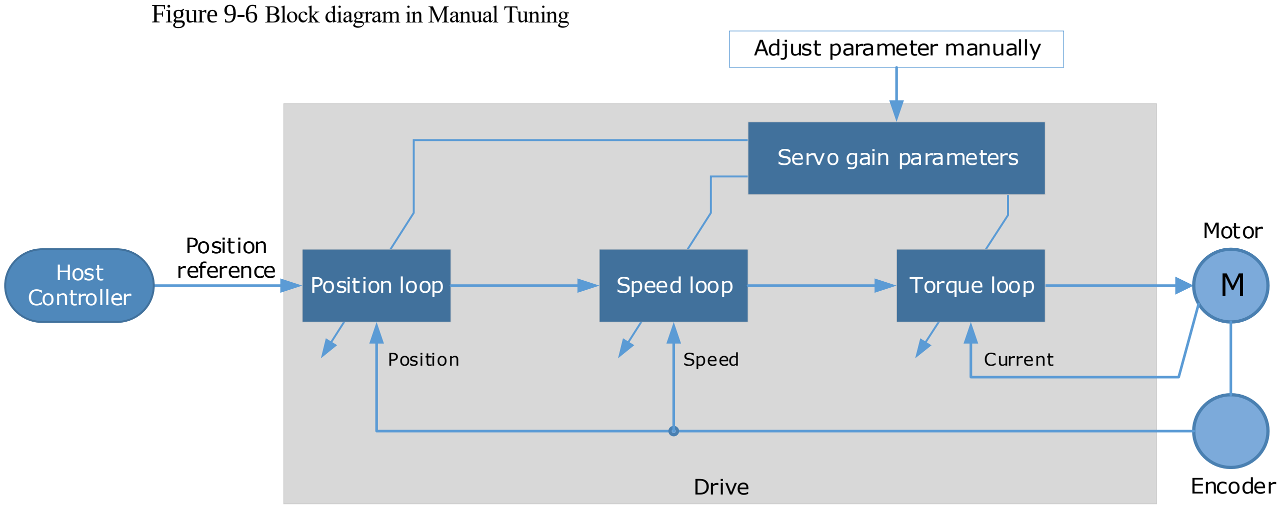
- Gain switch is disabled.
- Model Following Control Function is disabled.

9.2.3 Manual Tuning

Function Description

In the Manual Tuning, you need to manually adjust the gain parameters without using the autotune parameter adjustment module, until the Servo get the desired performance. Figure 9-6 shows the block diagram in Manual Tuning.

Figure 9-6 Block diagram in Manual Tuning



It is necessary to adjust the three-loop control parameters of the Servo from the inside out, that is, the adjustment sequence is $\boxed{\text{Torque loop}}$ → $\boxed{\text{Speed loop}}$ → $\boxed{\text{Position loop}}$. In addition, in order to meet the stability, the bandwidth setting should be the largest in the torque loop, the speed loop is the second, and the position loop is the smallest.

The following parameters need to be adjusted in each loop when performing Manual Tuning.

- Torque loop (Torque Control Mode)
  - Torque Reference Filter Time (Tf):

    The torque reference filter filters the torque reference to remove the high frequency band, which can effectively reduce the torque ripple of the Motor output, eliminate signal noise and reduce the temperature rise of the Motor.

  The larger the Torque Reference Filter Time, the better the filtering effect on the torque reference. However, the greater the phase lag, and the slower the torque response. Therefore, a smaller acceptable value should be set to obtain a larger torque loop bandwidth in the actual tuning.
- Speed loop (Speed Control Mode)
  - Relevant parameter in torque loop (Tf)
  - Load Inertia Percentage (JL)

    Properly setting the Load Inertia Percentage is a prerequisite for the tuning to obtain a better Servo performance.

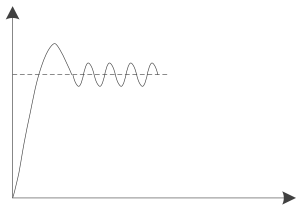
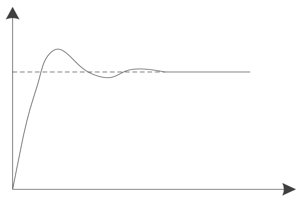
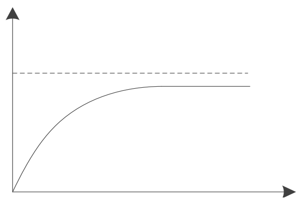
    You can calculate the load inertia percentage (difficult and complex) by yourself, or you can get it by the utility function Fn009 or by ESView V4, certainly, you can directly modify the parameters by the host controller.
  - Speed Loop Gain (Kv), Speed Loop Integral Time (Ti)

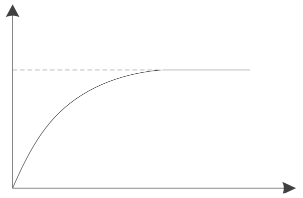
    The speed loop is controlled using a Proportional-Integral Controller that contains Speed Loop Gain and Speed Loop Integral Time. Both of them determine the speed loop bandwidth and anti-disturbance performance of the Servo.

    In general, if you can increase the setting of the Speed Loop Gain, the speed loop bandwidth will be increased and the anti-load disturbance performance will be better. And, if you can decrease the setting of the Speed Loop Integral Time, the integral action will be stronger, the speed loop bandwidth will be increased, and the anti-load disturbance performance will be better. In addition, the integral action may reduce the steady-state error to zero.

  Table 9-2 lists several commonly used adjustment methods based on the characteristics of the speed step response.

Table 9-2 Adjustment example in speed loop

Response Curve	Description	Adjustment method
	Speed loop bandwidth is high	Properly decrease the Speed Loop Gain or increase the Speed Loop Integral Time.
	Speed loop damping ratio is low	Properly increase the Speed Loop Integral Time.
	Steady-state error is existed	Properly decrease the Speed Loop Integral Time.

Response Curve	Description	Adjustment method
	Speed loop bandwidth is low	Properly increase the Speed Loop Gain or decrease the Speed Loop Integral Time.

It is recommended to increase the Speed Loop Gain and decrease the Speed Loop Integral Time to obtain a larger speed loop bandwidth.

- Position loop (Position Control Mode)
  - Relevant parameters in speed loop (Kv, Ti, Tf, and JL)
  - Position Loop Gain (Kp)
    The position loop is controlled using a Proportional Controller that only contains the Position Loop Gain. This parameter determines the position loop bandwidth. If you increase the Position Loop Gain, the position loop bandwidth will be increased and the anti-load disturbance performance will be better. However, overshooting and vibration in the position reference may be occurred.

  It is recommended to set the Position Loop Gain to a quarter of the Speed Loop Gain, and make appropriate adjustments based on this.

Applicated Case

- Applied for that more than 50 times the load moment of inertia.
- Applied for any rotation speed.

Relevant Parameters

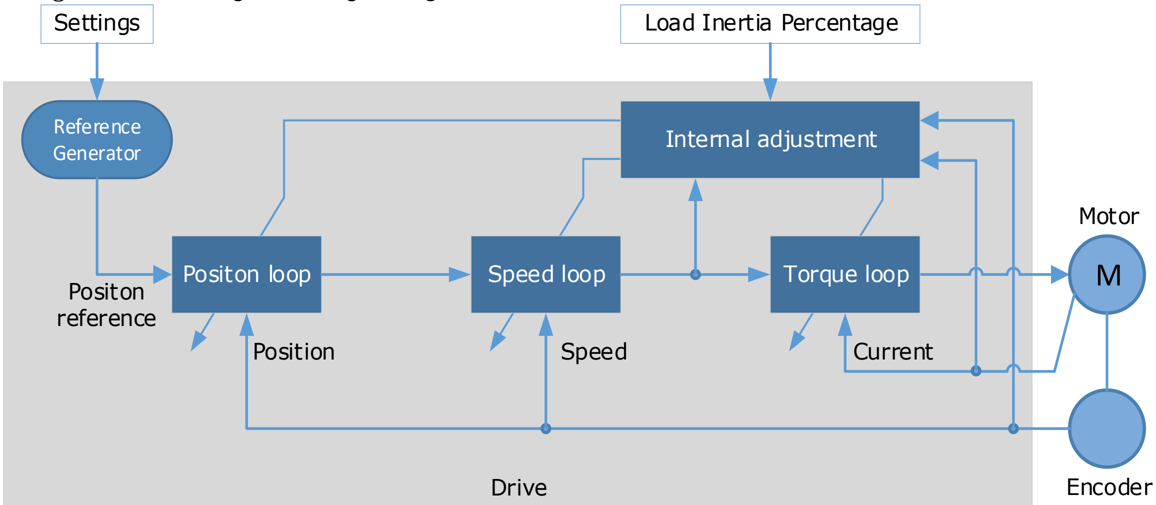
Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	5 [Default]	Set the **Tuning Mode** as **Manual tuning**.	After restart	Function
Pn102/Pn107	–	Speed Loop Gain	Immediately	Adjustment
Pn103/Pn108	–	Speed Loop Integral Time	Immediately	Adjustment
Pn104/Pn109	–	Position Loop Gain	Immediately	Adjustment
Pn105/Pn110	–	Torque Command Filter Time	Immediately	Adjustment
Pn106	–	Load Inertia Percentage	Immediately	Adjustment

NOTE: the settings of Pn107 to Pn110 are taken effect after the gain is switched.

9.3 Tuning Tools

There is an Auto-Tuning Tool and a Manual Tuning Tool in Tuning tools. When using a tuning tool, the Drive will execute the position references generated internally, Figure 9-7 shows the block diagram in using a tuning tool.

Figure 9-7 Block diagram in using a tuning tool



The reference generator plans an appropriate position reference according to the settings of relevant parameter.

WARNING	Since the limit function is unavailable when using the tuning tools, please make sure that the movable parts have sufficient travel in the planned motion track.

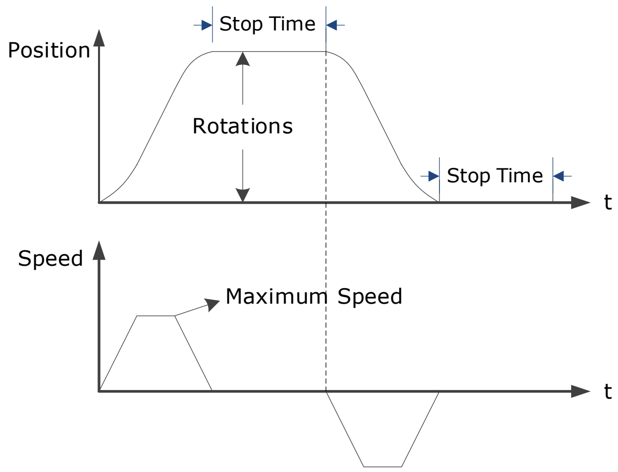
9.3.2 Auto-Tuning Tool

Function Description

With the Auto-Tuning Tool, the reference generator can plan the position curve and generate a position reference as inputs to the position loop.

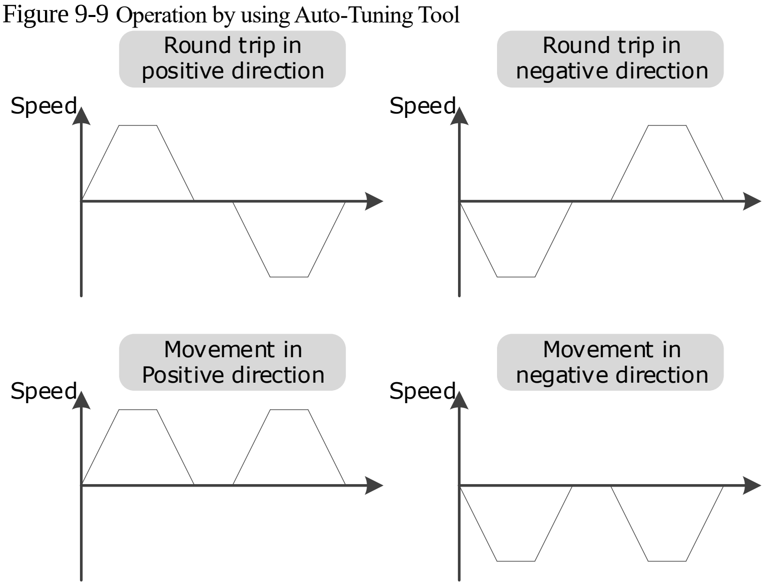
There are two operation patterns (POS0 and POS1), you can set their relevant parameters respectively. Figure 9-8 shows an example of position-speed timing diagram in PJOG operation.

Figure 9-8 Position-speed timing diagram



The Drive will operator the Motor repeatedly according to the parameter settings of the two operation patterns until the tuning is completed. You can set the parameters Pn164 and Pn168 to a negative value for reversing the Motor, so that there are four ways of the operation in the program jogging, as is shown in Figure 9-9.

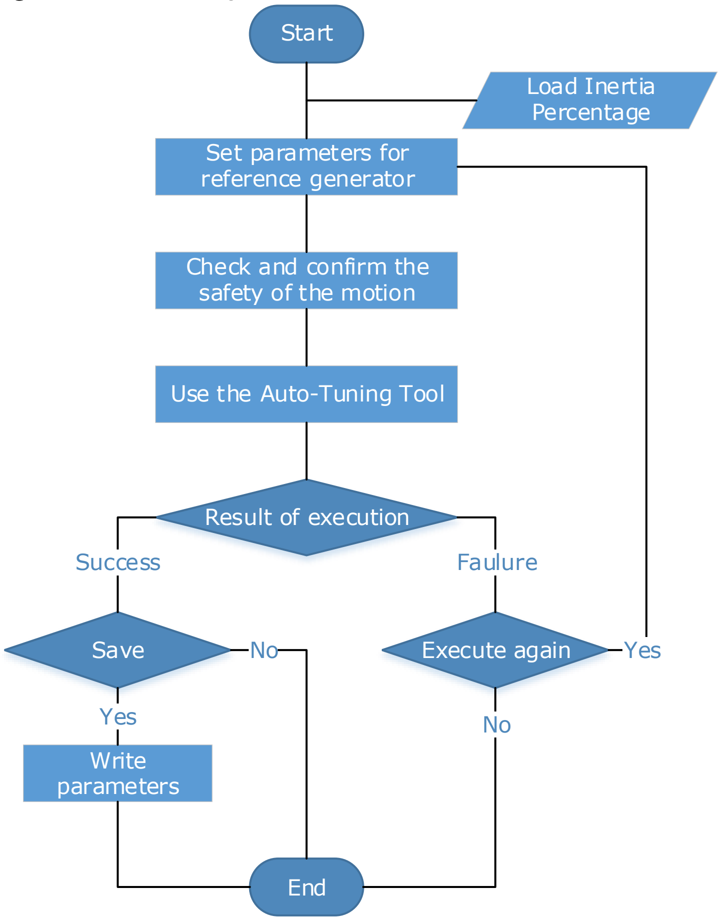
Figure 9-9 Operation by using Auto-Tuning Tool



You shall set the Rotations (Pn164 and Pn168) and Max Speed (Pn165 and Pn169) to a proper value. If the Rotations is set too small or the Max Speed is set too large, it is possible that the maximum speed set cannot be reached. In this case, it is necessary to increase the Rotations or decrease the Max Speed.

Use the Auto-Tuning Tool as shown in Figure 9-10.

Figure 9-10 Auto-Tuning Tool flowchart



The following parameters are automatically adjusted when using the auto-tuning tool.

Parameter	Adjustment method	Write into
Speed Loop Gain	Auto-tuning	Pn102
Speed Loop Integral Time	Auto-tuning	Pn103
Position Loop Gain	Auto-tuning	Pn104
Torque Command Filter Time	Auto-tuning	Pn105

CAUTION

- The parameters cannot be changed automatically when using the Auto-Tuning Tool.
- You have to choose whether to save (write) the parameters into the Drive. If you choose to save, parameters will be changed, but they are only available for **Manual Tuning** function.

Applicated Case

- Applied for the high rigidity (up to 20 times load moment of inertia) equipment.
- Applied for the low rigidity (up to 10 times load moment of inertia) equipment.
- The number of revolutions is more than 1 rotation, and the rotation speed is higher than 100 rpm.

Relevant Parameters

Parameter	Setting	Description	When Enabled	Classification
Pn106	–	Load Inertia Percentage	Immediately	Adjustment
Pn164	–	Turns for PJOG0	Immediately	Adjustment
Pn165	–	Max Speed for PJOG0	Immediately	Adjustment
Pn167	–	Stop Time for PJOG0	Immediately	Adjustment
Pn168	–	Turns for PJOG1	Immediately	Adjustment
Pn169	–	Max Speed for PJOG1	Immediately	Adjustment
Pn171	–	Stop Time for PJOG1	Immediately	Adjustment

Application Restrictions

You can use the automatic vibration suppression function when using the auto-tuning tool.

The following functions or applications are not available when using Auto-Tuning Tool:

- Gain switch is disabled.
- Model Following Control Function is disabled.
- Notch Filter is disabled.
- Vibration Suppression is disabled.
- Load Oscillation Suppression is disabled.

CAUTION The Auto-Tuning Tool is unavailable in fully-closed loop control.

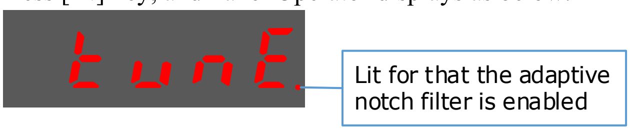
Operation Procedure: Use the Panel Operator of the Drive

The following are the steps to use the Auto-tuning tool.

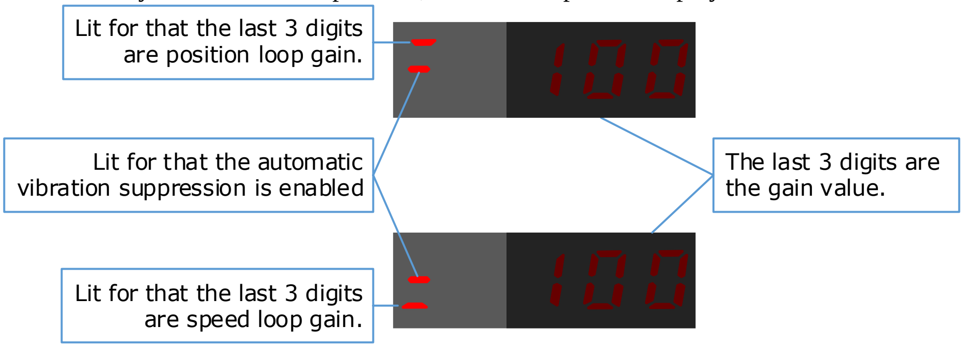
Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn017.

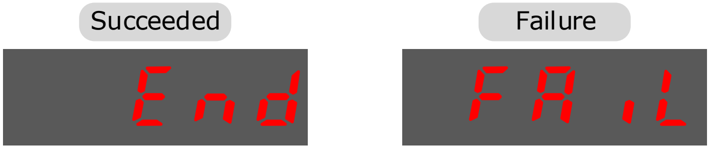
Step 3 Press [◄] key, and Panel Operator displays as below.



Step 4 Press [**M**] key to execute this operation, and Panel Operator display as below.



Step 5 When this operation has been completed, Panel Operator will display the result of execution.



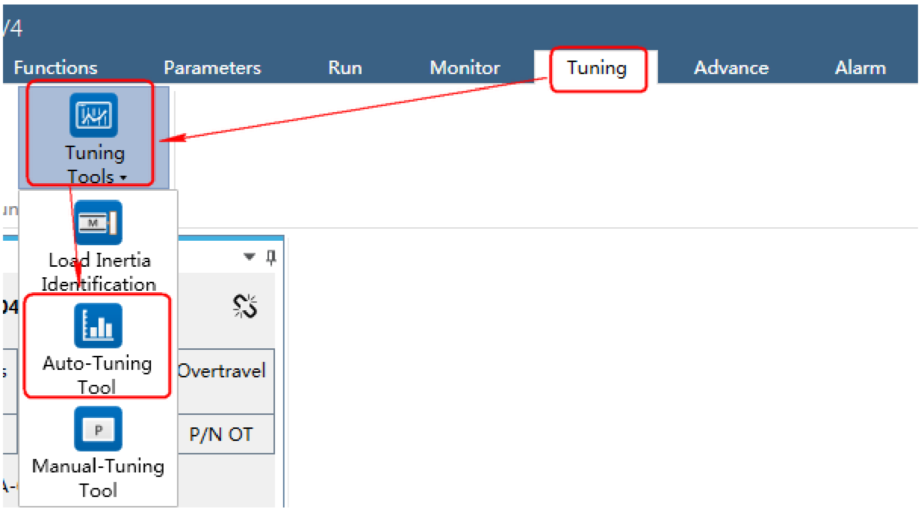
Step 6 Press [◀] key to return to the display of the Fn017.

----End

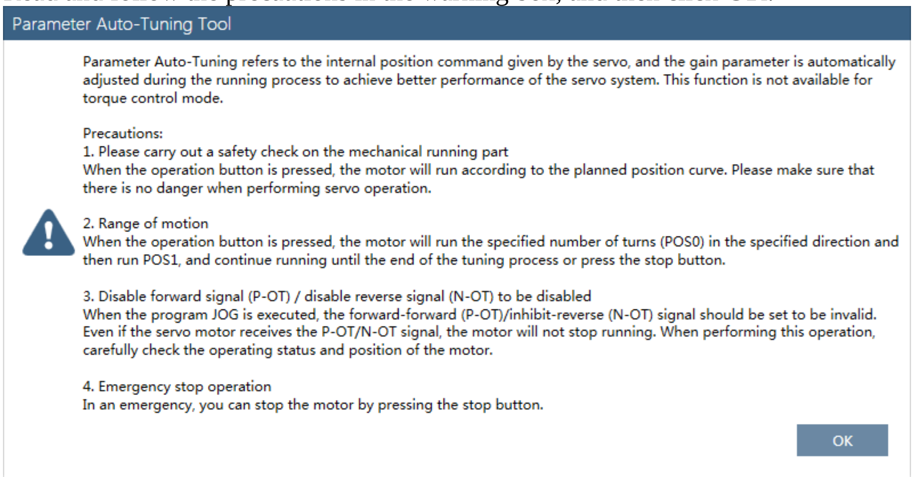
Operation Procedure: Use the ESView V4

By using the **Auto-Tuning Tool**, the Drive can automatically perform the round-trip (forward and reverse) operation to adjust for machine characteristics.

Step 1 Select **Tuning** → **Tuning Tools** → **Auto-Tuning Tool** in the **Menu Bar** of the *ESView V4* main windows.

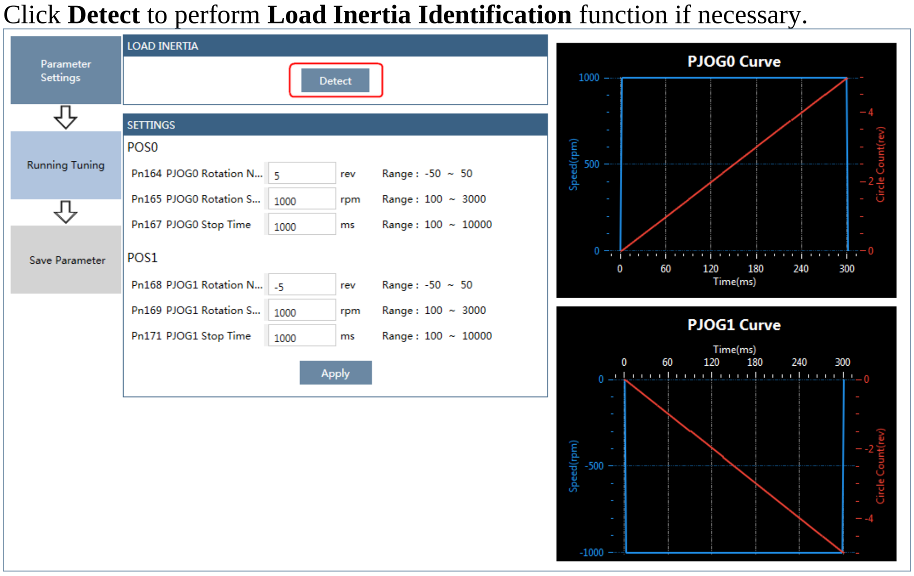


Step 2 Read and follow the precautions in the warning box, and then click **OK**.

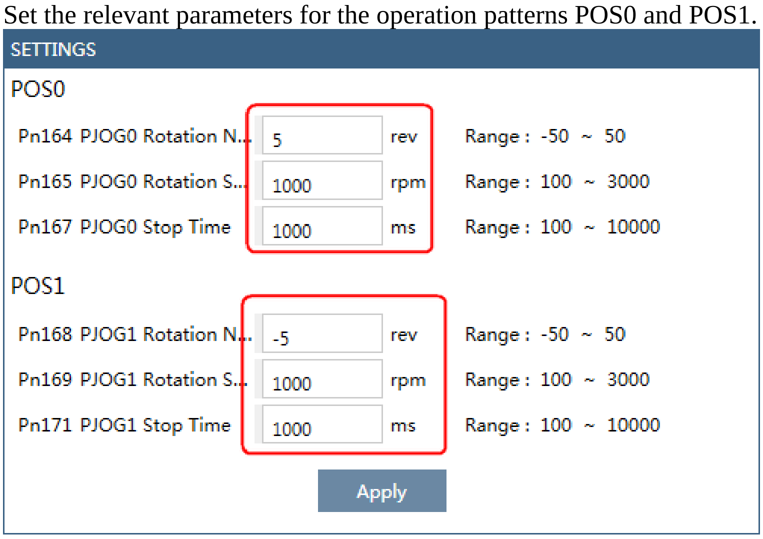


Step 3 The **Auto-Tuning Tool** window will be displayed in **Function Display Area**.

Step 4 Click **Detect** to perform **Load Inertia Identification** function if necessary.



Step 5 Set the relevant parameters for the operation patterns POS0 and POS1.

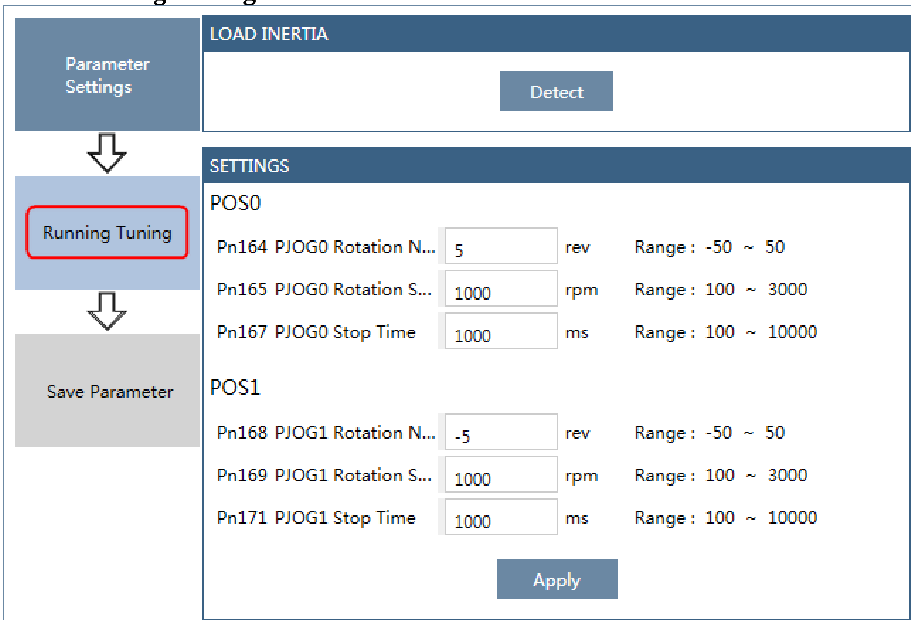


- **Rotation Number**: Set the numbers of rotation the Motor will run in the operation pattern POS0 or POS1.
- **Rotation Speed**: Set the Motor running speed in the operation pattern POS0 or POS1.

