2023

Summa ED3L Series AC Servodrive Product Manual

MODEL: ED3L-□□AEA

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 EtherCAT
DC	Distributed Clocks
EEPROM	Electrically Erasable Programmable Read Only Memory
ESC	EtherCAT Slave Controller

Abbreviation	Meaning
ESI	EtherCAT Slave Information
ESM	EtherCAT 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 EtherCAT state machine
PDO	Process Data Object
PREOP	Pre-Operational state of EtherCAT state machine
RxPDO	Receive PDO
SAFEOP	Safe-Operational state of EtherCAT 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.

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Chapter 1 ED3L Servo Drive

1.1 Product Features

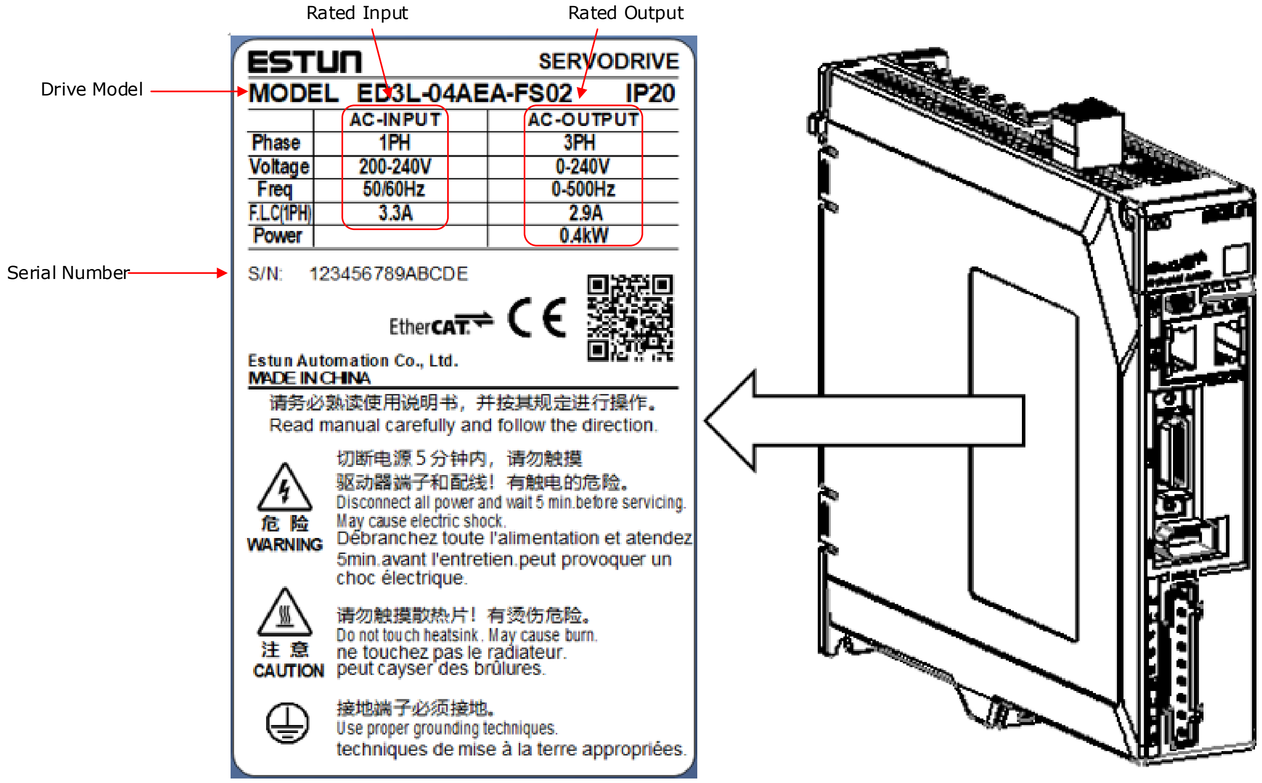
As a new single-axis AC servo product from ESTUN, ED3L is designed with its excellent performance and practical control functions to create a complete set of solutions with the best cost performance for customers.

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

ED3L has the following outstanding features.

- EtherCAT support, update rates down to 125 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 20-bit incremental/23-bit absolute encoder (photoelectric)
- Comprehensive tuning technology including: Auto-tuning function, adaptive vibration suppression, friction compensation
- Functional Safety Dual STO (SIL3, PLe)

1.2 Interpreting the Nameplate



ESTUN SERVODRIVE

MODEL ED3L-04AEA-FS02 IP20

	AC-INPUT	AC-OUTPUT
Phase	1PH	3PH
Voltage	200-240V	0-240V
Freq	50/60Hz	0-500Hz
F.L.C(1PH)	3.3A	2.9A
Power		0.4kW

S/N: 123456789ABCDE

EtherCAT CE

Estun Automation Co., Ltd.
MADE IN CHINA

请务必熟读使用说明书，并按其规定进行操作。
Read manual carefully and follow the direction.

危 险
WARNING
切断电源 5 分钟内，请勿触摸
驱动器端子和配线！有触电的危险。
Disconnect all power and wait 5 min.before servicing.
May cause electric shock.
Débranchez toute l'alimentation et atendez 5min.avant l'entretien.peut provoquer un choc électrique.

注 意
CAUTION
请勿触摸散热片！有烫伤危险。
Do not touch heatsink. May cause burn.
ne touchez pas le radiateur.
peut cayser des brûlures.

接地端子必须接地。
Use proper grounding techniques.
techniques de mise à la terre appropriées.

1.3 Model Designations

Product family - Output power Voltage Options Encoder types Extended functions

Product family
ED3L
ED3E
ED3F
ED3H
CD3L

Output power	
A5	0.05kw
01	0.1kw
02	0.2kw
04	0.4kw
08	0.75kw
10	1kw
15	1.5kw
20	2kw
30	3kw
50	5kw
75	7.5kw

Voltage	
A	200VAC
D	400VAC

Options	
E	EtherCAT
M	CANopen
P	Profinet

Encoder types	
A	Serial coder
D	Linear encoder

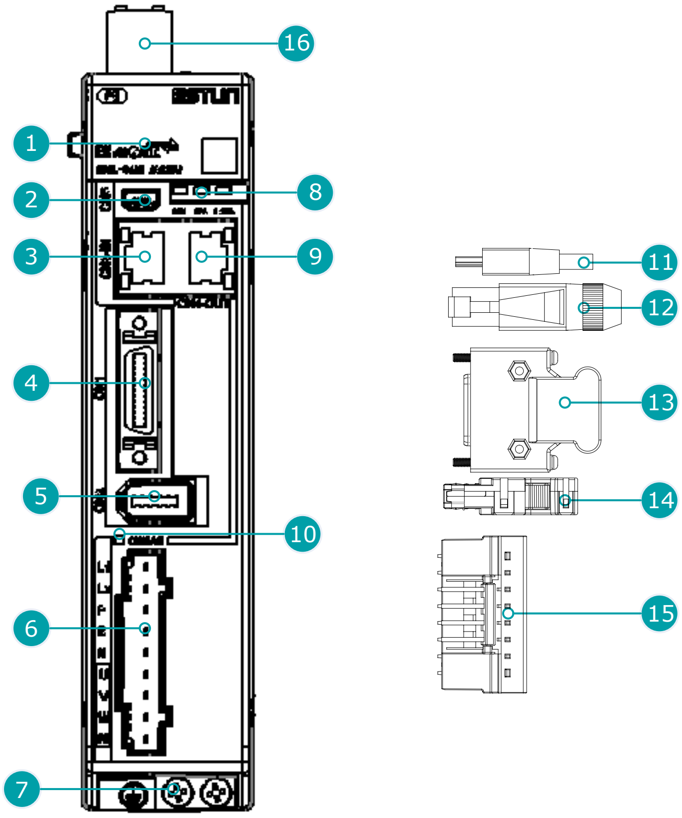
Extended functions	
FS02	STO

NOTE

If Voltage is A, then output power can only be A5,01,02,04,08,10,15 and 20. If Voltage is set to D, output power can only be 10,15,20,30,50 and 75.

1.4 Part Names

200VAC,rated power from 50W to 400W



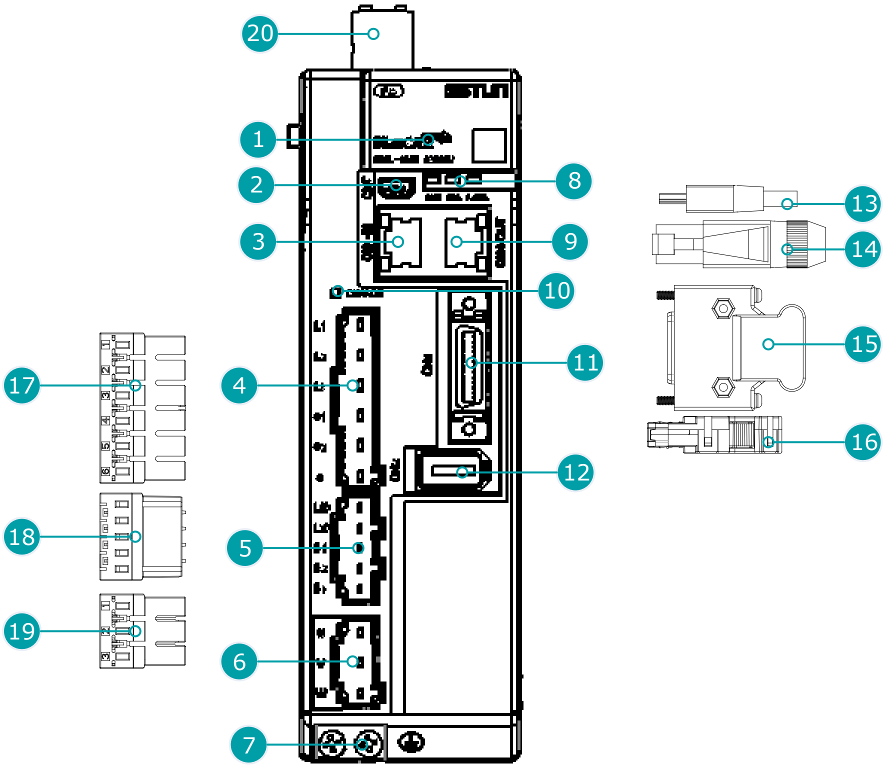
说明

Separate STO safety connection terminals are available only for -FS02 drives

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	EtherCAT Input Connector	Connect to an EtherCAT 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	EtherCAT communication indicators	• RUN: running indicator lamp • ERR: Error indicator lamp • POWER: power on indicator lamp

No.	Name	Description
9	EtherCAT Output Connector	Connects to an EtherCAT 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	USB Terminals	Standard Mini USB Type-B
12	EtherCAT Terminals	Standard RJ-45 terminal
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 Connector	Safe Torque Off (STO)

200VAC, rated power from 750W to 2kW



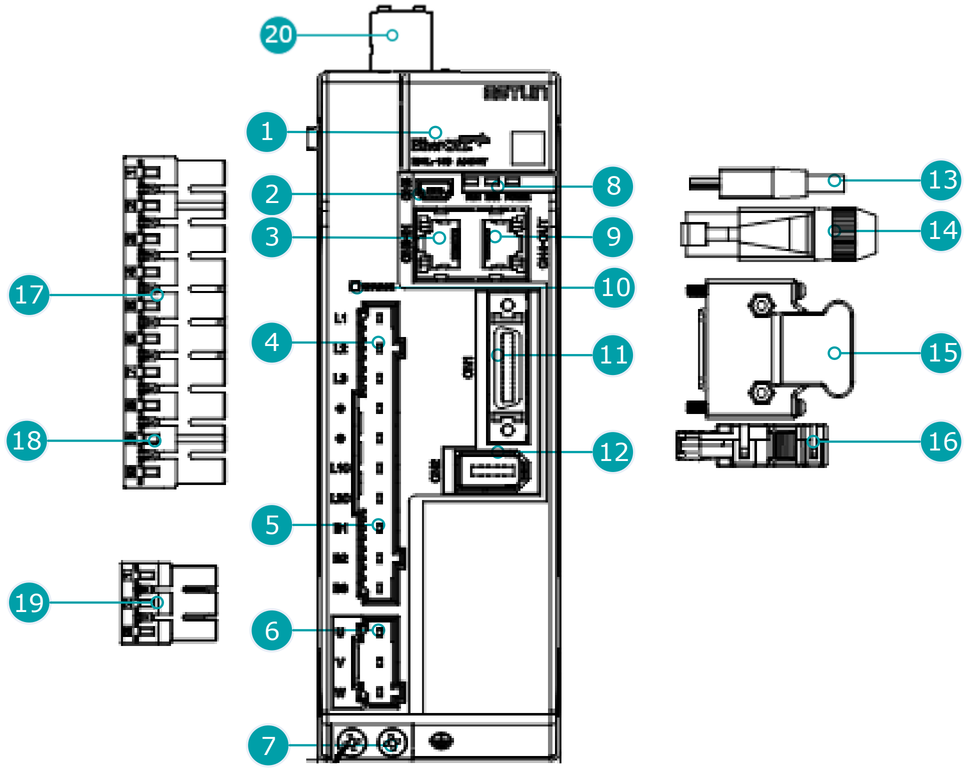
NOTE

The figure above shows an example of a product with a rated power of 750W to2kW. Separate STO safety connection terminals are available only for -FS02 drives

No.	Name	Description
1	Panel Operator	A module for Servo status displays and parameter settings
2	USB Connector	Connects a computer for ESView V4

No.	Name	Description
3	EtherCAT Input Connector	Connect to an EtherCAT 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
8	EtherCAT communication indicators	● RUN: running indicator lamp ● ERR: Error indicator lamp ● POWER: power on indicator lamp
9	EtherCAT Output Connector	Connects to an EtherCAT 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	EtherCAT 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 Connector	Safe Torque Off (STO)

400VAC, rated power from 1kW to 3kW



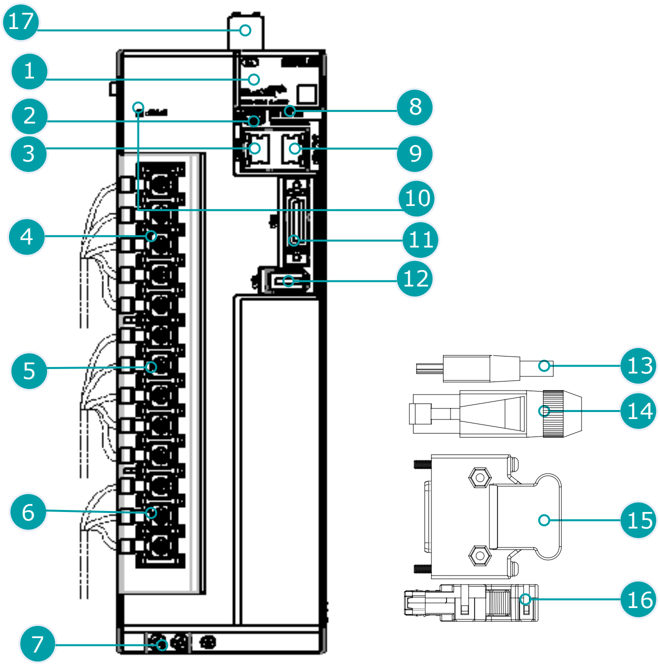
说明

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. Separate STO safety connection terminals are available only for -FS02 drives

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	EtherCAT Input Connector	Input signal socket for EtherCAT 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	EtherCAT Communication Indicator	• RUN: Run indicator • ERR: Error indicator • POWER: System indicator
9	EtherCAT Output Connection Port	Output signal connection port for EtherCAT communication cables.

No.	Name	Description
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	EtherCAT 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 Connector	Safe Torque Off (STO)

400VAC, rated power from 5kW to 7.5kW



说明

Separate STO safety connection terminals are available only for -FS02 drives

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.

No.	Name	Description
3	EtherCAT Input Connector	Input signal socket for EtherCAT 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	EtherCAT Communication Indicator Lamp	• RUN: Run indicator • ERR: Error indicator • POWER: System indicator
9	EtherCAT Output Connection Port	Output signal connection port for EtherCAT 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.
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	EtherCAT Connector	Standard RJ-45 terminal.
15	IO Signal Connector	Connector for IO signal cables.
16	Encoder Connector	Connector for motor encoder cables.
17	Safety Connector	Safe Torque Off (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	Encoder division signals output		Supports A, B, and C CMOS differential type sensor signal

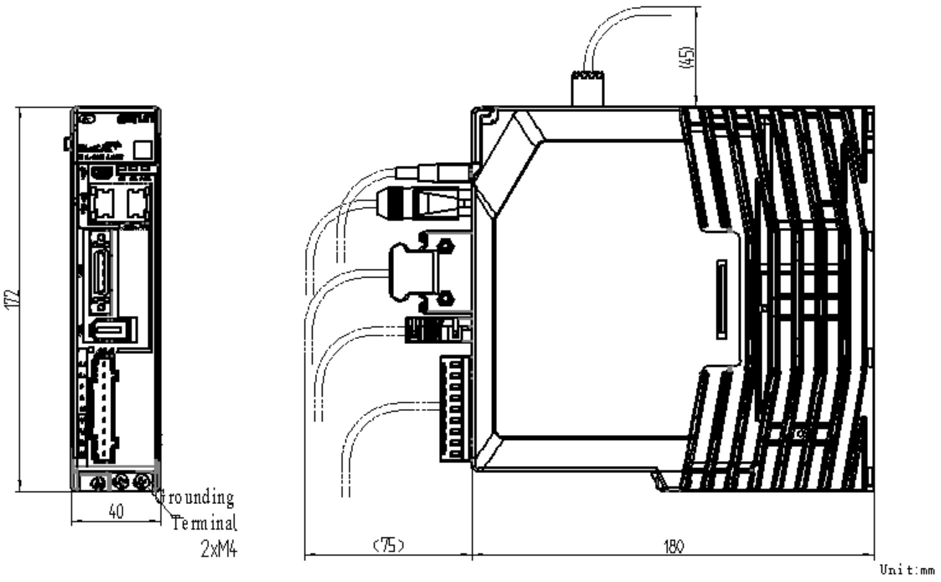
	Input Signals	Allowable voltage range: 24 VDC±20% Number of input points: 5
		Input Signals are S-ON (Servo ON), N-OT (Reverse Drive Prohibit), P-OT (Forward Drive Prohibit), PCL (Forward External Torque Limit) or EXT1 (Touch Probe 1), NCL (Reverse External Torque Limit) or EXT2 (Touch Probe 2).
	Output 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.
EtherCAT Communications	Applicable Communications Standards	IEC 61158 Type12, IEC 61800-7 CiA402 Drive Profile
	Physical Layer	100BASE-TX (IEEE802.3)
	Communications Connectors	CN3-IN (RJ45): EtherCAT signal input connector CN4-OUT (RJ45): EtherCAT 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.
	EtherCAT 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 EtherCAT)		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.

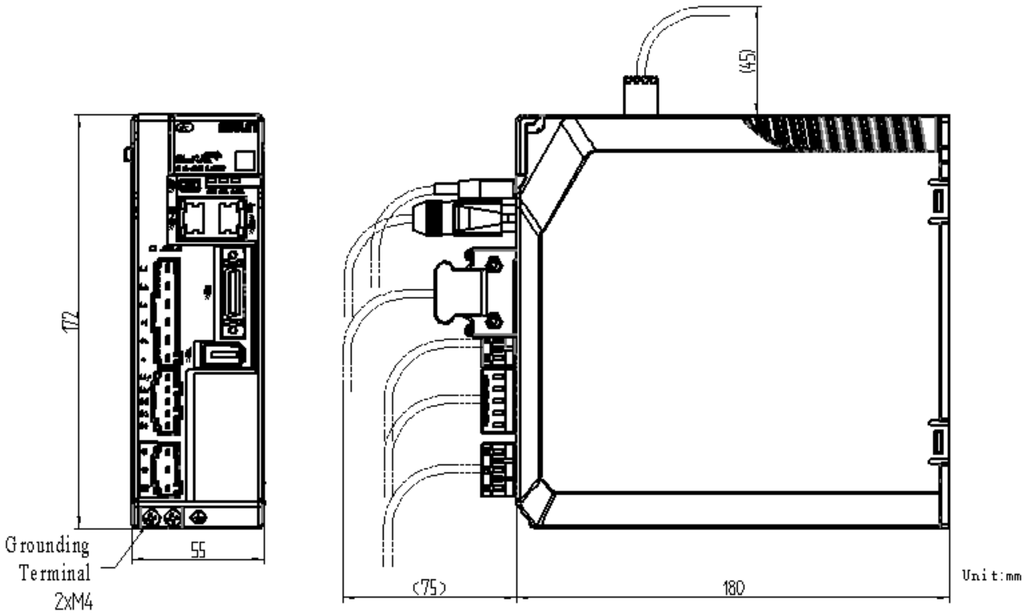
Note: When operating from a single-phase power supply for the ED3L-15AEA (rated power 1.5 kW), please deratify to 1.2 kW.