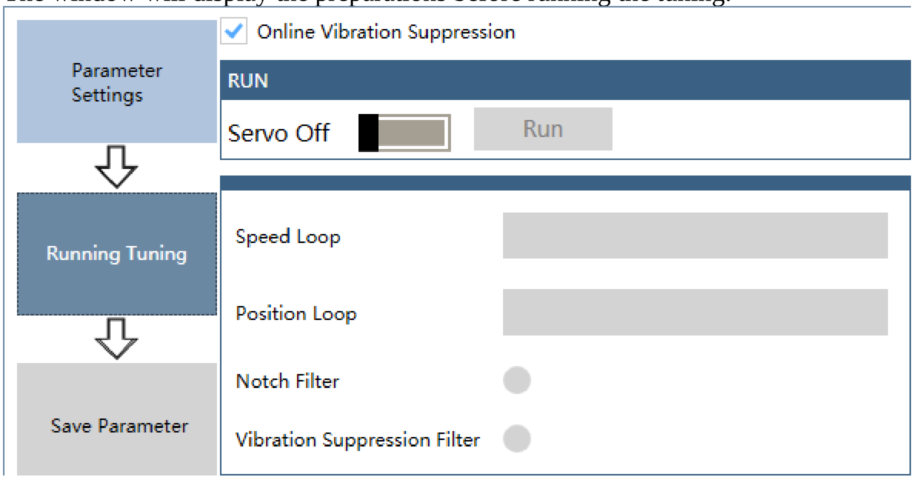
- **Stop Time**: Set the hold time when the Motor stops running in the operation pattern POS0 or POS1, and then switches to the other operation pattern.

Step 6 Click **Apply** to complete the settings.

Step 7 Click **Running Tuning**.

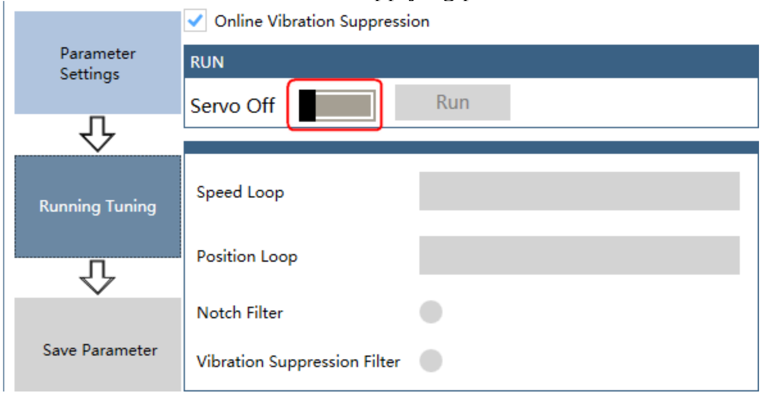


Step 8 The window will display the preparations before running the tuning.

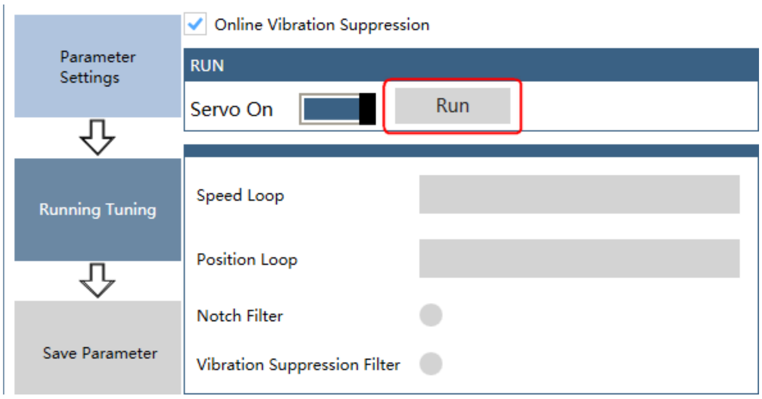


The setting will be written into the Drive automatically after you check or uncheck **Online Vibration Suppression** option.

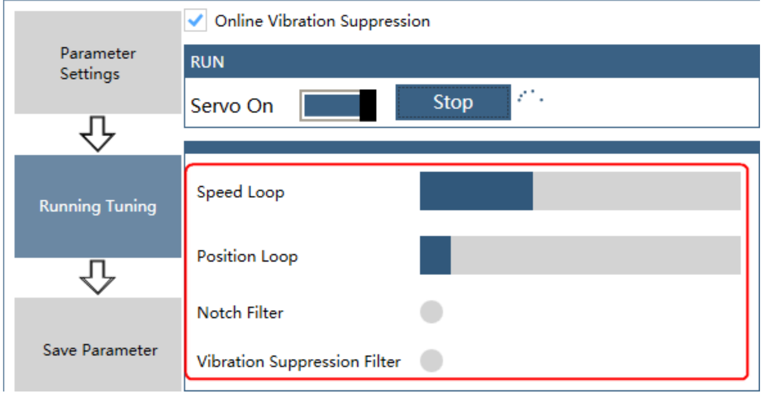
Step 9 Click **Servo Off** / **Servo On** for supplying power to the Motor.



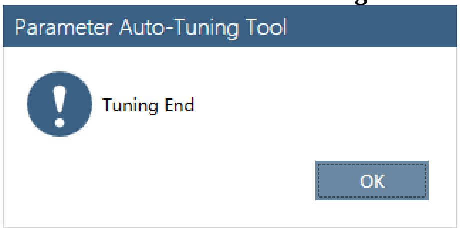
Step 10 Click **Run**.



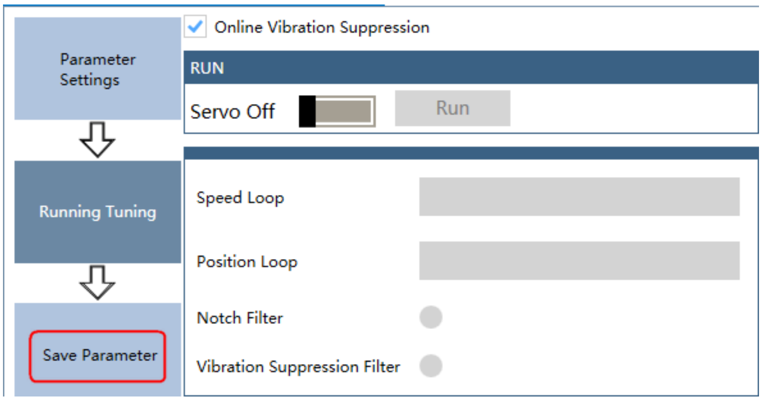
Step 11 The Motor will be run between the operation patterns POS0 and POS1.



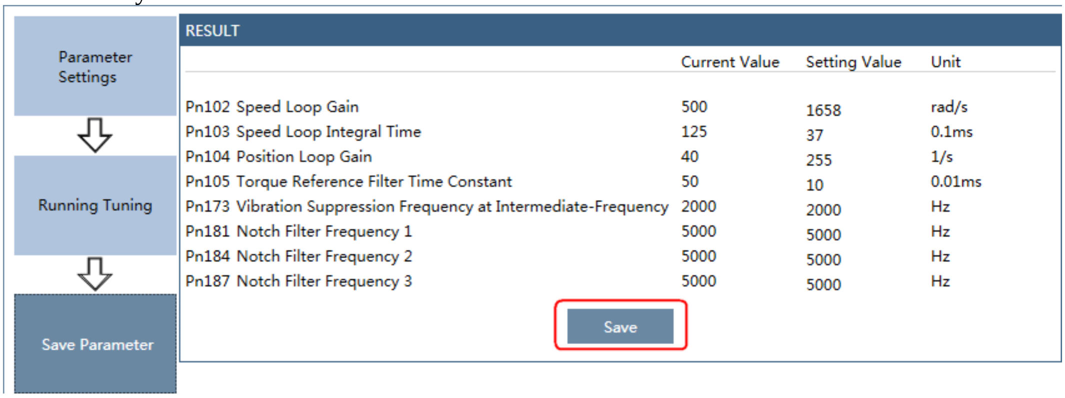
Step 12 Click **OK** when the **Auto-Tuning Tool** function has been completed.



Step 13 Click **Save Parameter**.



Step 14 Check the **RESULT**, and click **Save**, the settings of parameters will be written into the Drive automatically.

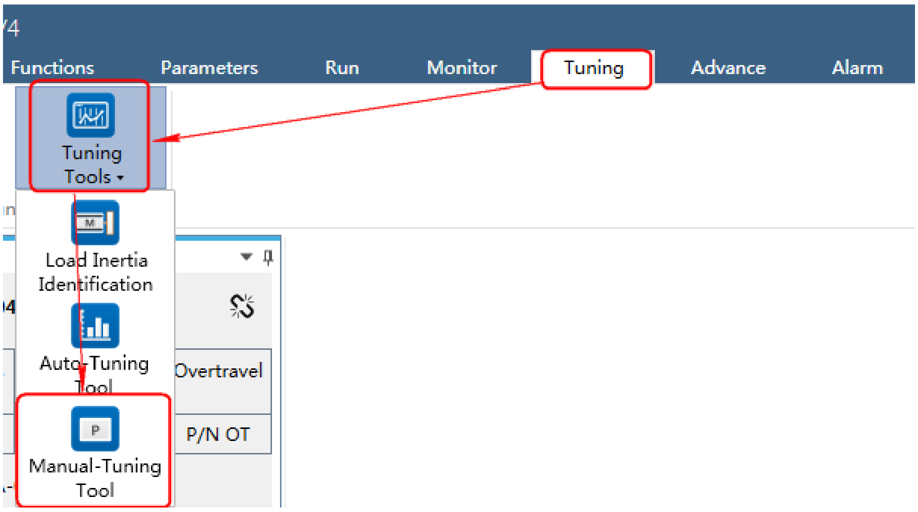


----End

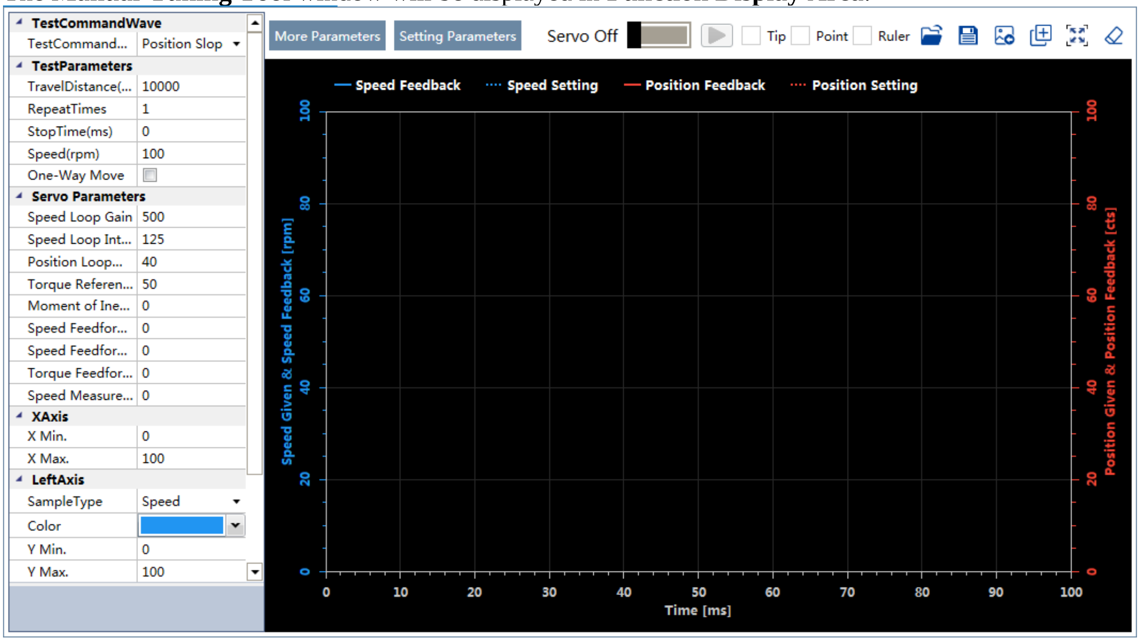
9.3.3 Manual-Tuning Tool

By using the Manual-Tuning Tool, you will set the Servo gain parameters again and again according to the waveform graphics of the data (Speed Feedback, Speed Setting, Position Feedback and Position Setting), as far as the performance of the servo meets the requirements.

Step 1 Select **Tuning** → **Tuning Tools** → **Manual-Tuning Tool** in the **Menu Bar** of the *ESView V4* main windows.

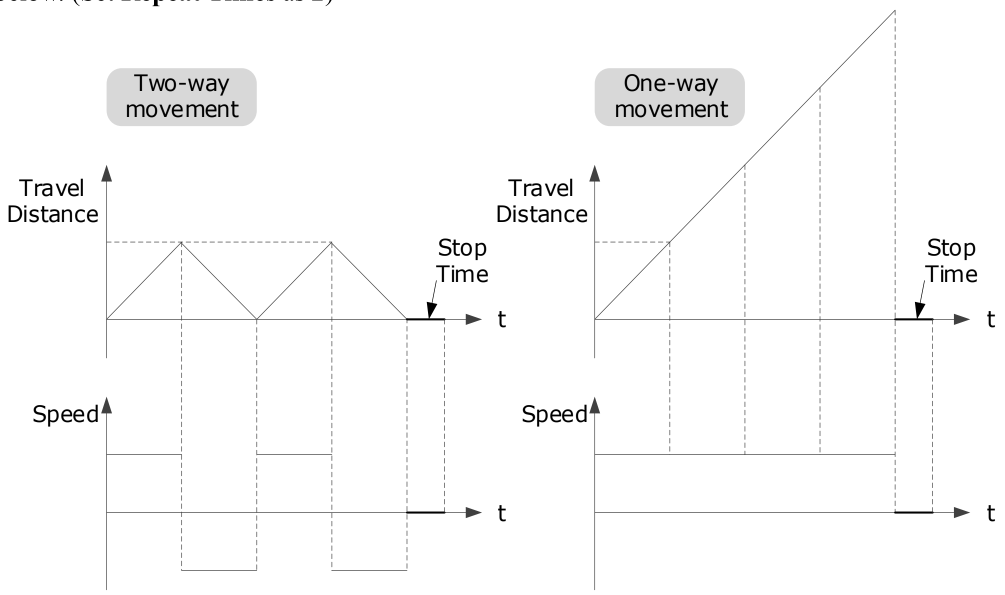


Step 2 The **Manual-Tuning Tool** window will be displayed in **Function Display Area**.



Step 3 Set the necessary parameters of the **Test Command**.

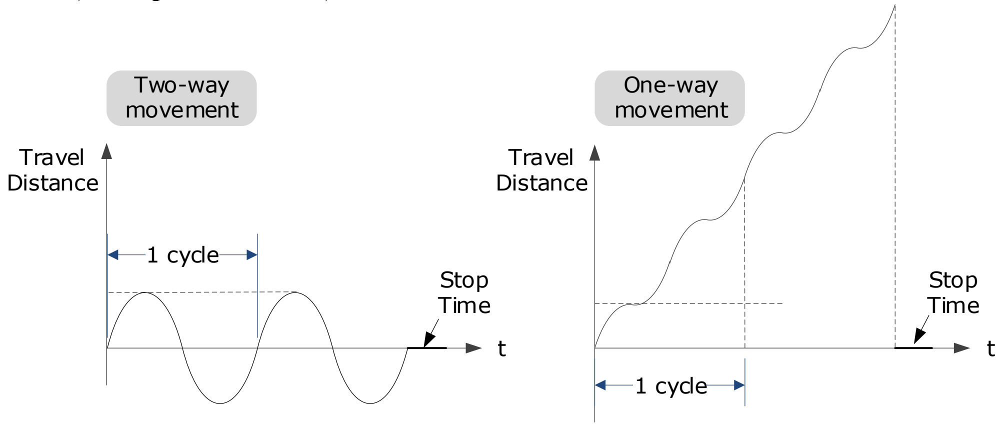
- Choose **Test Command Wave** as **Position Slope**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



The relevant parameters in the **Position Slope** are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel distance the Motor moves in one command. The positive and negative values indicate the direction of rotation.
Repeat Times	1 to 10	The number of times the command was executed.
Stop Time	0 to 32767	Set the hold time when the Motor stops running.
Speed	0 to 3000	The speed of the Motor when the command is executed.
One-Way Move	–	Check this option indicates that the Motor is running in One-way movement.

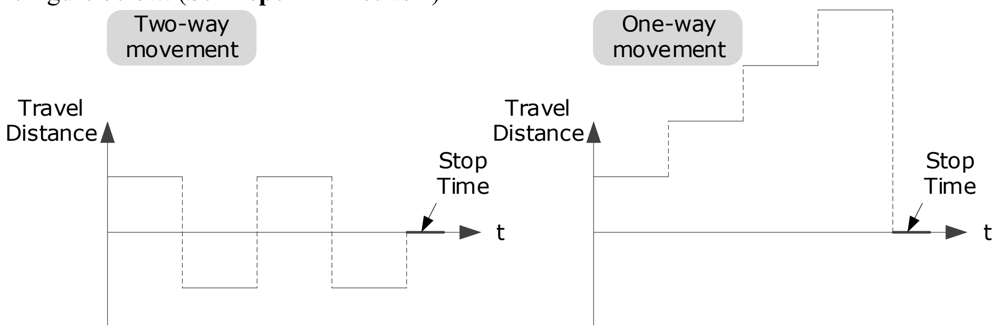
- Choose **Test Command Wave** as **Position Sine**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



The relevant parameters in the Position Sine are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel distances the Motor moves in one command. The positive and negative values indicate the direction of rotation.
Repeat Times	1 to 10	The number of times the command was executed.
Stop Time	0 to 32767	Set the hold time when the Motor stops running.
Frequency	1 to 50	The number of cycles the command completes in 1 second.
One-Way Move	–	Check this option indicates that the Motor is running in One-way movement.

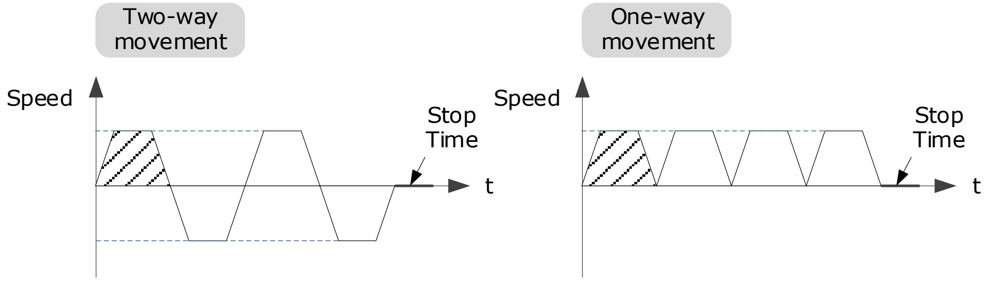
- Choose **Test Command Wave** as **Position Stepwise**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



The relevant parameters in the **Position Stepwise** are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel distances the Motor moves in one command. The positive and negative values indicate the direction of rotation.
Repeat Times	1 to 10	The number of times the command was executed.
Stop Time	0 to 32767	Set the hold time when the Motor stops running.
Stepwise Time	1 to 32767	The time to execute one command.
One-Way Move	–	Check this option indicates that the Motor is running in One-way movement.

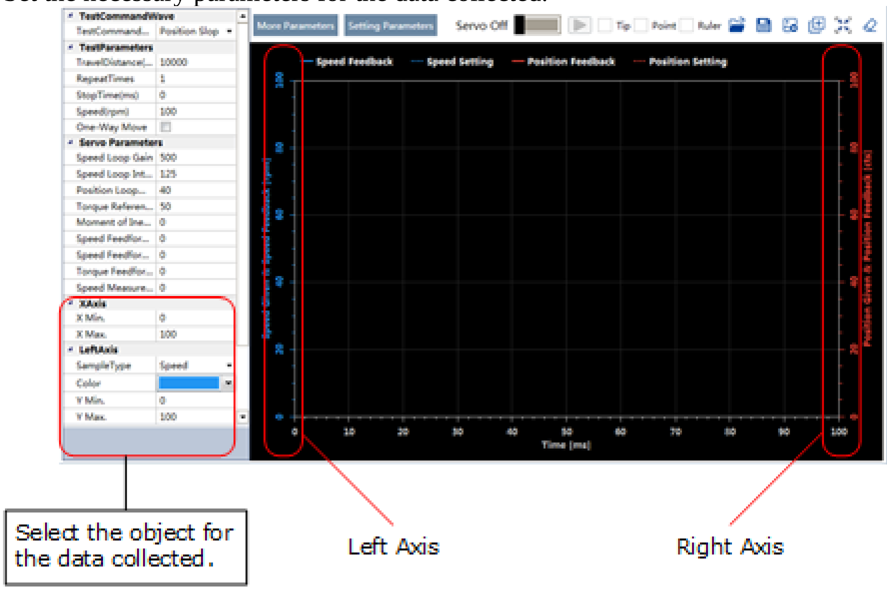
- Choose **Test Command Wave** as **Speed Trapezoid**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



The relevant parameters in the Speed Trapezoid are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel distances the Motor moves in one command. The positive and negative values indicate the direction of rotation.
Repeat Times	1 to 10	The number of times the command was executed.
Stop Time	0 to 32767	Set the hold time when the Motor stops running.
Speed	0 to 3000	The speed of the Motor when the command is executed.
Acceleration	1 to 65535	The Acceleration of the Motor when the command is executed.
One-Way Move	–	Check this option indicates that the Motor is running in One-way movement.

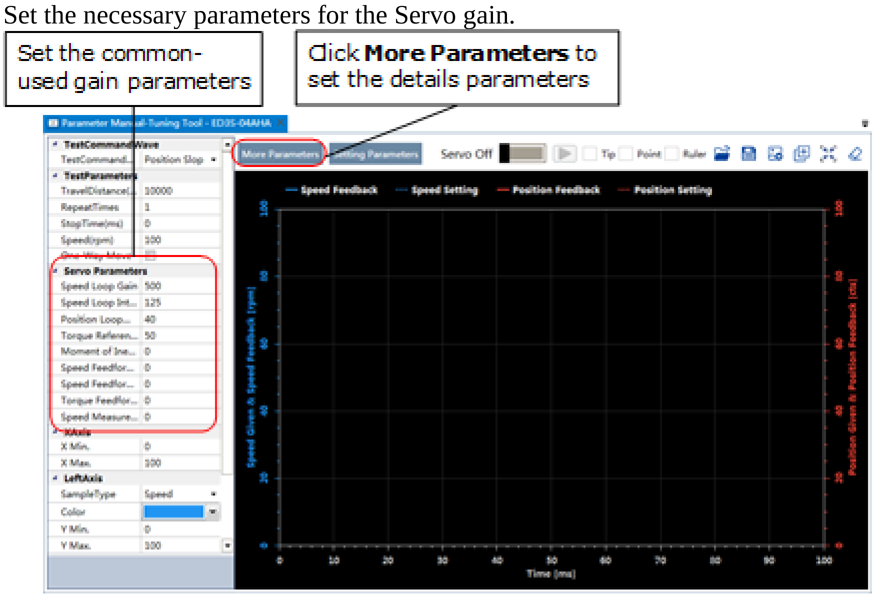
Step 4 Set the necessary parameters for the data collected.



- X Axis: Indicates Times.
- Left Axis: Select **Sample Type** as **Speed** or **Position**.
  This selection will affect the **Sample Type** of the Right Axis.

- Right Axis: Select **Sample Type** as **None**, **Speed**, **Position**, or **Offset**.
  The setting **Offset** indicates the deviation of the sample type (speed or position) selected by the left axis.

Step 5 Set the necessary parameters for the Servo gain.



The parameters that may be used are shown in Table 9-3.