1.6 Dimensions

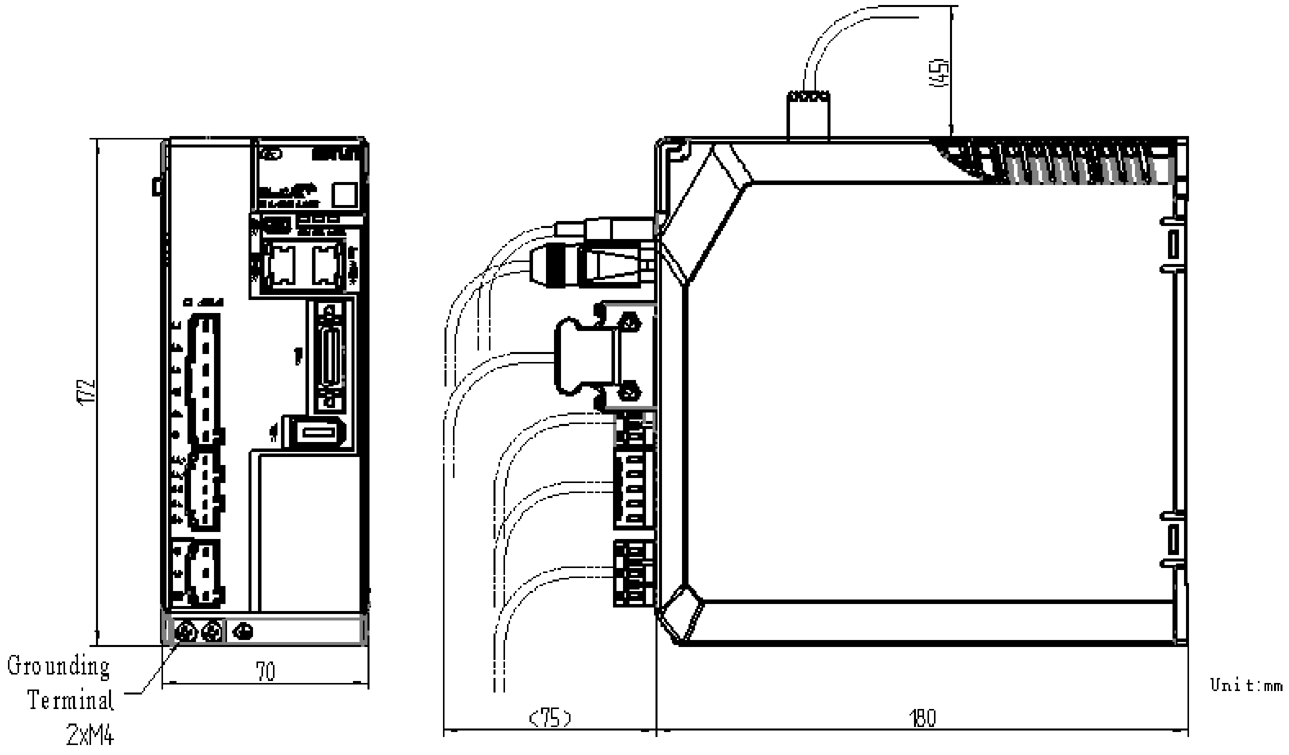
200VAC, rated power from 50W to 400W



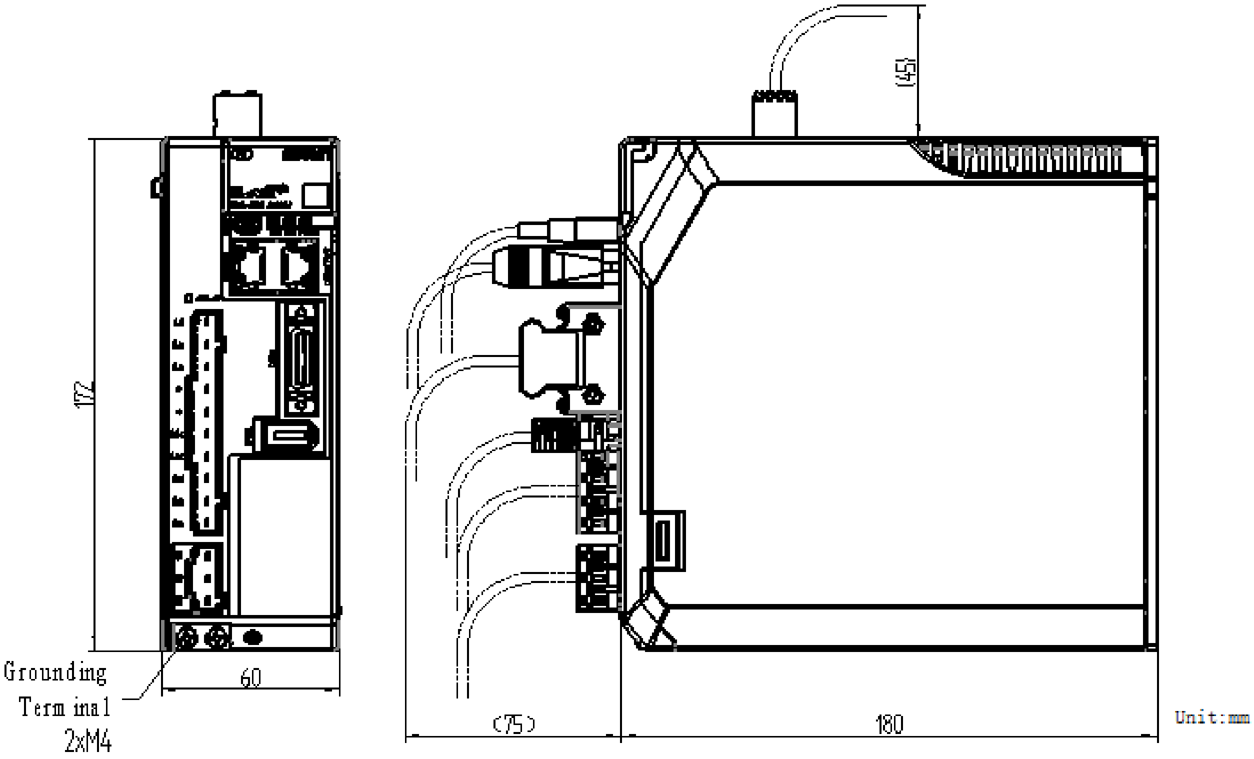
200VAC, rated power from 750W to 1kW



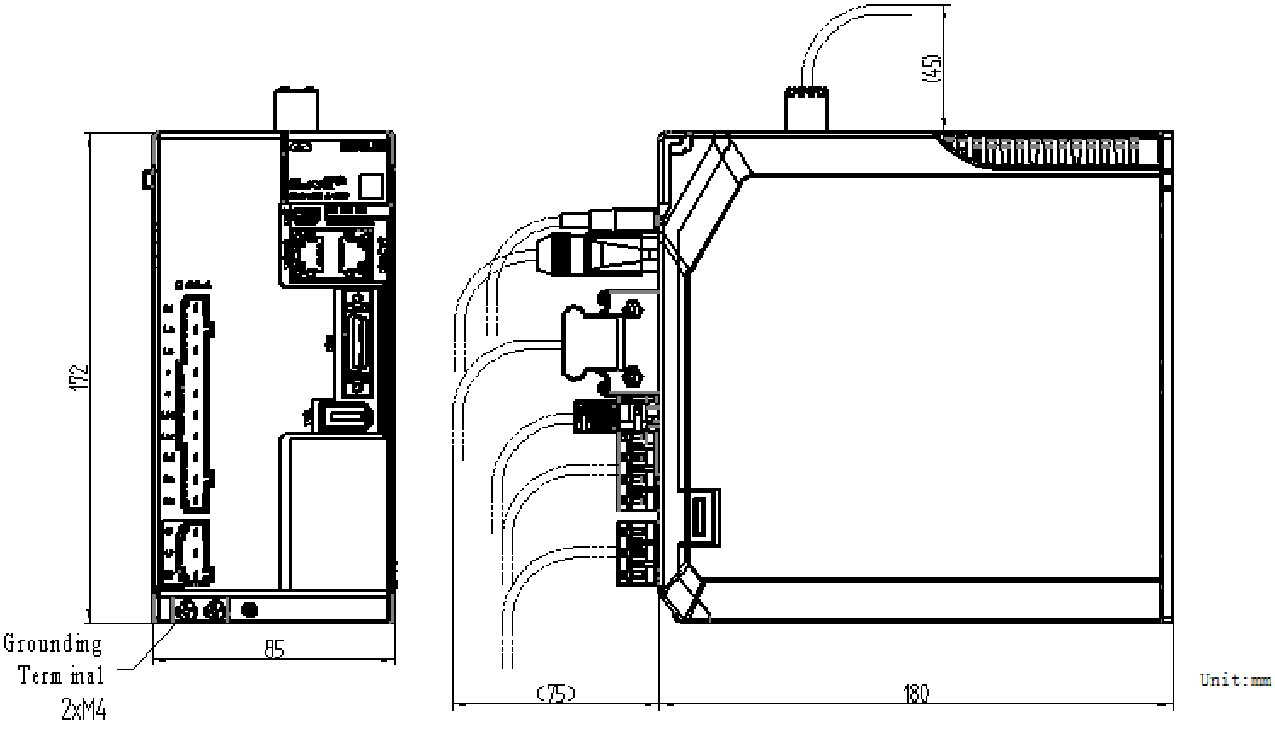
200VAC, rated power from 1.5kW to 2kW



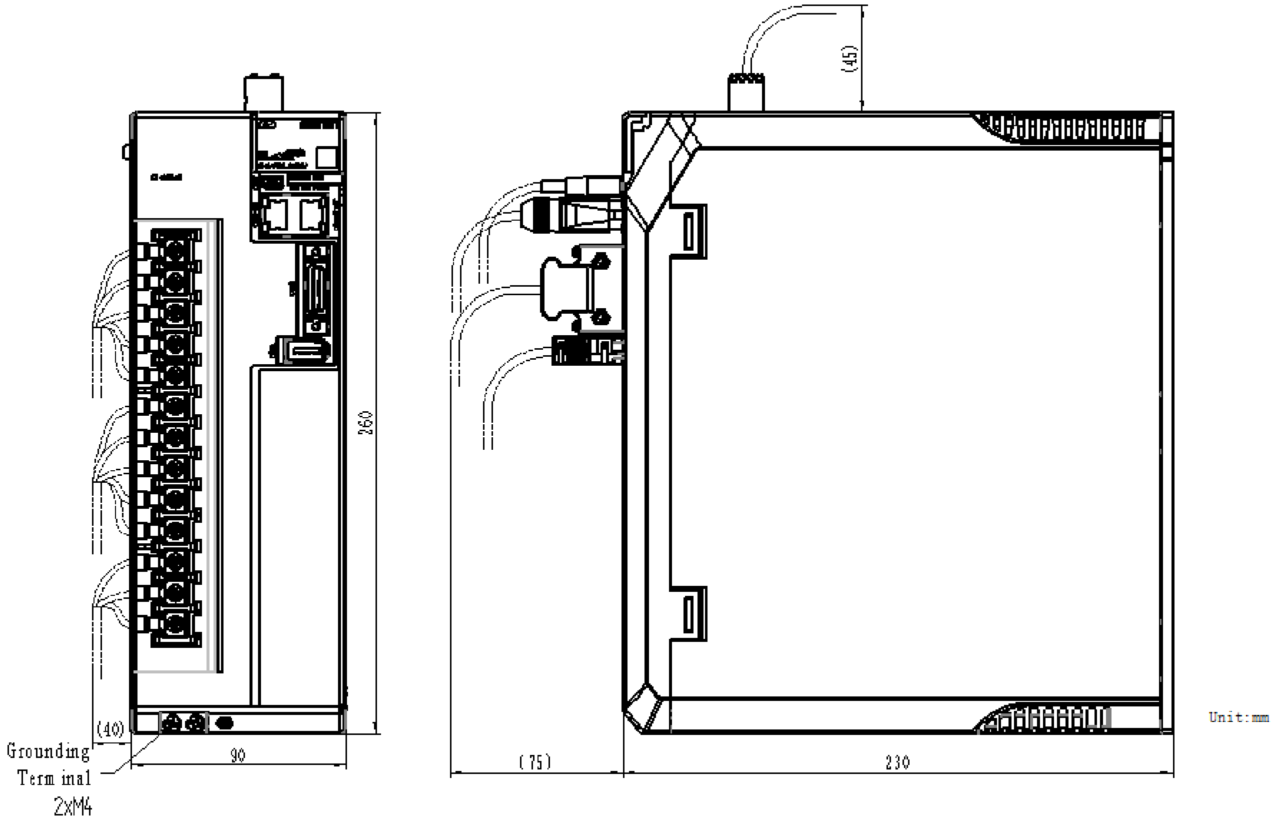
400VAC, rated power from 1kW to 1.5kW



400VAC, rated power from 2kW to 3kW



400VAC, rated power from 5kW to 7.5kW



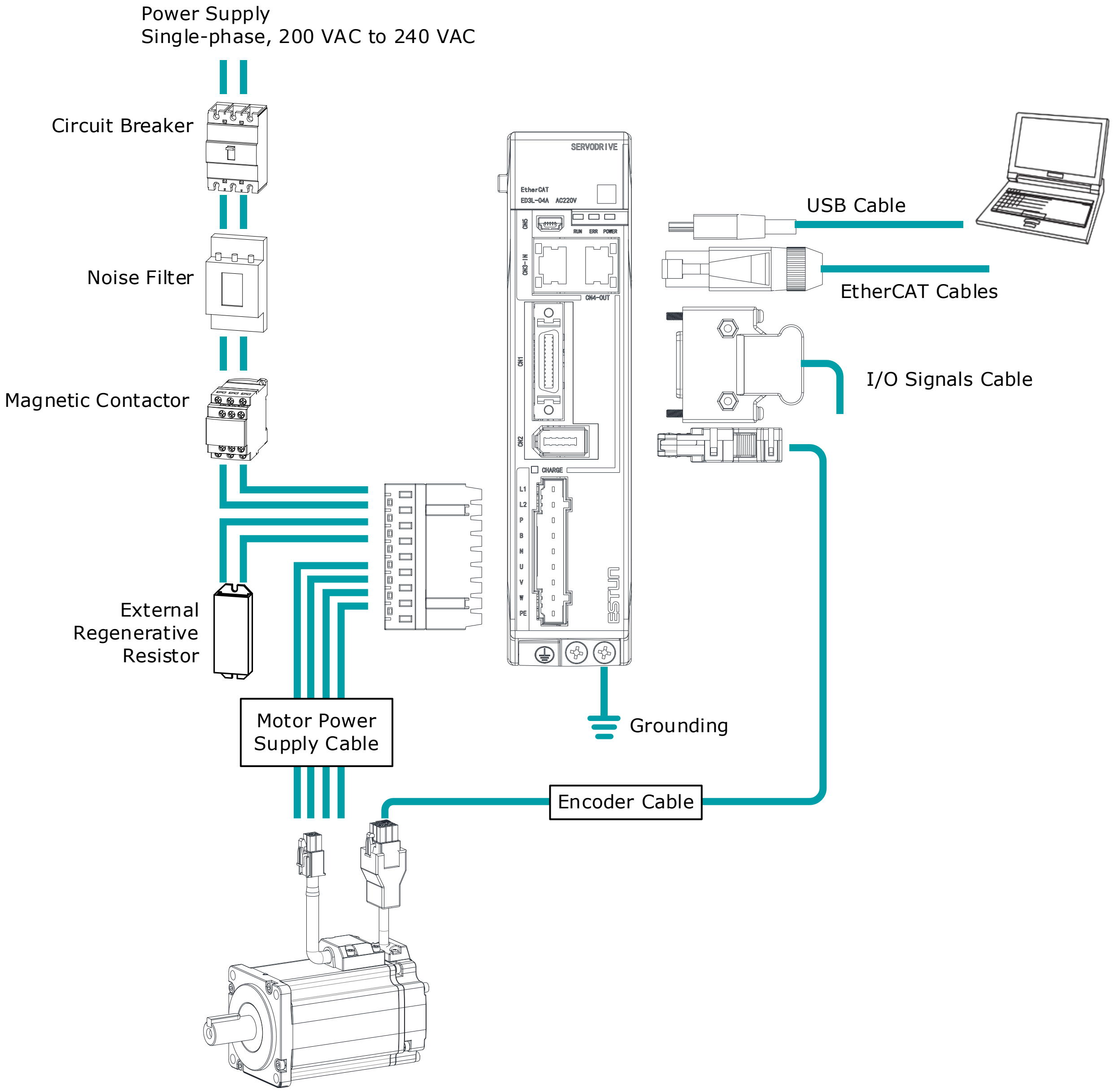
说明

Separate STO safety connection terminals are available only for -FS02 drives

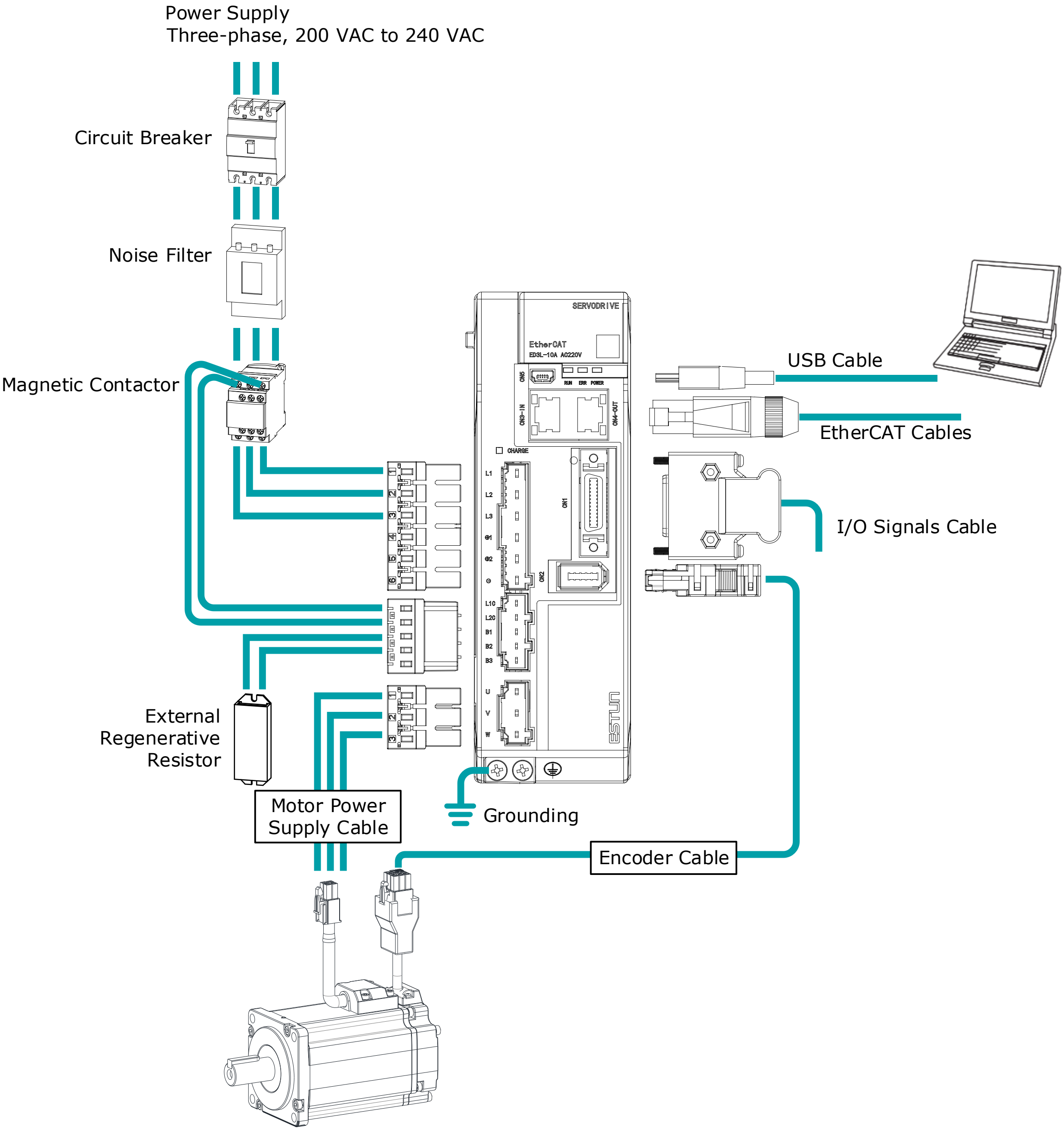
1.7 System Configuration

1.7.1 Example Diagram

200VAC, rated power from 50W to 400W

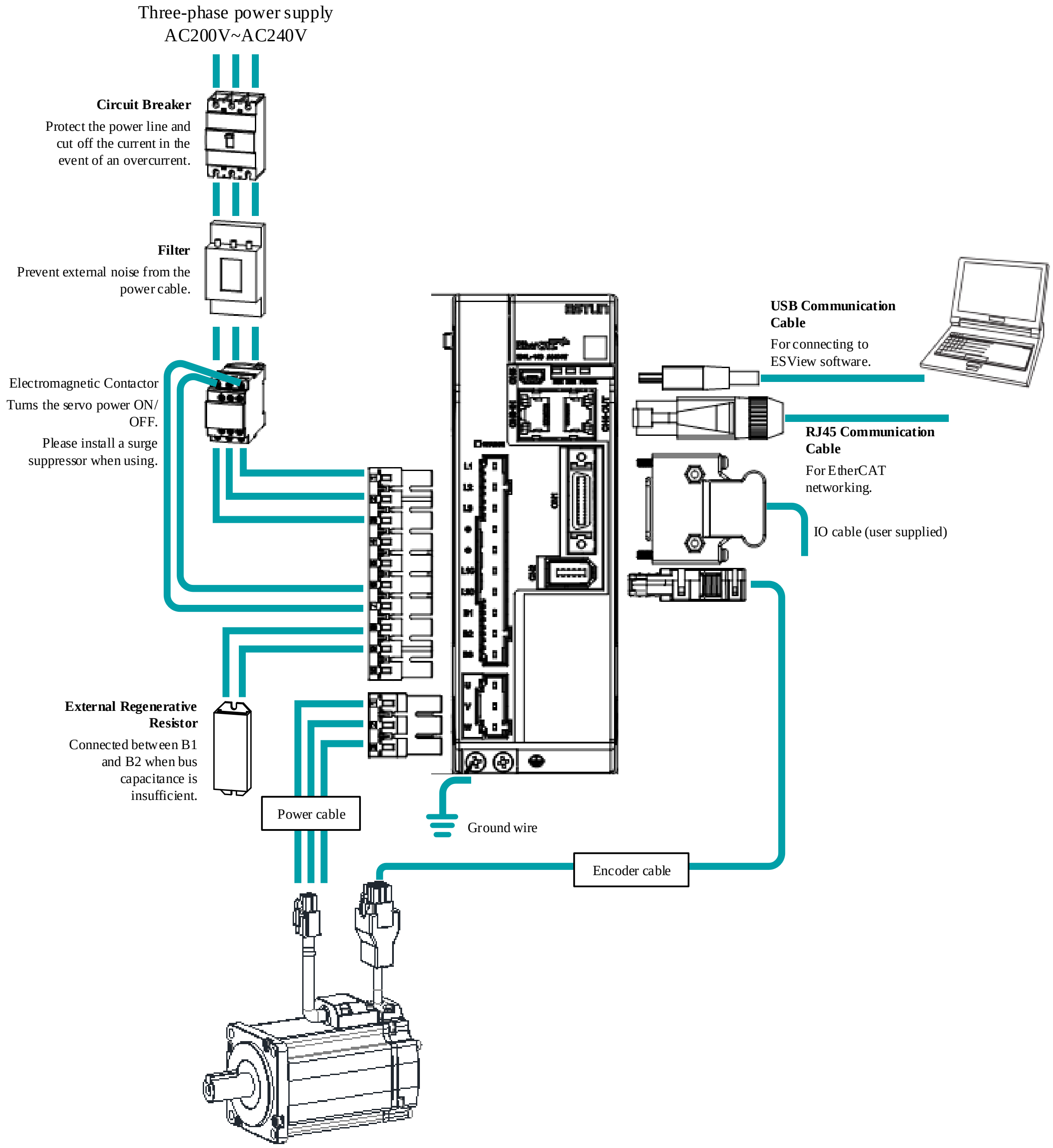


200VAC, rated power from 750W to 2kW



400VAC, rated power from 1kW to 7.5kW

Take a 1kW drive as an example:



1.7.2 Minimum System Configuration

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, EtherCAT 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.
External regenerative resistor	The minimum resistance value of the external regenerative resistor varies with the drive model.

Component	Specification
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, EtherCAT 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)

Drive Model	Power	Motor Model	Power Cable	Encoder Cable
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)
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-□□(无制动器) 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

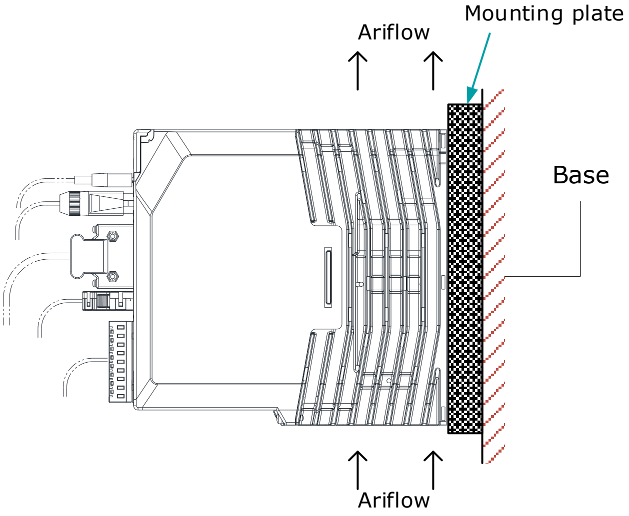
  Never install the Drive in a location subject to high temperatures, high humidity, water drops, cutting oil, excessive dust, excessive dirt, excessive iron powder, corrosive gasses, or radioactivity.

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



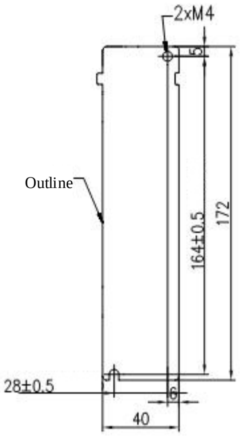
2.3 Mounting Hole Dimensions

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.

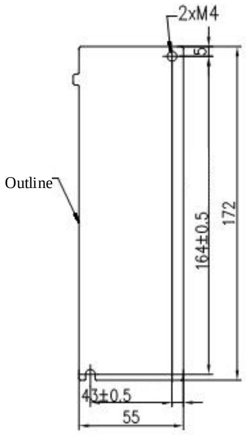
Wiring diagram for mounting holes at 200VAC

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



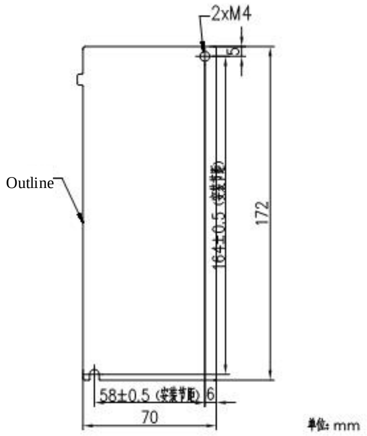
Machining Diagram for Mounting Holes (Mounting pitch)

ED3L-08AEA
ED3L-10AEA



Machining Diagram for Mounting Holes (Mounting pitch)

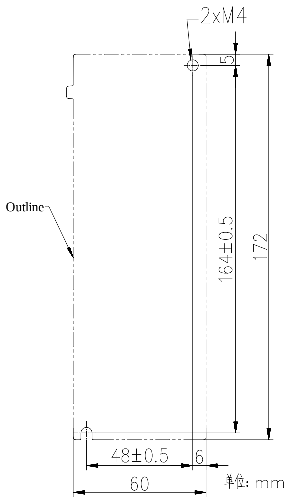
ED3L-15AEA
ED3L-20AEA



Machining Diagram for Mounting Holes (Mounting pitch)

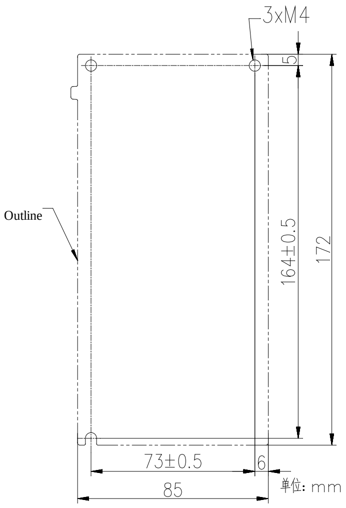
Wiring diagram for mounting holes at 400VAC

ED3L-10DEA
ED3L-15DEA



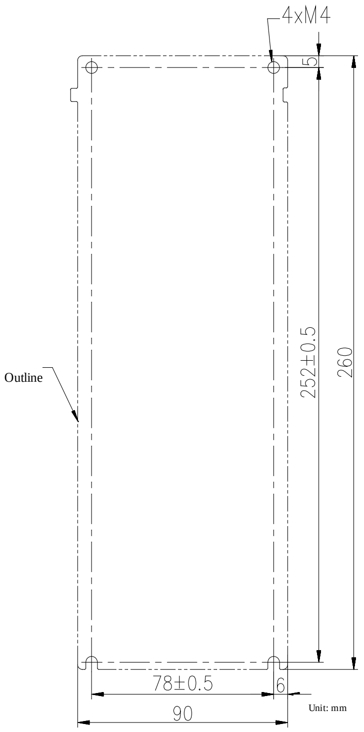
Machining Diagram for Mounting Holes (Mounting pitch)

ED3L-20DEA
ED3L-30DEA



Machining Diagram for Mounting Holes (Mounting pitch)

ED3L-50DEA
ED3L-75DEA



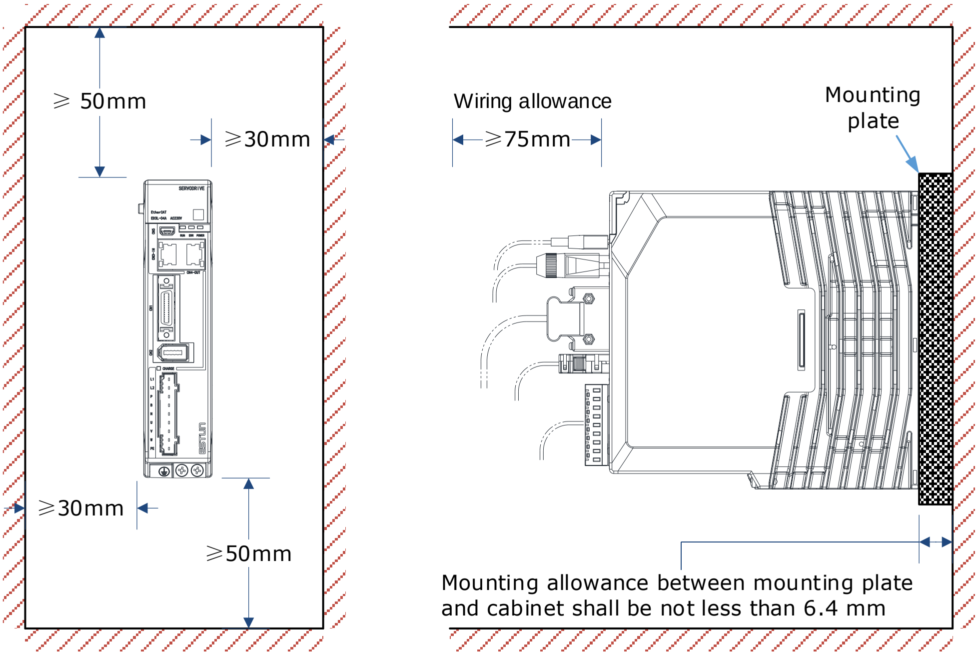
Machining Diagram for Mounting Holes (Mounting pitch)

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.

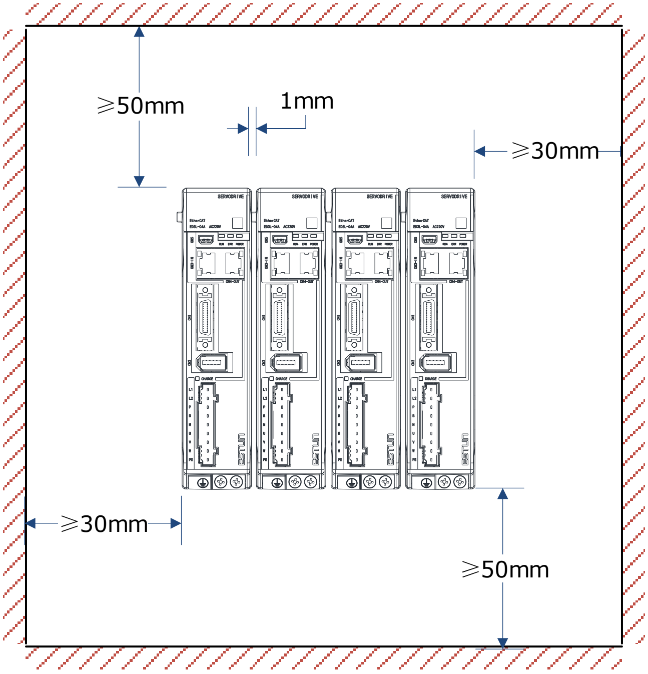
Figure 2-2 Installing a single Drive in a control cabinet



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.

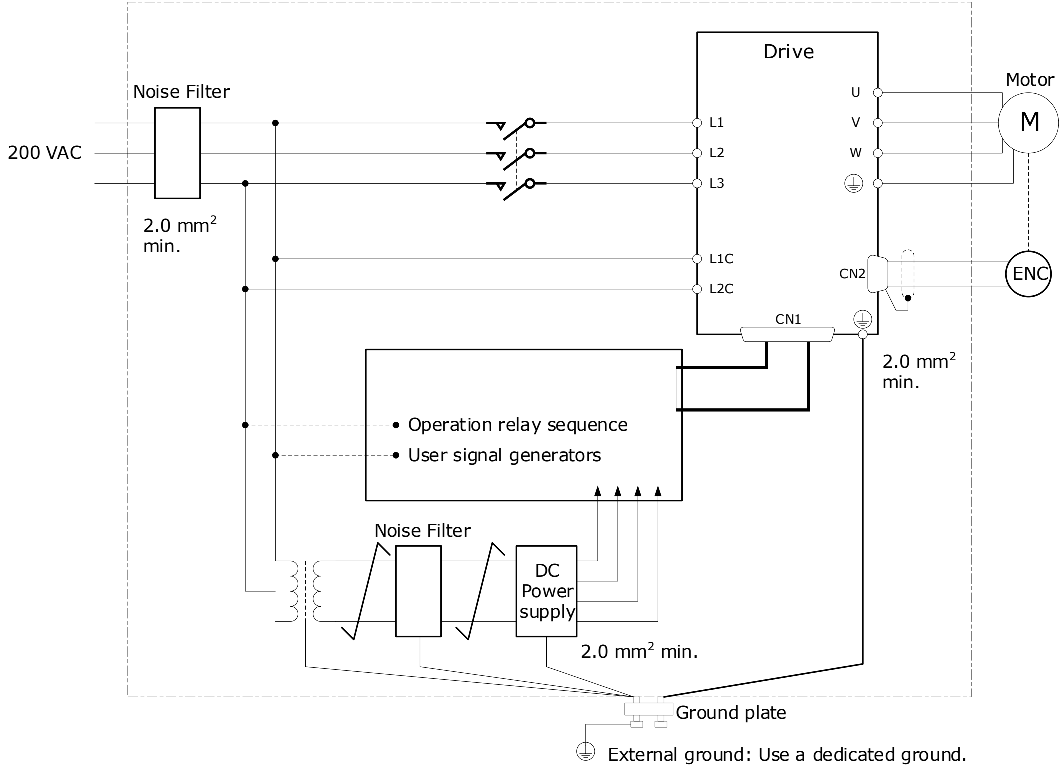
To prevent the noise from the Drive or the peripheral devices from causing malfunctions of any devices, take the following countermeasures against noise as required.