Table 9-3 The parameters that may be used

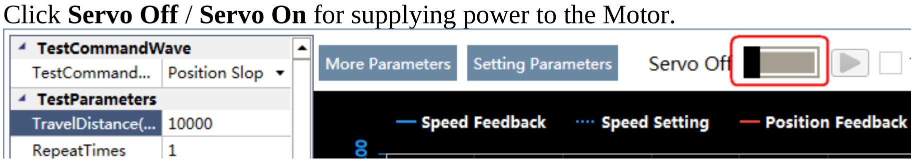
Type	Parameter	Name	Range	Unit	Default	When Enabled
Gain	Pn102	Speed Loop Gain	1 to 10000	rad/s	500	Immediately
	Pn103	Speed Loop Integral Time	1 to 5000	0.1ms	125	Immediately
	Pn104	Position Loop Gain	0 to 1000	1/s	40	Immediately
	Pn105	Torque Command Filter Time	0 to 2500	0.01ms	50	Immediately
	Pn106	Load Inertia Percentage	0 to 9999	%	0	Immediately
	Pn107	Second Speed Loop Gain	1 to 10000	rad/s	250	Immediately
	Pn108	Second Speed Loop Integral Time	1 to 5000	0.1ms	200	Immediately
	Pn109	Second Position Loop Gain	0 to 1000	1/s	40	Immediately
	Pn110	Second Torque Reference Filter Time	0 to 2500	0.01ms	100	Immediately
	Pn116	P/PI Switch Mode	0 to 4	–	0	After restart
	Pn117	Torque Reference Threshold for P/PI Switch	0 to 300	200	%	Immediately

Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn118	Deviation Counter Threshold for P/PI Switch	0 to 10000	0	1 pulse	Immediately
	Pn119	Acceleration Reference Threshold for P/PI Switch	0 to 3000	0	10 rpm/s	Immediately
	Pn120	Speed Reference Threshold for P/PI Switch	0 to 10000	rpm	0	Immediately
	Pn121	Gain Switch Mode	0 to 10	–	0	After restart
	Pn122	Delay Time for Gain Switch	0 to 20000	0.1 ms	0	Immediately
	Pn123	Threshold for Gain Switch	0 to 20000	–	0	Immediately
	Pn124	Speed Threshold for Gain Switch	0 to 2000	rpm	0	Immediately
	Pn125	Ramp Time for Position Loop Gain Switch	0 to 20000	0.1ms	0	Immediately
	Pn126	Hysteresis for Gain Switch	0 to 20000	–	0	Immediately
Feedforward and Vibration Suppression	Pn005	Application Function Selections 5	00d0 to 33d3	–	00d0	After restart
	Pn005.0	Internal Torque Feedforward Method	0 to 3	–	0	
	Pn005.1	Local Control Method	d to d	–	d	
	Pn005.2	Torque Feedforward Method	0 to 3	–	0	
	Pn005.3	Speed Feedforward Method	0 to 3	–	0	
	Pn112	Speed Feedforward	0 to 100	%	0	Immediately
	Pn113	Speed Feedforward Filter Time	0 to 640	0.1ms	0	Immediately
	Pn114	Torque Feedforward	0 to 100	%	0	Immediately
	Pn115	Torque Feedforward Filter Time	0 to 640	0.1ms	0	Immediately

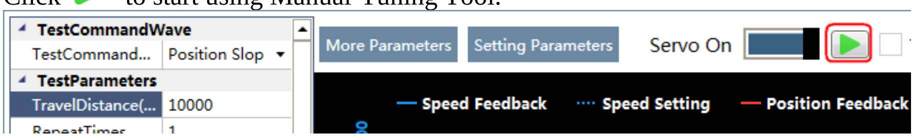
Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn150	Model Following Control Function	0000 to 0002	–	0000	After restart
	Pn150.0	Model Following Control Selection	0 to 2	–	0	
	Pn151	Model Following Control Gain	10 to 1000	1/s	50	Immediately
	Pn152	Model Following Control Gain Correction	20 to 500	%	100	Immediately
	Pn153	Model Following Control Speed Feedforward	0 to 200	%	100	Immediately
	Pn154	Model Following Control Torque Feedforward	0 to 200	%	100	Immediately
	Pn155	Load Oscillation Frequency	50 to 500	0.1Hz	100	Immediately
	Pn156	Filter Time for Load Oscillation Suppression	2 to 500	0.1ms	10	Immediately
	Pn157	Limit for Load Oscillation Suppression	0 to 1000	rpm	100	Immediately
	Pn173	Frequency of Vibration Suppression Filter	100 to 2000	Hz	2000	Immediately
	Pn174	Adjust Bandwidth of Vibration Suppression Filter	1 to 100	–	30	Immediately
	Pn175	Vibration Suppression	0 to 500	–	100	Immediately
	Pn176	Lowpass Filter Time for Vibration Suppression	0 to 50	0.1ms	0	Immediately
	Pn177	Highpass Filter Time for Vibration Suppression	0 to 1000	0.1ms	1000	Immediately
	Pn178	Damping of Vibration Suppression Filter	0 to 500	–	100	Immediately
	Pn181	Frequency of Notch Filter 1	50 to 5000	Hz	5000	Immediately
	Pn182	Depth of Notch Filter 1	0 to 23	–	0	Immediately

Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn183	Width of Notch Filter 1	0 to 15	–	2	Immediately
	Pn184	Frequency of Notch Filter 2	50 to 5000	Hz	5000	Immediately
	Pn185	Depth of Notch Filter 2	0 to 23	–	0	Immediately
	Pn186	Width of Notch Filter 2	0 to 15	–	2	Immediately
	Pn187	Frequency of Notch Filter 3	50 to 5000	Hz	5000	Immediately
	Pn188	Depth of Notch Filter 3	0 to 23	–	0	Immediately
	Pn189	Width of Notch Filter 3	0 to 15	–	2	Immediately
Others	Pn127	Low Speed Filter	0 to 100	1cycle	0	Immediately
	Pn130	Coulomb Friction Compensation	0 to 3000	0.1%Tn	0	Immediately
	Pn131	Speed Dead Band for Coulomb Friction Compensation	0 to 100	rpm	0	Immediately
	Pn132	Viscous Friction Compensation	0 to 1000	0.1%Tn/1000rpm	0	Immediately
	Pn135	Encoder Speed Filter Time	0 to 30000	0.01ms	4	Immediately
	Pn160	Load Torque Compensation	0 to 100	%	0	Immediately
	Pn161	Load Torque Observer Gain	0 to 1000	Hz	200	Immediately
	Pn162	Feedback Speed Selection	0 to 1	–	0	After restart

Step 6 Click **Servo Off** / **Servo On** for supplying power to the Motor.



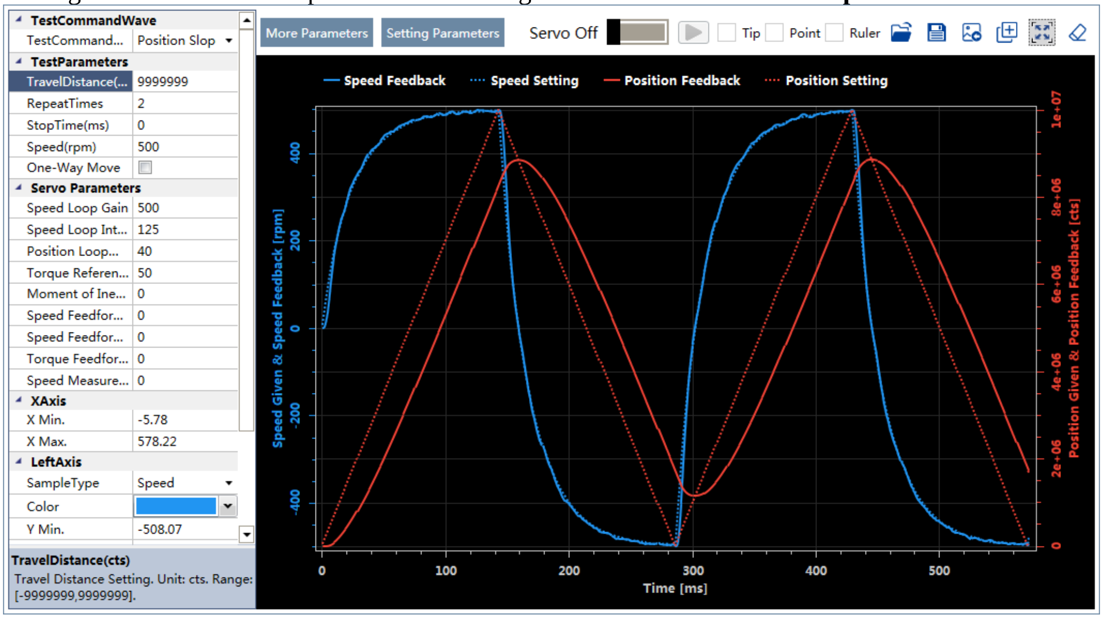
Step 7 Click  to start using Manual-Tuning Tool.



The Motor will run according to the set parameters and perform the data collecting.

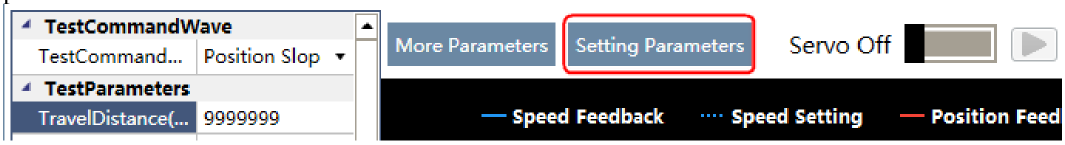
Step 8 When the **Manual-Tuning Tool** function has been completed, the waveform graphics of the data result is displayed in the window.

The figure below is an example of data collecting results with the **Position Slope** command.



Step 9 Repeat setting the parameters and perform the data collecting until result meets the requirements.

Step 10 Click **Setting Parameters** after confirming that the results have reached the desired performance, and the parameters will be written into the Drive.



----End

9.4 Feedback Speed Selection

The speed feedback from the encoder is the calculate result that the Drive read the position value from the encoder and differentiate time.

There is a speed observer inside the Drive for detecting the speed of the Motor in real time. The detected speed can be used for host controller monitoring or as a speed feedback for the speed loop.

In the case of low speed or low encoder resolution, the method of position-to-time differentiation introduces large noise. You can set Pn162=1 to use observed speed as the feedback speed.

In addition, you can increase the setting of Pn161 for making the observed speed closer to the actual speed, but overshooting will be likely to occur.

Parameter	Setting	Meaning	When Enabled	Classification
Pn161	–	Load Torque Observer Gain	Immediately	Adjustment
Pn162	0 [Default]	Use encoder speed as the feedback speed.	After restart	Function
	1	Use observed speed as the feedback speed.		

If you keep the default setting of Pn162, you can use a low-pass filter to eliminate the noise and high-frequency band, in this case, you shall set Encoder Speed Filter Time (Pn135) as a proper value.

Increase the setting of Pn135, the filtering effect will be better, and the encoder feedback speed will be smooth, but the phase lag of the speed feedback is also larger, which can reduce the servo performance.

Parameter	Setting	Meaning	When Enabled	Classification
Pn135	–	Encoder Speed Filter Time	Immediately	Adjustment

9.5 Additional Adjustment Functions

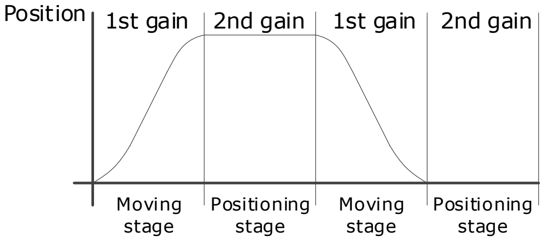
9.5.1 Gain Switching

Function Description

The gain switching function can be used for the manual tuning. It is required to switch from 1st gain parameters to 2nd gain parameters for the Servo operation in a specific stage, so that the overall performance of the Servo system can reach the desired performance.

Take Figure 9-11 as an example, the position stage focuses on the performances such as position ripples and positional rigidity, while the moving stage focuses on the performance such as following error. In this case, two switchable groups of gain parameters are required to meet the Servo performance.

Figure 9-11 Gain switching example

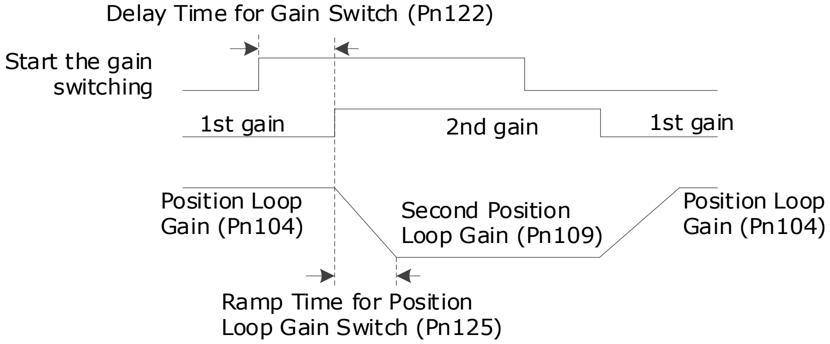


The parameters of the first gain and the second gain are as follows.

Parameter	First Gain	Second Gain
Speed Loop Gain	Pn102	Pn107
Speed Loop Integral Time	Pn103	Pn108
Position Loop Gain	Pn104	Pn109
Torque Command Filter Time	Pn105	Pn110

The gain switching function includes two settings: one is the conditions for starting the gain switching and the other is which process to start the gain switching. Figure 9-12 shows a timing diagram for the gain switching.

Figure 9-12 Gain switching timing diagram



Conditions for the Gain Switching

The Drive uses the first group of gain parameters by default. You can set the parameter Pn121 (Gain Switch Mode) as a desired value, so that the second group of gain parameters are used when the condition set in Pn121 are met.

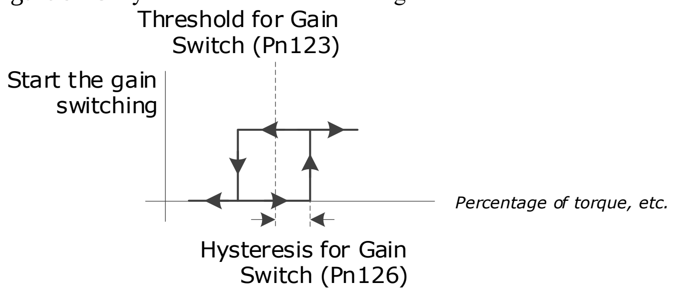
Parameter	Setting	Meaning	When Enabled	Classification
Pn121	0 [Default]	Fixed to first group gains.	After restart	Function
	1	Use external signal (G-SEL) as the condition.		
	2	Use torque reference as the condition (threshold setting: Pn117).		
	3	Use position deviation counter as the condition (threshold setting: Pn118).		
	4	Use acceleration as the condition (threshold setting: Pn119).		
	5	Use speed reference as the condition (threshold setting: Pn120).		
	6	Use position reference as the condition (threshold setting: Pn123).		
	7	Use actual speed as the condition (threshold setting: Pn124).		

Parameter	Setting	Meaning	When Enabled	Classification
	8	Use position reference (Pn123) and actual speed (Pn124) as the condition.		
	9	Fixed to second group gains.		
	10	Use positioning completed flag as the condition.		

- Set Pn121 to 0 (Fixed to first group gains), indicating that the first group of gain parameters is always used.
- Set Pn121 to 1 (Use external signal (G-SEL) as the condition) or 10 (Use positioning completed flag as the condition), indicating that switch to second group of gain parameters when the G-SEL signal is active or positioning completed, otherwise the first group of gain parameters is used.
- Set Pn121 as 2 to 7, indicating that switch to second group of gain parameters when the switching condition exceeds the set threshold value, otherwise the first group of gain parameters is used.

  In this case, you can set a proper Hysteresis for Gain Switch (Pn126) to avoid the error between input and output, and Figure 9-13 shows the diagram for this setting.

Figure 9-13 Hysteresis for Gain Switch diagram



- Set Pn121 to 8 (Use position reference and actual speed as the condition), indicating that there are two conditions to be met when switching to the second gain:
  - Condition 1: Hysteresis switching based on position reference, you shall set a proper Threshold value for Gain Switch (Pn123) and Hysteresis for Gain Switch (Pn126).
    This condition is met when the output exceeds the sum of Pn123 and Pn126.
  - Condition 2: Switch based on actual speed judgment, and you shall set a proper Speed Threshold for Gain Switch (Pn124).
    This condition is met when the actual speed exceeds the threshold value.

  Both condition 1 and condition 2 are met, switching to second group of gain parameters, otherwise the first group of gain parameters is used.
- Set Pn121 to 9 (Fixed to second group gains), indicating that the second group of gain parameters is always used.

Relevant Parameters

Parameter	Setting	Meaning	When Enabled	Classification
Pn122	–	Delay Time for Gain Switch	Immediately	Adjustment
Pn123	–	Threshold for Gain Switch	Immediately	Adjustment
Pn124	–	Speed Threshold for Gain Switch	Immediately	Adjustment
Pn125	–	Ramp Time for Position Loop Gain Switch	Immediately	Adjustment

Parameter	Setting	Meaning	When Enabled	Classification
Pn126	–	Hysteresis for Gain Switch	Immediately	Adjustment

9.5.2 P / PI Switching

The Drive uses the Proportional-Integral Controller by default to adjust the speed loop. You can set Pn116 (P/PI Switch Mode) for switching to the Proportional Controller when the set condition is met.

Parameter	Setting	Meaning	When Enabled	Classification
Pn116	0 [Default]	Use torque reference as the condition (threshold setting: Pn117).	After restart	Function
	1	Use position deviation counter as the condition (threshold setting: Pn118).		
	2	Use acceleration reference as the condition (threshold setting: Pn119)		
	3	Use the speed reference as the condition (threshold setting: Pn120).		
	4	Fixed to PI Control.		

- Set Pn116 to 4 (Fixed to PI Control), indicating that the Proportional-Integral Controller is always used.
- Set Pn116 as 0 to 3, indicating that switch to Proportional Controller when the switching condition exceeds the set threshold value, otherwise the Proportional-Integral Controller is used.

The relevant threshold parameters are shown in the table below.

Parameter	Setting	Meaning	When Enabled	Classification
Pn117	–	Torque Reference Threshold for P/PI Switch	Immediately	Adjustment
Pn118	–	Deviation Counter Threshold for P/PI Switch	Immediately	Adjustment
Pn119	–	Acceleration Reference Threshold for P/PI Switch	Immediately	Adjustment
Pn120	–	Speed Reference Threshold for P/PI Switch	Immediately	Adjustment

Take the default settings as an example, the default setting of Pn116 is **0** (Use torque reference as the condition), and the default Torque Reference Threshold for P/PI Switch (Pn117) is 200, in this case, when the torque reference percentage exceeds 200, the speed loop adjustment will be switched from PI control to P control, and then if the torque reference percentage is not more than 200, the speed loop adjustment is switched to PI control.

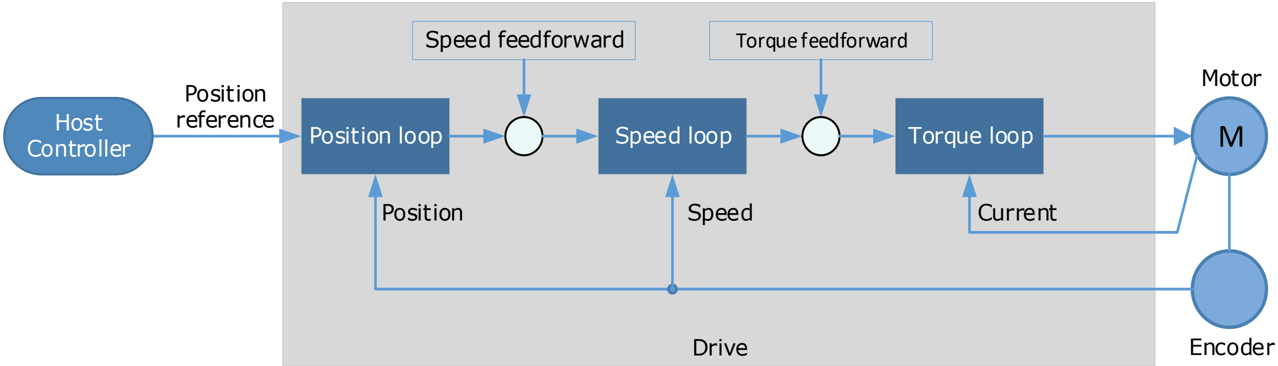
9.5.3 Feedforward

Feedforward includes speed feedforward and torque feedforward.

- Speed feedforward can improve position response and reduce position following error
- Torque feedforward can improve the speed response and reduce the speed following error

Figure 9-14 shows the block diagram in the feedforward function.

Figure 9-14 Feedforward block diagram



In general, the differential of the position reference is used as the feedforward, you can also set the feed forward by the controller or other application functions.

You can set Pn005 to select the method for the feedforward.

Parameter	Setting	Meaning	When Enabled	Classification
Pn005.3	0 [Default]	Use the internal speed feedforward.	After restart	Function
	1	Use the model following control speed feedforward, which is available when Model Following Control Selection (Pn150.0) is enabled.		
	2	Use the speed feedforward set by the controller, which is available in the bus control and set by the object 60B1h.		
	3	Use the speed feedforward generated by Cubic interpolation algorithm, which is available when the object 60C0h is set to Cubic interpolation algorithm in bus control.		
Pn005.2	0 [Default]	Use the internal torque feedforward.		
	1	Use the model following control torque feedforward, which is available when Model Following Control Selection (Pn150.0) is enabled.		
	2	Use the torque feedforward set by the controller, which is available in the bus control and set by the object 60B2h.		
	3	Use the torque feedforward generated by Cubic interpolation algorithm, which is available when the object 60C0h is set to Cubic interpolation algorithm in bus control.		

Internal Feedforward

In order to reduce the overshoot caused by the feedforward when the setting of Pn005.3 or Pn005.2 is 0, it is necessary to set Speed Feedforward (Pn112) or Torque Feedforward (Pn114) to adjust the feedforward compensation value.

- Internal Speed Feedforward = Differential of position reference × Speed Feedforward
- Internal Torque Feedforward = Differential of speed reference × Load Inertia Percentage × Torque Feedforward

In addition, it is required to filter the noise caused by the differential for the feedforward. You can increase the Filter Time for the feedforward, the noise can be filtered better, but overshooting may be occurred.

In the case of high rotation speed, you shall set Pn005.0 to 2 and Pn005.2=0.

Parameter	Setting	Meaning	When Enabled	Classification
Pn005.0	0	Use the general internal torque feedforward.	After restart	Function
	2	Use the high-speed internal torque feedforward.		
Pn112	–	Speed Feedforward	Immediately	Adjustment
Pn113	–	Speed Feedforward Filter Time	Immediately	Adjustment
Pn114	–	Torque Feedforward	Immediately	Adjustment
Pn115	–	Torque Feedforward Filter Time	Immediately	Adjustment

Model Following Control Feedforward

You shall confirm and set that the Model Following Control function has been enabled (Pn150.0=1 or 2), and then set Pn005.3=1(Use the model following control speed) or Pn005.2=1 (Use the model following control torque feedforward).

Feedforward Set by Controller

The setting of Pn005.3=2 (Use the speed feedforward set by the controller) or Pn005.2=2 (Use the torque feedforward set by the controller) is only available for Profinet Communication.

The relevant objects are 60B1h and 60B2h.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60B1h	0	Velocity Offset	INT32	RW	Yes	-2147483648 to 2147483647
60B2h	0	Torque Offset	INT16	RW	Yes	-32768 to 32767

Feedforward calculated by Cubic Interpolation

The setting of Pn005.3=3 (Use the speed feedforward generated by Cubic interpolation algorithm) or Pn005.2=3 (Use the torque feedforward generated by Cubic interpolation algorithm) is only available for Profinet Communication.

The relevant object is 60C0h.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60C0h	0	Interpolation sub mode select	INT16	RW	No	-1

9.5.4 Friction Compensation

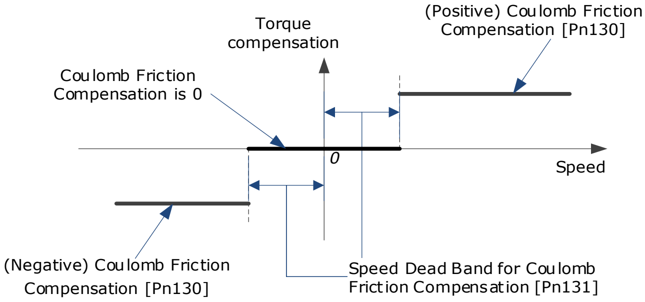
The load friction must exist in the transmission system. However, severe load friction may cause low-speed crawling, waveform distortion at speed zero-crossing, positioning lag, etc., which can affect the dynamic and static performance of the Servo system.

The friction compensation function is that the Drive compensates the load friction by using the relevant parameter settings, which can be used for applications with frequently forward and reverse motion, and high speed-stability requirements.

Friction compensation is used to compensate for viscous friction fluctuations and coulomb friction fluctuations.

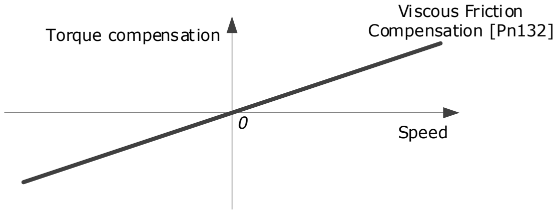
You can set Coulomb Friction Compensation (Pn130) manually, and its direction is consistent with the direction of rotation speed. In addition, it is necessary to set Speed Dead Band for Coulomb Friction Compensation (Pn131) to avoid the Motor changing the compensation direction frequently near zero speed, in this case, the Friction Compensation in the Dead Band is 0, as is shown in Figure 9-15.

Figure 9-15 Friction compensation diagram



The viscous friction compensation is a linear relationship with the Motor speed, as is shown in Figure 9-16. You can set the Viscous Friction Compensation by Pn132.

Figure 9-16 Relationship between viscous friction and speed



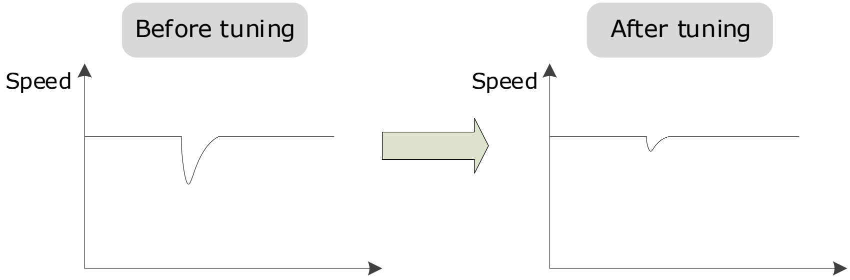
Parameter	Setting	Meaning	When Enabled	Classification
Pn130	–	Coulomb Friction Compensation	Immediately	Adjustment
Pn131	–	Speed Dead Band for Coulomb Friction Compensation	Immediately	Adjustment
Pn132	–	Viscous Friction Compensation	Immediately	Adjustment

9.5.5 Load Torque Compensation

If there is a sudden load torque during the operation of the Motor, the speed will decrease or the position will move. The continuously changing load torque will also cause the speed fluctuation or position jitter. In this case, it is generally necessary to improve the anti-load disturbance performance of the servo by tuning.

In the tuning process, the load torque compensation function can be used to improve the anti-load disturbance performance, considering that the reference response performance and the load disturbance resistance cannot be balanced.

As shown in the figure below, the speed drop is caused by a sudden load torque, and the load torque compensation function can be used to reduce the drop of the speed.



The load torque compensation function is to compensate the load torque compensation to the torque reference through the load torque observer.

To reduce the overshoot caused by load torque compensation, use the load disturbance compensation percentage to adjust the compensation value:
Load Torque Compensation = Load Torque Observer × Load Inertia Percentage (Pn160)

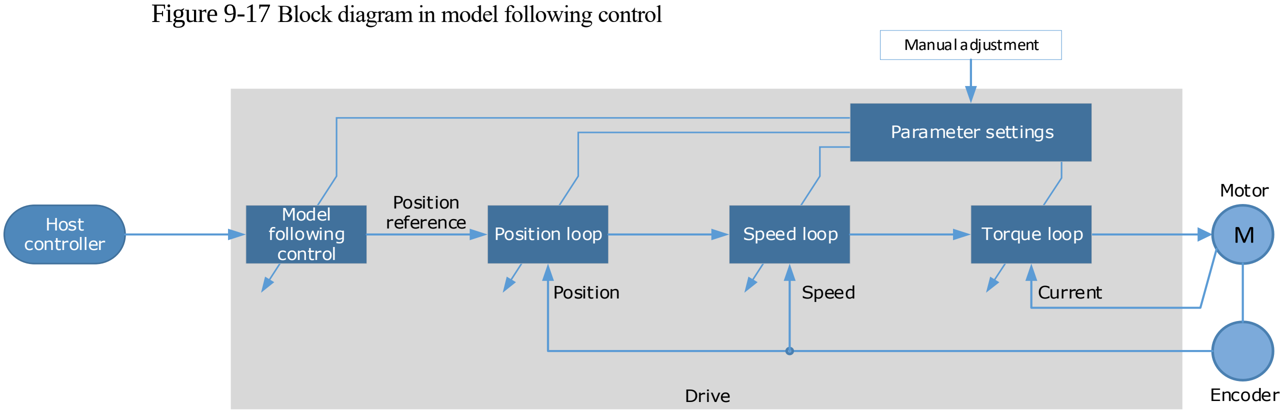
In addition, you can adjust the bandwidth of the load torque observer via Load Torque Observer Gain (Pn161). Increase the setting of Pn161 for making the observed torque closer to the actual torque, but overshooting will be likely to occur.

Parameter	Setting	Meaning	When Enabled	Classification
Pn160	–	Load Torque Compensation	Immediately	Adjustment
Pn161	–	Load Torque Observer Gain	Immediately	Adjustment

9.5.6 Model Following Control

The Model Following Control is outside of the position loop. In Model Following Control, new position references are generated based on the theoretical Motor control model, and relevant speed feedforward and torque feedforward are generated. Applying these controls to the actual control loop can significantly improve the response performance and positioning performance of the position control. Figure 9-17 shows the block diagram in model following control.

Figure 9-17 Block diagram in model following control



To use the Model Following Control function, set the following parameter.

Parameter	Setting	Meaning	When Enabled	Classification
Pn150.0	0 [Default]	Do not use Model Following Control.	After restart	Function
	1	Use the model following control.		
	2	Use the model following control and load oscillation suppression.		

To use the Model Following Control properly, you shall adjust the relevant parameters in the order of Torque Loop → Speed Loop → Position Loop → Model Following Control.

For details on the relevant parameter of Torque Loop, Speed Loop and Position Loop, refers to the section 9.2.3 Manual Tuning. The relevant parameters of Model Following Control are as follows.

Parameter	Setting	Meaning	When Enabled	Classification
Pn151	–	Model Following Control Gain	Immediately	Adjustment
Pn152	–	Model Following Control Gain Correction	Immediately	Adjustment

The Model Following Control Gain (Pn151) determines the position response performance, and increase this setting can improve speed of response, but overshooting will be likely to occur.

The Model Following Control Gain Correction (Pn152) determines the damping ratio, and increase this setting can also increase the damping ratio.

The (speed/torque) feedforward in Model Following Control is a percentage factor that is used to adjust the output feedforward.

Parameter	Setting	Meaning	When Enabled	Classification
Pn153	–	Model Following Control Speed Feedforward	Immediately	Adjustment
Pn154	–	Model Following Control Torque Feedforward	Immediately	Adjustment

NOTE: only when Pn005.3=1 or Pn005.2=1, the settings of above parameter are available.

The following application restrictions apply to the Mode Following Control.

- Only applied for the Manual Tuning.
- Only applied for the Position Control Modes.
- It is unavailable in fully-closed loop control.

9.6 Vibration Suppression

9.6.1 Notch Filter

The notch filter is used to eliminate vibration caused by mechanical resonance.

There are three notch filters in the Drive, those who can used independently or in combination, Figure 9-18 shows the block diagram of using the notch filters.

Figure 9-18 Block diagram of using the notch filters

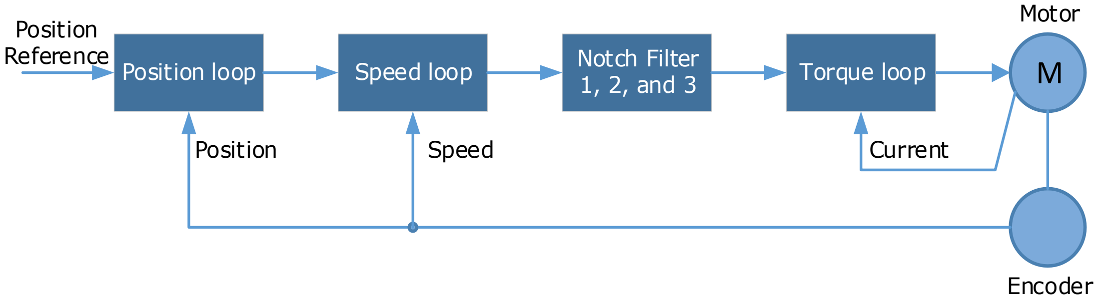
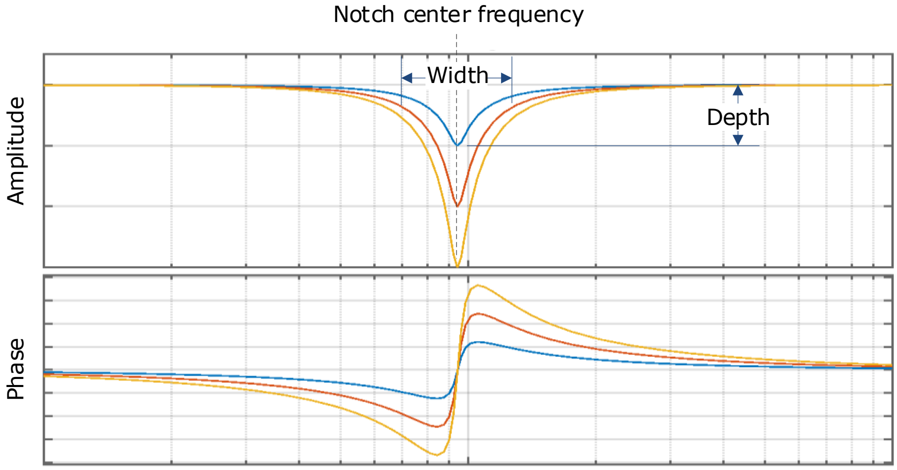


Figure 9-19 shows the relevant parameters for the notch filter. Since the notch filter can attenuate the signal at the notch frequency, if you set a proper frequency (Pn181, Pn184 or Pn187), depth (n182, Pn185 or Pn188) and width (n183, Pn186 or Pn189), the vibration signal in the torque reference can be filtered.

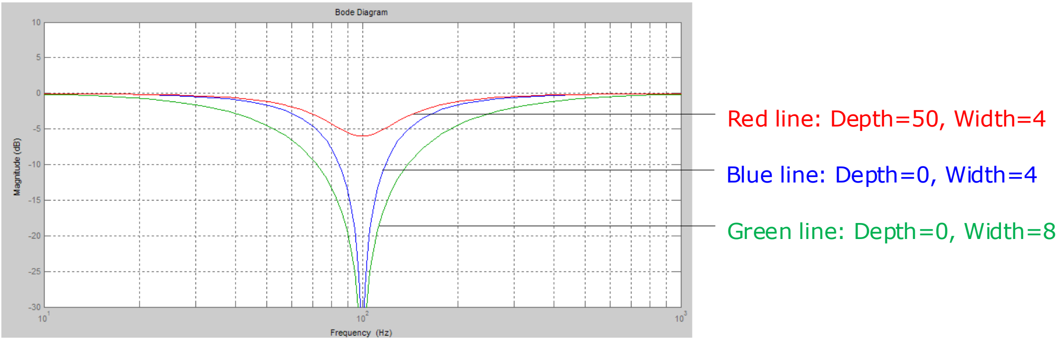
Figure 9-19 Diagram of notch filter parameters



Parameter	Setting	Meaning	When Enabled	Classification
Pn181	–	Frequency of Notch Filter 1	Immediately	Adjustment
Pn182	–	Depth of Notch Filter 1	Immediately	Adjustment
Pn183	–	Width of Notch Filter 1	Immediately	Adjustment
Pn184	–	Frequency of Notch Filter 2	Immediately	Adjustment
Pn185	–	Depth of Notch Filter 2	Immediately	Adjustment
Pn186	–	Width of Notch Filter 2	Immediately	Adjustment
Pn187	–	Frequency of Notch Filter 3	Immediately	Adjustment

Parameter	Setting	Meaning	When Enabled	Classification
Pn188	–	Depth of Notch Filter 3	Immediately	Adjustment
Pn189	–	Width of Notch Filter 3	Immediately	Adjustment

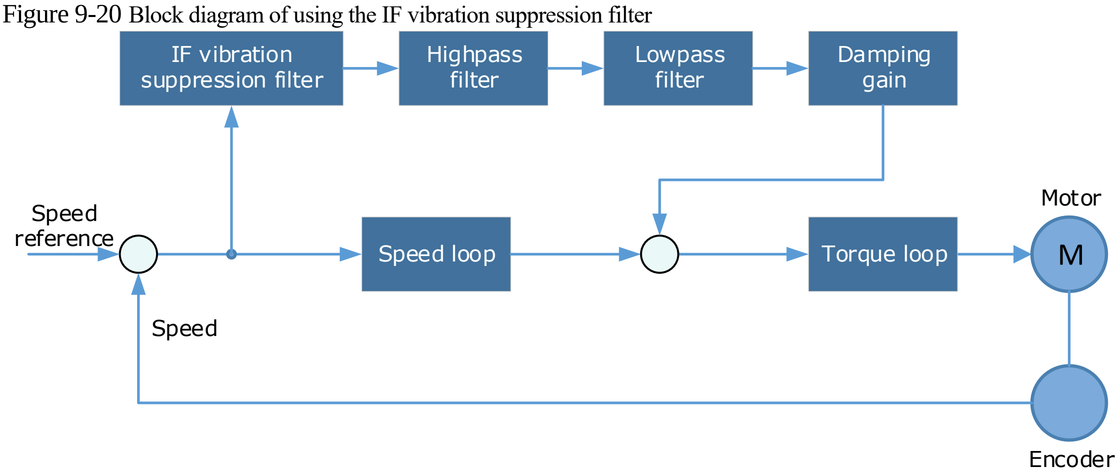
- Set the frequency of notch filter to 5000, indicating the notch filter is unavailable.
- The setting range of the depth is from 0 to 23.
- The setting range of the width is from 0 to 15.



9.6.2 IF (Intermediate Frequency) Vibration Suppression

The IF vibration suppression filter is used to process the speed deviation and compensated to the torque reference. It is applied for the frequency range 100 Hz to 2000 Hz. Figure 9-20 shows the block diagram of using the IF vibration suppression filter.

Figure 9-20 Block diagram of using the IF vibration suppression filter



- Pn173 determines the frequency center at which vibration suppression is to be performed.
- Pn174 determines the vibration suppression bandwidth of the filter, indicating the range of the adjustment filter near the center frequency. Increase this setting can increase the range of vibration suppression, but it will affect the phase of the frequency near the center.
- The highpass filter and the lowpass filter are respectively used to filter high frequency DC signals and low frequency DC signals.
- Pn178 determines the level of the final compensated IF vibration suppression.

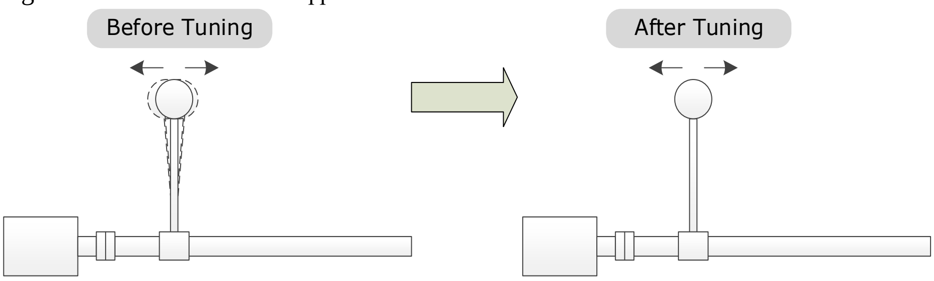
Parameter	Setting	Meaning	When Enabled	Classification
Pn173	–	Frequency of Vibration Suppression Filter	Immediately	Adjustment
Pn174	–	Adjust Bandwidth of Vibration Suppression Filter	Immediately	Adjustment
Pn175	–	Vibration Suppression	Immediately	Adjustment
Pn176	–	Lowpass Filter Time for Vibration Suppression	Immediately	Adjustment
Pn177	–	Highpass Filter Time for Vibration Suppression	Immediately	Adjustment
Pn178	–	Damping of Vibration Suppression Filter	Immediately	Adjustment

NOTE: Set Pn173 to 2000, indicating the notch filter is unavailable.

9.6.3 Load Oscillation Suppression

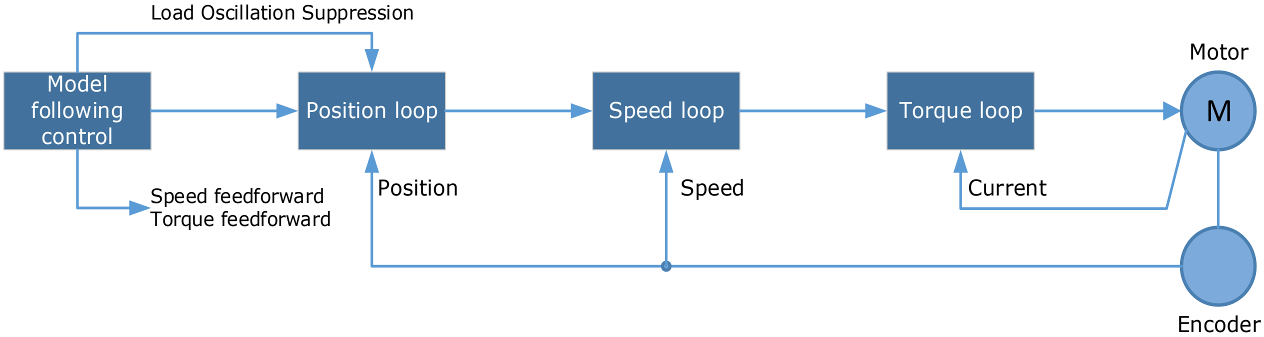
Use the Load Oscillation Suppression function for suppressing low frequency jitter at the end of the load during position control, as is shown in Figure 9-21.

Figure 9-21 Load Oscillation Suppression



This function is based on the Model Following Control. According to the relationship between the load position and the Motor position in the Model Following Control, aiming at controlling the stability of the load position, and correcting the position reference, as well as the feedforward generated by the Model Following Control. Figure 9-22 shows the block diagram of using the Load Oscillation Suppression.

Figure 9-22 Block diagram of using the Load Oscillation Suppression



Parameter	Setting	Meaning	When Enabled	Classification
Pn150.0	2	Use the model following control and load oscillation suppression.	After restart	Function
Pn155	–	Load Oscillation Frequency	Immediately	Adjustment
Pn156	–	Filter Time for Load Oscillation Suppression	Immediately	Adjustment
Pn157	–	Limit for Load Oscillation Suppression	Immediately	Adjustment

- Pn155 determines frequency at which Load Oscillation Suppression is to be performed.
- Pn156 determines the filter time. You can increase this setting, and the filtering effect will be better. However, it may reduce the suppression effect due to the lag.
- You can set Limit for Load Oscillation Suppression (Pn157) as a proper limit value, helping to reduce overshooting during the start and stop.

Frequency Detection for Load Oscillation Suppression

If the frequency for the Load Oscillation Suppression can be detected by a measuring instrument (laser interferometer, etc.), please write the frequency data (in 0.1 Hz) into the Pn155 directly.

You can also use related functions in ESView V4 (FFT, etc.) to measure the frequency for the Load Oscillation Suppression.

Application Restrictions

The following application restrictions apply to the Load Oscillation Suppression.

- Load Oscillation Suppression can only be used when the Model Following Control is in effect.
- Only applied for the Manual Tuning.
- Only applied for the Position Control Modes.
- It is unavailable in fully-closed loop control.

9.6.4 Automatic Vibration Suppression

The automatic vibration suppression function determines the vibration state by the Motor during operation and recognizes the vibration frequency, and then selects the notch filter or the intermediate frequency vibration suppression function according to the characteristics of the vibration and automatically sets the vibration frequency.

The automatic vibration suppression function determines and detects the vibration frequency during the operation of the Motor, and then choose the notch filter or the IF suppression function, and set the relevant parameters for the vibration suppression.

Parameter	Setting	Meaning	When Enabled	Classification
Pn100.2	0 [Default]	Automatic Vibration Suppression is disabled.	After restart	Function
	1	Automatic Vibration Suppression is enabled.		
Pn179	–	Amplitude Threshold for Vibration Detection	Immediately	Adjustment

Pn179 determines the threshold of a frequency amplitude. If the detected frequency amplitude exceeds this setting, it will be regarded as a vibration.

Applied in Tuning-less, One-Parameter Auto-Tuning, Manual Tuning, and Manual-Tuning Tool

When the automatic vibration suppression function is applied in the Tuning-less, One-Parameter Auto-Tuning, Manual Tuning, and Manual-Tuning Tool, the following parameters can be set temporarily.

Parameter	Setting	Meaning	When Enabled	Classification
Pn184	–	Frequency of Notch Filter 2	Immediately	Adjustment
Pn173	–	Frequency of Vibration Suppression Filter	Immediately	Adjustment

Applied in Auto-Tuning Tool

When the automatic vibration suppression function is applied in the Auto-tuning Tool, the following parameters can be preset, and you can decide whether to write into the Drive.

Parameter	Setting	Meaning	When Enabled	Classification
Pn181	–	Frequency of Notch Filter 1	Immediately	Adjustment
Pn184	–	Frequency of Notch Filter 2	Immediately	Adjustment
Pn187	–	Frequency of Notch Filter 3	Immediately	Adjustment
Pn173	–	Frequency of Vibration Suppression Filter	Immediately	Adjustment

9.7 Diagnostic Tools

9.7.1 Load Inertia Identification

The Load Inertia Identification function is used to calculate the load inertia relative to the Motor rotor inertia (percentage of load inertia).

The Motor will rotate back and forth several times (the maximum rotations is 8) when using this function. You can change the number of Motor rotations for this function by the parameter Pn172.

Parameter	Setting	Meaning	When Enabled	Classification
Pn172	0 [Default]	8 rotations	Immediately	Function
	1	4 rotations		

WARNING

- Stop the Motor running before performing this function.
- Ensure the movable parts have sufficient travel in the forward and reverse directions, as the Motor will run for up to 8 rotations during this operation.

Use the Panel Operator of the Drive

The following are the steps to execute the load inertia identification by using the Panel Operator.

Step 1 Make sure the drive is in manual tuning mode

Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn009.

Step 3 Press [◀] key, and Panel Operator displays as below.

Step 4 Press [**M**] key to execute the load inertia identification.
At this time, Panel Operator displays the speed of the Motor in real time.

Step 5 When this operation has been completed, Panel Operator will display the detection result (Unit: %).

NOTE: You can press the [**M**] key several times to execute this operation until the detection result is confirmed.

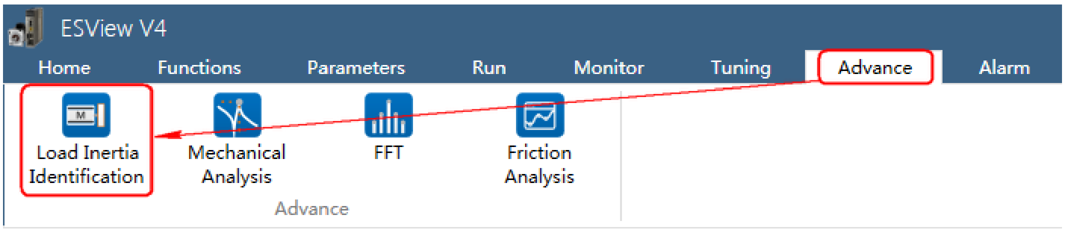
Step 6 Press [▲] key to write the detection value to the parameter Pn106 (Load Inertia Percentage).

Step 7 Press [◀] key to return to the display of the Fn009.

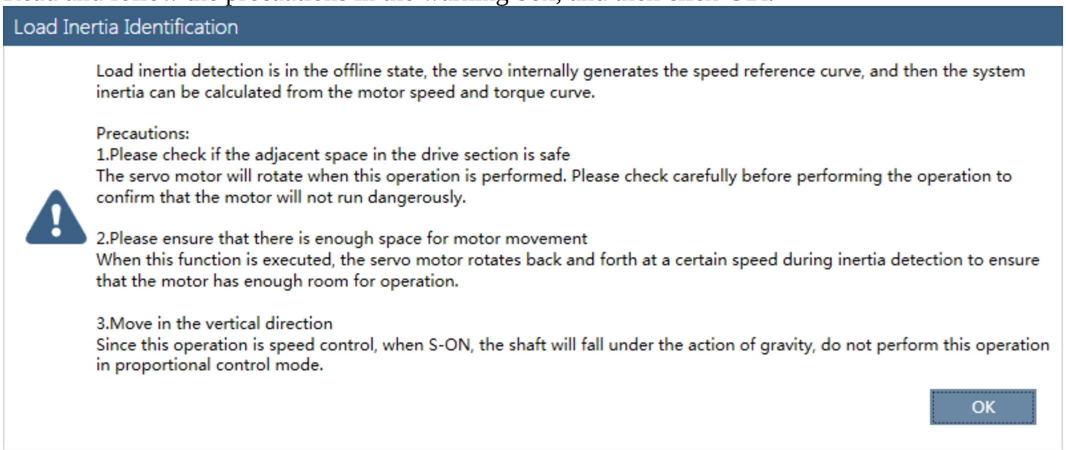
Use the ESView V4

The following are the steps to execute the load inertia identification by using ESView V4.

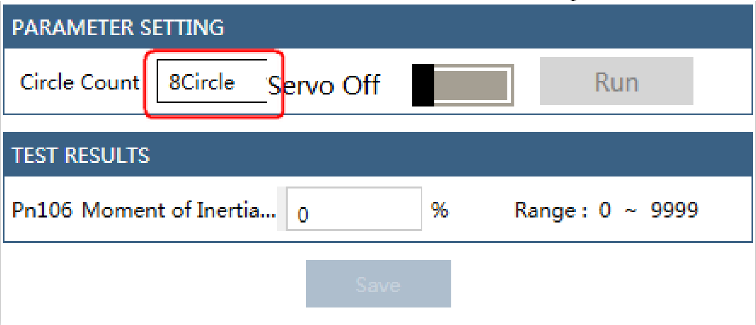
Step 1 Select **Advance** → **Load Inertia Identification** in the **Menu Bar** of the *ESView V4* main windows.



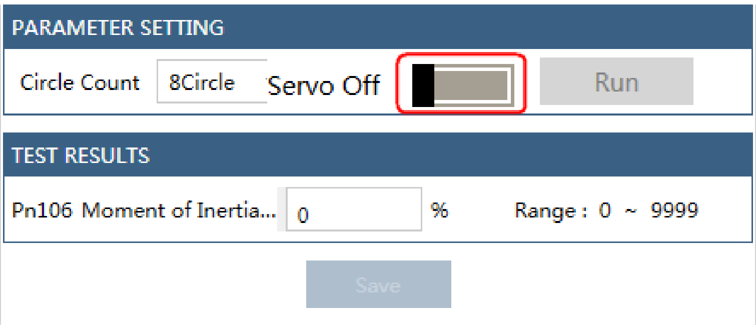
Step 2 Read and follow the precautions in the warning box, and then click **OK**.



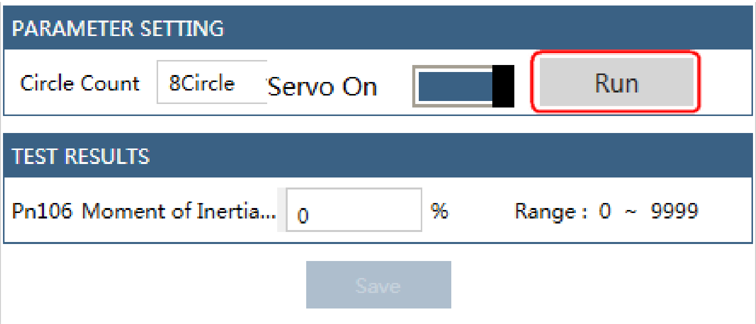
Step 3 Set **Circle Count** on the **Load Inertia Identification** dialog box, indicating the rotation number of the Motor when **Load Inertia Identification** function is performed.



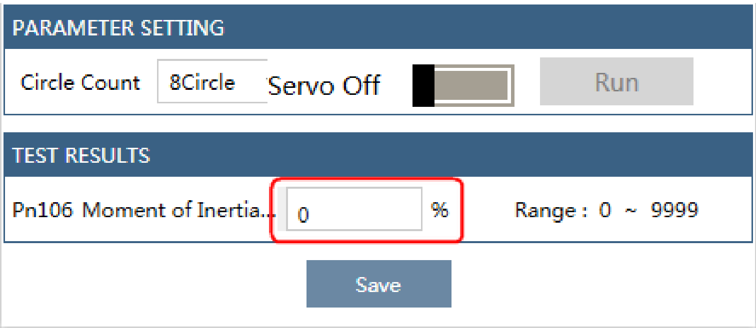
Step 4 Click **Servo Off** / **Servo On** for supplying power to the Motor.



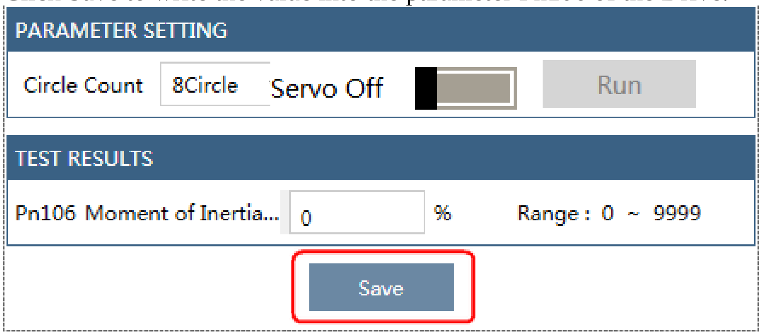
Step 5 Click **Run**.



Step 6 When the **Load Inertia Identification** function has been completed, the result will be displayed in the textbox.



Step 7 Click Save to write the value into the parameter Pn106 of the Drive.



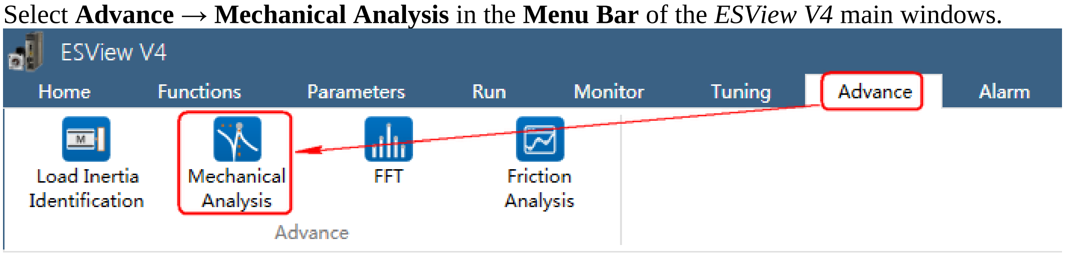
----End

9.7.2 Mechanical Analysis

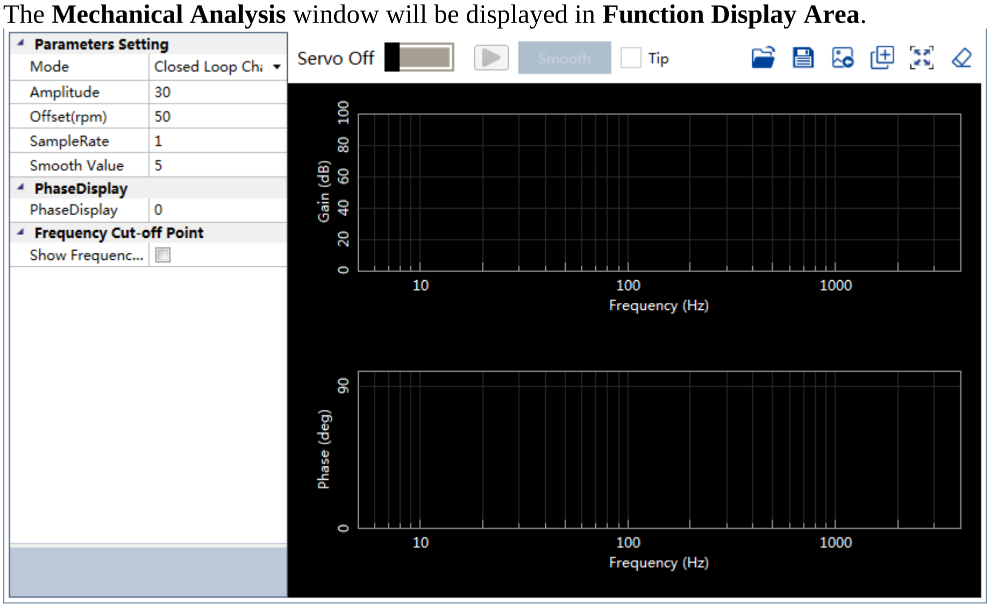
Stop the Motor running before performing this function.