- 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

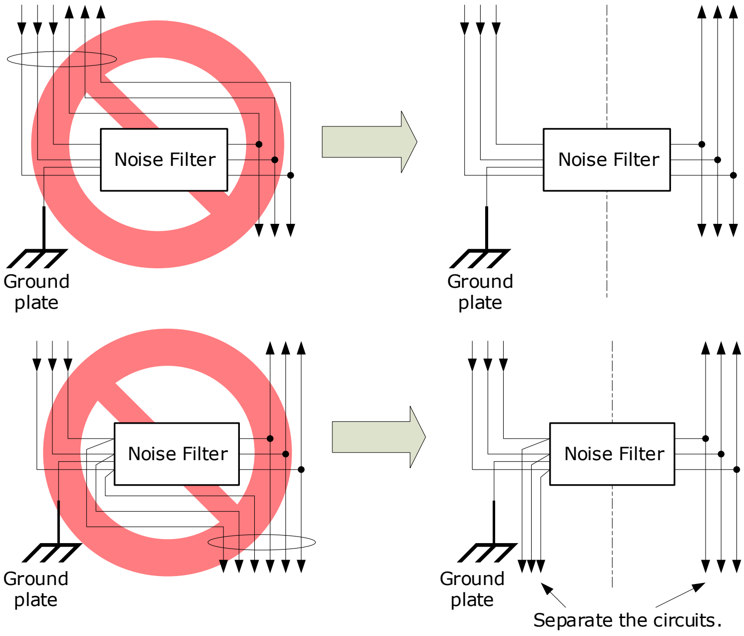


- For the ground wire, use a wire with a thickness of at least 2.0 mm2 (preferably, flat braided copper wire).
- Whenever possible, use twisted-pair wires to wire all connections marked with ⌿

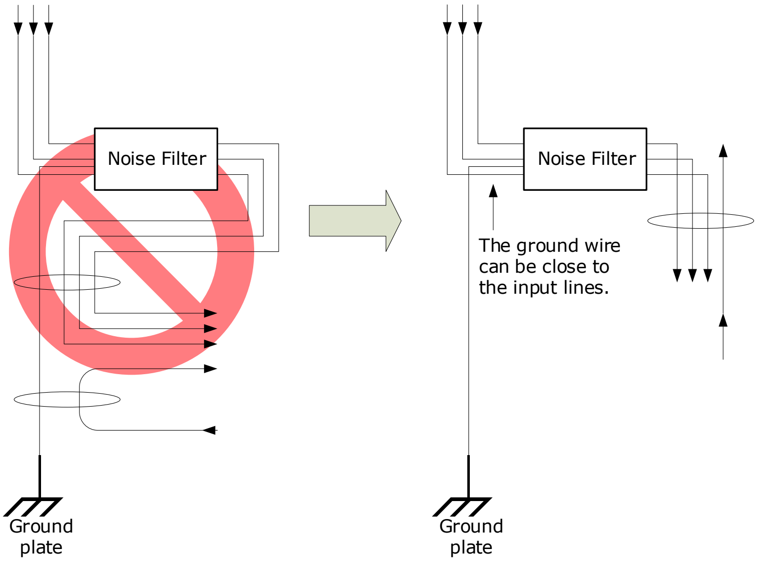
Noise Filter Wiring and Connection Precautions

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

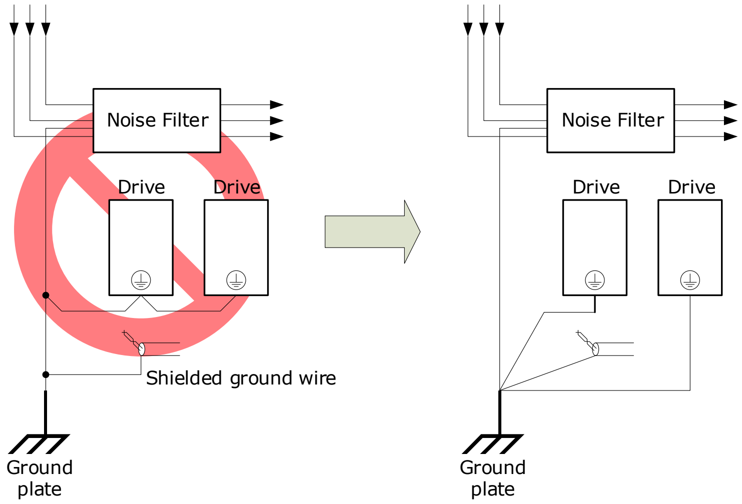
- Separate input lines from output lines. Do not place input lines and output lines in the same duct or bundle them together.



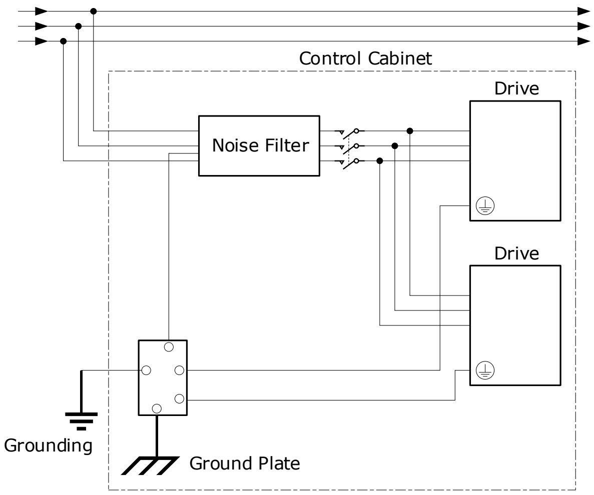
- Separate the Noise Filter ground wire from the output lines. Do not place the Noise Filter ground wire, output lines, and other signal lines in the same duct or bundle them together.



- 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~1.5 kW	Schaffner FN 3025HP-10-71
	2~3kW	Schaffner FN 3025HP-20-71
	5 kW	Schaffner FN 3025HP-30-71
	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

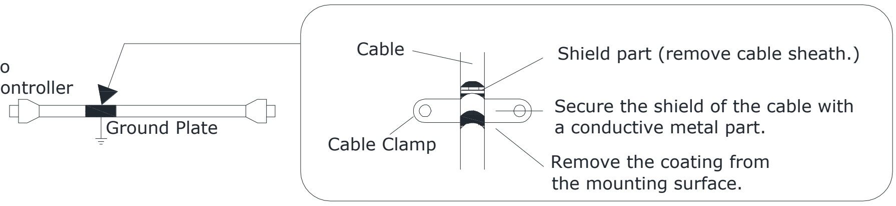
To prevent noise entering the I/O Signal Cable connect the shield of the I/O Signal Cable to the connector shell and ensure the shell is connected to ground.

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:

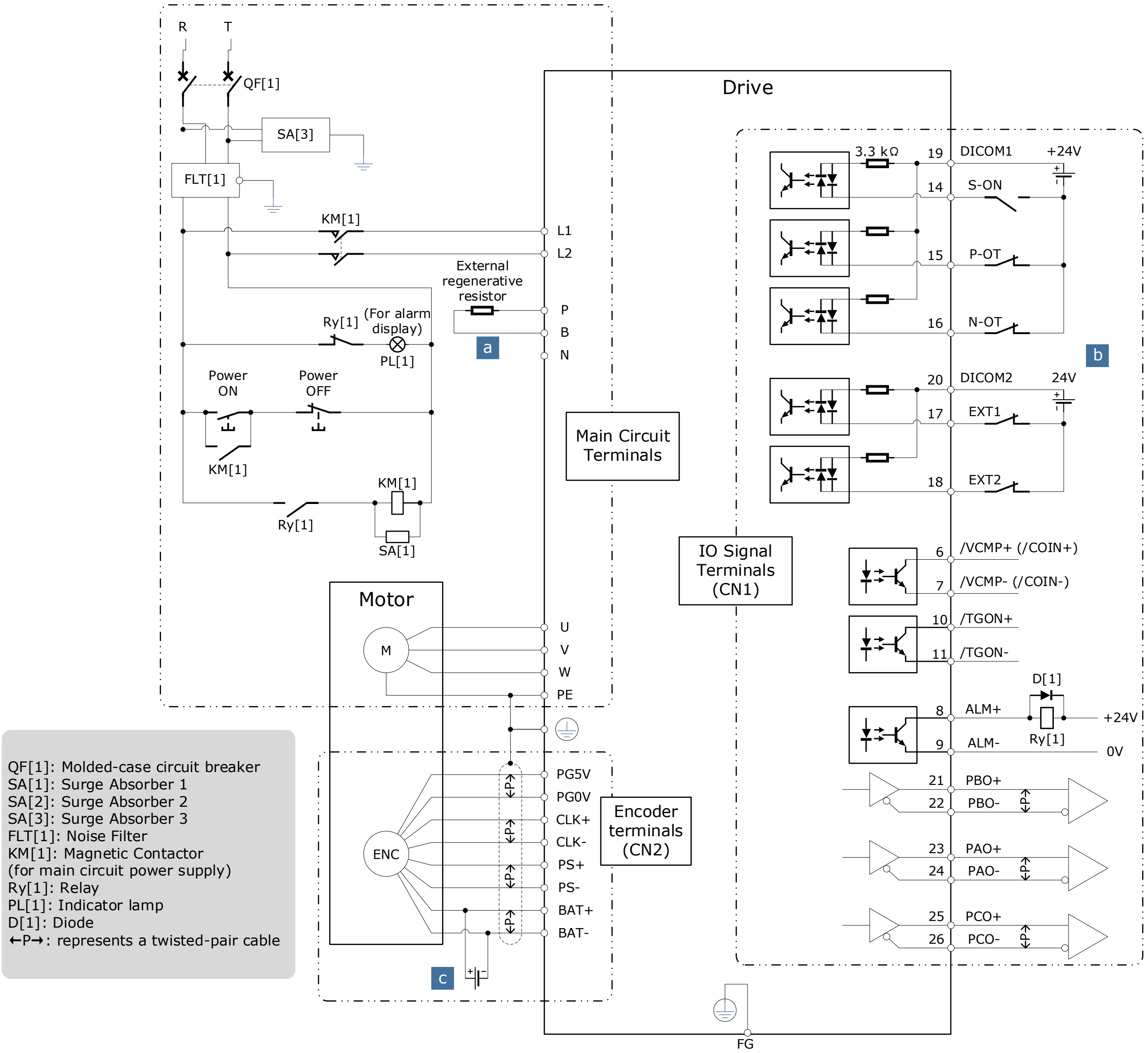


Ferrite Coils

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

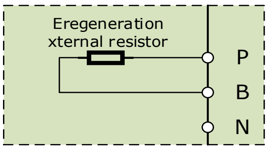
3.2 Basic Wiring Diagrams

200V AC, 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
KM[1]: Magnetic Contactor
(for main circuit power supply)
Ry[1]: Relay
PL[1]: Indicator lamp
D[1]: Diode
←P→: represents a twisted-pair cable

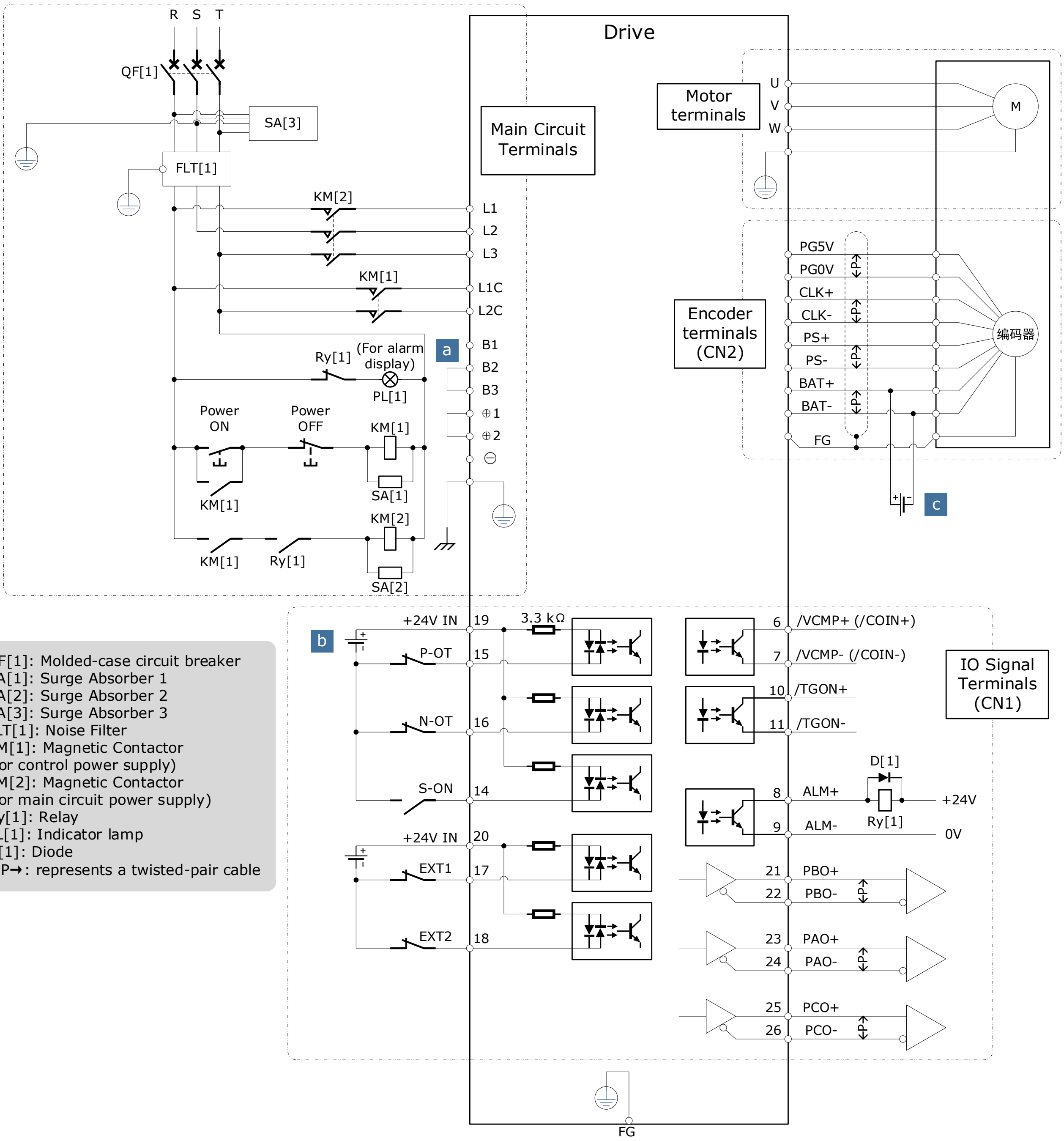
a: When an external discharge resistor is required, an external regenerative resistor is connected between P and B. The connection method is as follows. In addition, check and set "Pn521.0=0".



b: The external wiring of the input signals can use the co-cathode method or the co-anode method.
The 21-26 wiring is available only for FS02 drives.

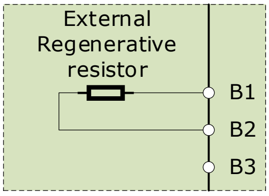
c: The connection of the battery is only for the Motors with the absolute encoder.

200VAC, Rated power from 750W to 2kW



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
KM[1]: Magnetic Contactor
(for control power supply)
KM[2]: Magnetic Contactor
(for main circuit power supply)
Ry[1]: Relay
PL[1]: Indicator lamp
D[1]: Diode
←P→: represents a twisted-pair cable

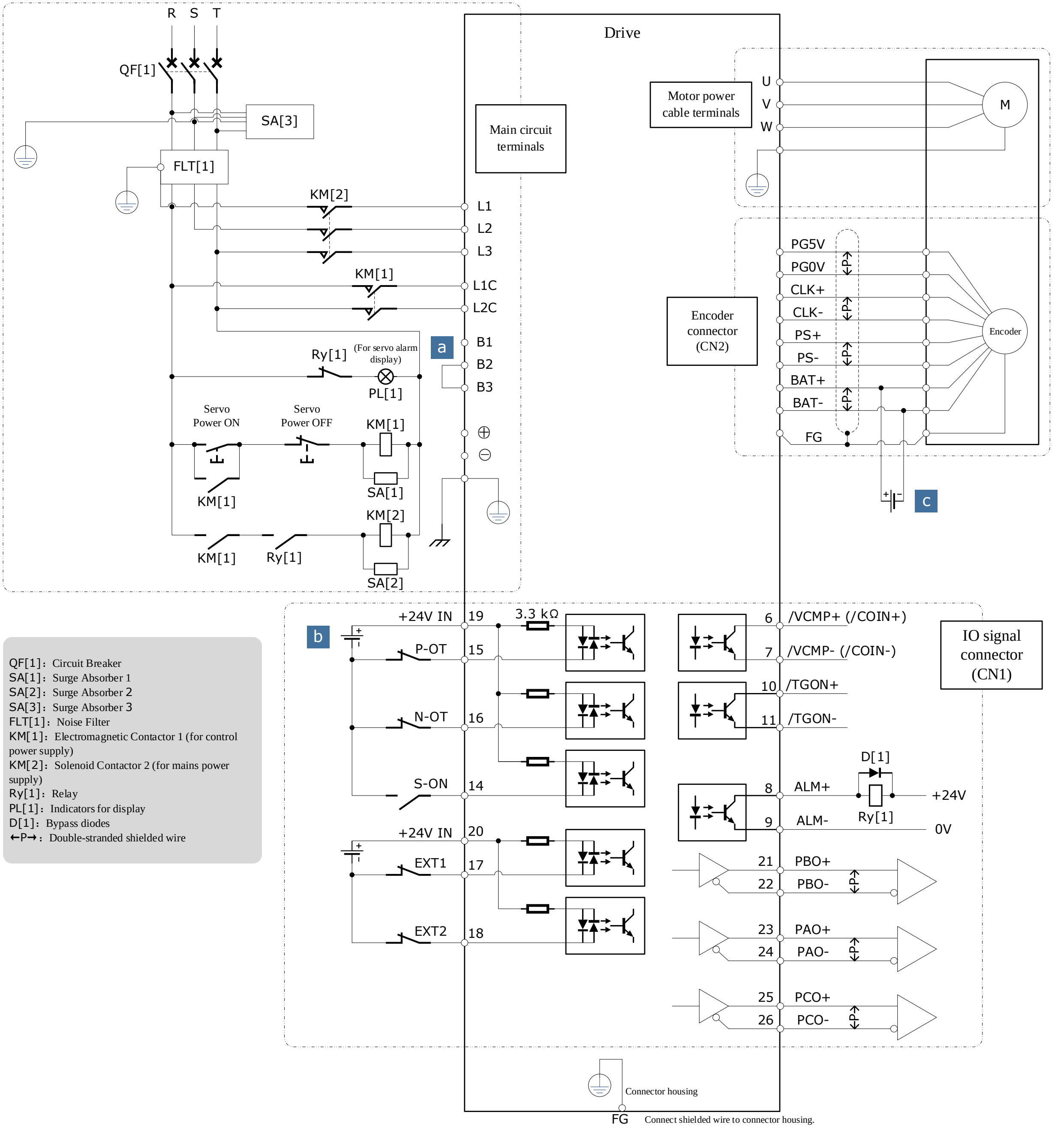
a: When the busbar capacitance is insufficient, remove the short wiring between B2 and B3, and connect an external regenerative resistor between B1 and B2, as is shown in the following figure. In addition, check and set Pn521.0 as 0 after the power up.



b: The external wiring of the input signals can use the co-cathode method or the co-anode method.
The 21-26 wiring is available only for FS02 drives.

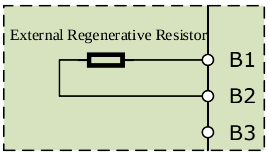
c: The connection of the battery is only for the Motors with the absolute encoder.

400VAC, rated power from 1kW to 7.5kW



c

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".

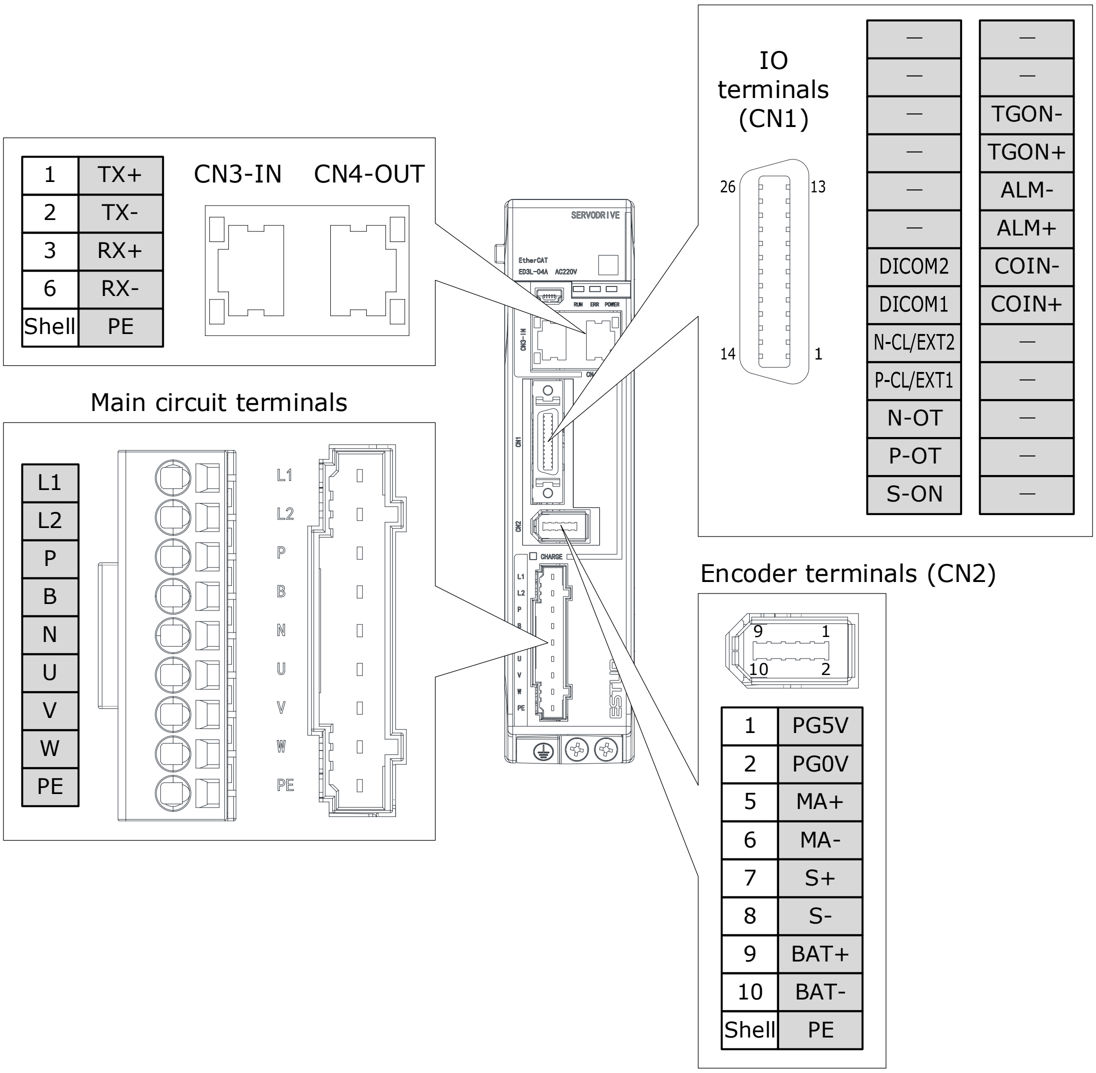


b: The input signal can be wired with a common cathode or common anode.
The 21-26 wiring is available only for FS02 drives.

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

3.3 Terminals Arrangements

200VAC, rated power from 50W to 400W



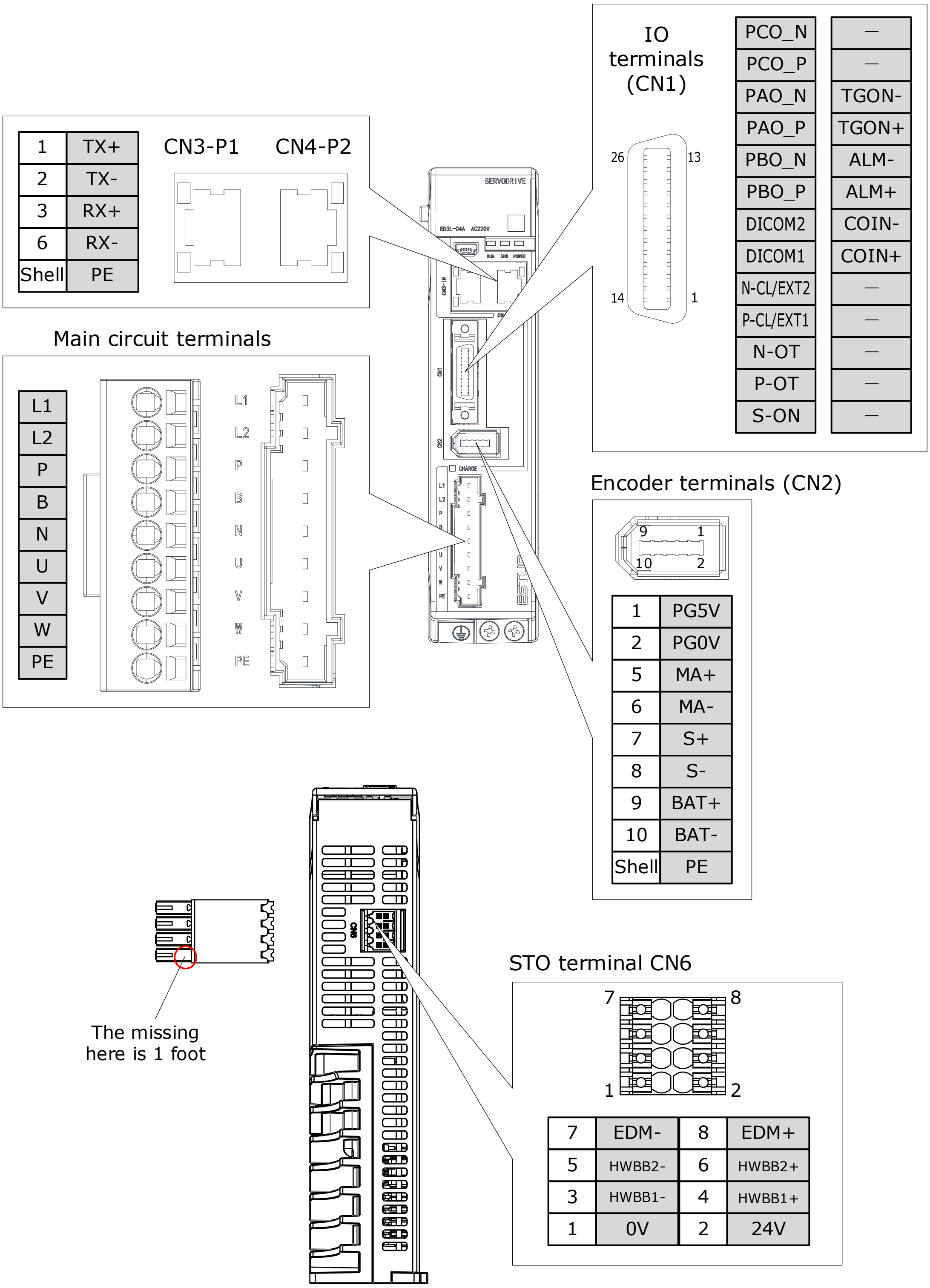
1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

L1
L2
P
B
N
U
V
W
PE

—	—
—	—
—	TGON-
—	TGON+
—	ALM-
—	ALM+
DICOM2	COIN-
DICOM1	COIN+
N-CL/EXT2	—
P-CL/EXT1	—
N-OT	—
P-OT	—
S-ON	—

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

200VAC ， rated power from 50W to 400W（-FS02 drive）



CN3-P1 / CN4-P2

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

Main circuit terminals

L1
L2
P
B
N
U
V
W
PE

IO terminals (CN1)

PCO_N	—
PCO_P	—
PAO_N	TGON-
PAO_P	TGON+
PBO_N	ALM-
PBO_P	ALM+
DICOM2	COIN-
DICOM1	COIN+
N-CL/EXT2	—
P-CL/EXT1	—
N-OT	—
P-OT	—
S-ON	—

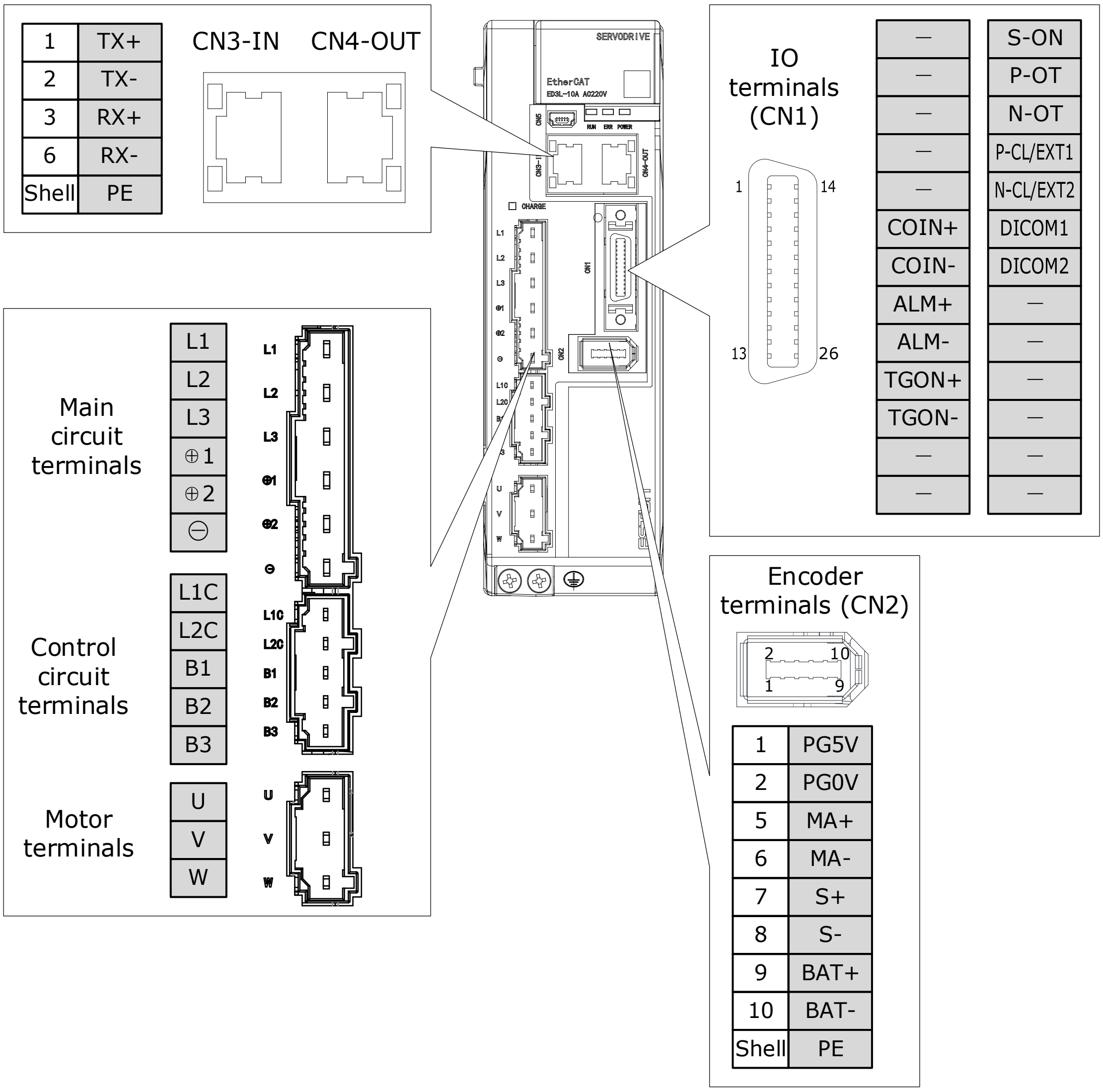
Encoder terminals (CN2)

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

STO terminal CN6

7	EDM-	8	EDM+
5	HWBB2-	6	HWBB2+
3	HWBB1-	4	HWBB1+
1	0V	2	24V

200VAC, rated power from 750W to 2kW



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

—	S-ON
—	P-OT
—	N-OT
—	P-CL/EXT1
—	N-CL/EXT2
COIN+	DICOM1
COIN-	DICOM2
ALM+	—
ALM-	—
TGON+	—
TGON-	—
—	—
—	—

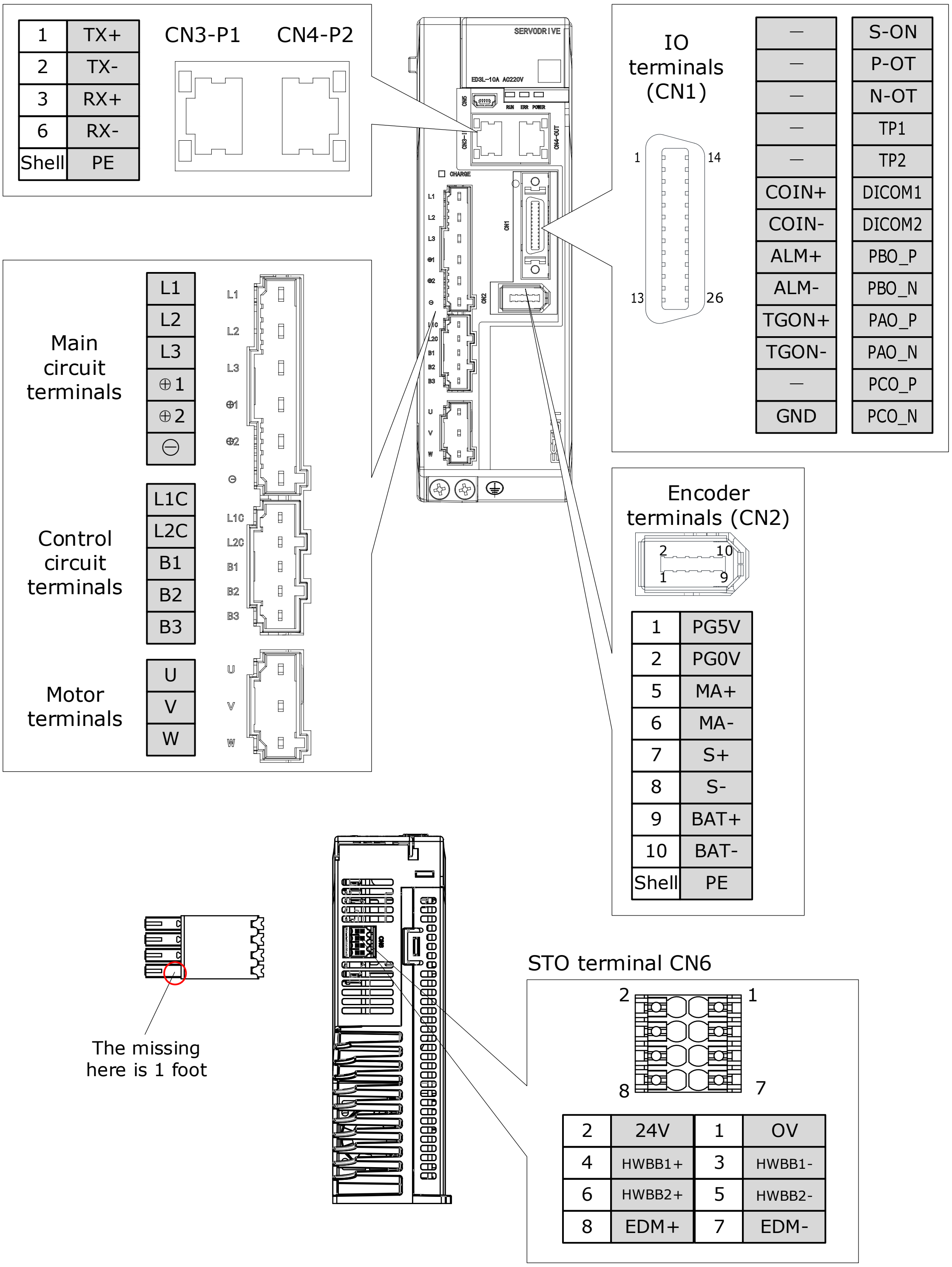
L1
L2
L3
⊕1
⊕2
⊖

L1C
L2C
B1
B2
B3

U
V
W

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

200VAC ， rated power from 750W to 2kW（-FS02 drive）



CN3-P1 CN4-P2

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

IO terminals (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 terminals

L1
L2
L3
⊕1
⊕2
⊖

Control circuit terminals

L1C
L2C
B1
B2
B3

Motor terminals

U
V
W

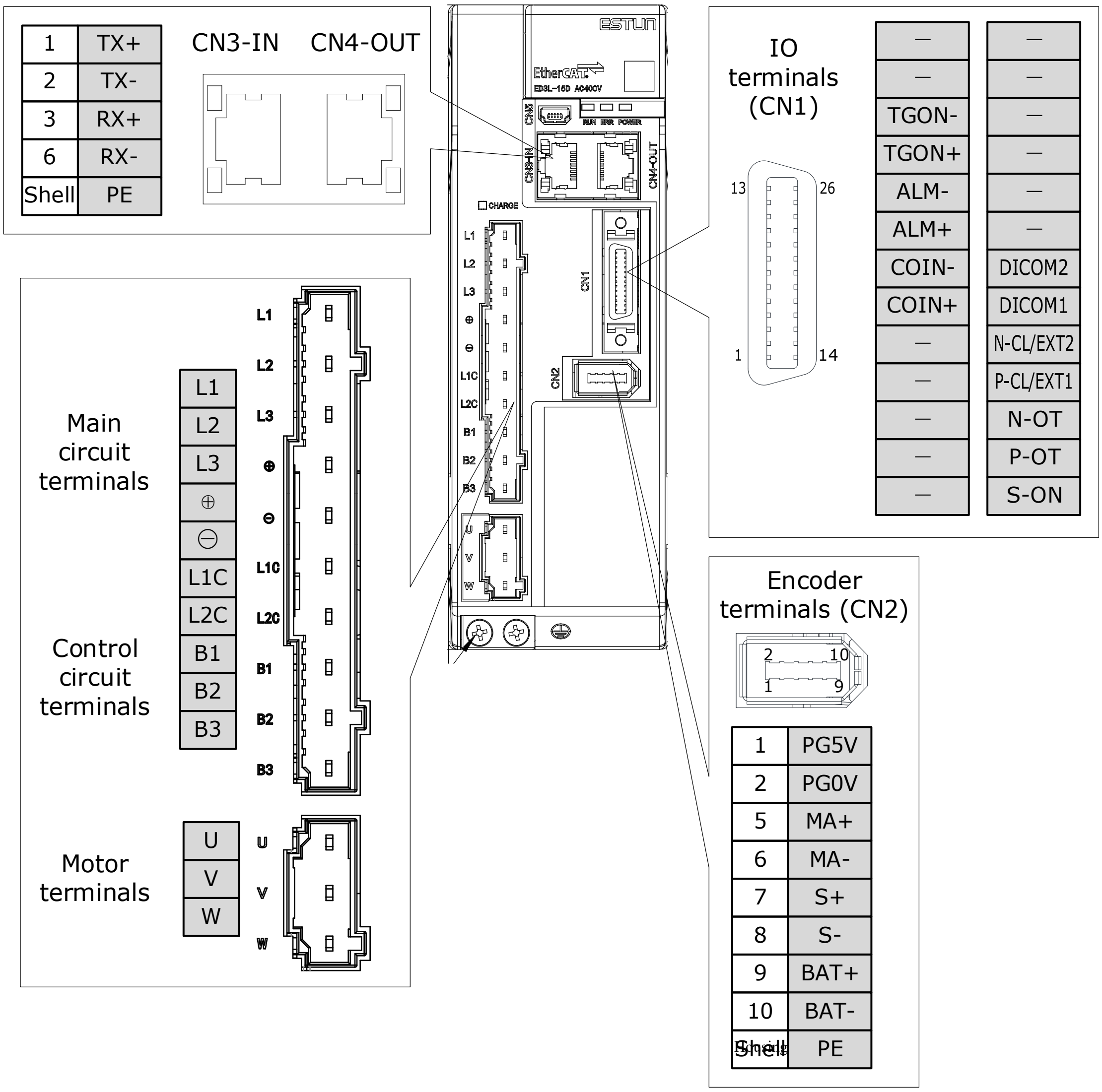
Encoder terminals (CN2)

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



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

Main circuit terminals

- L1
- L2
- L3
- ⊕
- ⊖

Control circuit terminals

- L1C
- L2C
- B1
- B2
- B3

Motor terminals

- U
- V
- W

IO terminals (CN1)

—	—
—	—
TGON-	—
TGON+	—
ALM-	—
ALM+	—
COIN-	DICOM2
COIN+	DICOM1
—	N-CL/EXT2
—	P-CL/EXT1
—	N-OT
—	P-OT
—	S-ON

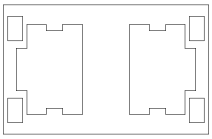
Encoder terminals (CN2)

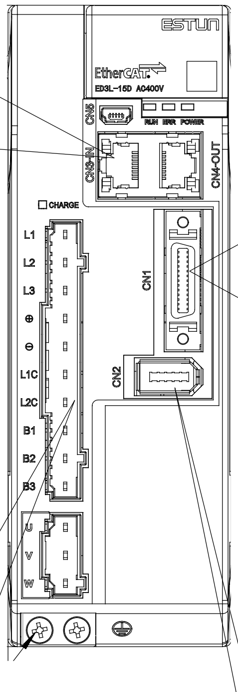
1	PG5V
2	PG0V
5	MA+
6	MA-
7	S+
8	S-
9	BAT+
10	BAT-
Shell	PE

400VAC ， rated power from 1kW to 1.5kW（-FS02drive）

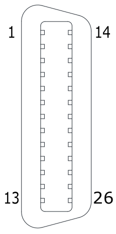
1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

CN3-P1 CN4-P2





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

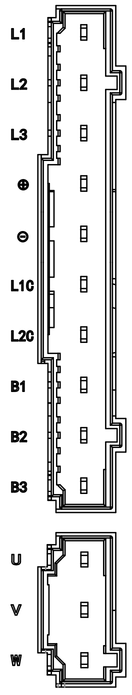
Main circuit terminals

Control circuit terminals

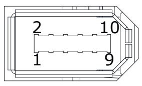
Motor power terminals

L1
L2
L3
⊕
⊖
L1C
L2C
B1
B2
B3

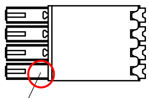
U
V
W



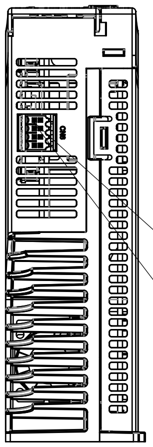
Encoder terminal CN2



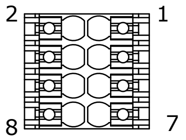
1	PG5V
2	PG0V
5	MA+
6	MA-
7	S+
8	S-
9	BAT+
10	BAT-
Shell	PE



The missing here is 1 foot

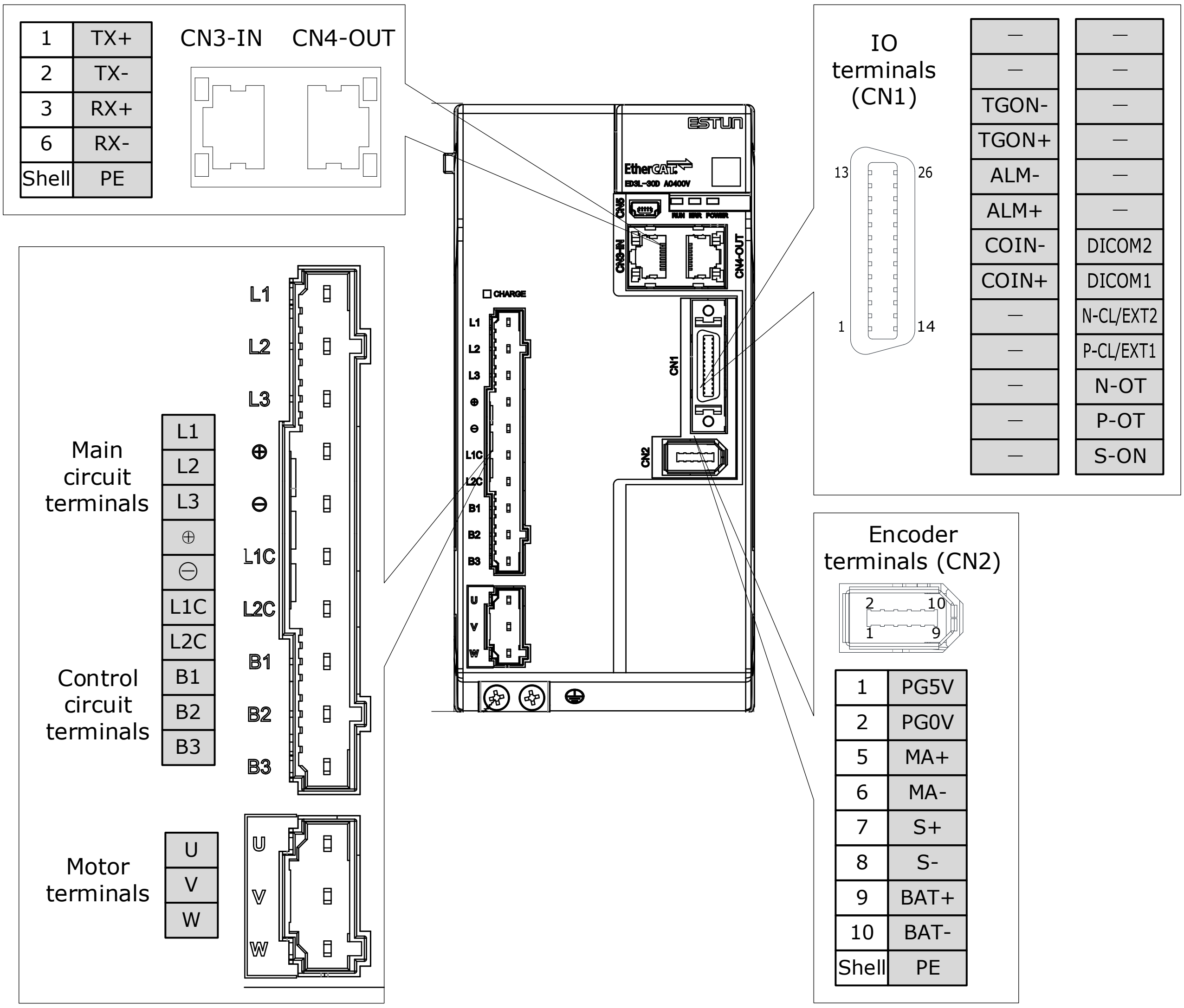


STO terminal CN6

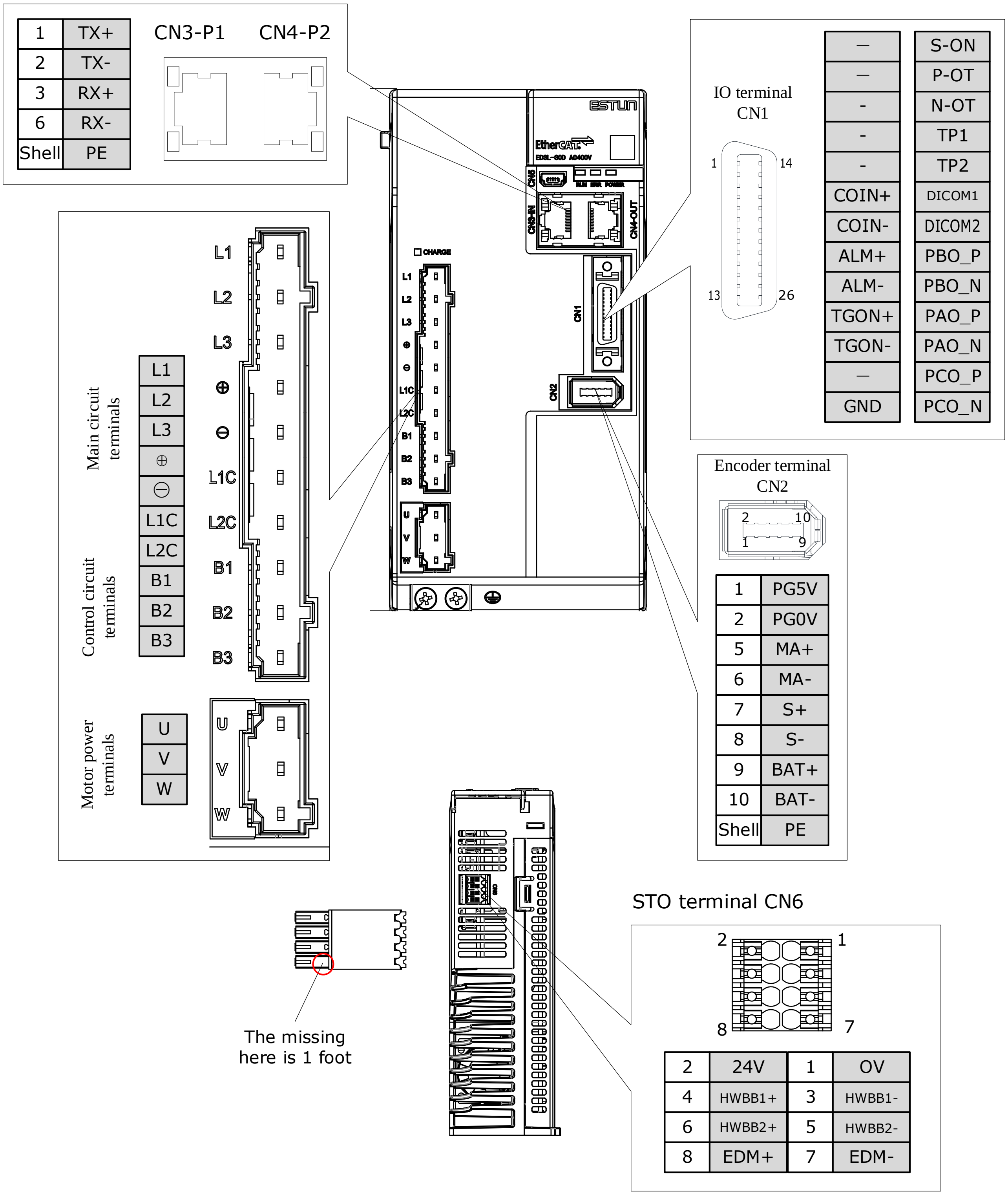


2	24V	1	OV
4	HWBB1+	3	HWBB1-
6	HWBB2+	5	HWBB2-
8	EDM+	7	EDM-

400VAC, rated power from 2kW to 3kW



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



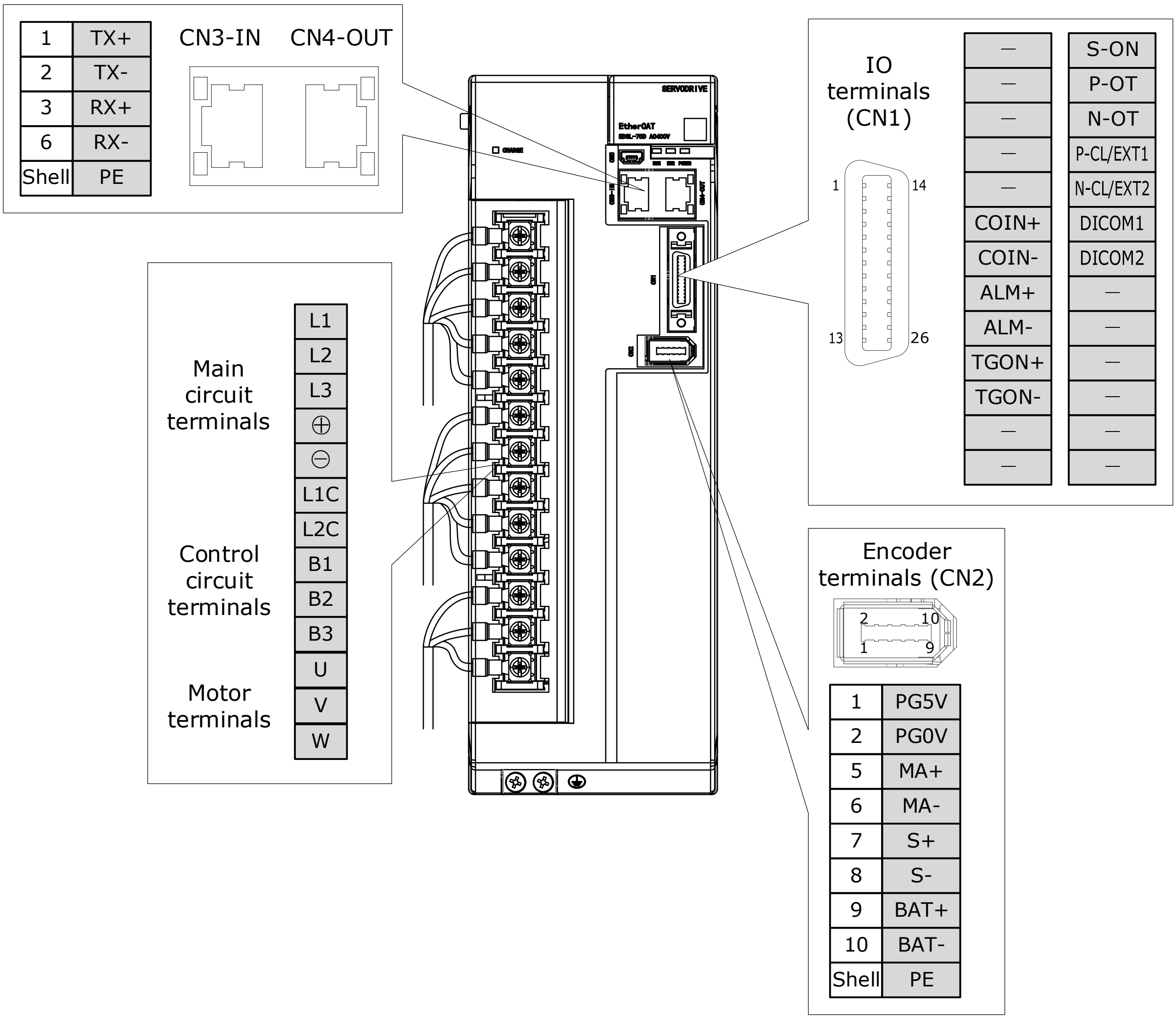
1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

—	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 5kW to 7.5kW

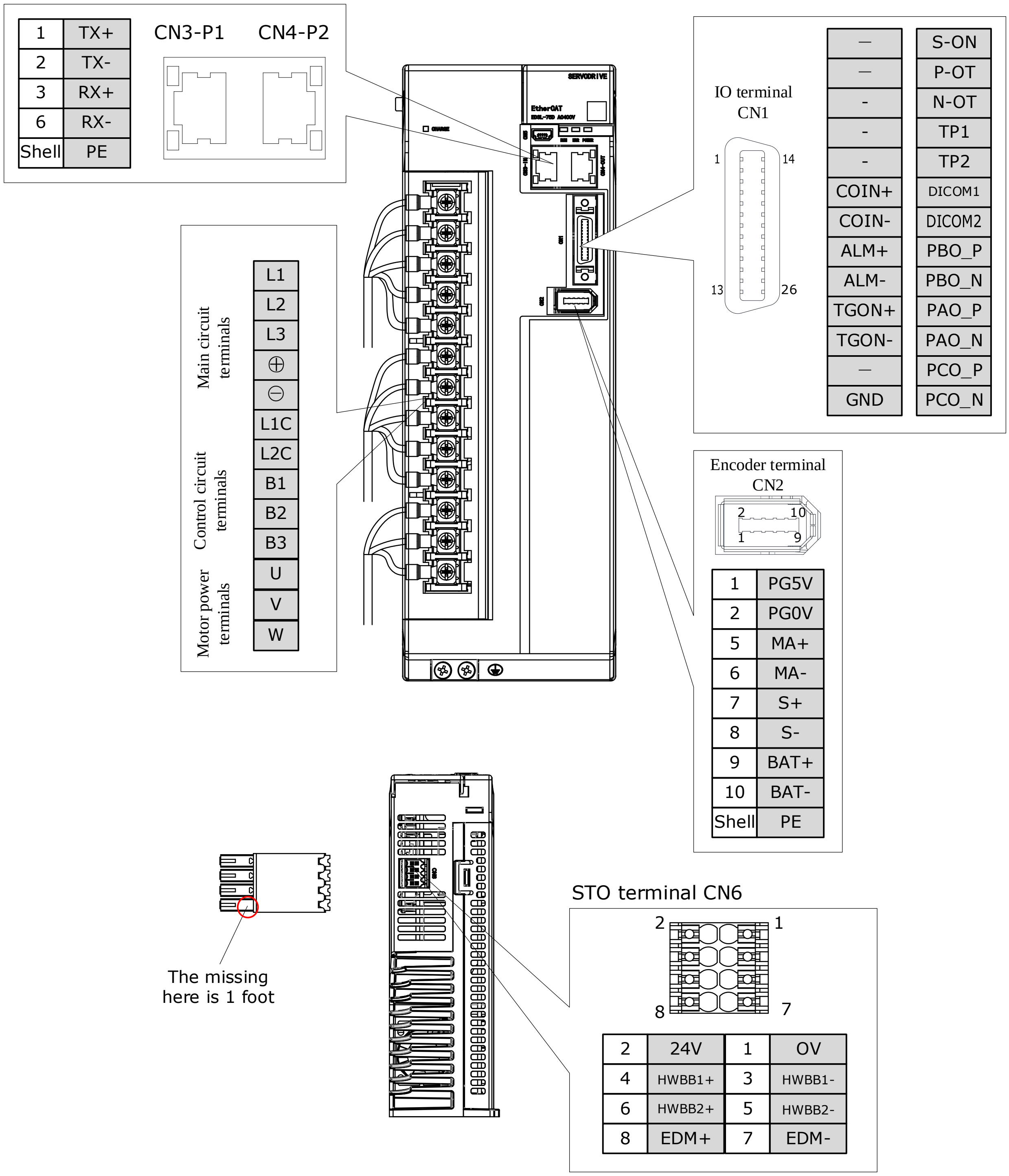


1	TX+
2	TX-
3	RX+
6	RX-
Shell	PE

—	S-ON
—	P-OT
—	N-OT
—	P-CL/EXT1
—	N-CL/EXT2
COIN+	DICOM1
COIN-	DICOM2
ALM+	—
ALM-	—
TGON+	—
TGON-	—
—	—
—	—

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

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



CN3-P1 CN4-P2

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 terminals	L1
	L2
	L3
	⊕
	⊖
Control circuit terminals	L1C
	L2C
	B1
	B2
	B3
Motor power terminals	U
	V
	W

Encoder terminal CN2

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

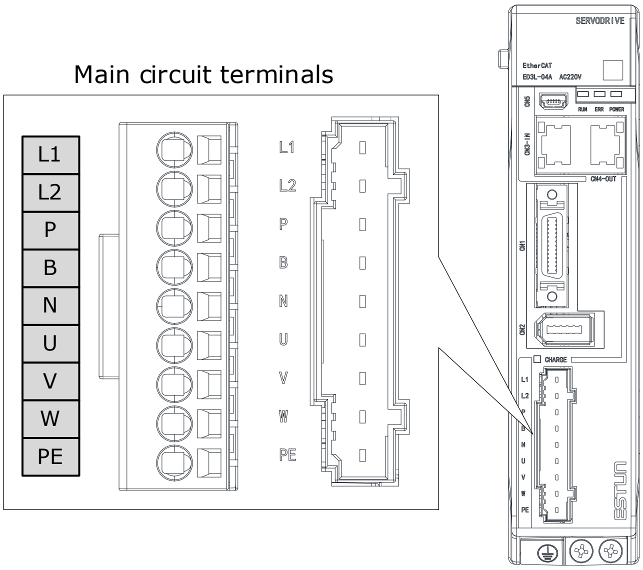
STO terminal CN6

2	24V	1	0V
4	HWBB1+	3	HWBB1-
6	HWBB2+	5	HWBB2-
8	EDM+	7	EDM-

3.4 Wiring the Power Supply to Drive

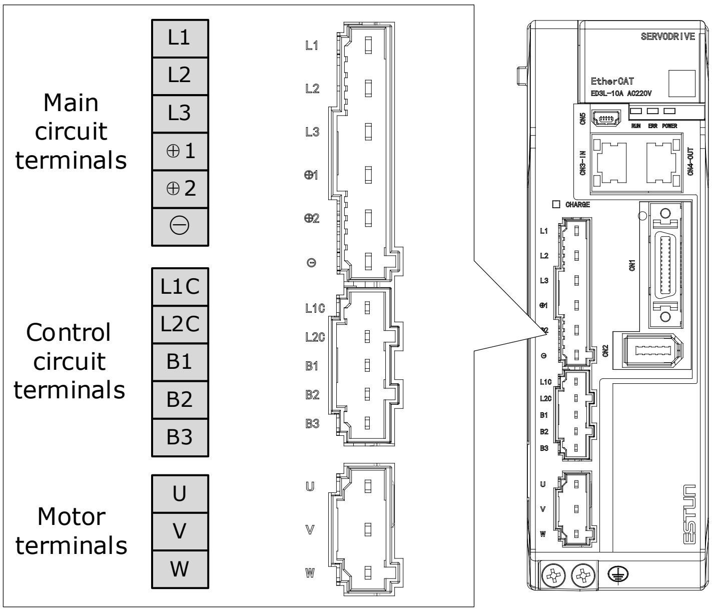
3.4.1 Terminals Arrangement

200VAC, rated power from 50W to 400W



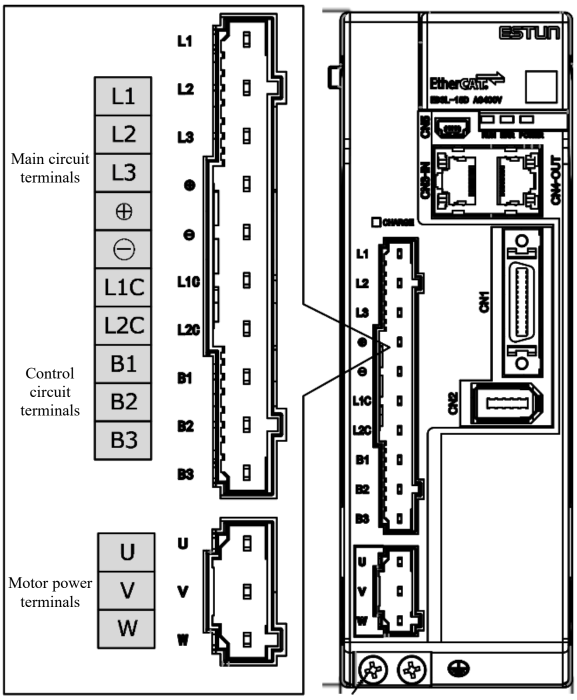
Symbols	Name	Specifications and Reference
L1, L2	Main circuit power supply input terminals	Single-phase, 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz
P, B	Regenerative Resistor terminal	Connects a regenerative resistor with a minimum resistance value of 45 ohm
P, N	DC terminals	For the common DC bus, 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.