This function measures the frequency characteristics of a mechanical system where a Drive is connected to a PC. It enables the measurement of mechanical frequency characteristics without the use of special equipment.

Step 1 Select **Advance** → **Mechanical Analysis** in the **Menu Bar** of the *ESView V4* main windows.

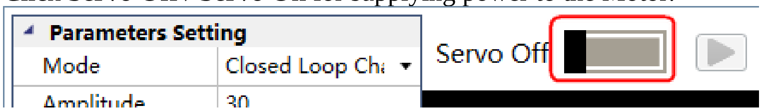


Step 2 The **Mechanical Analysis** window will be displayed in **Function Display Area**.

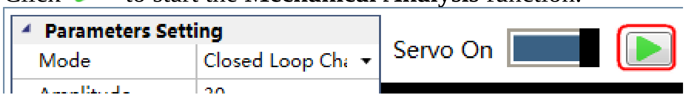


Step 3 Set the necessary parameters before performing the **Mechanical Analysis** function.

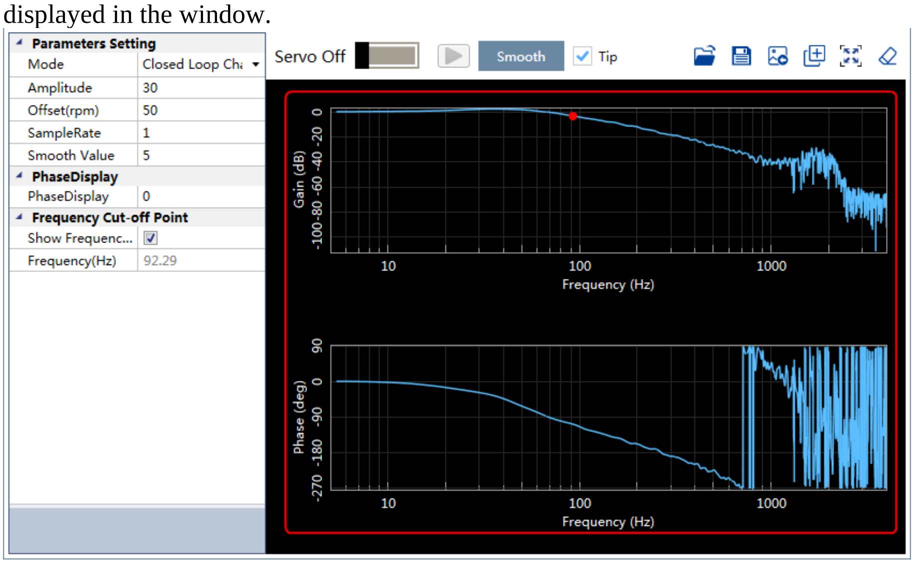
Step 4 Click **Servo Off** / **Servo On** for supplying power to the Motor.



Step 5 Click ▶ to start the **Mechanical Analysis** function.



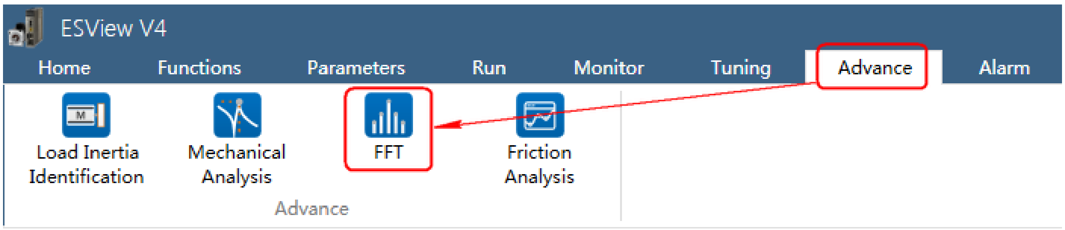
Step 6 When the **Mechanical Analysis** function has been completed, the waveform graphics of the data result is displayed in the window.



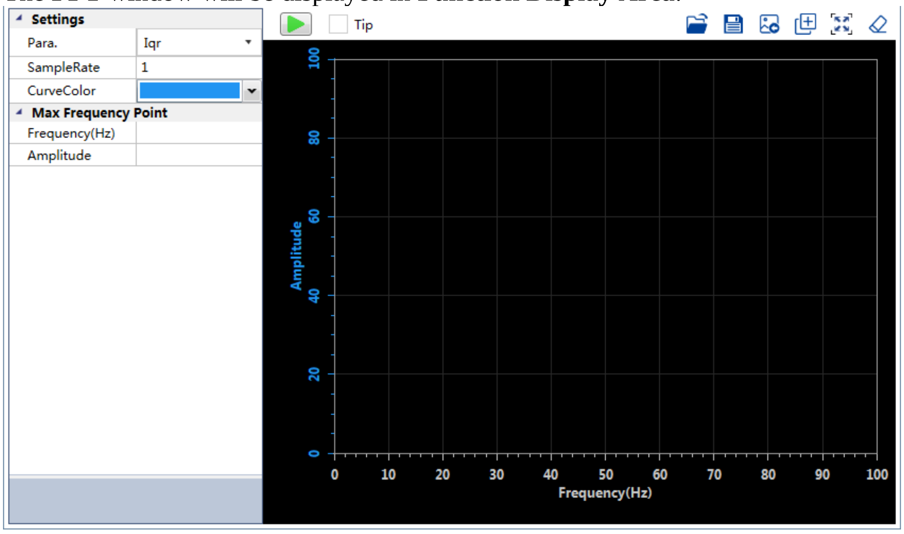
9.7.3 FFT

This function can analyze the vibration frequency of the machine and draw the graphics on the window when the Motor is running.

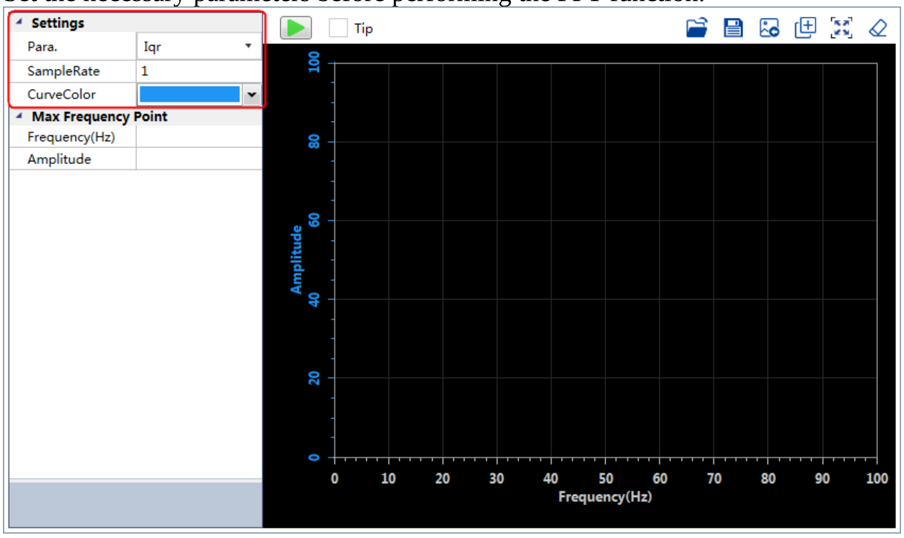
Step 1 Select **Advance** → **FFT** in the **Menu Bar** of the *ESView V4* main windows.



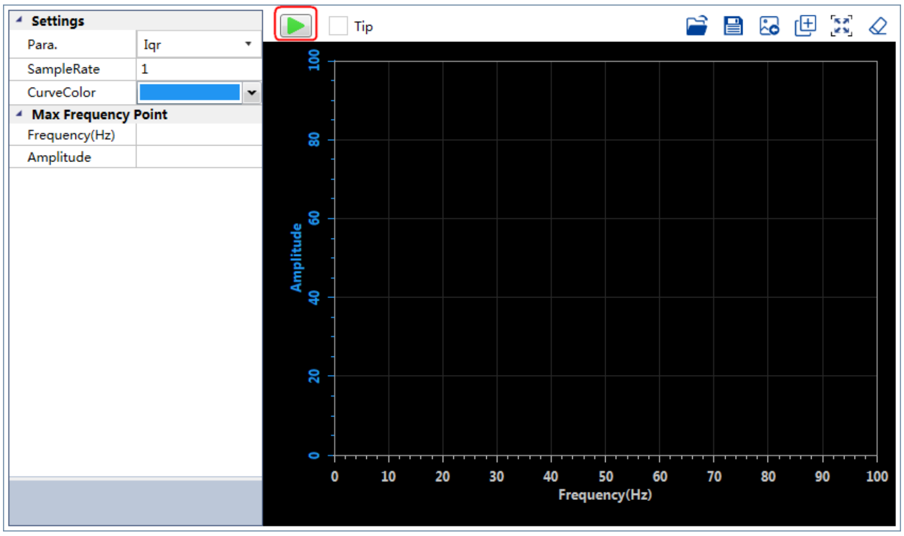
Step 2 The **FFT** window will be displayed in **Function Display Area**.



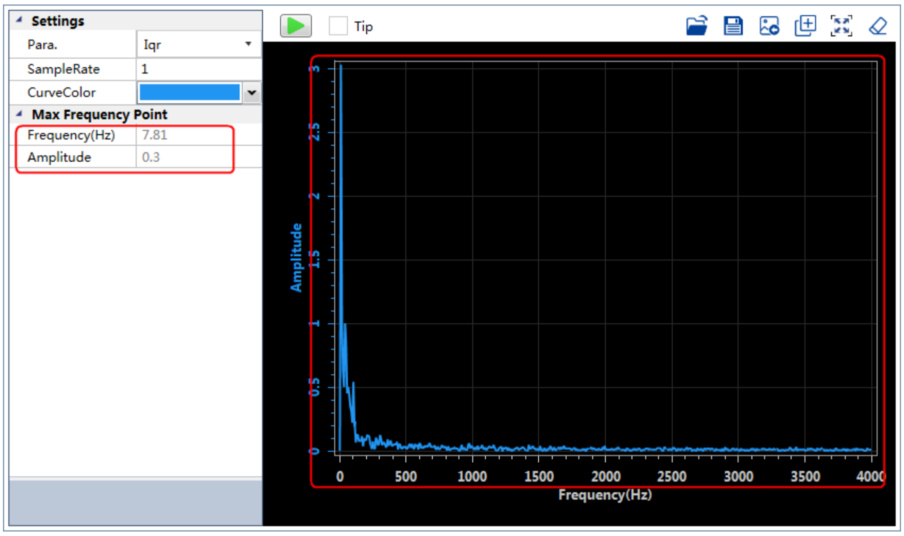
Step 3 Set the necessary parameters before performing the FFT function.



Step 4 Click  to start the FFT function.



Step 5 When the **FFT** function has been completed, the waveform graphics of the data result is displayed in the window.

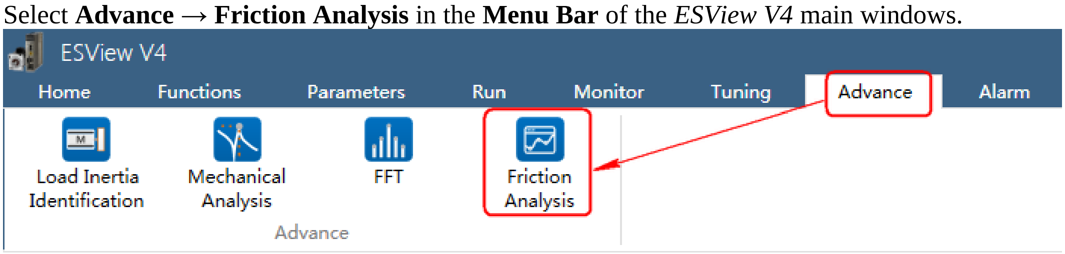


9.7.4 Friction Analysis

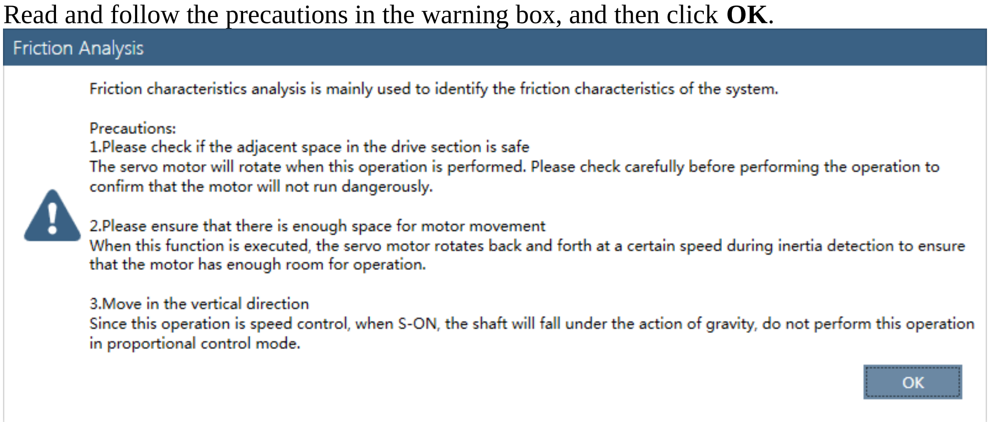
Stop the Motor running before performing this function.

The parameters related to friction compensation of the Servo system can be set according to the friction characteristics of the Motor operation.

Step 1 Select **Advance** → **Friction Analysis** in the **Menu Bar** of the *ESView V4* main windows.

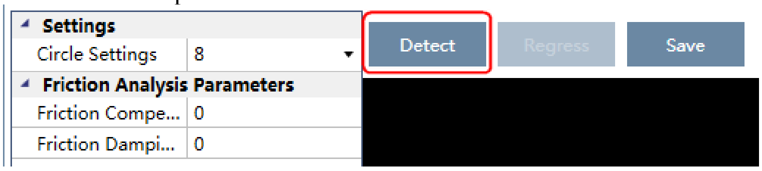


Step 2 Read and follow the precautions in the warning box, and then click **OK**.

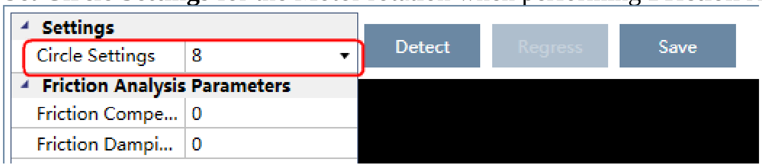


Step 3 The **Friction Analysis** window will be displayed in **Function Display Area**.

Step 4 Click **Detect** to perform Load Inertia Identification function if necessary.



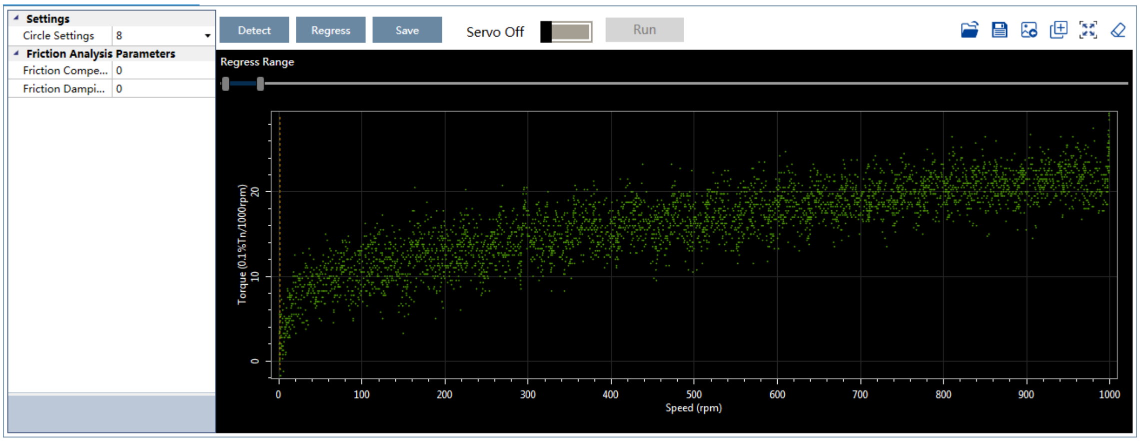
Step 5 Set **Circle Settings** for the Motor rotation when performing **Friction Analysis** function.



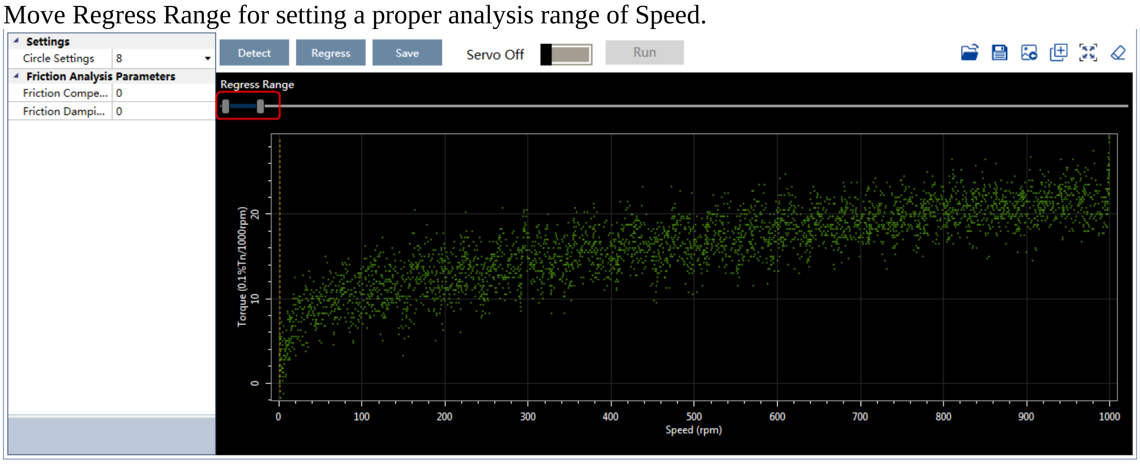
Step 6 Click **Servo Off** / **Servo On** for supplying power to the Motor.

Step 7 Click **Run**.

Step 8 When the **Friction Analysis** function has been completed, the waveform graphics of the data result is displayed in the window.

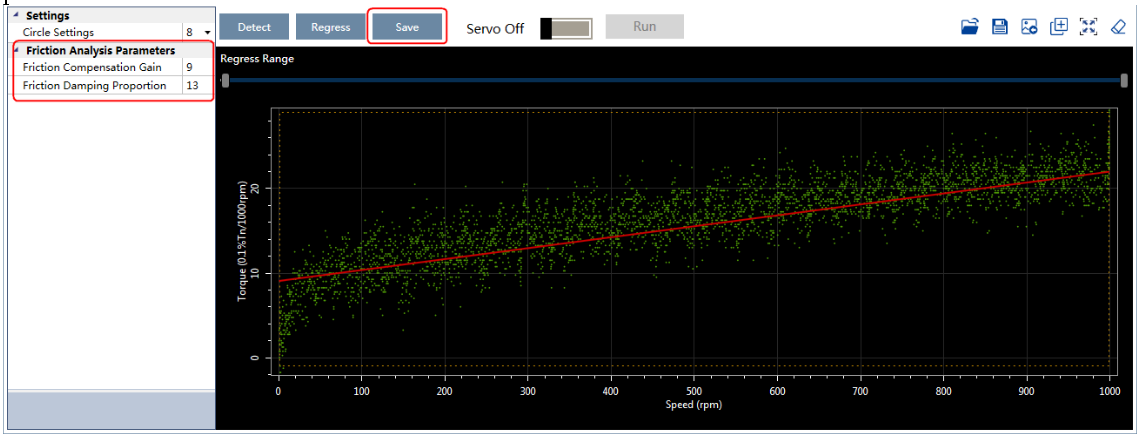


Step 9 Move Regress Range for setting a proper analysis range of Speed.



Step 10 Click **Regress** for calculating the **Friction Compensation Gain** and **Friction Damping Proportion**.

Step 11 Click **Save** to write **Friction Compensation Gain** and **Friction Damping Proportion** into the parameters Pn130 and Pn132 of the Drive.

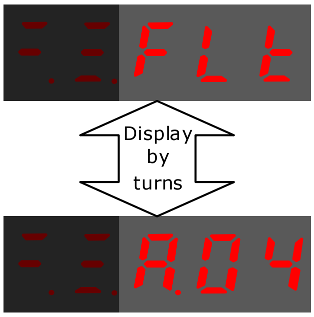
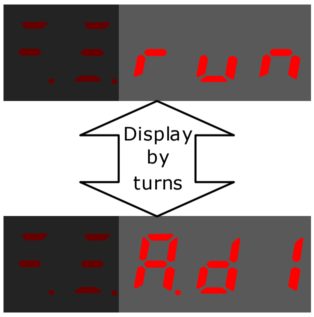


----End

Chapter 10 Alarm Displays

10.1 Alarm Classifications

There are three classifications of alarms for the Drive: Gr.1, Gr.2, and Warning. They will affect the display and operation for the Servo System.

Classification	Stopping Method	Panel Display
Gr.1	Stops the Motor according to the setting of Pn003.0. For details, refers to 6.4.1 Motor Stop Methods for Gr.1 Alarms, Safety State and Servo OFF.	The Panel Operator displays between Alarm No and Servo state **FLT** by turns. 
Gr.2	Stops the Motor according to the setting of Pn004.0 For details, refers to 6.4.3 Motor Stop Methods for Gr.2 Alarms.	
Warning	Do not stop the Motor, and keep the current operation	The Panel Operator displays between Alarm No and Servo state **run** by turns. 

10.2 Troubleshooting methods

10.2.1 Gr.1Alarm

A.01：Parameter destruction

Possible causes	Confirm the method	Action
The supply voltage drops instantaneously	Measure the supply voltage.	The supply voltage is set within the specification range and the initialization of the parameter setpoint is performed.
Parameters are written to interrupt power	Confirm the time of the power outage.	Re-write the parameter after restoring the factory value of the parameter (Fn002).
Malfunction due to noise	Confirm the runtime environment.	Take anti-interference countermeasures and then power the drive back in.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.03：Motor overspeed

Possible causes	Confirm the method	Action
The U, V, W phase sequence of the motor wiring is incorrect	Confirm the wiring of the motor.	Confirm if there is a problem with the motor wiring.
The instruction input value exceeds the overspeed value	Confirm the input instruction.	Lower the instruction value, or adjust the gain.
The motor speed exceeds the maximum speed	Confirm the waveform of the motor speed.	Reduce the speed command input gain or adjust the setting of the Pn323 (Overspeed Alarm Detection Threshold).
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	It may be a drive failure. Replace the drive.

A.04：Overload

Possible causes	Confirm the method	Action
Motor wiring, encoder wiring, or poor connection	Confirm the wiring。	Check whether there is a problem with the motor wiring and encoder wiring.
The motor runs beyond the overload protection characteristics	Confirm the overload characteristics and operating instructions of the motor。	Revisit load conditions and operating conditions. Or revisit the motor capacity.

Possible causes	Confirm the method	Action
Due to mechanical factors, the motor is not driven, resulting in excessive load during operation	Confirm the operating instructions and motor speed.	Improve mechanical factors.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure。	Replace the drive.

A.05：The position deviation counter overflows

Possible causes	Confirm the method	Action
The wiring of the motor U, V, W is incorrect	Confirm the wiring of the motor main circuit cable.	Confirm that the motor cable or encoder cable has problems such as poor contact.
Position commands are too fast	Try lowering the position command speed before running.	Lower the position command speed or command acceleration, or adjust the electronic gear ratio.
The position instruction accelerates too much	Try slowing down the instruction acceleration before running.	With the Profinet command, the position command acceleration is reduced.
Deviation counter overflow alarm (Pn504) is low relative to operating conditions	Confirm that the position deviation counter overflow alarm (Pn504) is appropriate.	Correctly set the value of the parameter Pn504.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.06：The position deviation pulse overflows

Possible causes	Confirm the method	Action
Servo ON is maintained when the position deviation in servo OFF exceeds the setpoint of (Pn504× electronic gear).	Confirm the amount of positional deviation when servo OFF。	Set the correct deviation counter overflow alarm (Pn504) when servo ON.

A.07：The electronic gear setting or pulse frequency is unreasonable

Possible causes	Confirm the method	Action
The setting of the electronic gear ratio: Pn725/Pn726 (6093-01h/6093-02h) is not within the set range	Confirm that the electronic gear ratio is within a reasonable range	The setting range of the electronic gear ratio depends on the number of encoder bits: Encoder bits≤20, set range: [0.001， 4000] Encoder bits≤21, set range: [0.001， 8000] Encoder bits≤22, set range: [0.001， 16000] Encoder bits≤23, set range: [0.001， 32000] Encoder bits≤24, set range: [0.001， 64000]

A.08：There is a problem with the first channel of current detection

Possible causes	Confirm the method	Action
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.09：There is a problem with the second channel of current detection

Possible causes	Confirm the method	Action
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.12：Overcurrent

Possible causes	Confirm the method	Action
The main circuit cable is wired incorrectly, or the contact is poor	Confirm that the wiring is correct.	Modify the wiring.
The main loop cable is shorted internally or a short-to-ground circuit has occurred	Confirm whether a short circuit has occurred between the UVW phases of the cable and between the UVW and the ground.	There is a possibility that the cable will be short-circuited. Replace the cable.
A short circuit or a short circuit to the ground occurs inside the motor	Confirm whether a short circuit has occurred between the UVW phases of the motor terminals and between the UVW and the ground.	It is possible that the motor is faulty. Replace the motor.
A short circuit or short-to-ground circuit occurs inside the drive	Confirm whether a short circuit has occurred between the UVW phases of the motor connection terminals of the drive and between the UVW and the ground.	It may be a drive failure. Replace the drive.
The braking resistor is wired incorrectly or has poor contact	Confirm that the wiring is correct.	Modify the wiring.
Dynamic brakes (emergency stops due to DB or drives) are used frequently, or DB brake circuit damage alarms occur	The DB usage frequency is confirmed by the DB resistor power dissipation. Or use the alarm display to confirm if damage to the DB braking circuit (A.1B) has occurred.	变更驱动器的选型、运行方法和机构，以降低 DB 的使用频率。
Exceeds the braking capacity	Confirm how often the braking resistor is used.	Change the selection, operating method, and mechanism of the drive to reduce the frequency of DB usage.
The braking resistance value of the drive is too small	Confirm how often the braking resistor is used.	Change the braking resistance value to a value above the minimum allowable resistance value of the drive.