200VAC, 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.

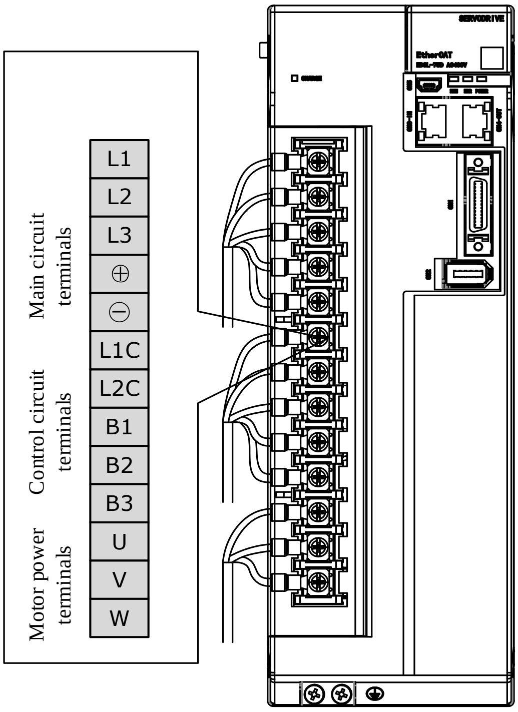
400VAC, rated power from 1kW to 3kW



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.

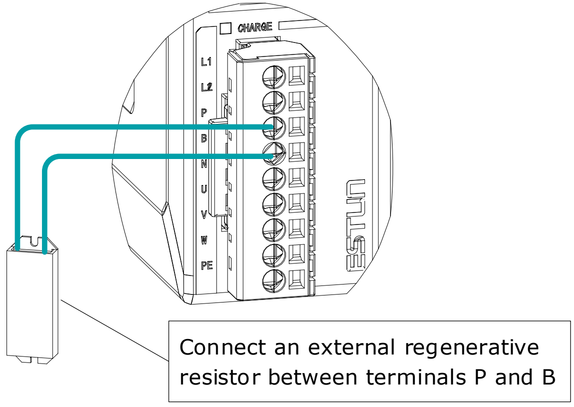
3.4.2 Wiring a Regenerative Resistor

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	25Ω	
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



Connect an external regenerative resistor between terminals P and B

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.

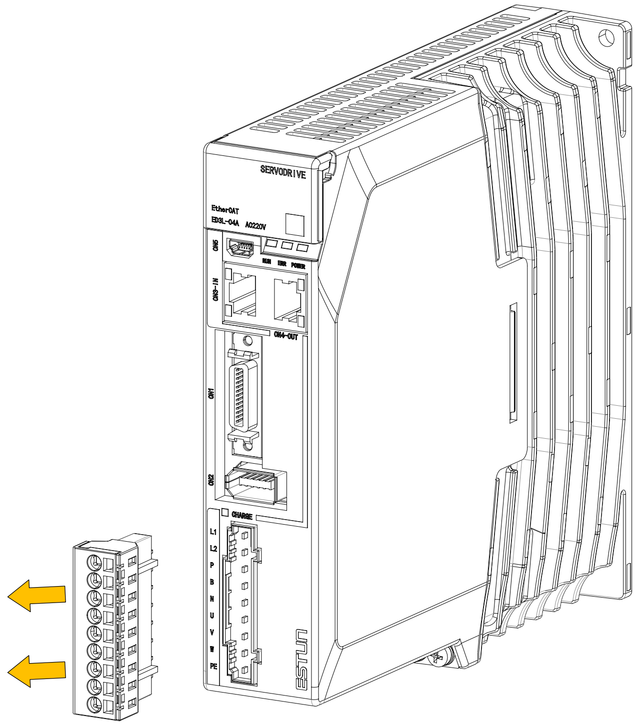
3.4.3 Wiring Procedure

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

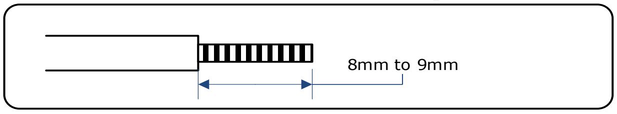
Required Item	Description
Flat-blade screwdriver or Terminal removal tool	● Flat-blade screwdriver: commercially available screwdriver with tip width of 3.0 mm to 3.5 mm ● Terminal removal tool: an accessory of the Drive
Cold pressed terminals	Sleeve type ferrule with cross-section from 1.5 mm^2 to 2.5 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.

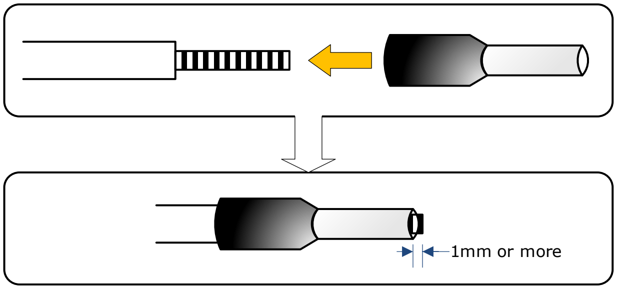
Step 1 Remove the Main Circuit Terminals and Control Circuit Terminals from the Drive.



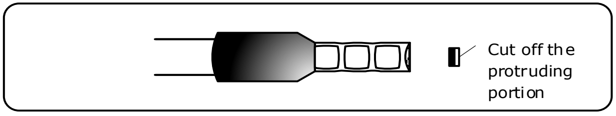
Step 2 Peel off the sheath so that the conductor portion of the cable will protrude from the tip of the ferrule.



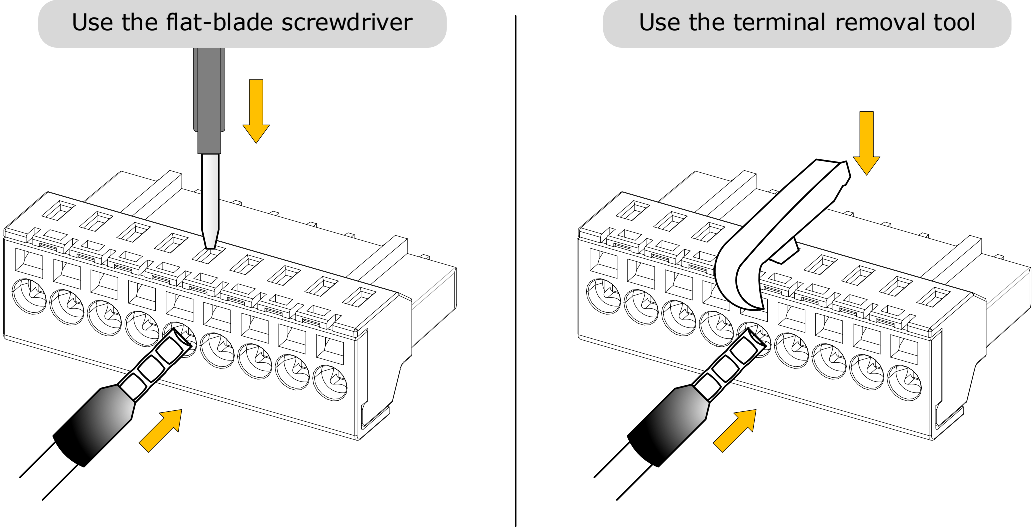
Step 3 Insert the cable into the ferrule (It should protrude 1 mm or more from the ferrule).



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.

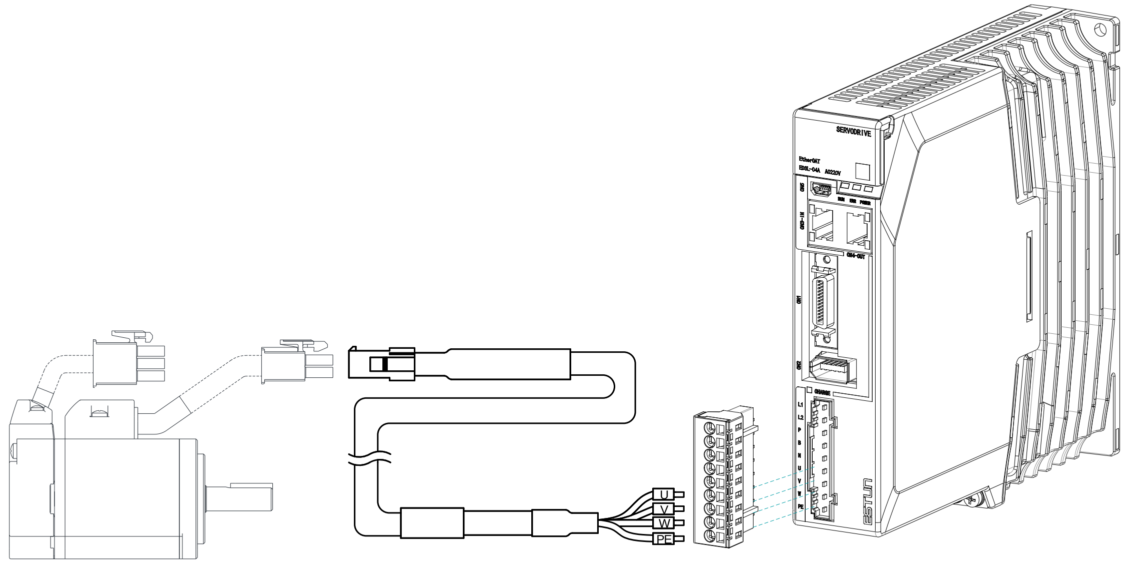
Step 9 When you have completed wiring, attach connection terminals to the Drive.

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

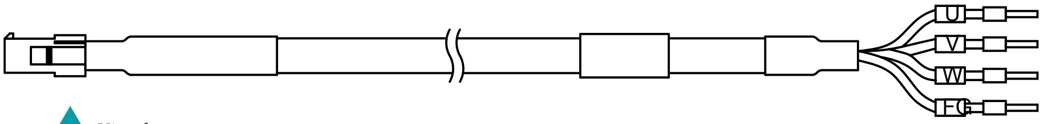
The Motor power cable depends on the Motor model. The common models are shown in the table below.

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
				EC3P-N9314-03	EC3P-N9314-05	EC3P-N9314-10
				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

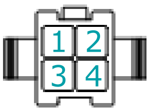
The following shows the diagram and wiring description of each Motor power cable.

<table>
<tr><th>Cable Model</th><th>Brake</th><th>IP65 Plug</th></tr>
<tr><td>EC3P-N9118-□□</td><td>No</td><td>No</td></tr>
<tr><td colspan="3">
Motor side

Drive side



View from this end

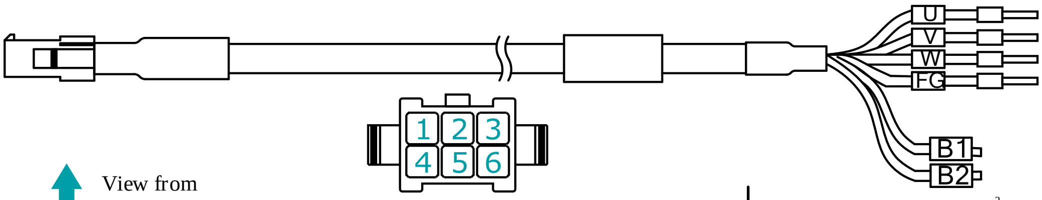


Recommended wire diameter for U, V, W and FG: 1mm²

<table>
<tr><th>Pin No.</th><th>Signal</th><th>Color</th></tr>
<tr><td>1</td><td>U</td><td>Brown</td></tr>
<tr><td>2</td><td>V</td><td>Grey</td></tr>
<tr><td>3</td><td>W</td><td>Black</td></tr>
<tr><td>4</td><td>FG</td><td>Yellow/ green</td></tr>
</table>

<table>
<tr><th>Pin No.</th><th>Signal</th><th>Color</th></tr>
<tr><td>1</td><td>U</td><td>Brown</td></tr>
<tr><td>2</td><td>V</td><td>Grey</td></tr>
<tr><td>3</td><td>W</td><td>Black</td></tr>
<tr><td>4</td><td>FG</td><td>Yellow/ green</td></tr>
</table>
</td></tr>
<tr><td>EC3P-B9118-□□</td><td>Yes</td><td>No</td></tr>
<tr><td colspan="3">
Motor side

Drive side



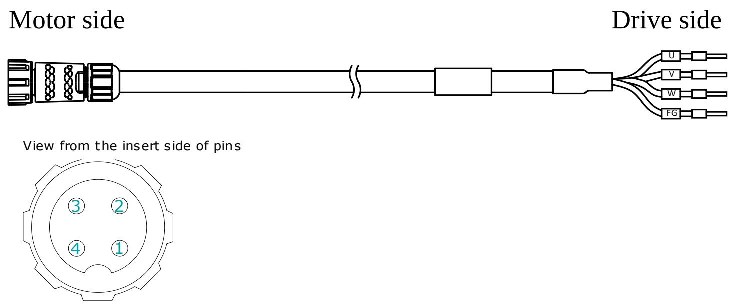
View from this end

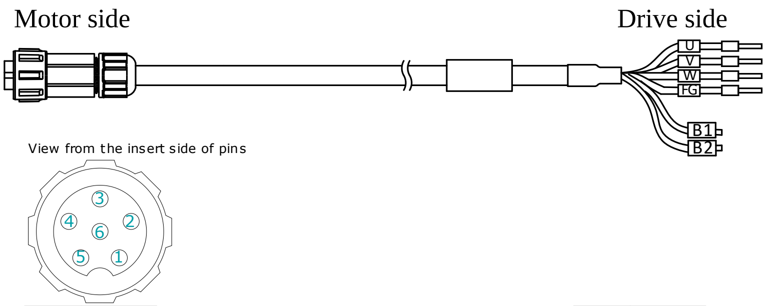
Recommended wire diameter for U, V, W and FG: 1mm²

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

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

Recommended wire diameter for B1 and B2:0.5mm²
</td></tr>
</table>

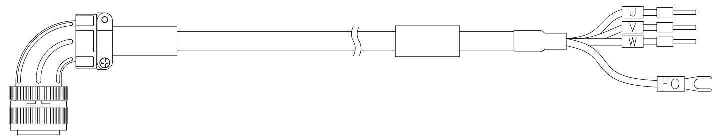
<table>
<tr><th>Cable Model</th><th>Brake</th><th>IP65 Plug</th></tr>
<tr><td>EC3P-N9718-□□</td><td>No</td><td>Yes</td></tr>
<tr><td colspan="3">


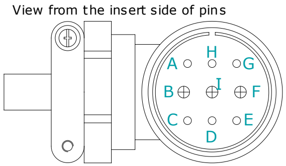
<table>
<tr><th>Pin</th><th>Signal</th><th>Pin</th><th>Signal</th></tr>
<tr><td>1</td><td>U</td><td></td><td>U</td></tr>
<tr><td>2</td><td>V</td><td></td><td>V</td></tr>
<tr><td>3</td><td>W</td><td></td><td>W</td></tr>
<tr><td>4</td><td>FG</td><td>Crimp terminal</td><td>FG</td></tr>
</table>
</td></tr>
<tr><td>EC3P-B9718-□□</td><td>Yes</td><td>Yes</td></tr>
<tr><td colspan="3">


<table>
<tr><th>Pin</th><th>Signal</th><th>Pin</th><th>Signal</th></tr>
<tr><td>1</td><td>U</td><td></td><td>U</td></tr>
<tr><td>2</td><td>V</td><td></td><td>V</td></tr>
<tr><td>3</td><td>W</td><td></td><td>W</td></tr>
<tr><td>4</td><td>FG</td><td>Crimp terminal</td><td>FG</td></tr>
<tr><td>5</td><td>B1</td><td></td><td>B1</td></tr>
<tr><td>6</td><td>B2</td><td></td><td>B2</td></tr>
</table>
</td></tr>
</table>

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

Motor side Drive side



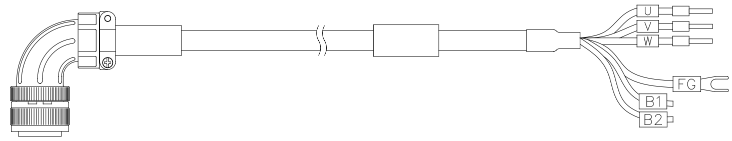


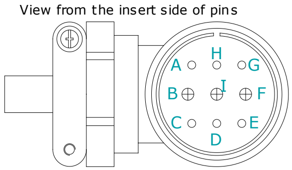
Pin	Signal	Pin	Signal
B	U		U
I	V		V
F	W		W
C	FG	Crimp terminal	FG
D	FG		

Short wiring: BVR 1.5mm²

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

Motor side Drive side





Pin	Signal	Pin	Signal
B	U		U
I	V		V
F	W		W
C	FG	Crimp terminal	FG
D	FG		
G	B1		B1
H	B2		B2

Short wiring: BVR 1.5mm²

3.4.6 Power Input Wiring Specifications

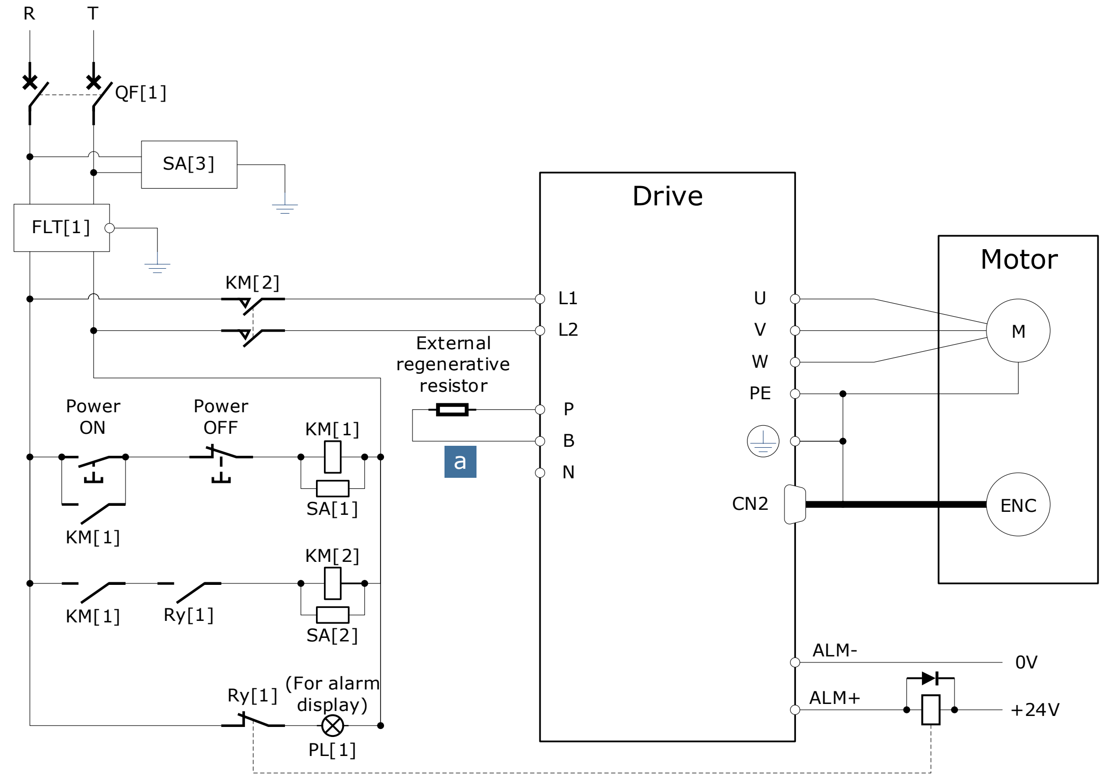
The power input wiring specification depends on the Motor model. The following table shows the recommended wire gauge for each Drive.

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.

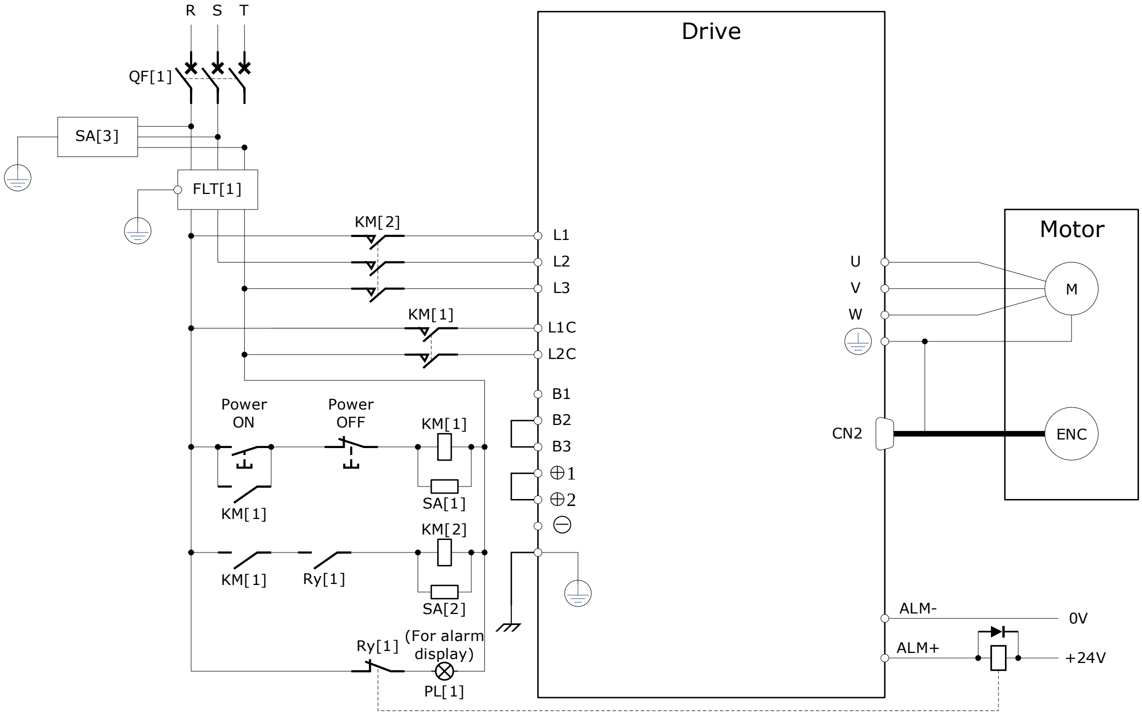


QF[1]: Molded-case circuit breaker
SA[1]: Surge Absorber 1
SA[2]: Surge Absorber 2
SA[3]: Surge Absorber 3
FLT[1]: Noise Filter
Ry[1]: Relay
PL[1]: Indicator lamp
KM[1]: Magnetic Contactor (for control power supply)
KM[2]: Magnetic Contactor (for main circuit power supply)

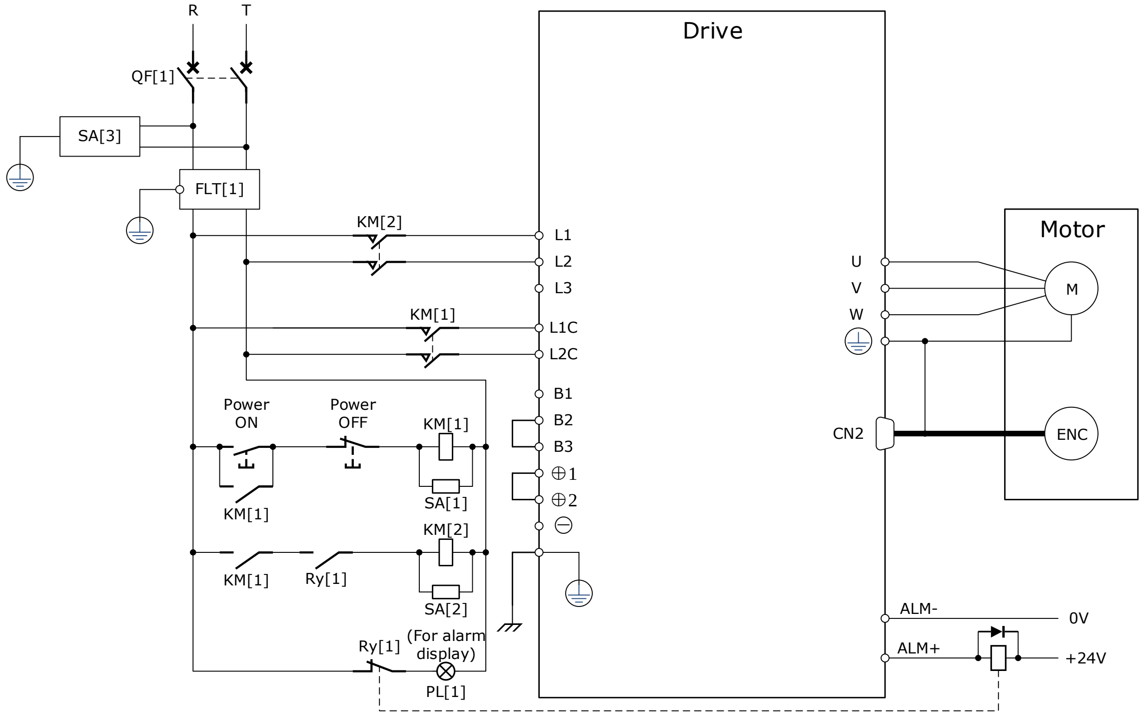
200VAC , rated power from 750W to 2kW

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.

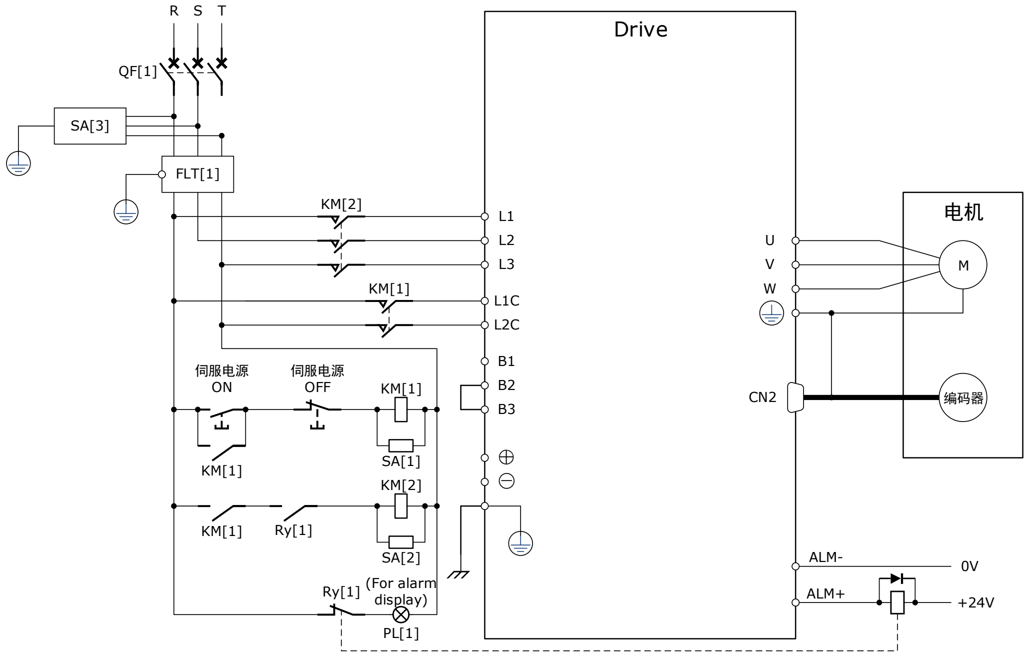


QF[1]: Molded-case circuit breaker
SA[1]: Surge Absorber 1
SA[2]: Surge Absorber 2
SA[3]: Surge Absorber 3
FLT[1]: Noise Filter
Ry[1]: Relay
PL[1]: Indicator lamp
KM[1]: Magnetic Contactor (for control power supply)
KM[2]: Magnetic Contactor (for main circuit power supply)

400VAC , rated power from 1kW to 5kW

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

【When using a three-phase AC power supply】

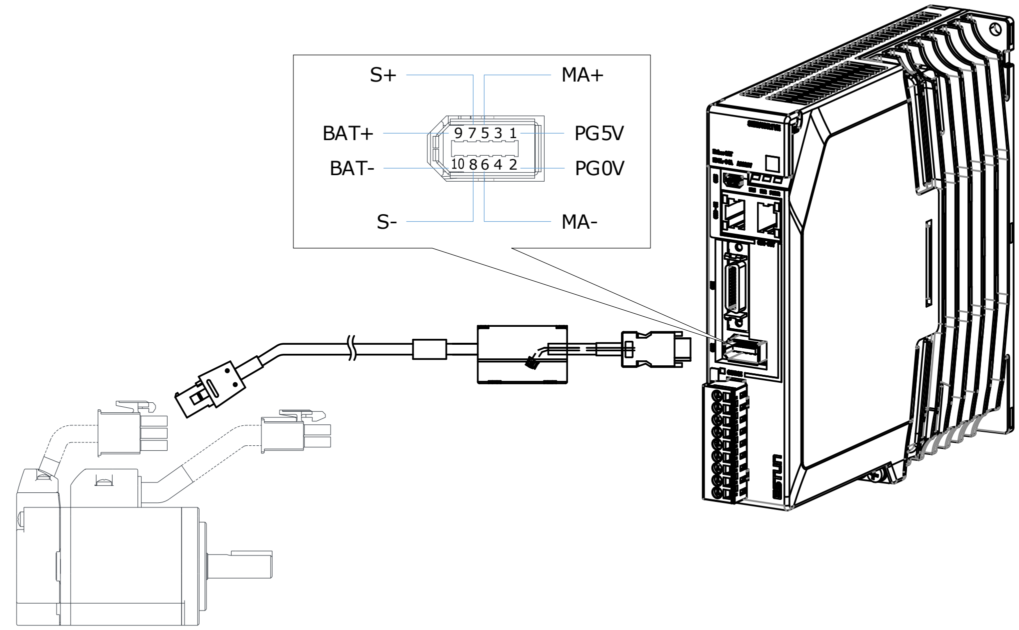


QF[1]: Molded-case circuit breaker
SA[1]: Surge Absorber 1
SA[2]: Surge Absorber 2
SA[3]: Surge Absorber 3
FLT[1]: Noise Filter
Ry[1]: Relay
PL[1]: Indicator lamp
KM[1]: Magnetic Contactor (for control power supply)

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

3.5 Wiring the Encoder

3.5.1 Connection Diagram



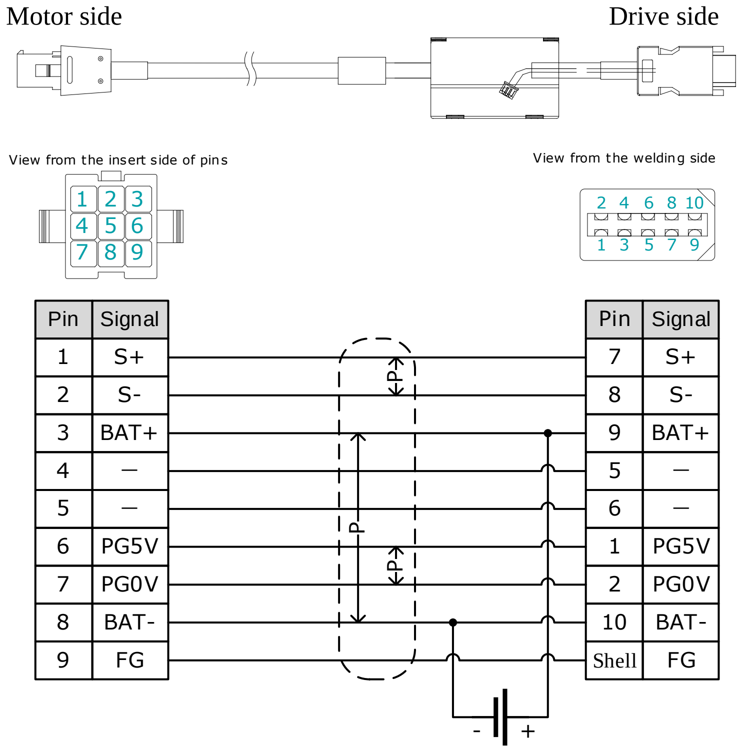
3.5.2 Encoder Cable Description

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

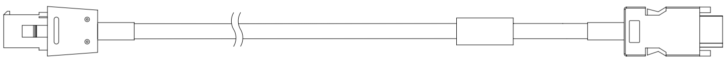
Motor model	Encoder	IP65	Motor power cable		
			length is 3.0m	length is 5.0m	length is 10.0m
EM3A-A5A EM3A-01A EM3A-02A EM3A-04A EM3A-08A EM3A-10A EM3J-02A EM3J-04A EM3J-08A	Incremental	NO	EC3S-I1124-03	EC3S-I1124-05	EC3S-I1124-10
	Absolute	NO	EC3S-A1124-03	EC3S-A1124-05	EC3S-A1124-10
	Incremental	YES	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

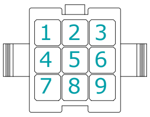
The following shows the diagram and wiring description of each encoder cable.

<table>
<tr><th>Applicable models</th><th>Cable Model</th><th>Encoder</th><th>IP65 Plug</th></tr>
<tr><td rowspan="2">EM3A-A5A□□□□1
EM3A-01A□□□□1
EM3A-02A□□□□1
EM3A-04A□□□□1
EM3A-08A□□□□1
EM3A-10A□□□□1</td><td>EC3S-A1124-□□</td><td>Absolute</td><td>No</td></tr>
<tr><td colspan="3"> <table><tr><th>Pin</th><th>Signal</th><th>Pin</th><th>Signal</th></tr><tr><td>1</td><td>S+</td><td>7</td><td>S+</td></tr><tr><td>2</td><td>S-</td><td>8</td><td>S-</td></tr><tr><td>3</td><td>BAT+</td><td>9</td><td>BAT+</td></tr><tr><td>4</td><td>—</td><td>5</td><td>—</td></tr><tr><td>5</td><td>—</td><td>6</td><td>—</td></tr><tr><td>6</td><td>PG5V</td><td>1</td><td>PG5V</td></tr><tr><td>7</td><td>PG0V</td><td>2</td><td>PG0V</td></tr><tr><td>8</td><td>BAT-</td><td>10</td><td>BAT-</td></tr><tr><td>9</td><td>FG</td><td>Shell</td><td>FG</td></tr></table></td></tr>
</table>

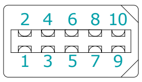
<table>
<tr><th>Applicable models</th><th>Cable Model</th><th>Encoder</th><th>IP65 Plug</th></tr>
<tr><td rowspan="2">EM3A-A5A□□
EM3A-01A□□
EM3A-02A□□
EM3A-04A□□
EM3A-08A□□
EM3A-10A□□</td><td>EC3S-I1124-□□</td><td>Incremental</td><td>No</td></tr>
<tr><td colspan="3">
Motor side Drive side

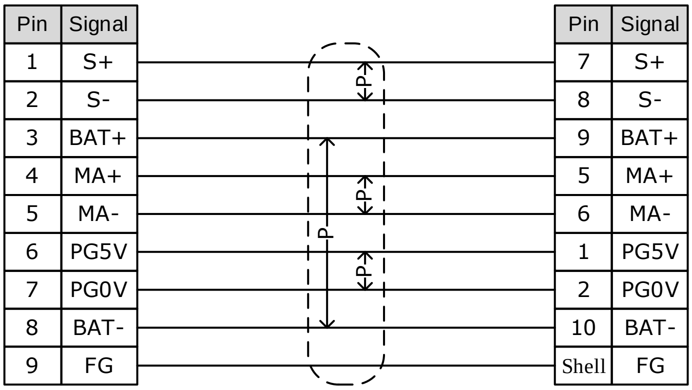


View from the insert side of pins

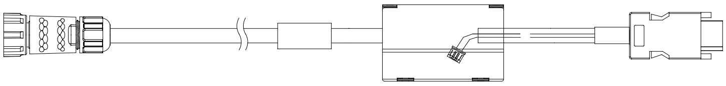


View from the welding side

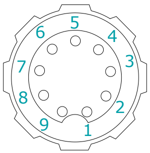




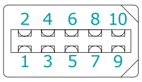
<table>
<tr><th>Pin</th><th>Signal</th><th>Pin</th><th>Signal</th></tr>
<tr><td>1</td><td>S+</td><td>7</td><td>S+</td></tr>
<tr><td>2</td><td>S-</td><td>8</td><td>S-</td></tr>
<tr><td>3</td><td>BAT+</td><td>9</td><td>BAT+</td></tr>
<tr><td>4</td><td>MA+</td><td>5</td><td>MA+</td></tr>
<tr><td>5</td><td>MA-</td><td>6</td><td>MA-</td></tr>
<tr><td>6</td><td>PG5V</td><td>1</td><td>PG5V</td></tr>
<tr><td>7</td><td>PG0V</td><td>2</td><td>PG0V</td></tr>
<tr><td>8</td><td>BAT-</td><td>10</td><td>BAT-</td></tr>
<tr><td>9</td><td>FG</td><td>Shell</td><td>FG</td></tr>
</table>
</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">
Motor side Drive side

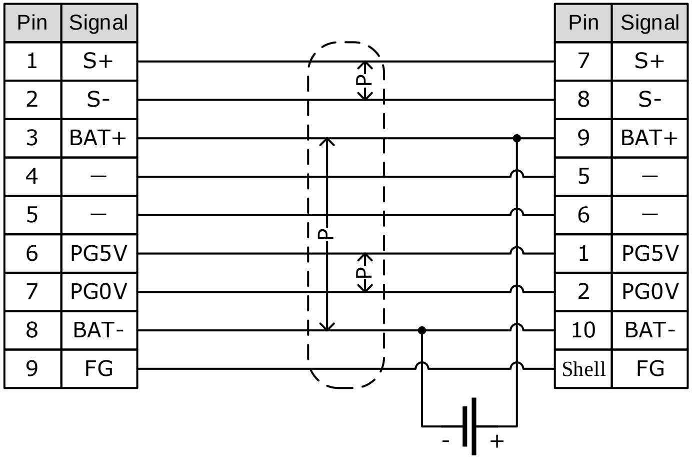


View from the insert side of pins

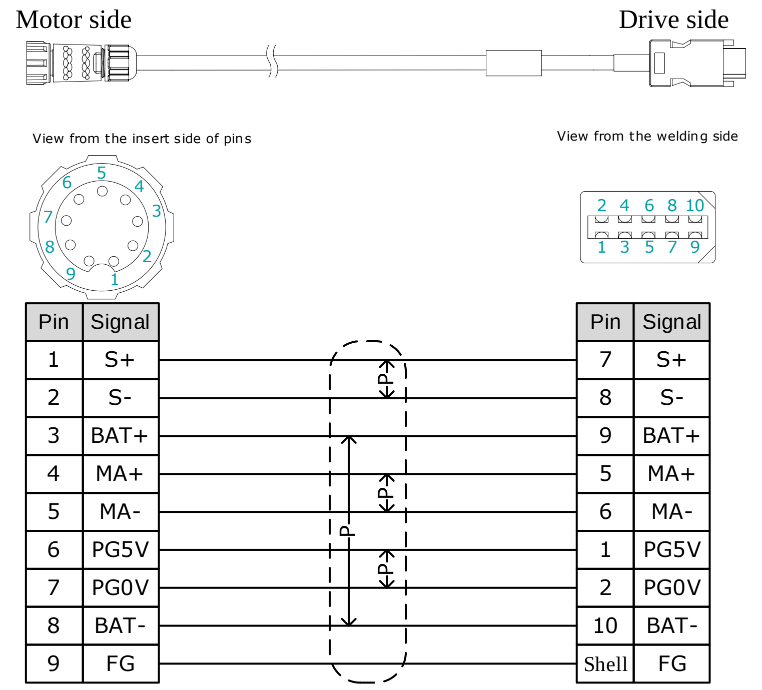
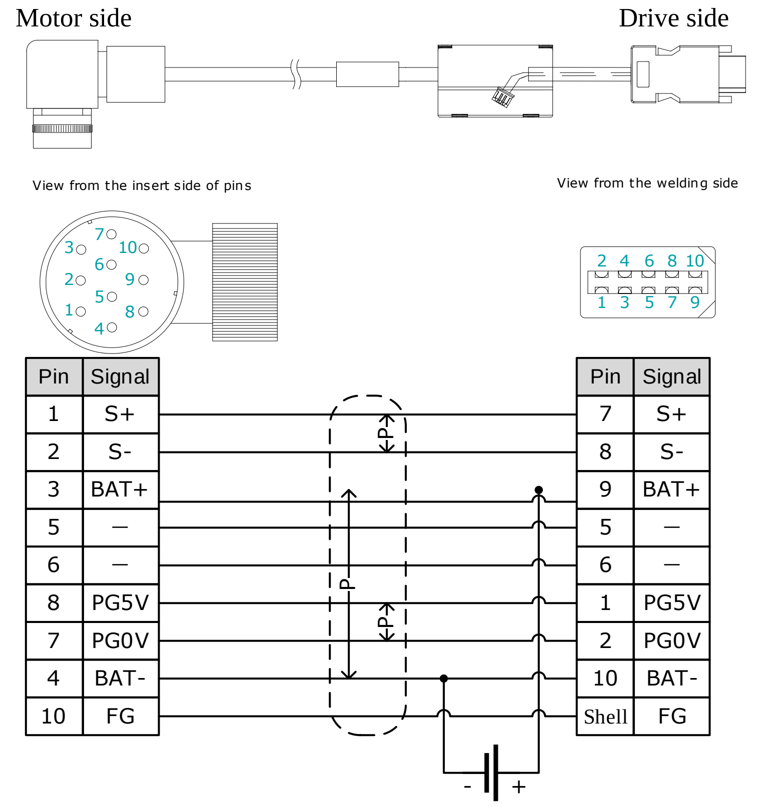


View from the welding side





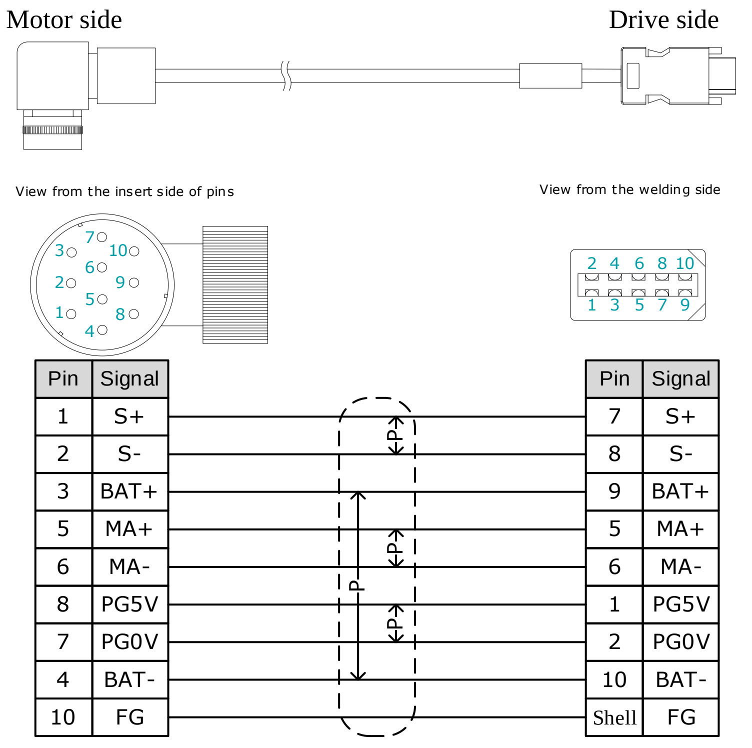
<table>
<tr><th>Pin</th><th>Signal</th><th>Pin</th><th>Signal</th></tr>
<tr><td>1</td><td>S+</td><td>7</td><td>S+</td></tr>
<tr><td>2</td><td>S-</td><td>8</td><td>S-</td></tr>
<tr><td>3</td><td>BAT+</td><td>9</td><td>BAT+</td></tr>
<tr><td>4</td><td>—</td><td>5</td><td>—</td></tr>
<tr><td>5</td><td>—</td><td>6</td><td>—</td></tr>
<tr><td>6</td><td>PG5V</td><td>1</td><td>PG5V</td></tr>
<tr><td>7</td><td>PG0V</td><td>2</td><td>PG0V</td></tr>
<tr><td>8</td><td>BAT-</td><td>10</td><td>BAT-</td></tr>
<tr><td>9</td><td>FG</td><td>Shell</td><td>FG</td></tr>
</table>
</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	Pin	Signal
1	S+	7	S+
2	S-	8	S-
3	BAT+	9	BAT+
5	MA+	5	MA+
6	MA-	6	MA-
8	PG5V	1	PG5V
7	PG0V	2	PG0V
4	BAT-	10	BAT-
10	FG	Shell	FG

3.5.3 Battery Case Connection

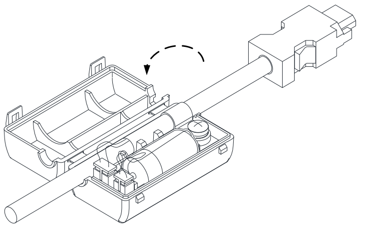
CAUTION

- 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.

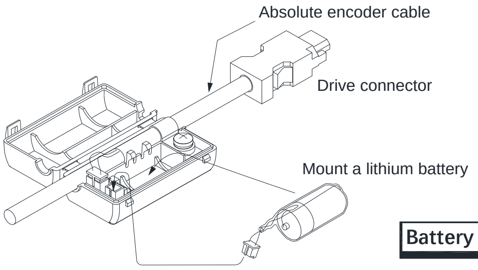
Follow the instructions below to install or replace the battery case.

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

Step 2 Open the cover of the battery case.

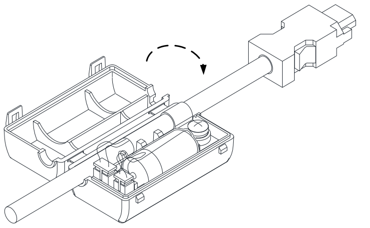


Step 3 Remove the old battery and mount a new battery.



Battery mode: LS 14500 (3.6V，AA)

Step 4 Close the cover of the battery case.



Step 5 Repower up the Drive.

Step 6 Resert the Alarms.

NOTE

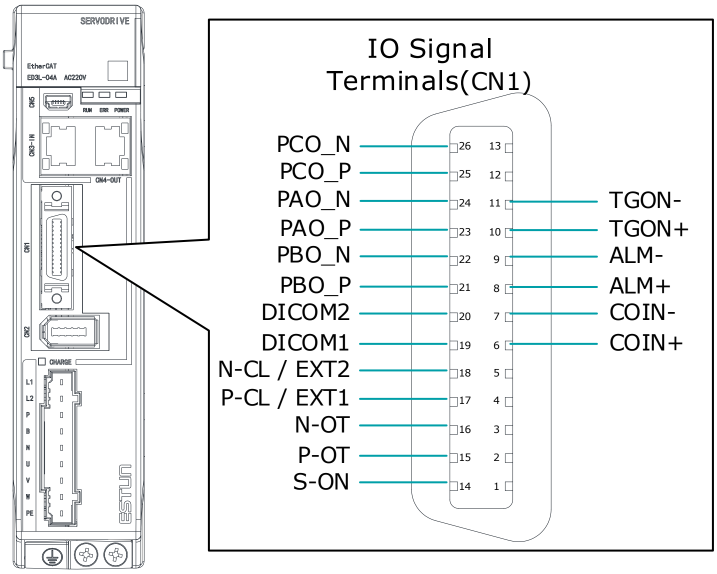
- Perform the Fn011 and Fn010 by Panel Operator to reset the alarms, for details, see the section Fn010 (Absolute encoder multi-turn reset) and Fn011 (Absolute encoder alarm reset).
- Also, you can reset the alarms by ESView V4, for details, see ESView Help Manual.

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 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 6.7 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.

Pin	Name	Type	Function
21	PBO_P	Output	Division Output of Encoder, channel B.
22	PBO_N	Output	
23	PAO_P	Output	Division Output of Encoder, channel A.
24	PAO_N	Output	
25	PCO_P	Output	Division Output of Encoder, channel C.
26	PCO_N	Output	

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.

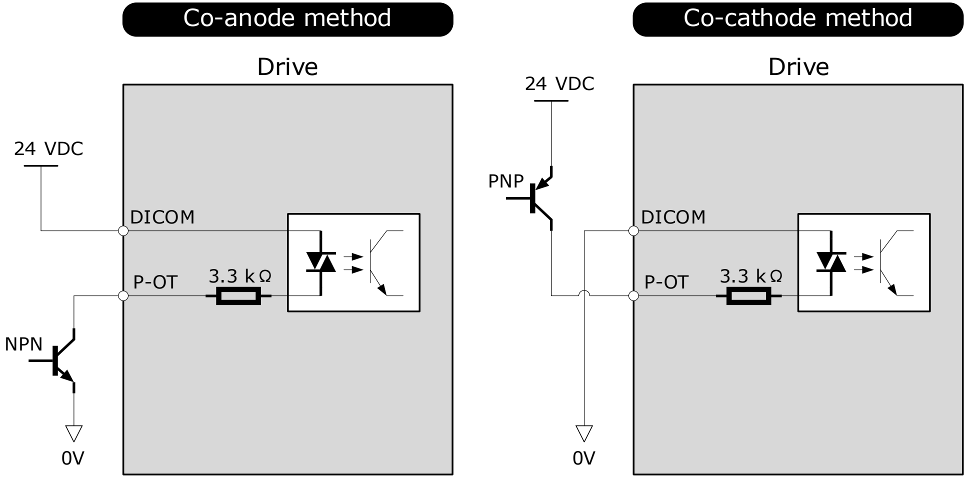
Group	Input Pins	Common Pin
Group 1	CN1-14, CN1-15, CN1-16	CN1-19
Group 2	CN1-17, CN1-18	CN1-20

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

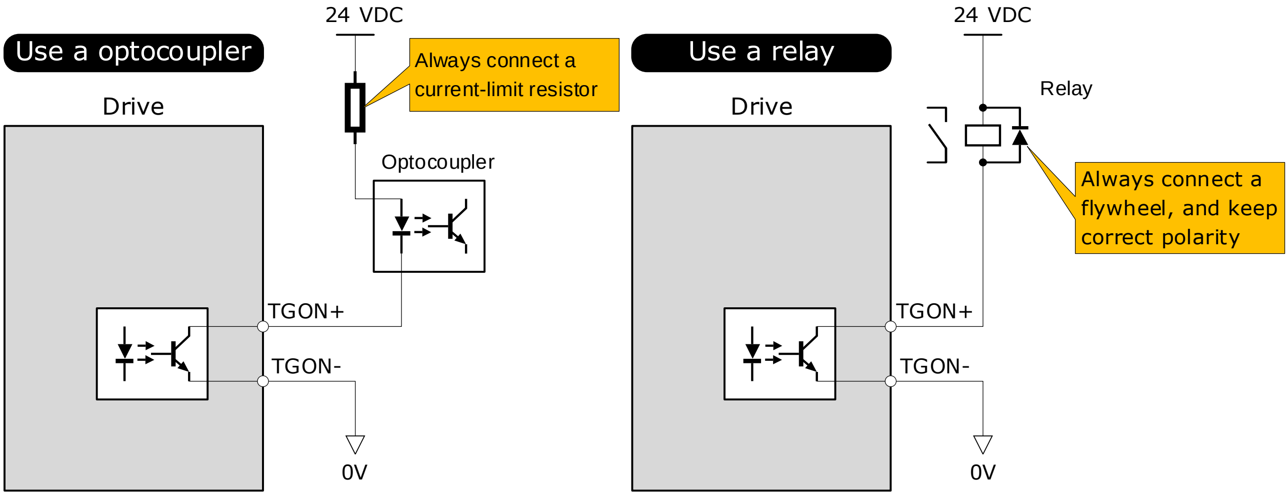


You can assign the input signals by Pn509 and Pn510, including TP (Touch Probe), S-ON (Servo ON), P-OT (Forward Drive Prohibit), N-OT (Reverse Drive Prohibit), P-CL (Forward External Torque Limit), N-CL (Reverse External Torque Limit), G-SEL (Gain Selection), HmRef (Homing), Remote (Remoted Input). For the input signal allocation, see the section 6.8.1 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

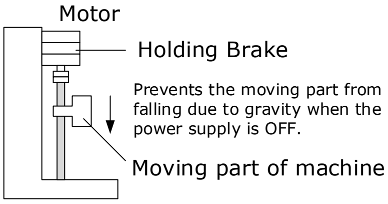
You can assign the output signals by Pn511, including COIN/VCMP (Positioning Completion or Speed Coincidence Detection), TGON (Rotation Detection), S-RDY (Servo Ready), CLT (Torque Limit Detection), BK (Brake), PGC (Motor C-pulse), OT (Overtravel), RD (Motor Excitation), TCR (Torque Detection), Remote (Remoted output). For the output signal allocation, see the section 6.8.2 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.

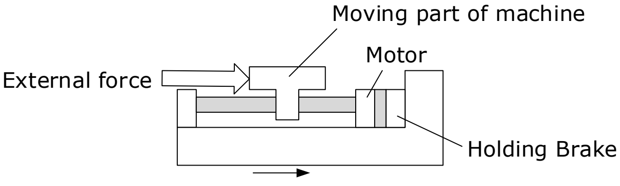
You can use the brake that is built into a Motor with a Brake, or you can provide one on the machine. The holding brake is used in the following cases.

Vertical Axis



Prevents the moving part from falling due to gravity when the power supply is OFF.

Shaft with External Force Applied



Prevents the moving part from moving due to an external force.

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

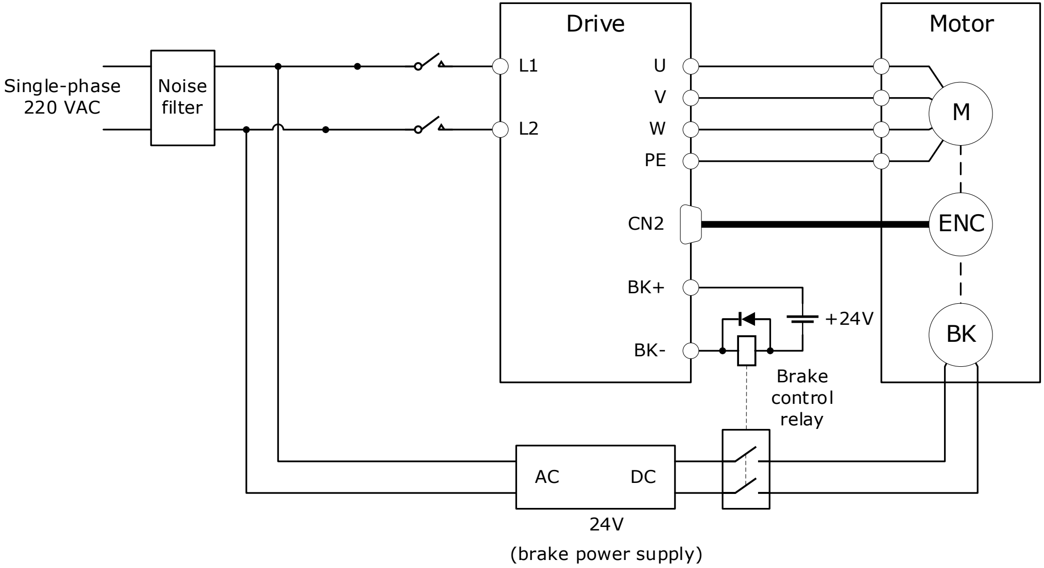


Table 3-1 lists brake specifications for each Motor matched with ED3L.