Possible causes	Confirm the method	Action
High loads are tolerated when the motor is stopped or when running at low speeds	Confirm that the operating conditions are outside the specification range of the servo drive.	Reduce the load on the motor. Or run at a higher operating speed.
Malfunction due to noise	Improve the noise environment such as wiring and settings to confirm whether there is any effect.	Take anti-interference measures, such as correct wiring of FG. In addition, please use a wire with the same size as the driver main circuit wire for the FG wire size.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.13：Overvoltage

Possible causes	Confirm the method	Action
The supply voltage is out of specification	Measure the supply voltage.	Adjust the AC/DC supply voltage to the product specifications.
The power supply is in an unstable state or has been affected by lightning strikes	Measure the supply voltage.	Improve power conditions and power the drive again after setting the surge suppressor. When an alert still occurs, it may be a drive failure. Replace the drive.
Acceleration and deceleration occur when the AC supply voltage exceeds the specification range	Confirm the supply voltage and speed and torque during operation.	Adjust the AC supply voltage to the product specifications.
The external braking resistance value is larger than the operating conditions	Confirm the operating conditions and braking resistance values.	Considering the operating conditions and loads, the braking resistance value is revisited.
Operates above the allowable moment of inertia or mass ratio	Confirm that the moment of inertia or mass ratio is within the allowable range.	Extend the deceleration time or reduce the load.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.14: Undervoltage

Possible causes	Confirm the method	Action
The supply voltage is below specification	Measure the supply voltage.	Regulate the supply voltage to the normal range.
The supply voltage drops during operation	Measure the supply voltage.	Increase the power supply capacity.
An instantaneous power outage occurs	Measure the supply voltage.	If the instantaneous stop hold time (Pn538) is changed, it is set to a smaller value.
The fuse of the drive is blown	–	Replace the drive, connect the reactor to the DC reactor connection terminals (P1, P2), and use the drive.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.16: Regeneration abnormalities

Possible causes	Confirm the method	Action
When using external regenerative resistors, the wiring is bad, falling off or broken	Check the wiring of the external regenerator resistor	Connect the external regenerative resistor correctly
When using the built-in regenerative resistor, the short wiring of B2 and B3 falls off	Verify that the short cables of B2 and B3 are connected properly	Perform normal wiring for short wiring
The drive parameters are incorrectly set	Check the Settings of Pn535 and Pn536	Set Pn535 and Pn536 to the appropriate values
External regenerative resistance value or capacity is insufficient	Reconfirm the operating condition, regenerator resistance value or capacity	Choose a larger external regenerative resistor specification
In a state of continuous regeneration	Confirm operating condition	Reselect the external regenerative resistor specification
The set value in Pn536 (bleed resistance power) is less than the actual capacity of the external regenerative resistor	Confirm the connection of the regenerator resistor and the value of Pn536	Correct the Settings of Pn536

Possible causes	Confirm the method	Action
The set value in Pn535(bleed resistance) is less than the external regenerative actual resistance value	Confirm the connection of the regenerator resistor and the value of Pn535	Correct the Settings of Pn535
The external regenerative resistance value is too large	Verify that the regenerative resistance value is correct	Change it to the correct resistance value and capacity

A.18：The module is overheating

Possible causes	Confirm the method	Action
The ambient temperature is too high	Measure the ambient temperature with a thermometer. Or confirm health through drive provisioning environment monitoring.	Improve drive setup conditions and reduce ambient temperature.
The overload alarm was reset several times by powering it off and then running	Use the alert display to confirm if an overload alert has occurred.	Change the reset method for the alert.
The load is too heavy, or the regeneration capacity is exceeded during operation	The load in operation is confirmed by the cumulative load rate, and the regenerative processing capacity is confirmed by the regenerative load rate.	Revisit load conditions and operating conditions.
The orientation of the drive and the spacing from other drives are unreasonable	Confirm the setup status of the drive.	Install according to the installation standards of the drive.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.1D：The temperature sensor is disconnected

Possible causes	Confirm the method	Action
The ambient temperature is too high	Measure the ambient temperature with a thermometer. Or confirm health through drive provisioning environment monitoring.	Improve drive setup conditions and reduce ambient temperature.
The overload alarm was reset several times by powering it off and then running	Use the alert display to confirm if an overload alert has occurred.	Change the reset method for the alert.
The load is too heavy, or the regeneration capacity is exceeded during operation	The load in operation is confirmed by the cumulative load rate, and the regenerative processing capacity is confirmed by the regenerative load rate.	Revisit load conditions and operating conditions.

Possible causes	Confirm the method	Action
The orientation of the drive and the spacing from other drives are unreasonable	Confirm the setup status of the drive.	Install according to the installation standards of the drive.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.1E：The main charge circuit is faulty

Possible causes	Confirm the method	Action
The power supply voltage is lower than the specification range	Measuring supply voltage	Adjust the supply voltage to the normal range
The power cable is improperly connected, disconnected, or disconnected	Checking power cables	Connect the power supply correctly
The short connections of ⊕1 and ⊕2 fall off	Check whether short cables are connected	Perform normal wiring for short wiring
Driver failure	When the power to reconnect the drive still generates an alarm, it may be a drive failure	Replace driver

A.1F：Short-to-ground fault

Possible causes	Confirm the method	Action
The motor cable has a short-circuit to ground	Confirm if a short circuit has occurred between the UVW of the cable and the ground.	There is a possibility that the cable will be short-circuited. Replace the cable.
A short-to-ground circuit has occurred inside the drive	Confirm whether a short circuit has occurred between the UVW and the ground of the motor connection terminal of the drive.	It may be a drive failure. Replace the drive.

A.24：The main loop power supply is wired incorrectly

Possible causes	Confirm the method	Action
A single-phase AC power supply input (Pn007.1 = 0) is not set and a single-phase power supply is entered	Confirm power and parameter settings.	Set the correct power inputs and parameters.

A.37：Control panel communication timed out

Possible causes	Confirm the method	Action
Poor connection between the operator panel and the drive	Confirm the contact of the connector.	Reinsert the connector. Or replace the cable.
Malfunction due to noise	Improve the noise environment such as wiring and settings to confirm whether there is any effect.	Keep the operator panel body or cable away from devices/cables that are generating noise interference.
Operator panel failure	Connect the operator panel again. When an alarm still occurs, it is possible that the operator panel is malfunctioning.	Replace the operator panel.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.42：The motor power does not match the drive power

Possible causes	Confirm the method	Action
The drive capacity does not match the capacity of the motor	The drive capacity must be the same as the motor capacity.	Match the capacity of the drive to the motor.
Encoder failure	After replacing the encoder, confirm that the alarm no longer occurs.	Replace the motor (encoder).
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.43：The encoder type is incorrect

Possible causes	Confirm the method	Action
Encoder failure	After replacing the encoder, confirm that the alarm no longer occurs.	Replace the motor (encoder).
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.45：Multi-turn data error

Possible causes	Confirm the method	Action
The battery is poorly connected and not connected	Confirm the connection of the battery.	Properly connect the battery.
The battery voltage is below the specified value	Measure the voltage of the battery.	Replace the battery and clear the alarm. See "3.5.3 Installing or Replacing the Battery".

Possible causes	Confirm the method	Action
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.46：Multi-turn data overflow

Possible causes	Confirm the method	Action
The battery is poorly connected and not connected	Confirm the connection of the battery.	Properly connect the battery.
Multiple laps of data have overflowed	–	Set up one of the following: Use the operator panel to perform Fn010 and Fn011. Using ESView V4, go to the "Functions→ Configuration Wizard→ Encoder Settings", then click "Clear Multiturn Messages" and "Clear Multiturn Alarms".

A.47：The absolute encoder battery voltage is too low

Possible causes	Confirm the method	Action
The battery is poorly connected and not connected	Confirm the connection of the battery.	Properly connect the battery.
The battery voltage is below 2.45V	Measure the voltage of the battery.	Replace the battery and clear the alarm. See "3.5.3 Installing or Replacing the Battery".
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.48：Absolute encoder battery voltage undervoltage

Possible causes	Confirm the method	Action
The battery is poorly connected and not connected	Confirm the connection of the battery.	Properly connect the battery.
The battery voltage is below 3.0V	Measure the voltage of the battery.	Replace the battery and clear the alarm. See "3.5.3 Installing or Replacing the Battery".
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.49：Multiple or singleturn data anomalies were detected

Possible causes	Confirm the method	Action
The battery is poorly connected and not connected	Confirm the connection of the battery.	Properly connect the battery.
The battery voltage is below 3.0V	Measure the voltage of the battery.	Replace the battery and clear the alarm. See "3.5.3 Installing or Replacing the Battery".
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.50：The encoder is disconnected

Possible causes	Confirm the method	Action
The encoder cable is wired incorrectly	Confirm the wiring of the motor encoder cable.	Confirm that the motor cable or encoder cable has problems such as poor contact.
Malfunction due to noise	Improve the noise environment such as wiring and settings to confirm whether there is any effect.	Adopt anti-interference countermeasures.
Encoder failure	Power on the drive. When an alarm still occurs, it is possible that the motor is malfunctioning.	Replace the motor.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.51：Absolute encoder overspeed detection

Possible causes	Confirm the method	Action
When the control power is turned on, the motor rotates at a speed of more than 200 rpm	The speed of the motor is confirmed by the speed of the motor when the power is turned on.	Adjust the motor speed to less than 200 rpm and turn on the control power.
Encoder failure	Power on the drive. When an alarm still occurs, it is possible that the motor or absolute encoder is faulty.	Replace the motor or absolute encoder.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.52: An error occurred inside the encoder

Possible causes	Confirm the method	Action
Encoder-related alarms have not been reset	Resets the encoder-related alarms	Set up one of the following: Use the operator panel to perform Fn010 and Fn011. Using ESView V4, go to the "Functions→ Configuration Wizard→ Encoder Settings", then click "Clear Multiturn Messages" and "Clear Multiturn Alarms".

A.53: Error encoder lap information

Possible causes	Confirm the method	Action
Encoder-related alarms have not been reset	Resets the encoder-related alarms	Set up one of the following: Use the operator panel to perform Fn010 and Fn011. Using ESView V4, go to the "Functions→ Configuration Wizard→ Encoder Settings", then click "Clear Multiturn Messages" and "Clear Multiturn Alarms".

A.54: Errors occurred at the check digits and cutoff bits in the encoder control domain

Possible causes	Confirm the method	Action
Encoder-related alarms have not been reset	Resets the encoder-related alarms	Set up one of the following: Use the operator panel to perform Fn010 and Fn011. Using ESView V4, go to the "Functions→ Configuration Wizard→ Encoder Settings", then click "Clear Multiturn Messages" and "Clear Multiturn Alarms".

A.58: Information such as encoder zone phase is empty or incorrect

Possible causes	Confirm the method	Action
Encoder failure	Power on the drive. When an alarm still occurs, it is possible that the motor or absolute encoder is faulty.	Replace the motor or absolute encoder.

A.59：Information such as the motor body in the second area of the encoder is empty or wrong

Possible causes	Confirm the method	Action
Encoder failure	Power on the drive. When an alarm still occurs, it is possible that the motor or absolute encoder is faulty.	Replace the motor or absolute encoder.

A.65：Location overflow alarm

Possible causes	Confirm the method	Action
The wiring of the motor U, V, W is incorrect	Confirm the wiring of the motor main circuit cable.	Confirm that the motor cable or encoder cable has problems such as poor contact.
Position commands are too fast	Try lowering the position command speed before running.	Lower the position command speed or command acceleration, or adjust the electronic gear ratio.
The position instruction accelerates too much	Try to reduce the acceleration of the command before running.	With the PROFINET command, the position command acceleration is reduced.
Deviation counter overflow alarm (Pn504) is low relative to operating conditions	Confirm that the position deviation counter overflow alarm (Pn504) is appropriate.	Correctly set the value of the parameter Pn504.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.70：DC synchronization error

Possible causes	Confirm the method	Action
Synchronization timing (Sync0) fluctuations in PROFINET communication.	–	Reboot the drive to re-establish PROFINET communication.

A.78：Network cable disconnected

Possible causes	Confirm the method	Action
The network cable is offline during Profinet communication	1. Check whether the network cable is a twisted pair communication cable with a shielded layer 2. Check whether the driver is grounded 3. Check whether the plug of the network cable is securely connected	1. Replace the twisted pair network cable with the shielded layer 2. Connect cables correctly according to the operation instructions

A.81：The motor UVW wiring is wrong

Possible causes	Confirm the method	Action
A short circuit or a short circuit to the ground occurs inside the motor	Confirm whether a short circuit has occurred between the UVW phases of the motor terminals and between the UVW and the ground	It is possible that the motor is faulty. Replace the motor.
The U, V, W phase sequence of the motor wiring is incorrect	Confirm the wiring of the motor.	Confirm if there is a problem with the motor wiring.

A.82：The motor type does not match

Possible causes	Confirm the method	Action
The drive capacity does not match the capacity of the motor	The drive capacity must be the same as the motor capacity。	Match the capacity of the drive to the motor.

A.83：The motor is operating abnormally

Possible causes	Confirm the method	Action
A short circuit or a short circuit to the ground occurs inside the motor	Confirm whether a short circuit has occurred between the UVW phases of the motor terminals and between the UVW and the ground.	It is possible that the motor is faulty. Replace the motor.
The U, V, W phase sequence of the motor wiring is incorrect	Confirm the wiring of the motor.	Confirm if there is a problem with the motor wiring.

A.F0：Internal logic exceptions

Possible causes	Confirm the method	Action
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

Gr.2 Alarm

A.15：The regenerative resistance is damaged

Possible causes	Confirm the method	Action
The drive requires an external braking resistor	Confirm the connection of the external regenerative resistor and check the setpoints of Pn535 and Pn536.	Aft Connell Tinte Externard Brakin Recisto, Setben 535 Anderben 536 Tot Aproprit Valluet.
When an external braking resistor is not used, the short wiring of B2 and B3 falls off	Confirm the connection of the short wires of B2 and B3.	Properly wire the short wiring.
External regenerative resistors are poorly wired, detached, or disconnected	Confirm the wiring of the external regenerative resistor.	Properly wired external regenerative resistors.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.1A：The charging resistance is overloaded

Possible causes	Confirm the method	Action
The input power supply is unstable	Measure and confirm the status of the input power supply.	Ensure that the input power supply is stable.
Power is turned on and off too frequently	–	Extend the interval between power on and off or reduce the frequency of power on and off.

A.1B：The DB braking circuit is damaged

Possible causes	Confirm the method	Action
The motor is driven by an external force	Confirm the health status。	Do not drive the motor by external force.

Possible causes	Confirm the method	Action
The rotational or running energy at the time the DB is stopped exceeds the capacity of the DB resistance	The DB usage frequency is confirmed by the DB resistor power dissipation.	Try the following measures. Reduce the command speed of the motor. Adjust the moment of inertia or mass ratio. Reduce the number of DB stops.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.20：The main loop power line is out of phase

Possible causes	Confirm the method	Action
Poor wiring of three-phase wires	Confirm the power wiring.	Confirm if there is a problem with the power wiring.
The three-phase power supply is unbalanced	Measure the voltage of each phase of a three-phase power supply.	Corrects the imbalance of the power supply (reversing phase).
A single-phase AC power supply input (Pn007.1 = 0) is not set and a single-phase power supply is entered	Confirm power and parameter settings.	Set the correct power inputs and parameters.
Drive failure	Power on the drive. When an alert still occurs, it may be a drive failure.	Replace the drive.

A.33: USB Power Supply Exceptions

Cause	Way of confirmation	Solution
USB cable is damaged	Confirm USB cable	Replace the USB drive
Drive failure	If the alarm still occurs when the USB cable is replaced, the drive may be faulty	Replace the drive

A.49: Multi-turn or Single-turn Data Exception Detected

Cause	Way of confirmation	Solution
Poor battery connection, or not connected	Confirm battery installation	Install the battery correctly
Battery voltage below 3.0V	Measure the battery voltage	• Replace the battery and clear the alarm. See “3.5.3 Installing or Replacing the Battery”.
Drive failure	Re-apply power to the drive. If the alarm still occurs, the drive may be faulty.	Replace the drive.

A.4A: Excessive Encoder Temperature

Cause	Way of confirmation	Solution
High ambient temperature of the motor	Measure the ambient temperature of the motor.	Adjust the ambient temperature of the motor to below 40°C.
Motor running at a load in excess of the rated value	Confirm load by cumulative load factor.	Adjust the load of the motor before running to a value within the rated value.
Encoder failure	Re-apply power to the drive. If the alarm still occurs, it is possible that the motor or absolute encoder is faulty.	Replace the motor or absolute encoder.
Drive failure	Re-apply power to the drive. If the alarm still occurs, the drive may be faulty.	Replace the drive.

10.2.3 Warnings

A.4B: Absolute Encoder Battery Undervoltage (Tamagawa)

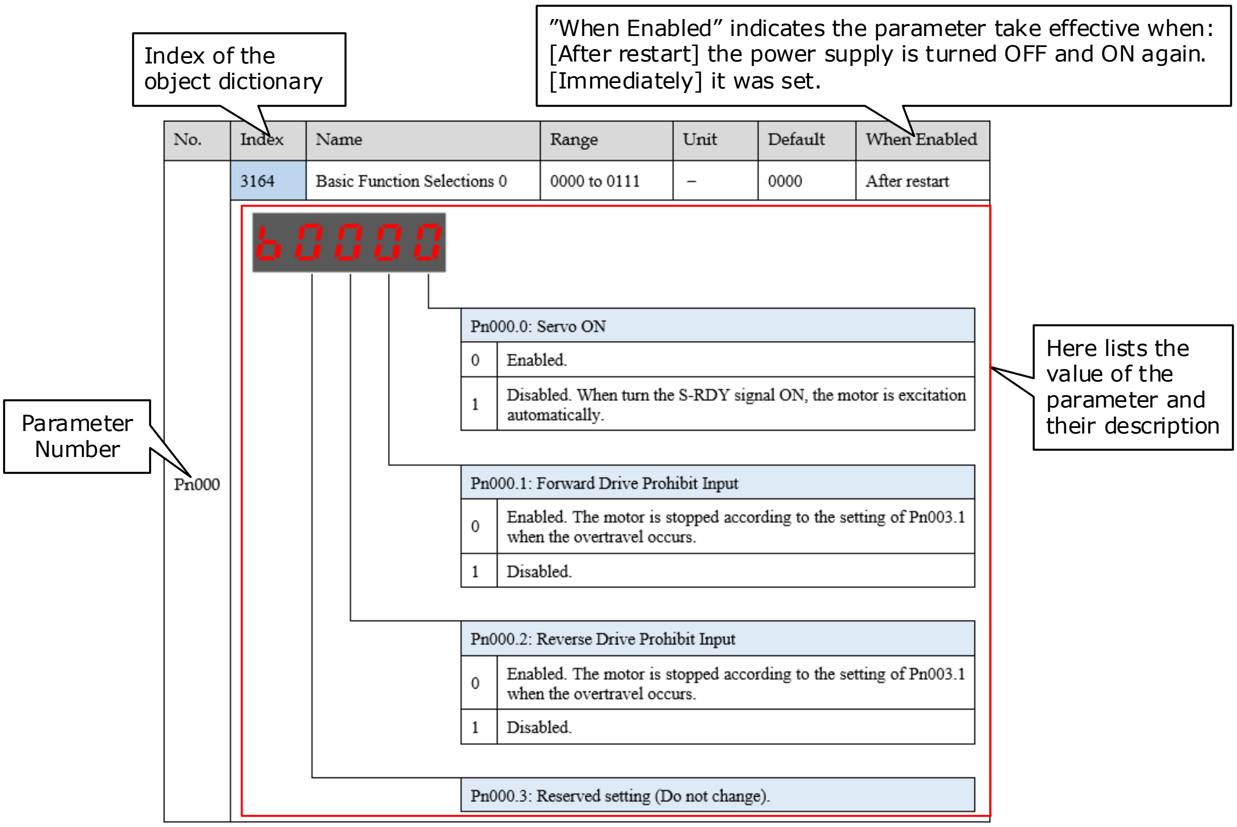
Cause	Way of confirmation	Solution
Poor battery connection, or not connected	Confirm battery installation	Install the battery correctly
Battery voltage below 3.0V	Measure the battery voltage	Replace the battery and clear the alarm. See “3.5.3 Installing or Replacing the Battery”.
Drive failure	Re-apply power to the drive. If the alarm still occurs, the drive may be faulty.	Replace the drive.

A.D5: Fan Disconnection Warning

Cause	Way of confirmation	Solution
Fan is disconnected	Confirm if the fan is working	Confirm if the internal fan is wired correctly
Fan is damaged	Fan does not work even after correct wiring	Replace the drive

Chapter 11 Parameters

11.1 Interpreting the Parameter Lists



11.2 Parameters Detailed

No.	Index	Name	Range	Unit	Default	When Enabled
Pn000	3164	Basic Function Selections 0	0000 to 0111	–	0000	After restart

Pn000.0: Servo ON	
0	Enabled.
1	Disabled. When turn the S-RDY signal ON, the Motor is excitation automatically.

Pn000.1: Forward Drive Prohibit Input	
0	Enabled. The Motor is stopped according to the setting of Pn003.1 when the overtravel occurs.
1	Disabled.

Pn000.2: Reverse Drive Prohibit Input	
0	Enabled. The Motor is stopped according to the setting of Pn003.1 when the overtravel occurs.
1	Disabled.

Pn000.3: Reserved setting (Do not change).

No.	Index	Name	Range	Unit	Default	When Enabled
Pn001	3165	Basic Function Selections 1	0000 to 0001	–	0000	After restart

Pn001.0: CCW, CW	
0	Use CCW as the forward direction.
1	Use CW as the forward direction.

Pn001.1: Reserved setting (Do not change).

Pn001.2: Reserved setting (Do not change).

Pn000.3: Reserved setting (Do not change).

No.	Index	Name	Range	Unit	Default	When Enabled
Pn002	3166	Application Function Selections 2	0000 to 0100	–	0000	After restart

Pn002.0: Reserved setting (Do not change).	
Pn002.1: Reserved setting (Do not change).	
Pn002.2: Usage of Absolute Encoder	
0	Use the encoder as an absolute encoder.
1	Use the encoder as an incremental encoder.
Pn002.3: Reserved setting (Do not change).	

No.	Index	Name	Range	Unit	Default	When Enabled
Pn003	3167	Application Function Selections 3	0000 to 1032	–	0000	After restart

Pn003.0: Motor Stopping Methods for Gr.1 Alarms, Servo OFF, STO, and Servo OFF	
0	Applying the dynamic brake and then let the Motor coast.
1	Applying the dynamic brake and then place the Motor in DB state.
2	Coast the Motor to a stop.

Pn003.1: Motor Stopping Method for Overtravel	
0	Applying the dynamic brake and then let the Motor coast.
1	Coast the Motor to a stop.
2	Applying the reverse brake and then place the Motor in zero clamping state.
3	Applying the reverse brake and then let the Motor coast.

Pn003.2: Reserved setting (Do not change).

Pn003.3: Overload Enhancement	
0	Disabled.
1	Enabled. This function can enhance the Motor load for instantaneous more than 2 times rated load, which can be used in the conditions that require frequent start and stop. This setting is unavailable for EM3A Motors.

No.	Index	Name	Range	Unit	Default	When Enabled
Pn004	3168	Application Function Selections 4	0000 to 0025	–	0000	After restart

Pn004.0: Motor Stopping Methods for Gr.2 Alarms	
0	Applying the dynamic brake and then let the Motor coast.
1	Applying the dynamic brake and then place the Motor in DB state.
2	Coast the Motor to a stop.
3	Applying the reverse brake and then place the Motor in DB state.
4	Applying the reverse brake and then let the Motor coast.
5	Regards Gr.2 Alarms as the Warnings, and the Motor will not be stopped.

Pn004.1: Deviation Counter Clear in Local Control Mode	
0	Reset to zero when Servo is OFF or STO is available.
1	Reserved setting (Do not change).
2	Reset to zero when Servo is OFF, or STO is available, or Overtravel is occurred.

Pn004.2: Reserved setting (Do not change).

Pn004.3: Reserved setting (Do not change).

No.	Index	Name	Range	Unit	Default	When Enabled
Pn005	3169	Application Function Selections 5	00d0 to 33d3	–	00d0	After restart

Pn005.0: Internal Torque Feedforward Method	
0	Use the general internal torque feedforward.
1	Reserved setting (Do not use.)
2	Use the high-speed internal torque feedforward.
3	Reserved setting (Do not use.)

Pn005.1: Local Control Method	
d	Use the parameter reference as default.

Pn005.2: Torque Feedforward Method	
0	Use the internal torque feedforward.
1	Use the model following control torque feedforward, which is available when Model Following Control Selection (Pn150.0) is enabled.
2	The controller sets torque feedforward
3	Cubic interpolation algorithm generated torque feedforward

Pn005.3: Speed Feedforward Method	
0	Use the internal speed feedforward.
1	Use the model following control speed feedforward, which is available when Model Following Control Selection (Pn150.0) is enabled.
2	The controller sets torque feedforward
3	Cubic interpolation algorithm generated torque feedforward

No.	Index	Name	Range	Unit	Default	When Enabled
Pn006	316A	Application Function Selections 6	0000 to 0001	–	0001	After restart
	H0001					
	Pn006.0: Bus Selection					
	0	Do not use the Bus. Select the control method by the setting of Pn005.1.				
	1	Use EtherCAT.				
	2	Use Profinet.				
	Pn006.1: Reserved setting (Do not change).					
	Pn006.2: Reserved setting (Do not change).					
	Pn006.3: Reserved setting (Do not change).					
Pn007	316B	Application Function Selections 7	0000 to 1120	–	0010	After restart
	H0010					
	Pn007.0: Reserved setting (Do not change).					
	Pn007.1: Power Supply Selection					
	0	Single-phase AC				
	1	Three-phase AC				
	Pn007.2: Torque Limit Action When Undervoltage Occurs					
	0	Disabled.				
	1	Enabled.				
	Pn007.3: AC Supply Frequency					
	0	50 Hz				
	1	60 Hz				

No.	Index	Name	Range	Unit	Default	When Enabled
Pn008	316C	Initial Display Selection When Power On	0 to 9999	–	0010	After restart
	Set the displayed Un Number when power on the device. For example, set this parameter to 0, the display is Un000 after powering on the device.					
Pn009	316D	Application Function Selections 9	0000 to 0001	–	0000	After restart
	 Pn009.0: Shared DC Bus Function 0 Disabled. 1 Enabled. Pn009.1: Reserved setting (Do not change). Pn009.2: Reserved setting (Do not change). Pn009.3: Reserved setting (Do not change).					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn100	31C8	Tuning Function	0001 to 1105	–	0001	After restart

Pn100.0: Tuning Mode	
1	Tuning-less
2	Reserved setting (Do not change).
3	One-parameter auto-tuning
4	Reserved setting (Do not change).
5	Manual tuning

Pn100.1: Reserved setting (Do not change).

Pn100.2: Automatic Vibration Suppression Selection	
0	Disabled.
1	Enabled.

Pn100.3: Damping Selection (This parameter is available when the One-parameter auto-tuning function is selected.)	
0	Standard: Short positioning time, but prone to overshoot.
1	Stable: Stable positioning, but long positioning time.