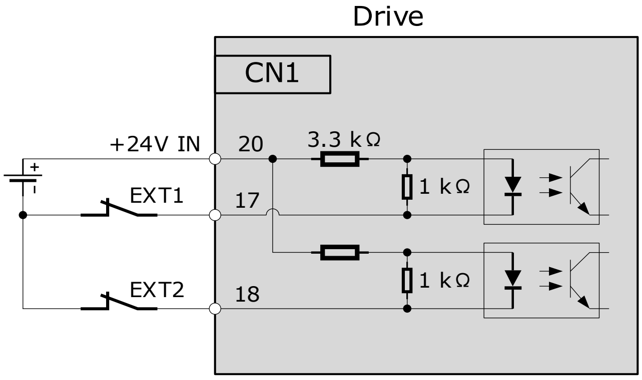
Table 3-1 Brake specifications

Motor Model	Voltage (V)	Holding torque (N·m)	Brake time (ms)	Release time (ms)	Power (W)
EM3A-A5A/01A	24V±10%	≥0.32	20	50	4
EM3A-02A/04A	24V±10%	≥1.5	25	50	7.6
EM3A-08A/10A	24V±10%	≥3.2	20	70	9.6
EM3A-15A/20A	24V±10%	≥8	20	100	17.6（±10%）
EM3A-30A/40A EM3A-40D/50D	24V±10%	≥20	40	100	23（±10%）
EM3G-09A EM3G-09D EM3G-13A EM3G-13D EM3G-18A EM3G-18D	24V±10%	≥20	40	100	23（±10%）
EM3G-29D EM3G-44D	24V±10%	≥44	25	150	36（±10%）
EM3G-55D EM3G-75D	24V±10%	≥72	25	200	36（±10%）
EM3J-02A EM3J-04A	24V±10%	≥1.5	25	50	7.6
EM3J-08A EM3J-10A EM3J-10D	24V±10%	≥3.2	20	70	9.6

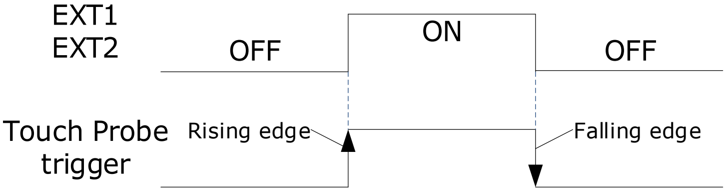
Note: The actual motor brake holding brake holding time and releasing the brake state time varies depending on the discharge circuit, and it is also necessary to consider the relay closing/opening time, etc. When using, be sure to confirm the action time with the actual product.

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.



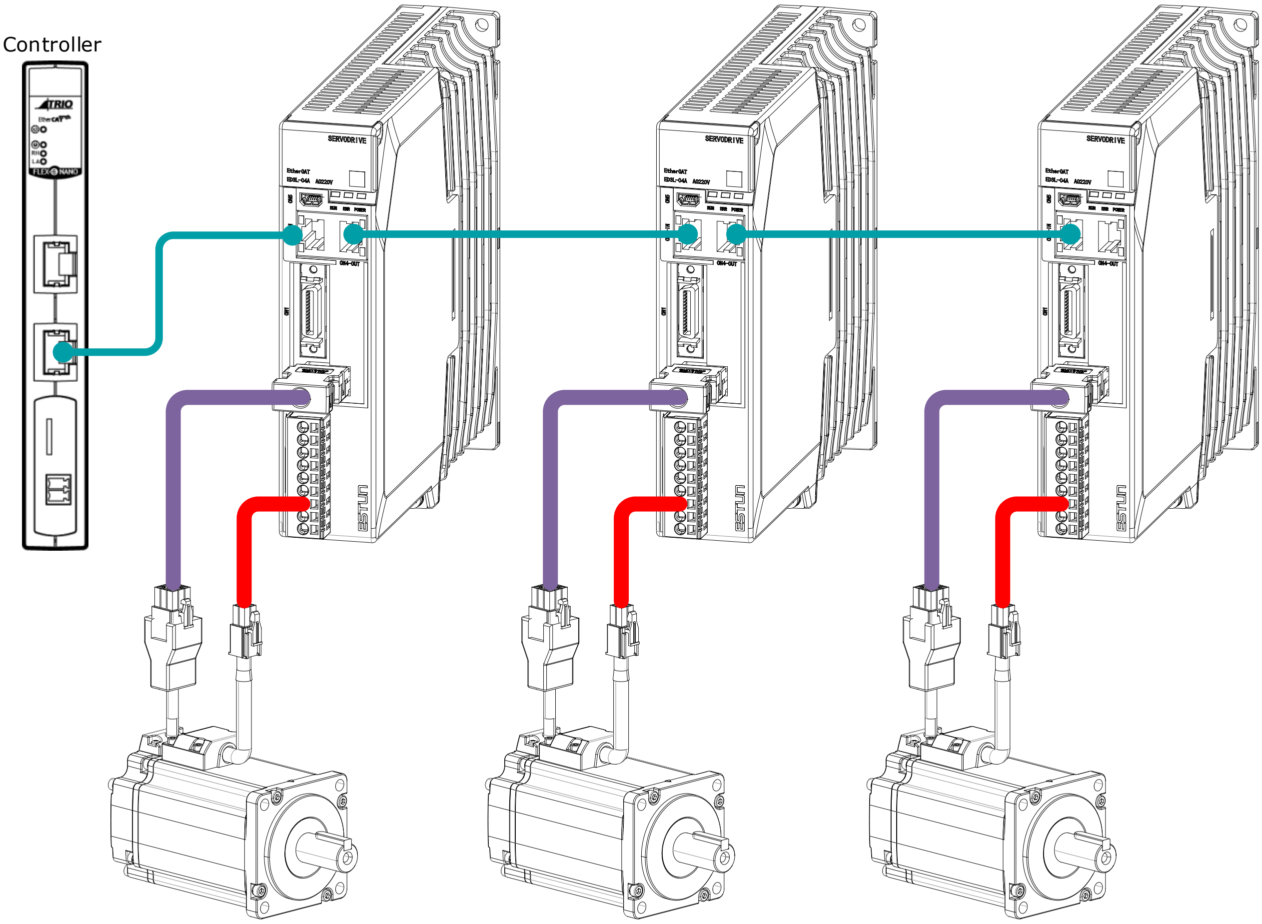
NOTE

For details about the function setting, see the section 8.10 Touch Probe.

3.7 Communication Connections

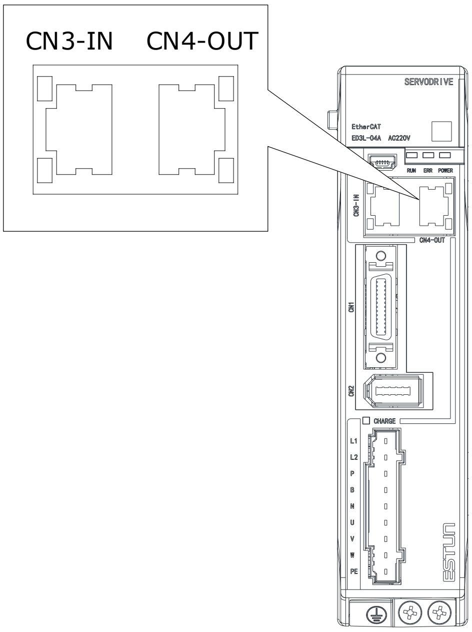
3.7.1 EtherCAT Communication

Connection Diagram



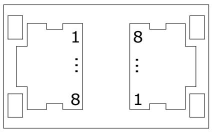
CN3-IN:
Connected by the OUT of the previous drive or controller.

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



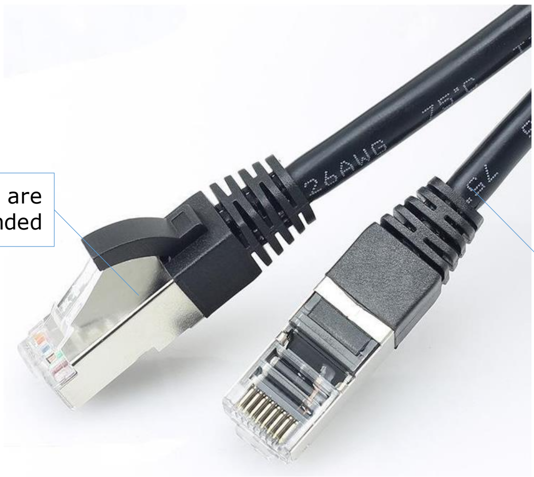
Pin Layout

EtherCAT 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.



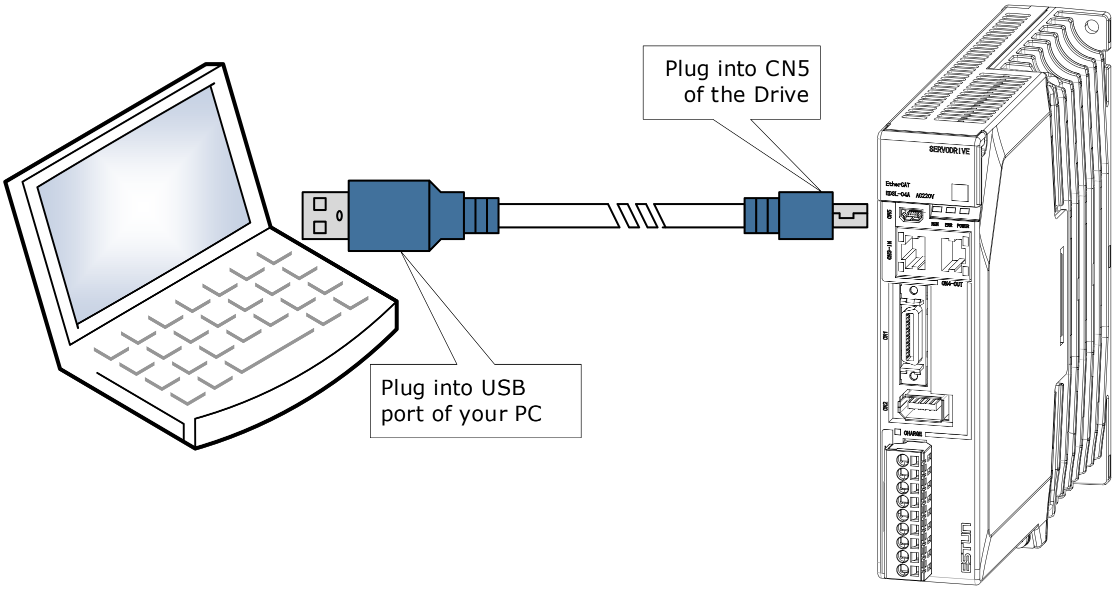
Metal shielded are recommended

Use CAT5e SF/UTP Ethernet communications cables

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.

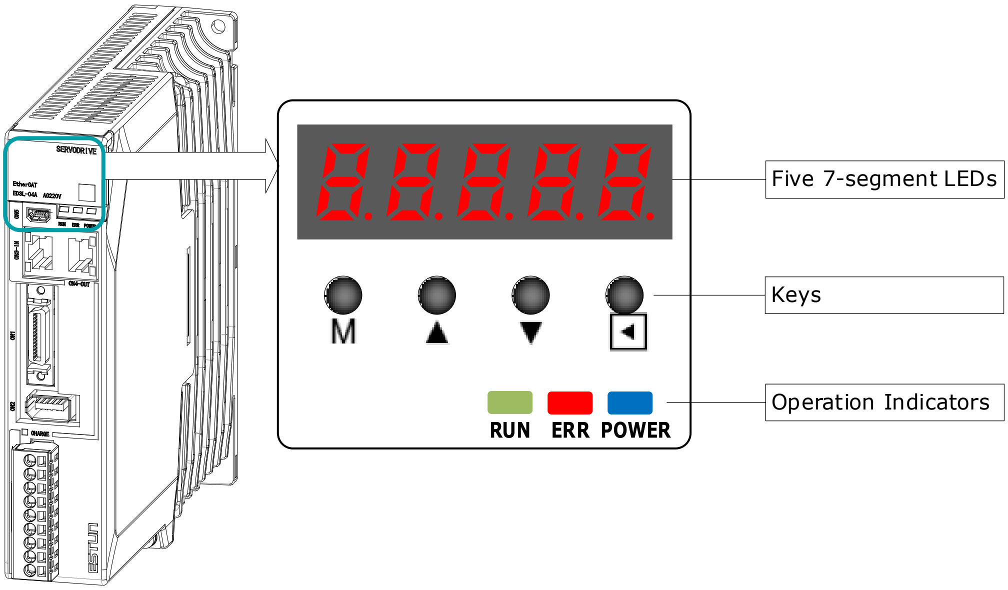
- Use the Panel Operator of the Drive
- Use the ESView V4 (Recommended)

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



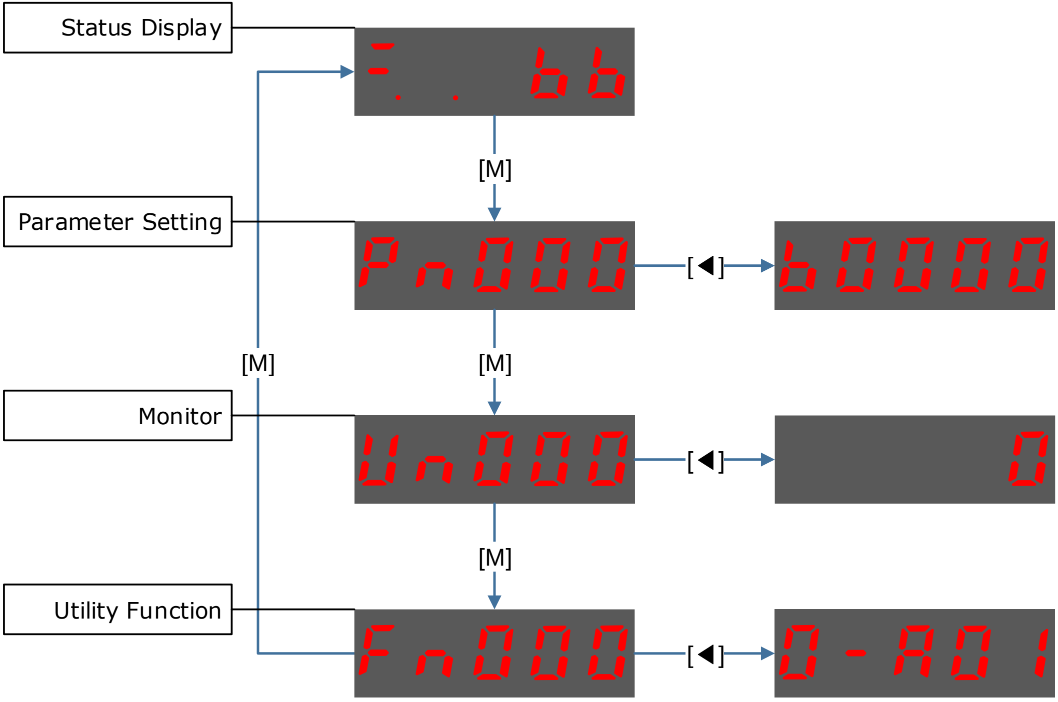
The names and functions of the keys on the Panel Operator are as follows.

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

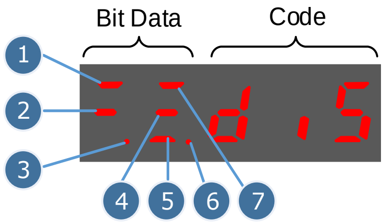


4.1.3 Status Display Mode

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 12 Parameters.

Function Parameters Setting

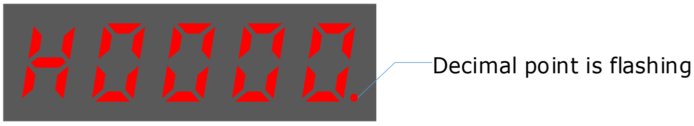
The example below shows how to change parameter Pn003 (Application Function Selections 3) from **0000** to **1032**.

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.

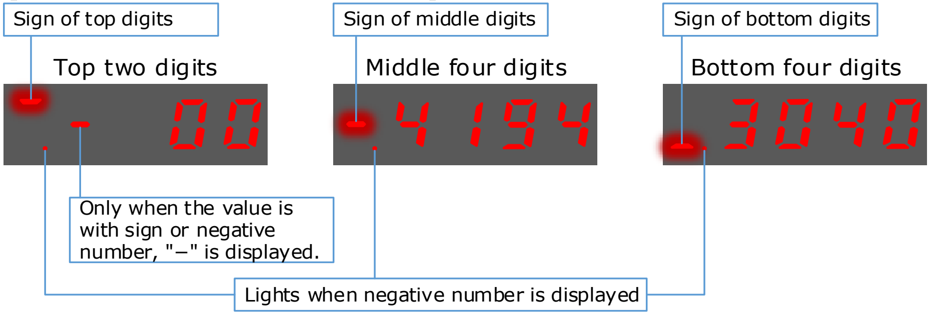
Step 4 Press [▲] key or [▼] key to change the value to 00085.
Press and hold [▲] key or [▼] key to jump the setting value quickly.

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.

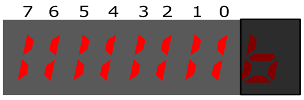
----End

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)

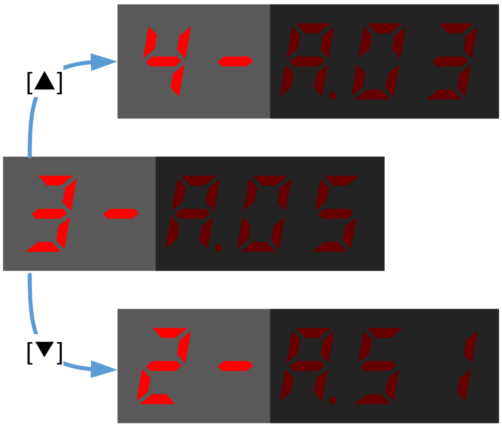
The alarm trace data display can display up to ten previously occurred alarms. The following are the steps to display the alarm trace data.

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)

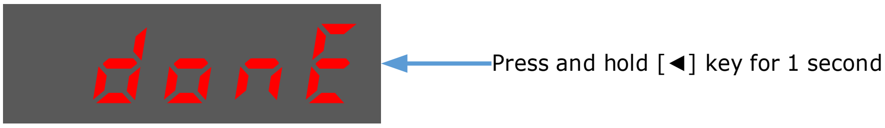
The following are the steps to initialize parameter settings.

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 9.3.3 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.

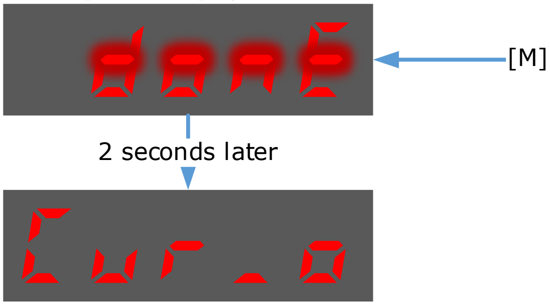
The following are the steps to execute the automatic offset adjustment.

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

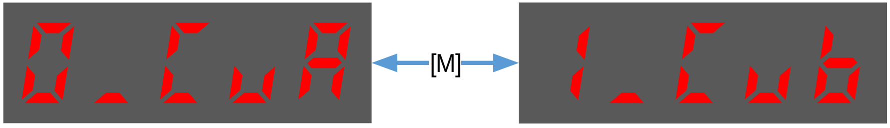
- Please carefully execute the manual offset-adjustment, in case worsen the characteristics of the Motor.
- When executing the manual offset-adjustment, run the Motor at a speed of approximately 100 rpm, and adjust the phase-U and phase-V offsets alternately several times until the torque ripple is minimized.

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

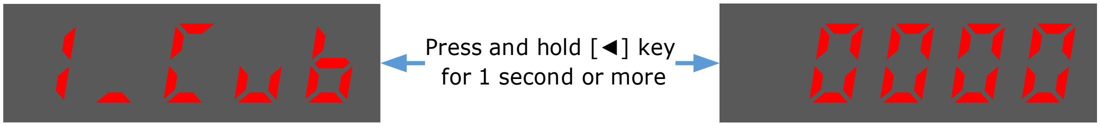
Step 2 Press [▲] key or [▼] key to select the function number Fn006.

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

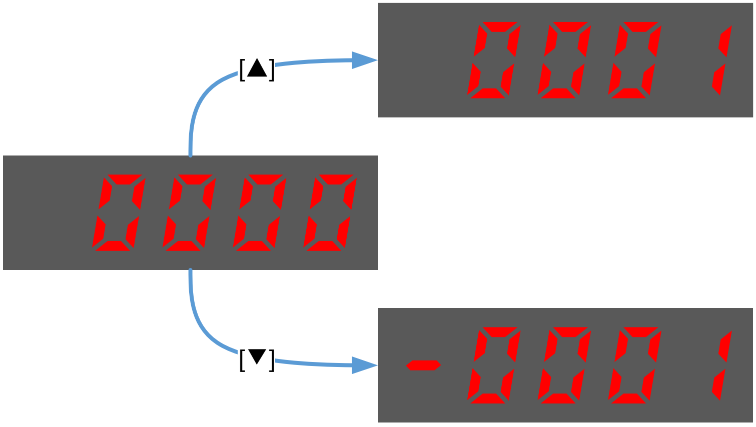
Step 4 Press [**M**] key for switching the display between 0_CuA (phase-U) and 1_Cub (phase-V).



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)

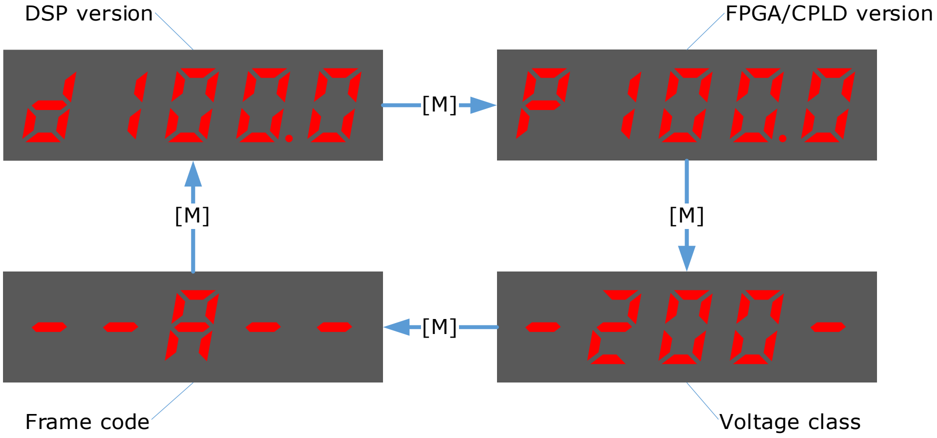
The following are the steps to display the software versions.

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 10.7.1 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 10.3.2 Auto-Tuning Tool.

Fn018 (PJOG operation)

This utility function often used for trial operation, refers to the section 9.5 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.

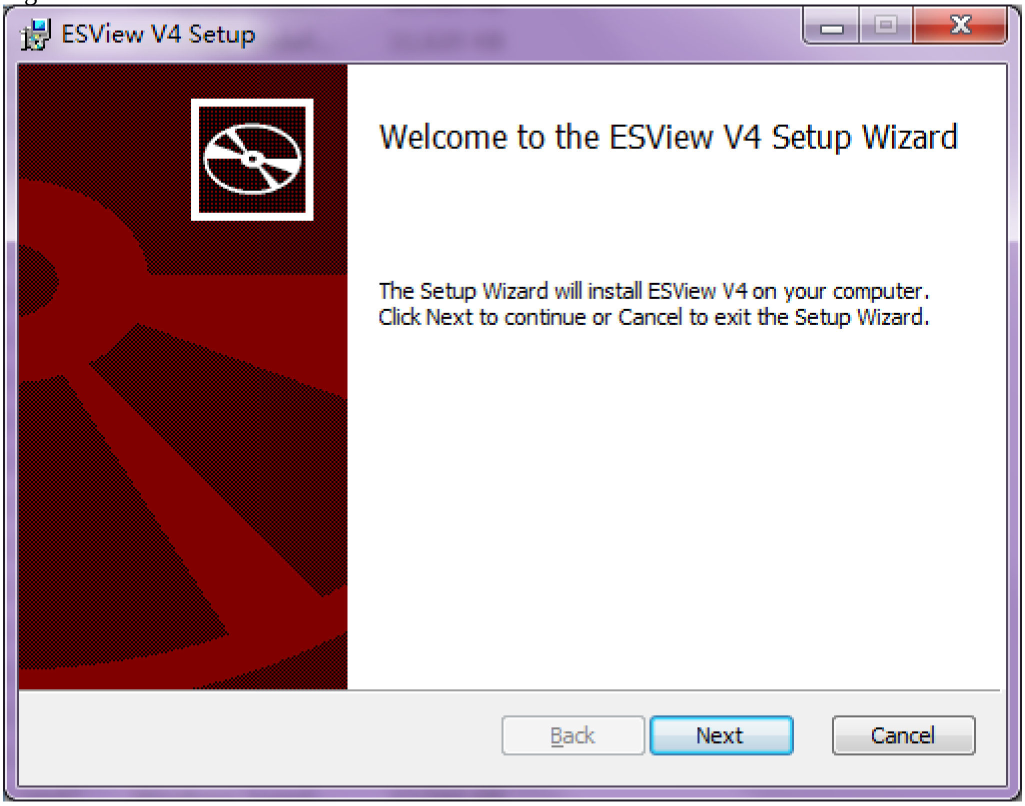
Install Software

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



Welcome to the ESView V4 Setup Wizard

The Setup Wizard will install ESView V4 on your computer. Click Next to continue or Cancel to exit the Setup Wizard.

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.

IMPORTANT

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.

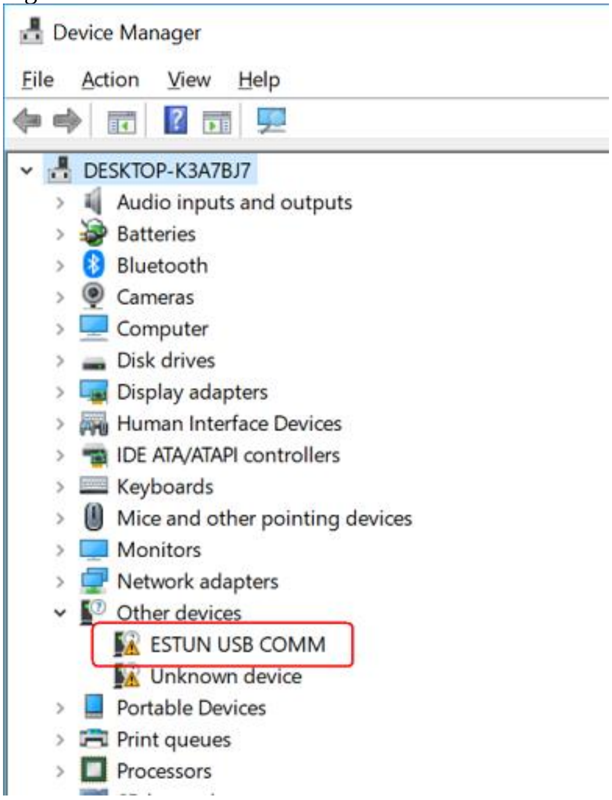
Step 2 Open the main directory of ESView V4 software (default location is *C:\ESView V4*), and extract the **USB Drivers.rar** compressed file to an appropriate directory of your PC.

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.

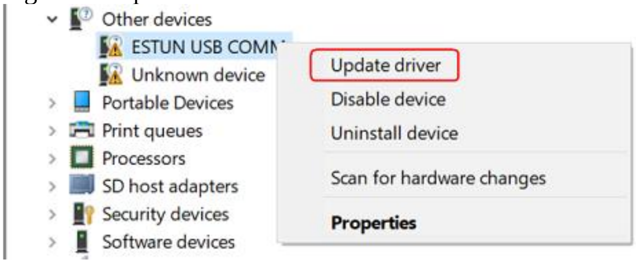
Step 4 An exclamatory mark attaches to the option **Other devices** > **ESTUN USB COMM** in **Device Manager** window, which indicates an error occurs in the driver and needs to update, as shown in Figure 4-4.

Figure 4-4 An error occurs in the driver



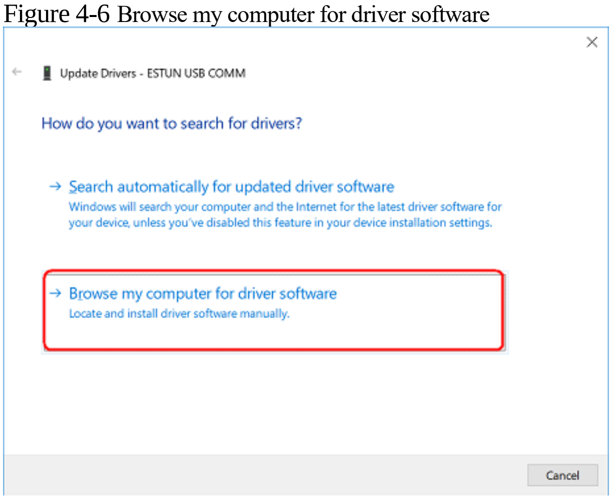
Step 5 Right-click **ESTUN USB COMM**, and select **Update driver** on the pop-up menu.

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



How do you want to search for drivers?