No.	Index	Name	Range	Unit	Default	When Enabled
Pn101	31C9	Servo Rigidity	0 to 500	Hz	40	Immediately
	This parameter determines the response characteristic of the servo system. The performance can be improved by increasing this value, and decrease if vibration occurs.					
Pn102	31CA	Speed Loop Gain	1 to 10000	rad/s	500	Immediately
	This parameter determines the bandwidth of the speed loop.					
Pn103	31CB	Speed Loop Integral Time	1 to 5000	0.1ms	125	Immediately
	Reduce this value can shorten positioning time and speed response time.					
Pn104	31CC	Position Loop Gain	0 to 1000	1/s	40	Immediately
	This parameter determines the bandwidth of position loop. Increase this value can improve the stiffness of positioning, decrease if the system vibrates.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn105	31CD	Torque Reference Filter Time	0 to 2500	50	0.01ms	Immediately
	This parameter determines the bandwidth of torque reference filter, the filter is used to filter out the noise in torque reference.					
Pn106	31CE	Load Inertia Percentage	0 to 9999	%	0	Immediately
	This value should be set to the percentage of load inertia and Motor inertia.					
Pn107	31CF	Second Speed Loop Gain	1 to 10000	rad/s	250	Immediately
	–					
Pn108	31D0	Second Speed Loop Integral Time	1 to 5000	rad/s	200	Immediately
	–					
Pn109	31D1	Second Position Loop Gain	0 to 1000	1/s	40	Immediately
	–					
Pn110	31D2	Second Torque Reference Filter Time	0 to 2500	0.01ms	100	Immediately
	–					
Pn112	31D4	Speed Feedforward	0 to 100	%	0	Immediately
	This value is a percentage of the internal speed feedforward. This value is available when the internal speed feedforward is selected (Pn005.3=0).					
Pn113	31D5	Speed Feedforward Filter Time	0 to 640	0.1ms	0	Immediately
	This parameter determines the bandwidth of internal speed feedforward filter. The filter is used to filter out the noise in internal speed feedforward.					
Pn114	31D6	Torque Feedforward	0 to 100	%	0	Immediately
	This value is a percentage of the internal torque feedforward. This value is available when the internal torque feedforward is selected (Pn005.2=0).					
Pn115	31D7	Torque Feedforward Filter Time	0 to 640	0.1ms	0	Immediately
	This parameter determines the bandwidth of internal torque feedforward filter. The filter is used to filter out the noise in internal torque feedforward.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn116	31D8	P/PI Switch Mode	0 to 4	–	0	After restart
	[0] Use torque reference as the condition (threshold setting: Pn117). [1] Use position deviation counter as the condition (threshold setting: Pn118). [2] Use acceleration reference as the condition (threshold setting: Pn119). [3] Use the speed reference as the condition (threshold setting: Pn120). [4] Fixed to PI Control.					
Pn117	31D9	Torque Reference Threshold for P/PI Switch	0 to 300	%	200	Immediately
	The threshold is used to switch speed controller from PI to P. This value is a percentage of torque reference.					
Pn118	31DA	Deviation Counter Threshold for P/PI Switch	0 to 10000	1 pulse	0	Immediately
	The threshold is used to switch speed controller from PI to P. This value is a pulse number.					
Pn119	31DB	Acceleration Reference Threshold for P/PI Switch	0 to 3000	10 rpm/s	0	Immediately
	The threshold is used to switch speed controller from PI to P. This value is an acceleration reference.					
Pn120	31DC	Speed Reference Threshold for P/PI Switch	0 to 10000	rpm	0	Immediately
	The threshold is used to switch speed controller from PI to P. This value is a speed reference.					
Pn121	31DD	Gain Switch Mode	0 to 10	–	0	After restart
	[0] Fixed to first group gains. [1] Use external signal (G-SEL) as the condition. [2] Use torque reference as the condition (threshold setting: Pn117). [3] Use position deviation counter as the condition (threshold setting: Pn118). [4] Use acceleration as the condition (threshold setting: Pn119). [5] Use speed reference as the condition (threshold setting: Pn120). [6] Use position reference as the condition (threshold setting: Pn123). [7] Use actual speed as the condition (threshold setting: Pn124). [8] Use position reference (Pn123) and actual speed (Pn124) as the condition. [9] Fixed to second group gains. [10] Use positioning completed flag as the condition.					
Pn122	31DE	Delay Time for Gain Switch	0 to 20000	0.1 ms	0	Immediately
	The delay time for gain switching after the condition has satisfied.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn123	31DF	Threshold for Gain Switch	0 to 20000	–	0	Immediately
	The threshold of speed reference for gain switching.					
Pn124	31E0	Speed Threshold for Gain Switch	0 to 2000	rpm	0	Immediately
	This parameter is available only when using position reference and actual speed as the condition (Pn121=8).					
Pn125	31E1	Ramp Time for Position Loop Gain Switch	0 to 20000	0.1 ms	0	Immediately
	Ramp time for gain switching, it is only available to position loop gain.					
Pn126	31E2	Hysteresis for Gain Switch	0 to 20000	–	0	Immediately
	Hysteresis of gain switching conditions. It is used to prevent gain switching frequently.					
Pn127	31E3	Low Speed Filter	0 to 100	1 cycle	0	Immediately
	This parameter determines the performance of the filter for low speed measurement. The filter will filter out the noise in low speed, but the measured speed has significant delay if this value is large.					
Pn130	31E6	Coulomb Friction Compensation	0 to 3000	0.1%Tn	0	Immediately
	This parameter is used to compensate coulomb friction. The value is the permillage of coulomb friction and Motor rated torque.					
Pn131	31E7	Speed Dead Band for Coulomb Friction Compensation	0 to 100	rpm	0	Immediately
	To set a dead band to disable coulomb friction compensation. It is used to prevent vibration at zero speed.					
Pn132	31E8	Viscous Friction Compensation	0 to 1000	0.1%Tn/ 1000rpm	0	Immediately
	–					
Pn135	31EB	Encoder Speed Filter Time	0 to 30000	0.01ms	4	Immediately
	To set a proper time for smoothing the changes in the feedback speed to reduce vibration. This parameter is available when the instantaneous speed is not used as the speed feedback (Pn162=0).					

<table>
<tr><th>No.</th><th>Index</th><th>Name</th><th>Range</th><th>Unit</th><th>Default</th><th>When Enabled</th></tr>
<tr><td rowspan="2">Pn150</td><td>31FA</td><td>Model Following Control Function</td><td>0000 to 0002</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">

Pn150.0: Model Following Control Selection
0 Do not use.
1 Use the model following control.
2 Use the model following control and load oscillation suppression.
Pn150.1: Reserved setting (Do not change).
Pn150.2: Reserved setting (Do not change).
Pn150.3: Reserved setting (Do not change).</td></tr>
<tr><td rowspan="2">Pn151</td><td>31FB</td><td>Model Following Control Gain</td><td>10 to 1000</td><td>1/s</td><td>50</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter determines the response characteristic of the servo system. If you increase the setting of the model following control gain, the response characteristic will improve and the positioning time will be shortened.</td></tr>
<tr><td rowspan="2">Pn152</td><td>31FC</td><td>Model Following Control Gain Correction</td><td>20 to 500</td><td>%</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter is used for correcting the setting of the model following control gain.</td></tr>
<tr><td rowspan="2">Pn153</td><td>31FD</td><td>Model Following Control Speed Feedforward</td><td>0 to 200</td><td>%</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter is used for fine tuning the speed feedforward value output by the model following control gain. If you increase this setting, the bias can be reduced but overshooting will be likely to occur.</td></tr>
<tr><td rowspan="2">Pn154</td><td>31FE</td><td>Model Following Control Torque Feedforward</td><td>0 to 200</td><td>%</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter is used for fine-tuning the torque feedforward value output by the model following control gain. If you increase this setting, the response characteristic can be improved but overshooting will be likely to occur.</td></tr>
<tr><td rowspan="2">Pn155</td><td>31FF</td><td>Load Oscillation Frequency</td><td>50 to 500</td><td>0.1 Hz</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">In general, this setting is the anti-resonance frequency of the two-mass servo system.</td></tr>
</table>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn156	3200	Filter Time for Load Oscillation Suppression	2 to 500	0.1 ms	10	Immediately
	If you increase this setting, the response characteristic can be softer but the effect of vibration suppression will be worse.					
Pn157	3201	Limit for Load Oscillation Suppression	0 to 1000	rpm	100	Immediately
	To set a compensation limiting for the jitter suppression at speed feedforward. If you decrease this setting, the response characteristic can be softer but the effect of vibration suppression will be worse.					
Pn160	3204	Load Torque Compensation	0 to 100	%	0	Immediately
	This parameter is a coefficient (percentage) to compensate load torque. Increase this value can improve load disturbance rejection performance but may cause vibration.					
Pn161	3205	Load Torque Observer Gain	0 to 1000	Hz	200	Immediately
	This parameter is used to adjust the response characteristic of the load observer.					
Pn162	3206	Feedback Speed Selection	0 to 1	–	0	After restart
	[0] Use encoder speed as the feedback speed. [1] Use observed speed as the feedback speed.					
Pn164	3208	Turns for PJOG0	-50 to 50	rotation	5	Immediately
	–					
Pn165	3209	Max Speed for PJOG0	100 to 3000	rpm	1000	Immediately
	–					
Pn166	320A	Acc./Dec. Time for PJOG0	50 to 2000	ms	500	Immediately
	–					
Pn167	320B	Stop Time for PJOG0	100 to 10000	ms	1000	Immediately
	–					
Pn168	320C	Turns for PJOG1	-50 to 50	rotation	5	Immediately
	–					
Pn169	320D	Max Speed for PJOG1	100 to 3000	rpm	1000	Immediately
	–					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn170	320E	Acc./Dec. Time for PJOG1	50 to 2000	ms	500	Immediately
	–					
Pn171	320F	Stop Time for PJOG1	100 to 10000	ms	1000	Immediately
	–					
Pn172	3210	Turns for Inertia Identification	0 to 1	–	0	Immediately
	To set the turns towards the forward direction in Inertia Identification operation. [0] 8 rotations. [1] 4 rotations. The number of turns the motor runs in the positive direction when offline inertia is identified					
Pn173	3211	Frequency of Vibration Suppression Filter	100 to 2000	Hz	2000	Immediately
	–					
Pn174	3212	Adjust Bandwidth of Vibration Suppression Filter	1 to 100	–	30	Immediately
	–					
Pn175	3213	Vibration Suppression	0 to 500	–	100	Immediately
	–					
Pn176	3214	Lowpass Filter Time for Vibration Suppression	0 to 50	0.1ms	0	Immediately
	–					
Pn177	3215	Highpass Filter Time for Vibration Suppression	0 to 1000	0.1ms	1000	Immediately
	–					
Pn178	3216	Damping of Vibration Suppression Filter	0 to 500	–	100	Immediately
	–					
Pn179	3217	Amplitude Threshold for Vibration Detection	5 to 500	–	100	Immediately
	This parameter is used for automatic vibration suppression.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn180	3218	Frequency Threshold for Vibration Detection	0 to 100	Hz	100	Immediately
	This parameter is used for automatic vibration suppression.					
Pn181	3219	Frequency of Notch Filter 1	50 to 5000	Hz	5000	Immediately
	–					
Pn182	321A	Depth of Notch Filter 1	0 to 23	–	0	Immediately
	–					
Pn183	321B	Width of Notch Filter 1	0 to 15	–	2	Immediately
	–					
Pn184	321C	Frequency of Notch Filter 2	50 to 5000	Hz	5000	Immediately
	–					
Pn185	321D	Depth of Notch Filter 2	0 to 23	–	0	Immediately
	–					
Pn186	321E	Width of Notch Filter 2	0 to 15	–	2	Immediately
	–					
Pn187	321F	Frequency of Notch Filter 3	50 to 5000	Hz	5000	Immediately
	–					
Pn188	3220	Depth of Notch Filter 3	0 to 23	–	0	Immediately
	–					
Pn189	3221	Width of Notch Filter 3	0 to 15	–	2	Immediately
	–					
Pn200	322C	PG Frequency Division	16 ~ 16384	pulse	16384	Immediately
	The encoder outputs orthogonal differential pulses. It is defined as the number of quadrature pulses output by the analog encoder for one revolution of the motor.					
Pn228	30A9	Multiturn limit	0 to 65535	1 rev	100	After restart
	The upper limit for absolute encoder rotation is set only when absolute encoder is used.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn304	3294	Inner Speed Reference	-6000 to 6000	rpm	500	Immediately
	To set the inner Motor speed reference. This setting is available when servo is in inner speed control mode (Pn006.0 = 0 and Pn005.1 = 1).					
Pn305	3295	Jogging Speed	0 to 6000	rpm	500	Immediately
	To set a speed for the Motor in JOG operation, and the rotation direction is determined by the reference.					
Pn306	3296	Soft Start Acceleration Time	0 to 10000	ms	0	Immediately
	To set ramp acceleration time per 1000 rpm.					
Pn307	3297	Soft Start Deceleration Time	0 to 10000	ms	0	Immediately
	To set ramp deceleration time per 1000 rpm.					
Pn308	3298	Speed Reference Filter Time	0 to 10000	ms	0	Immediately
	To set speed reference filter time.					
Pn309	3299	S-Curve Rise Time	0 to 10000	ms	0	Immediately
	To set a rise time for transiting from one speed point to another speed point in the S-curve.					
Pn310	329A	Speed Reference Smooth Mode Selection	0 to 3	–	0	After restart
	[0] Ramp [1] S-Curve [2] Primary filtering [3] Secondary filtering					
Pn311	329B	S-Curve Selection	0 to 3	–	0	After restart
	To set the transition form of the S-curve.					
Pn323	32A7	Overspeed Detection Threshold	1 to 8000	–	8000	Immediately
	A03 alarm occurs if the Motor velocity exceeds this threshold.					
Pn332	32B0	Touch Probe Digital Input Filtering Time	0 to 1000	10ns	0	Immediately
	–					
Pn401	32F5	Forward Internal Torque Limit	0 to 350	%	350	Immediately
	–					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn402	32F6	Reverse Internal Torque Limit	0 to 350	%	350	Immediately
	–					
Pn403	32F7	Forward External Torque Limit	0 to 350	%	100	Immediately
	–					
Pn404	32F8	Reverse External Torque Limit	0 to 350	%	100	Immediately
	–					
Pn405	32F9	Reverse Brake Torque Limit	0 to 350	%	300	Immediately
	–					
Pn406	32FA	Torque Limit at Main Circuit Voltage Drop	0 to 100	%	50	Immediately
	–					
Pn407	32FB	Release Time for Torque Limit at Main Circuit Voltage Drop	0 to 1000	ms	100	Immediately
	–					
Pn408	32FC	Speed Limit during Torque Control	0 to 6000	rpm	1500	Immediately
	–					
Pn500	3358	Position Arrival Tolerance	0 to 50000	1 pulse	10	Immediately
	The /COIN (Positioning Completion) output signal will turn ON when the deviation counter is less than this setting.					
Pn501	3359	Speed Arrival Tolerance	0 to 100	rpm	10	Immediately
	The /VCMP (Speed Coincidence Detection) output signal will turn ON when the deviation between the speed reference and speed feedback is less than this setting.					
Pn503	335B	Rotation Status Detection Threshold	0 to 3000	rpm	20	Immediately
	It is considered the Motor has been rotated stably and the /TGON (Rotation Detection) output signal turns ON when the Motor speed exceeds this setting.					

<table>
<tr><th>No.</th><th>Index</th><th>Name</th><th>Range</th><th>Unit</th><th>Default</th><th>When Enabled</th></tr>
<tr><td rowspan="2">Pn504</td><td>335C</td><td>Position Deviation Counter Overflow Threshold</td><td>1 to 83886080</td><td>1 pulse</td><td>41943040</td><td>Immediately</td></tr>
<tr><td colspan="6">It is considered the deviation counter has been overflowed and an alarm signal outputs when the deviation counter exceeds this setting.
NOTE: the default setting depends on the encoder resolution.</td></tr>
<tr><td rowspan="2">Pn505</td><td>335D</td><td>Servo ON Waiting Time</td><td>-2000 to 2000</td><td>ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">Parameters from Pn505 to Pn508 are available only when the /BK (Brake Output) signal turns ON.
They are used for controlling the holding brake, so that the moving part of the machine cannot move due to gravity or an external force.
● If this setting is a positive number, when the servo is ON, the /BK signal will turn ON firstly, and wait for this setting time, then excite the Motor.
● If the setting is a negative number, when the servo is ON, the Motor can be excited immediately, and wait for this setting time, then the /BK signal will turn ON.</td></tr>
<tr><td rowspan="2">Pn506</td><td>335E</td><td>Servo OFF Waiting Time</td><td>0 to 500</td><td>10 ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">When the Motor is stopped, the /BK signal turns OFF as soon as the Servo is OFF. Use this setting to change the timing to turn OFF power supply to the Motor after the Servo is OFF.</td></tr>
<tr><td rowspan="2">Pn507</td><td>335F</td><td>Brake Enable Speed Threshold</td><td>10 to 100</td><td>rpm</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">The /BK signal will turn ON when the Motor speed is lower than this setting after the Servo is OFF.</td></tr>
<tr><td rowspan="2">Pn508</td><td>3360</td><td>Brake Enable Waiting Time</td><td>10 ~ 100</td><td>10 ms</td><td>50</td><td>Immediately</td></tr>
<tr><td colspan="6">The /BK signal will turn ON when the delay exceeds this setting after the Servo is OFF.
The /BK signal tunes ON as long as one of the conditions, Brake Reference Waiting Speed and Brake Reference Waiting Time, is satisfied.</td></tr>
</table>

<table>
<tr><th>No.</th><th>Index</th><th>Name</th><th>Range</th><th>Unit</th><th>Default</th><th>When Enabled</th></tr>
<tr><td rowspan="2">Pn509</td><td>3361</td><td>Digital Input Signal Allocations 1</td><td>0000 to 7777</td><td>–</td><td>3210</td><td>After restart</td></tr>
<tr><td colspan="6">


<table>
<tr><th colspan="2">Pn509.0: Allocate signal to CN1-14</th></tr>
<tr><td>0</td><td>S-ON</td></tr>
<tr><td>1</td><td>P-OT</td></tr>
<tr><td>2</td><td>N-OT</td></tr>
<tr><td>3</td><td>P-CL</td></tr>
<tr><td>4</td><td>N-CL</td></tr>
<tr><td>5</td><td>G-SEL</td></tr>
<tr><td>6</td><td>HmRef</td></tr>
<tr><td>7</td><td>Remote</td></tr>
</table>
<table>
<tr><th>Pn509.1: Allocate signal to CN1-15</th></tr>
<tr><td>0 to 7: same as the allocation of CN1-14.</td></tr>
</table>
<table>
<tr><th>Pn509.2: Allocate signal to CN1-16</th></tr>
<tr><td>0 to 7: same as the allocation of CN1-14.</td></tr>
</table>
<table>
<tr><th colspan="2">Pn509.3: Allocate signal to CN1-17</th></tr>
<tr><td colspan="2">0 to 7: same as the allocation of CN1-14.</td></tr>
<tr><td>8</td><td>EXT1</td></tr>
<tr><td>9</td><td>EXT2</td></tr>
</table>
</td></tr>
</table>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn510	3362	Digital Input Signal Allocations 2	0000 to 0007	–	0004	After restart

Pn510.0: Allocate signal to CN1-18	
0	S-ON
1	P-OT
2	N-OT
3	P-CL
4	N-CL
5	G-SEL
6	HmRef
7	Remote
8	EXT1

Pn510.1: Reserved setting (Do not change).

Pn510.2: Reserved setting (Do not change).

Pn510.3: Reserved setting (Do not change).

<table>
<tr><th>No.</th><th>Index</th><th>Name</th><th>Range</th><th>Unit</th><th>Default</th><th>When Enabled</th></tr>
<tr><td rowspan="2">Pn511</td><td>3363</td><td>Digital Output Signal Allocations</td><td>0000 to 0bbb</td><td>–</td><td>0210</td><td>After restart</td></tr>
<tr><td colspan="6">


<table>
<tr><th colspan="2">Pn511.0: Allocate signal to CN1-6, 7</th></tr>
<tr><td>0</td><td>COIN/VCMP</td></tr>
<tr><td>1</td><td>TGON</td></tr>
<tr><td>2</td><td>S-RDY</td></tr>
<tr><td>3</td><td>CLT</td></tr>
<tr><td>4</td><td>BK</td></tr>
<tr><td>5</td><td>PGC</td></tr>
<tr><td>6</td><td>OT</td></tr>
<tr><td>7</td><td>RD</td></tr>
<tr><td>8</td><td>TCR</td></tr>
<tr><td>a</td><td>Remote0</td></tr>
<tr><td>b</td><td>Remote1</td></tr>
</table>
<table>
<tr><th>Pn511.1: Allocate signal to CN1-10, 11</th></tr>
<tr><td>0 to b: same as the allocation of CN1-6, 7.</td></tr>
</table>
<table>
<tr><th>Pn511.2: Reserved setting (Do not change).</th></tr>
</table>
<table>
<tr><th>Pn511.3: Reserved setting (Do not change).</th></tr>
</table>
</td></tr>
<tr><td rowspan="2">Pn512</td><td>3364</td><td>Digital Input Signals (Low Bits) from Bus Master</td><td>0000 to 1111</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">Use the bit-16 to bit-23 in the sub-index 01 of the object 0x60FE in CiA402 as the inputs, corresponding to CN1-14 to CN1-17.</td></tr>
<tr><td rowspan="2">Pn513</td><td>3365</td><td>Digital Input Signals (High Bits) from Bus Master</td><td>0000 to 1111</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">Use the bit-24 in the sub-index 01 of the object 0x60FE in CiA402 as the input, corresponding to CN1-18.</td></tr>
</table>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn514	3366	Digital Input Signals Filter Time	0 to 1000	1 cycle	1	Immediately
	To set a filtering time for the input signals. If you increase this setting, the signal changes on the input port will be delayed.					
Pn515	3367	Alarm Output Signal Filter Time	0 to 3	2 cycle	1	Immediately
	To set a filtering time for the alarm signals. If you increase this setting, the alarm will be delayed.					
Pn516	3368	Digital Input Signal Inverts 1	0000 to 1111	–	0000	After restart

Pn516.0: CN1-14 inverse selection	
0	The signal is not inverted.
1	The signal is inverted.

Pn516.1: CN1-15 inverse selection	
0	The signal is not inverted.
1	The signal is inverted.

Pn516.2: CN1-16 inverse selection	
0	The signal is not inverted.
1	The signal is inverted.

Pn516.3: CN1-17 inverse selection	
0	The signal is not inverted.
1	The signal is inverted.

No.	Index	Name	Range	Unit	Default	When Enabled
Pn517	3369	Digital Input Signal Inverts 2	0000 to 0001	–	0000	After restart
						
	Pn517.0: CN1-18 inverse selection					
	0	The signal is not inverted.				
	1	The signal is inverted.				
	Pn517.1: Reserved setting (Do not change).					
	Pn517.2: Reserved setting (Do not change).					
	Pn517.3: Reserved setting (Do not change).					
Pn518	336A	Dynamic Braking Time	50 ~ 20000	0.5ms	20000	Immediately
	The time required for dynamic braking of the motor.					
Pn519	336B	Serial Encoder Communication Error Tolerance	0 to 10000	1 cycle	3	Immediately
	No warning of serial encoder-related errors is reported during this parameter time.					
Pn520	336C	Position Arrival Status Detection Time Threshold	0 to 60000	0.1 ms	500	Immediately
	To set a required time for completing the positioning.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn521	336D	Alarm Masks	0000 to 0011	–	0011 (400W and below) 0010 (other power)	After restart

Pn521.0: A15 alarm mask bit (for drives of 400W and below, A.15 and A.16 use the same alarm mask bit Pn521.0; for drives of 800W and above, A.15 uses Pn521.0, and A.16 cannot be masked)	
0	Do not mask.
1	Mask (when A15 is masked, the bleeder resistor will not work even if a bleeder battery is connected)

Pn521.1: A06 Mask	
0	Do not mask.
1	Ignore the alarm.

Pn521.2: Reserved setting (Do not change).

Pn521.3: Reserved setting (Do not change).

No.	Index	Name	Range	Unit	Default	When Enabled
Pn525	3371	Motor Overload Detection Start Threshold	100 to 150	%	100	Immediately

A04 alarms occurs if the load percentage exceeds this setting more than a certain time.

The recommended setting is 120 or less, otherwise the Drive or the Motor may be damaged.

This setting is always 115 for the EM3A Motors.

<table>
<tr><th>No.</th><th>Index</th><th>Name</th><th>Range</th><th>Unit</th><th>Default</th><th>When Enabled</th></tr>
<tr><td rowspan="2">Pn528</td><td>3374</td><td>Digital Output Signal Inverts</td><td>0000 to 1111</td><td>–</td><td>0000</td><td>Immediately</td></tr>
<tr><td colspan="6">

<table>
<tr><th colspan="2">Pn516.0: CN1-6, 7 inverse selection</th></tr>
<tr><td>0</td><td>The signal is not inverted.</td></tr>
<tr><td>1</td><td>The signal is inverted.</td></tr>
</table>

<table>
<tr><th colspan="2">Pn516.1: CN1-8, 9 inverse selection</th></tr>
<tr><td>0</td><td>The signal is not inverted.</td></tr>
<tr><td>1</td><td>The signal is inverted.</td></tr>
</table>

<table>
<tr><th>Pn516.2: Reserved setting (Do not change).</th></tr>
</table>

<table>
<tr><th colspan="2">Pn516.3: CN1-12, 13 inverse selection</th></tr>
<tr><td>0</td><td>Not inverted</td></tr>
<tr><td>1</td><td>Inverted</td></tr>
</table>

</td></tr>
<tr><td rowspan="2">Pn529</td><td>3375</td><td>Torque Reaches Status Detection Torque Threshold</td><td>3 to 300</td><td>%</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">When the torque output exceeds the setting of Pn529 and the time is greater than the setting of Pn530, the /TCR (Torque Limit Detection Output) signal turns ON.</td></tr>
<tr><td rowspan="2">Pn530</td><td>3376</td><td>Torque Reaches Status Detection Time Threshold</td><td>1 to 1000</td><td>ms</td><td>10</td><td>Immediately</td></tr>
<tr><td colspan="6">When the torque output exceeds the setting of Pn529 and the time is greater than the setting of Pn530, the /TCR (Torque Limit Detection Output) signal turns ON.</td></tr>
<tr><td rowspan="2">Pn535</td><td>337B</td><td>Discharging Resistor Resistance</td><td>10 to 300</td><td>Ω</td><td>–</td><td>After restart</td></tr>
<tr><td colspan="6">To set the resistance value for the braking.
This setting is not reset when the default setting is restored.</td></tr>
<tr><td rowspan="2">Pn536</td><td>337C</td><td>Discharging Resistor Power</td><td>0 to 2000</td><td>W</td><td>–</td><td>After restart</td></tr>
<tr><td colspan="6">To set the power value for the braking resistor.
This setting is not reset when the default setting is restored.</td></tr>
</table>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn538	337E	Momentary Power Interruption Hold Time	0 to 50	1 cycle	1	Immediately
	Even if the main power supply to the Drive is interrupted momentarily, power supply to the Motor (servo ON status) will be maintained for the time set by this parameter. The setting is a number of periods, and the time of one period depends on the setting of Pn007.3: • Pn007.3=0, the time of one period is 1/50s. • Pn007.3=1, the time of one period is 1/60s.					
Pn541	3381	Current Threshold for Detecting Abnormal Operation	0 to 400	% In	200	Immediately
	Set a percentage threshold for the current to detect that the Motor has been operating abnormally.					
Pn542	3382	Acceleration Threshold for Detecting Abnormal Operation	0 to 1000	krpm/s	50	Immediately
	Set a threshold for the acceleration to detect that the Motor has been operating abnormally.					
Pn707	The torque limiting function was enabled		0～1	–	1	Restart
	Torque limiting function enables control					
Pn720	Zero-back mode		1～35	–	1	Immediately
Pn721	Look for the reference speed		1～2147483647	0.1rpm	1000	Immediately
Pn722	Find origin velocity		1～2147483647	0.1rpm	100	Immediately
Pn723	Return to zero acceleration		0～32767	–	16384	Immediately
Pn724	Origin migration		-2147483648～2147483647	1 pulse	0	Immediately
Pn725	Electronic gear ratio molecule		1～1073741824	–	1	Restart

No.	Index	Name	Range	Unit	Default	When Enabled
Pn726	Electronic gear score		1～1073741824	–	1	Restart
Pn730	EPOS maximum acceleration		0～2147483647	1000LU/S2	100	Immediately
Pn731	EPOS maximum reduction speed		0～2147483647	1000LU/S2	100	Immediately
Pn732	JOG1 velocity		-40000000～40000000	1000LU/min	-500	Immediately
Pn733	JOG2 velocity		-40000000～40000000	1000LU/min	500	Immediately
Pn734	Soft limit positive parameter		-2147483647～2147483647	LU	2147483647	Immediately
Pn735	Soft limit negative parameter		-2147483647～2147483647	LU	-2147483647	Immediately
Pn736	Enable additional torque limiting		0～1	–	0	Immediately
Pn737	Torque feedback		0～16384	–	0	Immediately
	4000 hex ≙ maximum torque					
Pn738	EPOS reaches the window threshold		0～2147483647	LU	50	Immediately
	The threshold used to determine the completion of the target location					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn739	EPOS time when the window threshold is reached		0～2147483647	ms	5	Immediately
	It is used to determine the time of threshold judgment when target location is completed					

11.2.1 Parameter Quick Query Table

For a detailed explanation of drive parameter objects, see 10.2. The following section provides only the quick query table.

Parameter number	name	Data type	accessibility	unit	Data range	Default value
Pn000	Basic function set 0	INT32	RW	–	0000～0111	0000
Pn001	Application function setting 1	INT32	RW	–	0000～0001	0000
Pn002	Application function setting 2	INT32	RW	–	0000～0100	0000
Pn003	Application function setting 3	INT32	RW	–	0000～1032	0000
Pn004	Application function setting 4	INT32	RW	–	0000～0025	0000
Pn005	Application function setting 5	INT32	RW	–	00d0～33d3	00d0
Pn006	Application function setting 6	INT32	RW	–	0000～0002	0002
Pn007	Application function setting 7	INT32	RW	–	0000～1120	0010
Pn008	Power-on panel display item selection	INT32	RW	–	0～9999	0010
Pn009	Application function setting 9	INT32	RW	–	0000～0001	0000
Pn100	Application function set 100	INT32	RW	–	0001～1105	0001
Pn101	Servo rigidity setting	INT32	RW	Hz	0～500	40
Pn102	Velocity loop gain	INT32	RW	rad/s	1～10000	500
Pn103	Velocity loop integration time	INT32	RW	0.1ms	1～5000	125
Pn104	Position loop gain	INT32	RW	1/s	0～1000	40
Pn105	Torque instruction filtering time constant	INT32	RW	0.01ms	0～2500	50
Pn106	Percentage of load inertia	INT32	RW	%	0～9999	0

Pn107	Second velocity loop gain	INT32	RW	rad/s	1～10000	250
Pn108	Second velocity loop integration time	INT32	RW	rad/s	1～5000	200
Pn109	Second position loop gain	INT32	RW	1/s	0～1000	40
Pn110	Second torque instruction filter time constant	INT32	RW	0.01ms	0～2500	100
Pn112	Percentage of internal speed feedforward	INT32	RW	%	0～100	0
Pn113	Internal velocity feedforward filtering time constant	INT32	RW	0.1ms	0～640	0
Pn114	Percentage of internal torque feedforward	INT32	RW	%	0～100	0
Pn115	Internal torque feedforward filter time constant	INT32	RW	0.1ms	0～640	0
Pn116	P/PI switchover condition	INT32	RW	－	0～4	0
Pn117	Torque switching threshold	INT32	RW	%	0～300	200
Pn118	Deviation counter switching threshold	INT32	RW	1 pulse	0～10000	0
Pn119	Given acceleration switching threshold	INT32	RW	10rpm/s	0～3000	0
Pn120	Given speed switching threshold	INT32	RW	rpm	0～10000	0
Pn121	Gain switching condition	INT32	RW	－	0～10	0
Pn122	Switching delay time	INT32	RW	0.1ms	0～20000	0
Pn123	Switching threshold level	INT32	RW	－	0～20000	0
Pn124	Speed threshold	INT32	RW	rpm	0～2000	0
Pn125	Position gain switching time	INT32	RW	0.1ms	0～20000	0
Pn126	Switching hysteresis	INT32	RW	－	0～20000	0
Pn127	Low speed measurement and filtering	INT32	RW	1cycle	0～100	0
Pn130	Coulomb friction load	INT32	RW	0.1%Tn	0～3000	0
Pn131	Coulomb friction compensation velocity	INT32	RW	rpm	0～100	0

	hysteresis region					
Pn132	Coefficient of viscous friction	INT32	RW	0.1%Tn/1000rpm	0～1000	0
Pn135	Velocity feedback filter	INT32	RW	0.01ms	0～30000	4
Pn150	Application function set 150	INT32	RW	–	0000～0002	0000
Pn151	Model tracking control gain	INT32	RW	1/s	10～1000	50
Pn152	Model tracking control gain compensation percentage	INT32	RW	%	20～500	100
Pn153	Model tracking control speed feedforward percentage	INT32	RW	%	0～200	100
Pn154	Model tracking control torque feedforward percentage	INT32	RW	%	0～200	100
Pn155	Low frequency vibration suppression frequency	INT32	RW	0.1Hz	50～500	100
Pn156	Low frequency vibration suppression filtering time constant	INT32	RW	0.1ms	2～500	10
Pn157	Low frequency vibration suppression speed feedforward compensation quantity limiting	INT32	RW	rpm	0～1000	100
Pn160	Percentage of load disturbance compensation	INT32	RW	%	0～100	0
Pn161	Load disturbance observer gain	INT32	RW	Hz	0～1000	200
Pn162	Use the instantaneous observed velocity as velocity feedback	INT32	RW	–	0～1	0
Pn164	PJOG0 Number of turns	INT32	RW	rotation	-50～50	5
Pn165	PJOG0 rotation speed	INT32	RW	rpm	100～3000	1000
Pn166	PJOG0 Acceleration and deceleration time	INT32	RW	ms	50～2000	500
Pn167	PJOG0 Stop time	INT32	RW	ms	100～10000	1000
Pn168	Number of turns of PJOG1	INT32	RW	rotation	-50～50	5
Pn169	Rotation speed of PJOG1	INT32	RW	rpm	100～3000	1000

Pn170	PJOG1 acceleration and deceleration time	INT32	RW	ms	50～2000	500
Pn171	PJOG1 stop time	INT32	RW	ms	100～10000	1000
Pn172	Load inertia detection motor rotation number selection	INT32	RW	–	0～1	0
Pn173	Intermediate frequency vibration suppression center frequency	INT32	RW	Hz	100～2000	2000
Pn174	Intermediate frequency vibration suppression bandwidth adjustment	INT32	RW	–	1～100	30
Pn175	Intermediate frequency vibration suppression damping gain	INT32	RW	–	0～500	100
Pn176	Intermediate frequency vibration suppression low pass filter time constant	INT32	RW	0.1ms	0～50	0
Pn177	Intermediate frequency vibration suppression high pass filter time constant	INT32	RW	0.1ms	0～1000	1000
Pn178	Intermediate frequency vibration suppression proportional attenuation gain	INT32	RW	–	0～500	100
Pn179	Amplitude threshold of vibration	INT32	RW	–	5～500	100
Pn180	Frequency threshold of vibration	INT32	RW	–	0～100	100
Pn181	Notch filter 1 frequency	INT32	RW	Hz	50～5000	5000
Pn182	Notch filter 1 depth	INT32	RW	–	0～23	0
Pn183	Notch filter 1 width	INT32	RW	–	0～15	2
Pn184	Notch filter 2 frequency	INT32	RW	Hz	50～5000	5000
Pn185	Notch filter 2 depth	INT32	RW	–	0～23	0
Pn186	Notch filter 2 width	INT32	RW	–	0～15	2
Pn187	Notch filter 3 frequency	INT32	RW	Hz	50～5000	5000
Pn188	Notch filter 3 depth	INT32	RW	–	0～23	0
Pn189	Notch filter 3 width	INT32	RW	–	0～15	2
Pn304	Parametric velocity	INT32	RW	rpm	-6000～6000	500

Pn305	JOG speed	INT32	RW	rpm	0～6000	500
Pn306	Soft start acceleration time	INT32	RW	ms	0～10000	0
Pn307	Soft start deceleration time	INT32	RW	ms	0～10000	0
Pn308	Speed instruction filtering time constant	INT32	RW	ms	0～10000	0
Pn309	S-curve rise time	INT32	RW	ms	0～10000	0
Pn310	Speed command curve form	INT32	RW	–	0～3	0
Pn311	S shape selection	INT32	RW	–	0～3	0
Pn323	Overspeed alarm detection threshold	INT32	RW	–	1～8000	8000
Pn332	Touch probe input overspeed alarm detection threshold filtering time	INT32	RW	10ns	0～200	20
Pn401	Positive internal torque limit	INT32	RW	%	0～350	350
Pn402	Invert the internal torque limit	INT32	RW	%	0～350	350
Pn403	Forward external torque limit	INT32	RW	%	0～350	100
Pn404	Reverse external torque limit	INT32	RW	%	0～350	100
Pn405	Reverse braking torque limit	INT32	RW	%	0～350	300
Pn406	Undervoltage torque limit	INT32	RW	%	0～100	50
Pn407	The undervoltage torque limits the release time	INT32	RW	ms	0～1000	100
Pn408	Speed limit when torque is controlled	INT32	RW	rpm	0～6000	1500
Pn500	Positioning error	INT32	RW	1 pulse	0～50000	10
Pn501	Same-speed error	INT32	RW	rpm	0～100	0
Pn503	Rotational detection speed	INT32	RW	rpm	0～3000	20
Pn504	Deviation counter overflow alarm	INT32	RW	1pulse	1～10*2^{23}	–
Pn505	Servo ON wait time	INT32	RW	ms	-2000～2000	0
Pn506	Basic waiting process	INT32	RW	10 ms	0～500	0

Pn507	Braking waiting speed	INT32	RW	rpm	10～100	100
Pn508	Braking waiting time	INT32	RW	10 ms	10～100	50
Pn509	Assign the input signal to port 1	INT32	RW	–	0000～9777	8210
Pn510	Assign the input signal to port 2	INT32	RW	–	0000～0009	0009
Pn511	Output signal distribution	INT32	RW	–	0000～0bbb	0210
Pn512	Enable low level of bus control input contact	INT32	RW	–	0000～1111	0000
Pn513	Bus control input contact high level enabled	INT32	RW	–	0000～1111	0000
Pn514	Enter the port filter time	INT32	RW	1 cycle	0～1000	1
Pn515	Alarm port filter time	INT32	RW	2 cycle	0～3	1
Pn516	The input port signal is negated by 1	INT32	RW	–	0000～1111	0000
Pn517	Input port signal negation 2	INT32	RW	–	0000～0001	0000
Pn519	Serial encoder error allowed time	INT32	RW	1 cycle	0～10000	3
Pn520	Position time	INT32	RW	0.1ms	0～60000	500
Pn521	Alarm mask register 521	INT32	RW	–	0000～0011	0000
Pn525	Overload alarm threshold	INT32	RW	%	100～150	100
Pn528	The output port signal is reversed	INT32	RW	–	0000～1111	0000
Pn529	Torque detection signal output threshold	INT32	RW	%	3～300	100
Pn530	Torque detection signal output time	INT32	RW	ms	1～1000	10
Pn535	Bleed resistor value	INT32	RW	Ω	10～300	–
Pn536	Bleed resistor power	INT32	RW	W	0～2000	–
Pn538	Instantaneous hold time	INT32	RW	1 period	0～50	1
Pn707	The torque limiting function is enabled	INT32	RW	-	0～1	1
Pn720	Zero-back mode	INT32	RW	–	1～35	1
Pn721	Look for the reference speed	INT32	RW	0.1rpm	1～ 2147483647	1000

Pn722	Find origin velocity	INT32	RW	0.1rpm	1～ 2147483647	100
Pn723	Return to zero acceleration	INT32	RW	-	0～32767	16384
Pn724	Origin migration	INT32	RW	1 pulse	-2147483648～2147483647	0
Pn725	Electronic gear ratio molecules	INT32	RW	－	1～2^{30}	1
Pn726	Electronic gear ratio denominator	INT32	RW	－	1～2^{30}	1
Pn730	EPOS maximum acceleration	INT32	RW	1000LU/S2	0～2147483647	100
Pn731	EPOS maximum reduction speed	INT32	RW	1000LU/S2	0～2147483647	100
Pn732	JOG1 velocity	INT32	RW	1000LU/min	-40000000～40000000	-500
Pn733	JOG2 velocity	INT32	RW	1000LU/min	-40000000～40000000	500
Pn734	Soft limit positive parameter	INT32	RW	LU	-2147483647～2147483647	2147483647
Pn735	Soft limit negative parameter	INT32	RW	LU	-2147483647～2147483647	-2147483647
Pn736	Limiting torque Indicates that limiting torque is enabled	INT32	RW	-	0～1	0
Pn737	Torque feedback	INT32	RW	-	0～16384	0
Pn738	EPOS reaches the window threshold	INT32	RW	LU	0～2147483647	50
Pn739	EPOS time when the window threshold is reached	INT32	RW	ms	0～2147483647	5

Chapter 12 Other

12.1 Bleed resistance selection

1、Drain resistance application

When the servo motor is in the reverse braking state, the motor runs in a power generation state, and the braking energy is fed back to the DC bus, resulting in the bus voltage pumping, which may cause drive damage if not handled in time. Therefore, the braking energy must be dissipated by means of a bleed resistor. There are two main reverse braking states:

◆the process of decelerating or stopping the motor;

◆The motor is dragged as a vertical shaft descending process.

2、Built-in, external bleed resistors

Built-in bleed resistor: mounted inside the servo drive.

ED3L 200V series products: 50W~400W products are not equipped with built-in bleed resistance; 750W~2KW product configuration built-in bleed resistance.

ED3L series 400V products are equipped with built-in bleed resistors in the full power segment.

External bleed resistor: mounted outside the driver and configured separately.

The built-in bleed resistor and the external bleed resistor cannot be used at the same time, and an external bleed resistor is required when the braking power exceeds the power allowed by the built-in bleed resistor.

The main specifications of the bleed resistance of the ED3L servo driver are as follows:

Table 11-1 Bleed resistance specifications of the ED3L servo driver

Model number	Main circuit voltage	Built-in drain resistance specification	External drain resistor Minimum value
ED3L-A5A	single-phase AC 200V～240V	—	45Ω
ED3L-01A	single-phase AC 200V～240V	—	45Ω
ED3L-02A	single-phase AC 200V～240V	—	45Ω
ED3L-04A	single-phase AC 200V～240V	—	45Ω
ED3L-08A	single-phase / Three phase AC 200V～240V	50Ω / 60W	25Ω
ED3L-10A	single-phase / Three phase AC 200V～240V	50Ω / 60W	25Ω
ED3L-15A	single-phase / Three phase AC 200V～240V	40Ω / 80W	25Ω

ED3L-20A	Three phase AC 200V～240V	40Ω / 80W	25Ω
ED3L-10D	Three phase AC 380V～440V	100Ω / 80W	65Ω
ED3L-15D	Three phase AC 380V～440V	100Ω / 80W	65Ω
ED3L-20D	Three phase AC 380V～440V	50Ω / 80W	40Ω
ED3L-30D	Three phase AC 380V～440V	50Ω / 80W	40Ω
ED3L-50D	Three phase AC 380V～440V	35Ω / 80W	20Ω
ED3L-75D	Three phase AC 380V～440V	35Ω / 80W	20Ω
ED3L-0404A	single-phase / Three phase AC 200V～240V	50Ω / 60W	45Ω
ED3L-1010A	single-phase / Three phase AC 200V～240V	40Ω / 80W	25Ω

3、External bleed resistor selection

When the value of the braking energy is greater than the maximum amount of energy that the built-in bleed resistor can absorb, an external bleed resistor is required. The magnitude of braking energy is affected by the moment of inertia, speed and load inertia of the motor rotor, and the actual working conditions shall prevail.

The main consumption of braking energy: bus capacitance absorption EC, discharge resistance consumption, mechanical friction loss, motor and drive own loss, here calculation ignores mechanical friction loss, motor and drive own loss.

The energy that can be absorbed by the servo system bus capacitance can be expressed by the following equation:

$$\text{Capacitance absorbed energy} \quad E_C = \frac{1}{2} C(U_1^2 - U_2^2) \qquad (13\text{-}1)$$

C：Busbar capacitance (uF)；

U_1：Pump lift busbar voltage, 200V products for 390V, 400V products for 760V;

U2: Normal bus voltage, 310V for 200V products, 530V for 400V products.

The braking energy of the servo system can be expressed as follows:

$$\text{Pump lift energy} \quad E_S = \frac{(J_L + J_M)N^2}{182} \qquad (13\text{-}2)$$

J_M：The moment of inertia of the motor rotor (10-4kg·m2) can be found in the specification of the motor；

J_L：The load inertia (10-4kg·m2) is determined according to the actual working condition；

N：The actual running speed of the motor (r/min) is determined according to the actual working condition。

Table 11-2 Energy absorbed by the ED3L 200V driver

Servo driver model	Matching motor model	Motor rotor rotation The inertia is J_M （$10^{-4}kg·m^2$）	Bus capacitance can be Absorbed energyEc （J）
ED3L-A5A	EM3A-A5ALA	0.023	18.48
ED3L-01A	EM3A-01ALA	0.0428	
	EM3A-01AFA		
	EM3A-01AKA		
	EM3A-01ATA		
ED3L-02A	EM3A-02ALA	0.147	18.48
	EM3A-02AFA		
	EM3A-02AKA		
	EM3A-02ATA		
ED3L-04A	EM3A-04ALA	0.244	18.48
	EM3A-04AFA		
	EM3A-04AKA		
	EM3A-04ATA		
	EM3J-04ALA	0.64	
	EM3J-04AFA		
	EM3J-04AKA		
	EM3J-04ATA		
ED3L-08A	EM3A-08ALA	0.909	31.36
	EM3A-08AFA		
	EM3J-08ALA	1.64	
	EM3J-08AFA		
ED3L-10A	EM3A-10AKA	1.14	31.36
	EM3A-10ATA		
	EMG-10ALB	13.2	
	EMG-10AFD		
	EM3G-09ALA	11.9	
ED3L-15A	EMG-15ALB	18.4	49.28
	EMG-15AFD		
	EM3G-13ALA	17.3	
	EM3A-15ATB	2.33	
ED3L-20A	EMG-20ALB	23.5	49.28
	EMG-20AFD		
ED3L-0404A	EM3A-02ALA	0.147	26.32

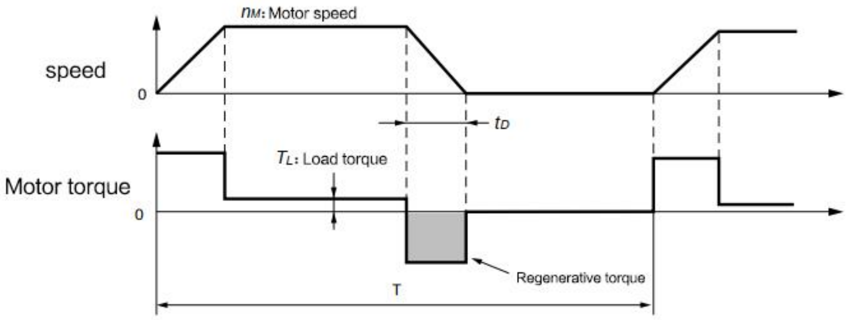
	EM3A-02AFA		
	EM3A-02AKA		
	EM3A-02ATA		
	EM3J-02ALA	0.33	
	EM3J-02AFA		
	EM3J-02AKA		
	EM3J-02ATA		
	EM3A-04ALA	0.244	
	EM3A-04AFA		
	EM3A-04AKA		
	EM3A-04ATA		
	EM3J-04ALA	0.64	
	EM3J-04AFA		
	EM3J-04AKA		
	EM3J-04ATA		
ED3L-1010A	EM3A-08ALA	0.909	45.92
	EM3A-08AFA		
	EM3J-08ALA	1.64	
	EM3J-08AFA		
	EM3A-10AKA	1.14	
	EM3A-10ATA		
	EM3G-09ALA	11.9	

Table 11-3 Energy absorbed by the ED3L 400V driver

Servo driver model	Matching motor model	Motor rotor rotation The inertia is J_M （10^{-4}kg·m^2）	Bus capacitance can be Absorbed energyEc（J）
ED3L-10D	EM3J-10DLA	2.2	41.538
	EM3G-09DTA	11.9	
	EM3G-09DLA		
ED3L-15D	EM3A-15DTB	2.33	
	EM3A-15DLB		
	EM3G-13DTA	17.3	
	EM3G-13DLA		
ED3L-20D	EM3A-20DTB	2.95	74.175
	EM3A-20DLB		
	EM3G-18DTA	22.3	
	EM3G-18DLA		
ED3L-30D	EM3A-30DLA	7.72	

	EM3G-29DLA	43.4	
ED3L-50D	EM3A-40DLA	10.24	121.647
	EM3A-50DLA	14	
	EM3G-44DLA	58.5	
ED3L-75D	EM3G-55DLA	85.5	148.35
	EM3G-75DLA	117	

4、Bleed resistance selection process:



◆ The motor decelerates in the horizontal direction:

（1）Find the braking energy ES of the servo system

The moment of inertia JM of the motor rotor, the load inertia JL and the actual speed N of the motor were determined, and the braking energy ES of the servo system was calculated by referring to formula (13-2).

◆Note: When calculating ES of multi-axis drivers, the braking energy of each axis should be calculated by summing.

(2) Determine the energy EC absorbed by the servo unit. For the EC values, see Table 13-2 and Table 13-3.

(3) According to the loss of the load system during deceleration, calculate the energy consumption EL and the energy loss EP of the servo motor coil resistance.

◆ Because the energy consumed by the load system EL and the energy lost by the resistance of the motor coil are small during the deceleration of the motor, they can be ignored here.

（4）Find the energy Ek consumed by the drain resistor

$$E_k = Es - Ec - E_L - E_P \qquad (13\text{-}3)$$

（5）Determine the time T of the reciprocating cycle movement, and the value of T is determined according to the actual working condition.

（6）Calculate the required brake resistance power Pa, and determine whether an external bleed resistor is needed.

$$Pa = \frac{2E_k}{T} \qquad (13\text{-}4)$$

If Pa is less than the power of the built-in drain resistance, it is not necessary to connect the external drain resistance. If Pa is greater than the power of the external drain resistance, the external drain resistance is required.

（7）When external drain resistance is selected, the derating can be reduced by 80%. In the case of forced heat dissipation, the derating can be reduced appropriately.

$$Pr=\frac{5(E_S-E_C)}{T} \tag{13-5}$$

◆ The motor decelerates in the vertical direction:

In the deceleration descent process, the energy consumed by the drain resistance at this time is Ek=ES+mgh-EC-EL-EP. Because EL and EP are relatively small, they can be equal to about 0 here. Then the required bleed resistance power Pa is:

$$Pa=\frac{2(E_S-mgh-E_C)}{T} \tag{13-6}$$

If Pa is less than the power of the built-in drain resistance, it is not necessary to connect the external drain resistance. If Pa is greater than the power of the external drain resistance, the external drain resistance is required. If external drain resistance is selected, the derating can be reduced by 80%. If forced heat dissipation is required, the derating can be reduced appropriately. For details, see actual tests.

$$Pr=\frac{5(E_S-mgh-E_C)}{T} \tag{13-7}$$

m: The quality of the load depends on the actual condition of the site;

g: The acceleration of gravity, let's say 9.8m/s2;

h: The height of vertical fall is determined according to the actual working condition.

5、Example reference

Taking ED3L-08A as an example, if the matching motor model is EM3A-08A, the motor runs in a horizontal deceleration, and the moment of inertia of the rotor is 0.909×10-4kg·m2.

Take the load inertia is 5 times, assuming the actual speed of the motor is 5000r/min, then calculate the braking energy according to equation (13-2).

$$E_S=\frac{(5+1)\times 0.909\times 10^{-4}\times 5000^2}{182}J=74.92J \tag{13-8}$$

Table 13-2 shows that the energy EC absorbed by the capacitor is 31.36J. According to Equation (13-3), the energy Ek consumed by the drain resistor is 43.54J. Assuming that T of the motor's reciprocating cycle movement is 2s, it can be seen from Equation (13-4) that the required brake resistance power Pa is 43.54W, which is less than 60W of the built-in drain resistor of ED3L-08A driver. Therefore, no external drain resistor is needed.

When the inertia of the load is 10 times and the maximum speed of the motor is 5000r/min, the braking energy is calculated according to Equation (13-2)

$$E_S=\frac{(10+1)\times 0.909\times 10^{-4}\times 5000^2}{182}J=137.35J \tag{13-9}$$

According to Equation (13-3), the energy consumed by the bleed resistor Ek= Es-Ec=105.99J, and assuming the reciprocating motion period T=2s, the required brake resistance power Pa=105.99W can be obtained from Equation (13-4), which is larger than the internal bleed resistor power of ED3L-08A is 60W, so an external bleed resistor is needed. Refer to Formula (13-5) to calculate the bleed resistance power:

$$Pr=\frac{5\times(137.35-31.56)}{2}W=265W \tag{13-10}$$

The recommended power of the external bleed resistor is 265W.

Similarly, if the motor decelerates in the vertical direction, the bleed resistance power can be calculated by using equations (13-6) and (13-7) according to the above calculation method.

12.2 Encoder Cable Calculation

Encoder cable calculation (theoretical length only, subject to actual measurement)

Assuming that the maximum consumption current of the encoder delivered with the motor sold by our company is 130mA when it is powered on, the recommended cable for the encoder is as follows:

Table 11.2.1 Maximum theoretical cable length supported by our encoder

Wire diameter	Unit resistance R (Ω/km)	Theoretical cable length (m)
26AWG(0.13mm^2)	143	10.8
25AWG(0.15mm^2)	89.4	17.2
24AWG(0.21mm^2)	79.6	19.3
23AWG(0.26mm^2)	68.5	22.5
22AWG(0.32mm^2)	54.3	28.3
21AWG(0.41mm^2)	42.7	36.0
20AWG(0.95mm^2)	34.6	44.5

If you do not use the encoder provided with our commercially sold motor, the theoretical maximum length of the encoder cable can be calculated according to the following formula:

$$L = \frac{\Delta U}{2 \cdot I \cdot R}$$

Where: L -- theoretical maximum length of encoder cable (km);

I -- the maximum current consumed when the encoder is powered on (A), the value can refer to the manufacturer's data;

R: Indicates the unit resistance of a cable (Ω/km). For details, see Table 2.1.

ΔU -- cable voltage drop margin (V), the value is 0.4V.

Revision History

No	Date	Version	Revised Contents
1	Feb, 2023	V1.00	Initial release.
2	Sep，2024	V1.01	Add STO content

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