→ Search automatically for updated driver software

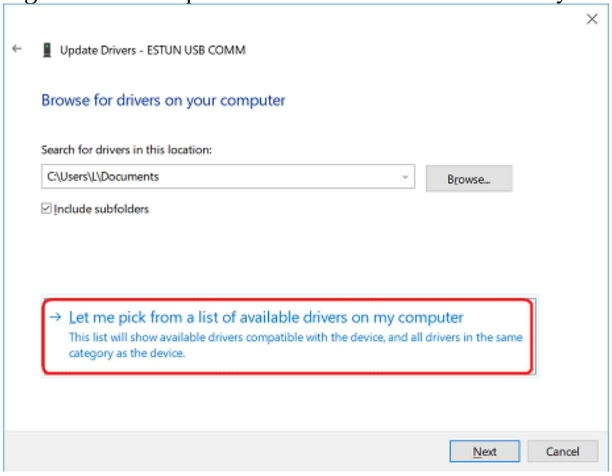
Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings.

→ Browse my computer for driver software

Locate and install driver software manually.

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



Update Drivers - ESTUN USB COMM

Browse for drivers on your computer

Search for drivers in this location:

C:\Users\L\Documents

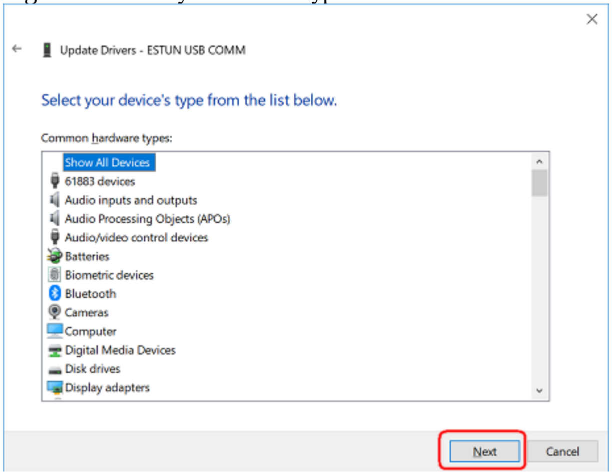
☑ Include subfolders

→ Let me pick from a list of available drivers on my computer

This list will show available drivers compatible with the device, and all drivers in the same category as the device.

Step 8 Click Next.

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



Update Drivers - ESTUN USB COMM

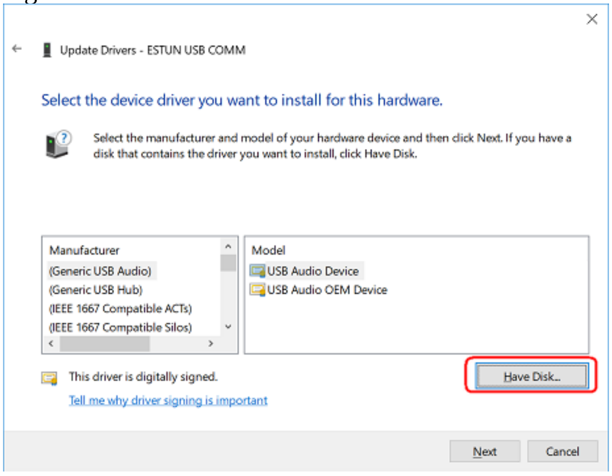
Select your device's type from the list below.

Common hardware types:

- Show All Devices
- 61883 devices
- Audio inputs and outputs
- Audio Processing Objects (APOs)
- Audio/video control devices
- Batteries
- Biometric devices
- Bluetooth
- Cameras
- Computer
- Digital Media Devices
- Disk drives
- Display adapters

Step 9 Click **Have Disk**.

Figure 4-9 Have Disk



Update Drivers - ESTUN USB COMM

Select the device driver you want to install for this hardware.

Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.

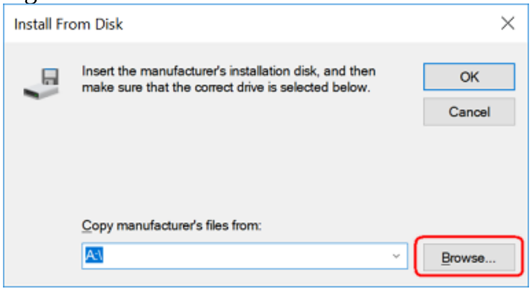
Manufacturer	Model
(Generic USB Audio)	USB Audio Device
(Generic USB Hub)	USB Audio OEM Device
(IEEE 1667 Compatible ACTs)	
(IEEE 1667 Compatible Silos)	

This driver is digitally signed.

Tell me why driver signing is important

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

Figure 4-10 Install From Disk



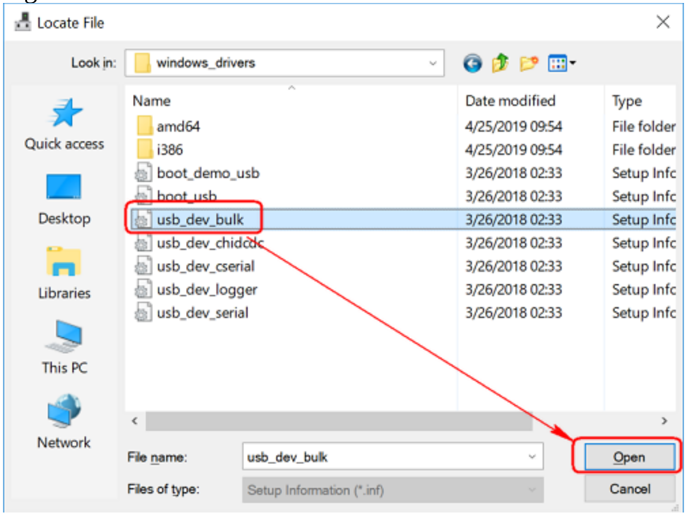
Insert the manufacturer's installation disk, and then make sure that the correct drive is selected below.

Copy manufacturer's files from: A:\

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



Look in: windows_drivers

Name	Date modified	Type
amd64	4/25/2019 09:54	File folder
i386	4/25/2019 09:54	File folder
boot_demo_usb	3/26/2018 02:33	Setup Infc
boot_usb	3/26/2018 02:33	Setup Infc
usb_dev_bulk	3/26/2018 02:33	Setup Infc
usb_dev_chidcdc	3/26/2018 02:33	Setup Infc
usb_dev_cserial	3/26/2018 02:33	Setup Infc
usb_dev_logger	3/26/2018 02:33	Setup Infc
usb_dev_serial	3/26/2018 02:33	Setup Infc

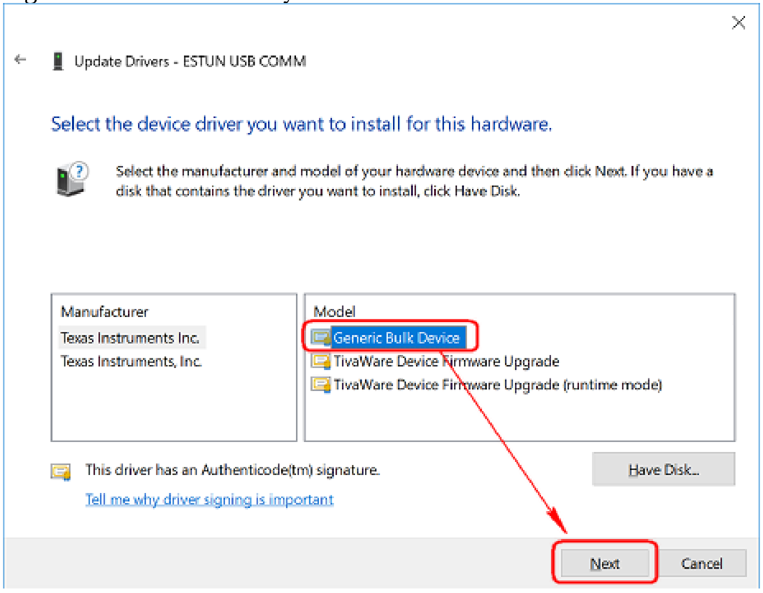
File name: usb_dev_bulk

Files of type: Setup Information (*.inf)

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



Select the device driver you want to install for this hardware.

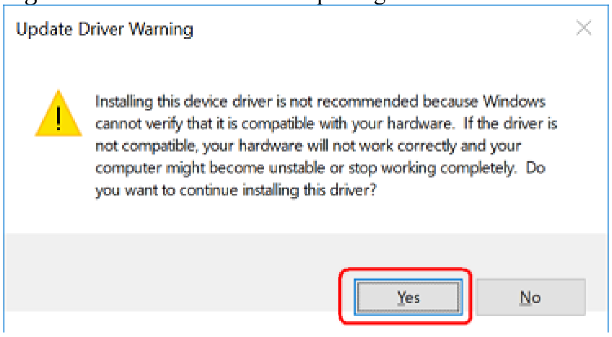
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.

Manufacturer	Model
Texas Instruments Inc.	Generic Bulk Device
Texas Instruments, Inc	TivaWare Device Firmware Upgrade
	TivaWare Device Firmware Upgrade (runtime mode)

This driver has an Authenticode(tm) signature.

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

Figure 4-13 Confirm the driver updating

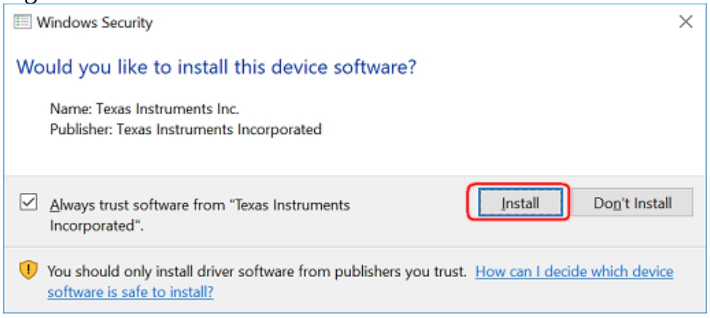


Update Driver Warning

Installing this device driver is not recommended because Windows cannot verify that it is compatible with your hardware. If the driver is not compatible, your hardware will not work correctly and your computer might become unstable or stop working completely. Do you want to continue installing this driver?

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

Figure 4-14 Confirm the installation



Windows Security

Would you like to install this device software?

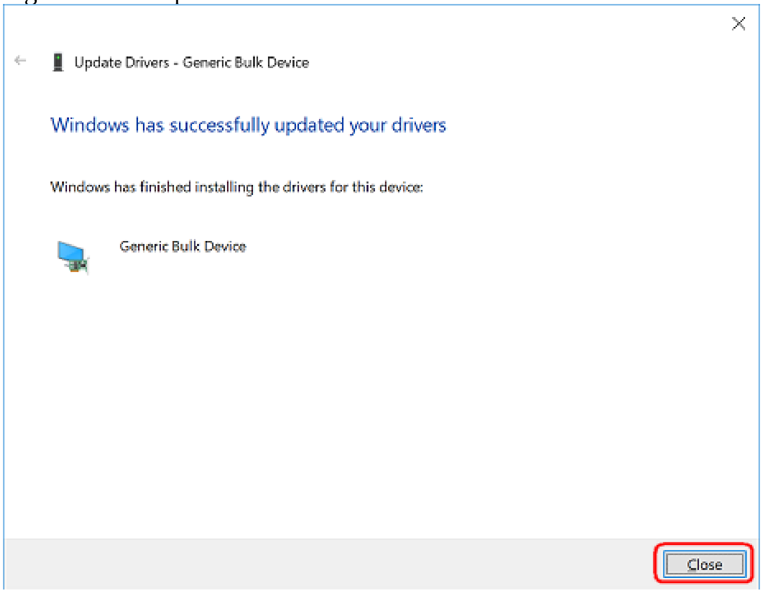
Name: Texas Instruments Inc.
Publisher: Texas Instruments Incorporated

☑ Always trust software from "Texas Instruments Incorporated".

You should only install driver software from publishers you trust. How can I decide which device software is safe to install?

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



Update Drivers - Generic Bulk Device

Windows has successfully updated your drivers

Windows has finished installing the drivers for this device:

Generic Bulk Device

----End

4.2.2 Start ESView V4

Online Operation

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.

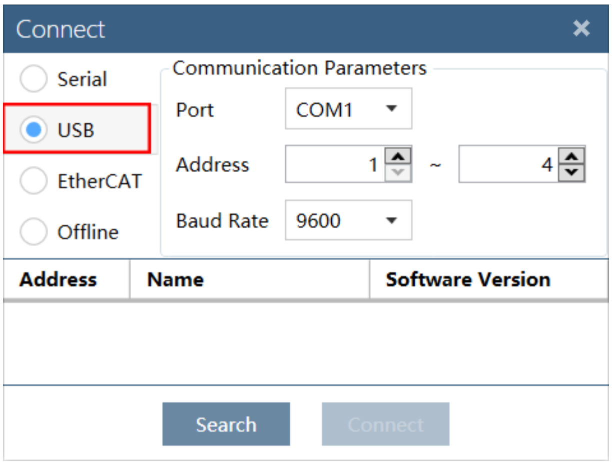
You need to connect the Drive to the PC by using the USB connection cable before the online operation.

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.

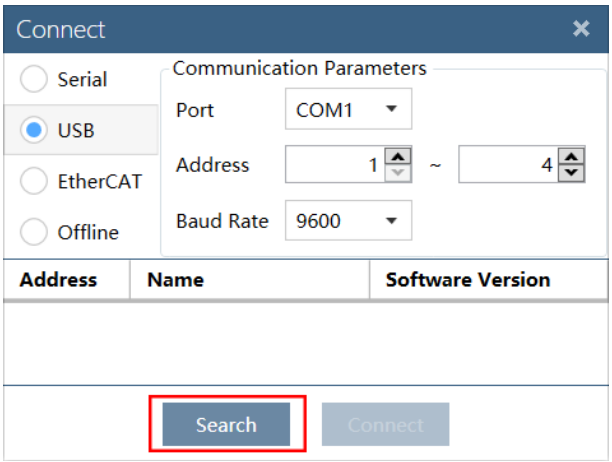
Step 3 The **Connect** dialog box will be displayed.
If you had started *ESView V4*, select **Home** > **Connect** in the **Menu** Bar.

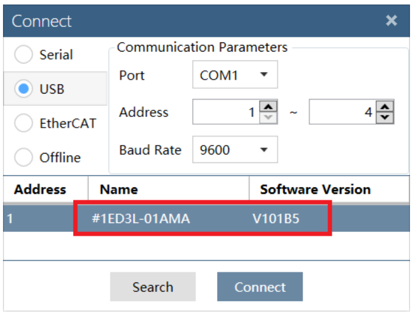
Step 4 Select **USB**.



Step 5 Click **Search**.

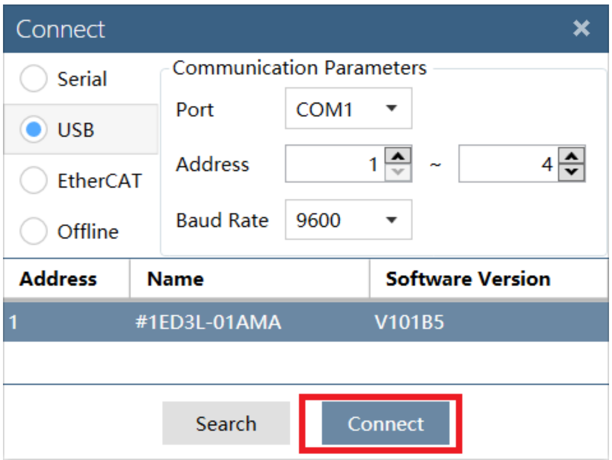
Step 6 Select the found device.





Address	Name	Software Version
1	#1ED3L-01AMA	V101B5

Step 7 Click **Connect**.



Connect

○ Serial
● USB
○ EtherCAT
○ Offline

Communication Parameters

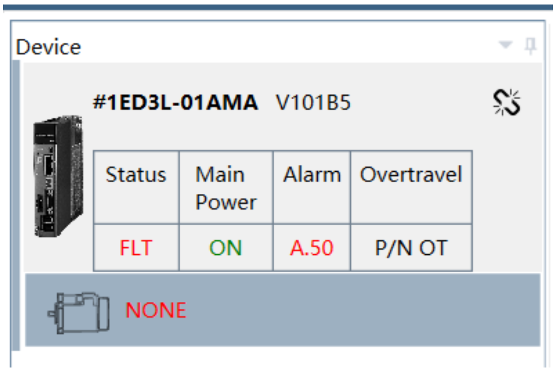
Port: COM1

Address: 1 ~ 4

Baud Rate: 9600

Address	Name	Software Version
1	#1ED3L-01AMA	V101B5

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



Device

#1ED3L-01AMA V101B5

Status	Main Power	Alarm	Overtravel
FLT	ON	A.50	P/N OT

NONE

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

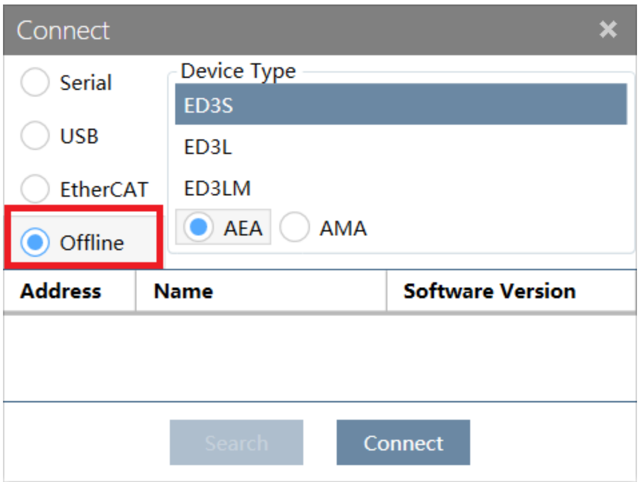
In offline operation, users do not need to connect any equipment, can perform oscilloscope, FFT, mechanical analysis and other image operations.

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.

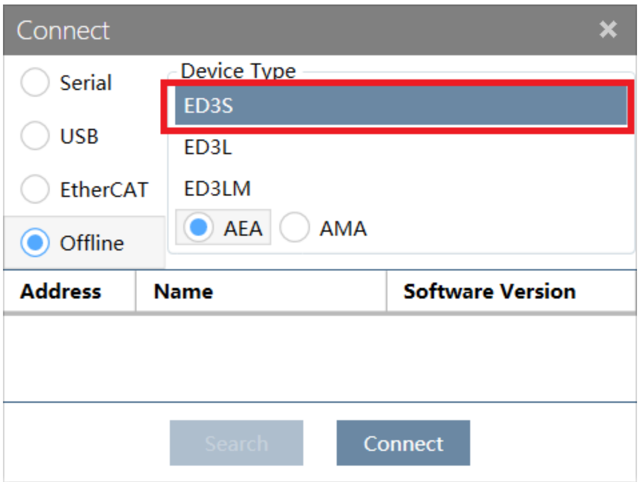
Step 2 The **Connect** dialog box will be displayed.
If you had started *ESView V4*, select **Home** > **Connect** in the **Menu** Bar.

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.

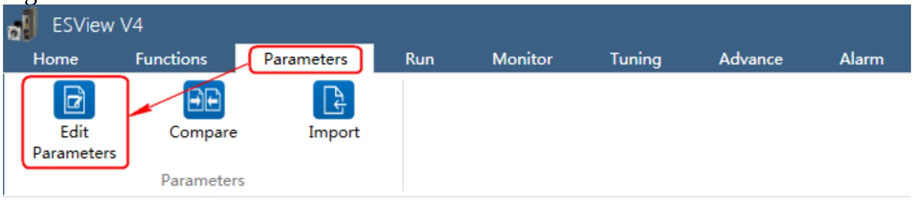
----End

4.2.3 Edit Parameters

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

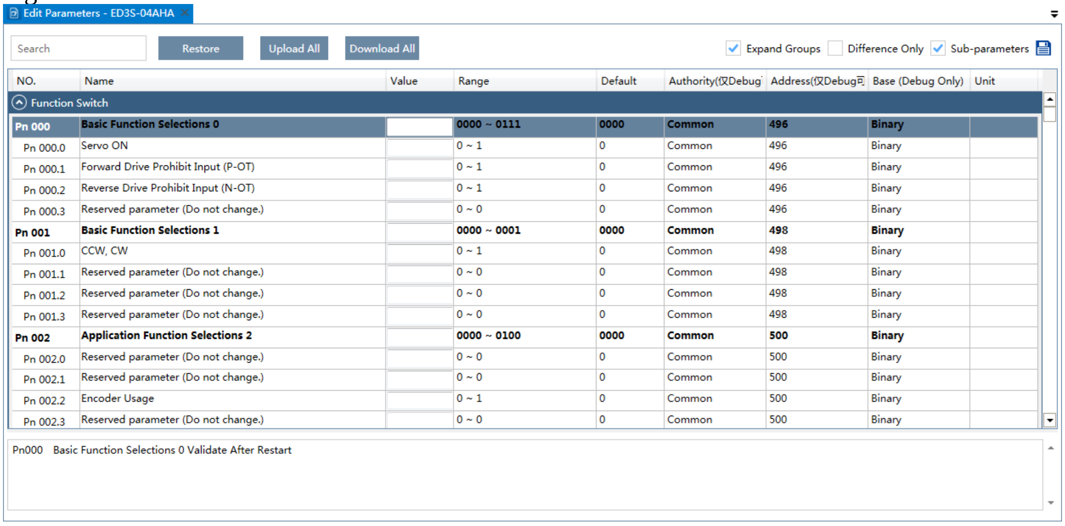
Step 1 Select **Parameters** > **Edit Parameters** in the **Menu Bar** of the *ESView V4* main windows.

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



NO.	Name	Value	Range	Default	Authority(仅Debug	Address(仅Debug可	Base (Debug Only)	Unit
Function Switch								
Pn 000	**Basic Function Selections 0**		**0000 ~ 0111**	**0000**	**Common**	**496**	**Binary**	
Pn 000.0	Servo ON		0 ~ 1	0	Common	496	Binary	
Pn 000.1	Forward Drive Prohibit Input (P-OT)		0 ~ 1	0	Common	496	Binary	
Pn 000.2	Reverse Drive Prohibit Input (N-OT)		0 ~ 1	0	Common	496	Binary	
Pn 000.3	Reserved parameter (Do not change.)		0 ~ 0	0	Common	496	Binary	
Pn 001	**Basic Function Selections 1**		**0000 ~ 0001**	**0000**	**Common**	**498**	**Binary**	
Pn 001.0	CCW, CW		0 ~ 1	0	Common	498	Binary	
Pn 001.1	Reserved parameter (Do not change.)		0 ~ 0	0	Common	498	Binary	
Pn 001.2	Reserved parameter (Do not change.)		0 ~ 0	0	Common	498	Binary	
Pn 001.3	Reserved parameter (Do not change.)		0 ~ 0	0	Common	498	Binary	
Pn 002	**Application Function Selections 2**		**0000 ~ 0100**	**0000**	**Common**	**500**	**Binary**	
Pn 002.0	Reserved parameter (Do not change.)		0 ~ 0	0	Common	500	Binary	
Pn 002.1	Reserved parameter (Do not change.)		0 ~ 0	0	Common	500	Binary	
Pn 002.2	Encoder Usage		0 ~ 1	0	Common	500	Binary	
Pn 002.3	Reserved parameter (Do not change.)		0 ~ 0	0	Common	500	Binary	

Pn000 Basic Function Selections 0 Validate After Restart

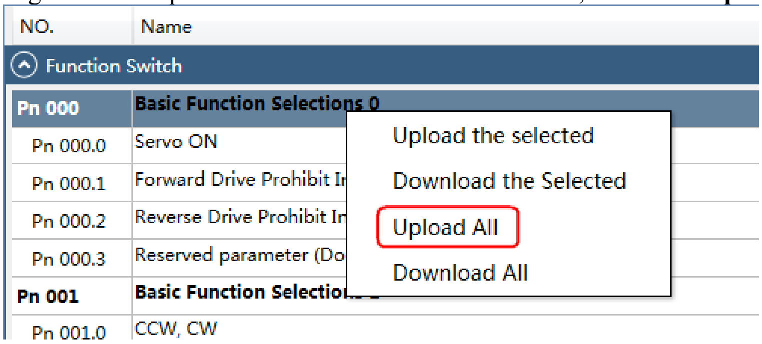
Upload Parameters

- Upload All

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

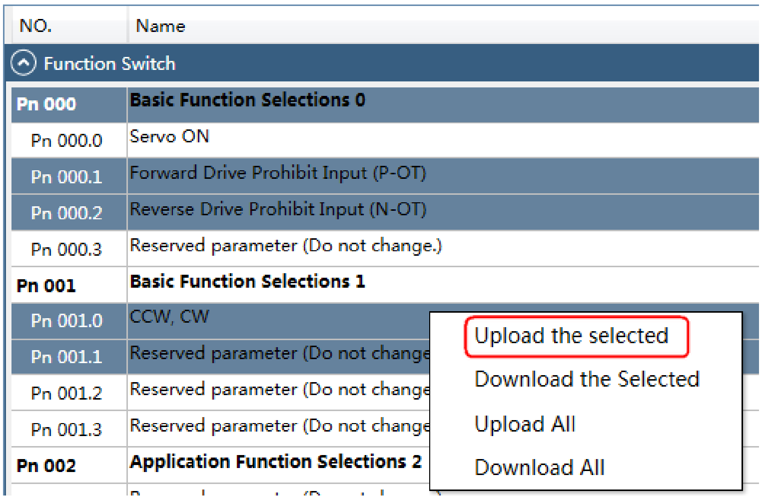
  - Click **Upload All** in the **Edit Parameters** window.

  - 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.



NO.	Name
Function Switch	
Pn 000	**Basic Function Selections 0**
Pn 000.0	Servo ON
Pn 000.1	Forward Drive Prohibit Input (P-OT)
Pn 000.2	Reverse Drive Prohibit Input (N-OT)
Pn 000.3	Reserved parameter (Do not change.)
Pn 001	**Basic Function Selections 1**
Pn 001.0	CCW, CW
Pn 001.1	Reserved parameter (Do not change
Pn 001.2	Reserved parameter (Do not change
Pn 001.3	Reserved parameter (Do not change
Pn 002	**Application Function Selections 2**

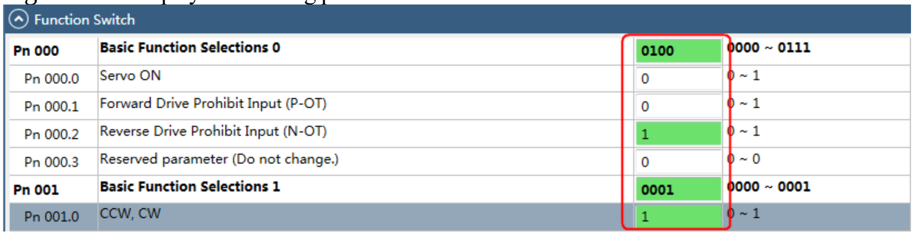
CAUTION

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.

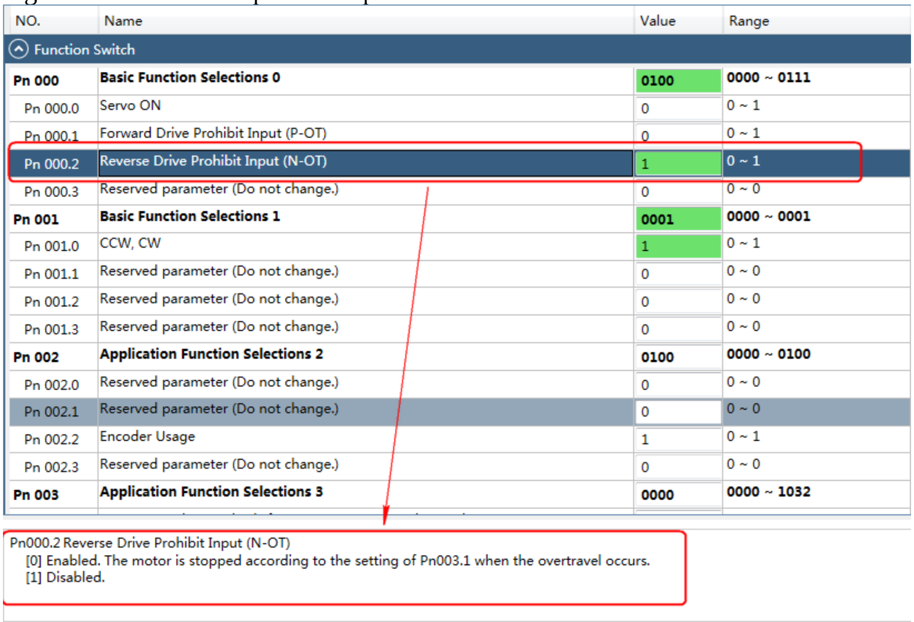
Figure 4-18 Display after editing parameters



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

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.

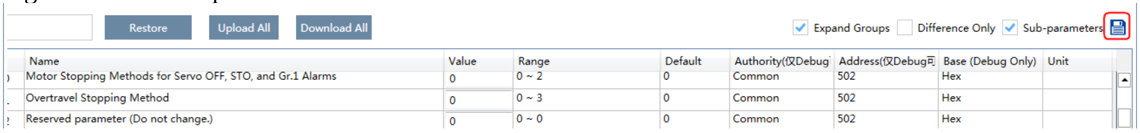
If you want to search multiple items at once, add one or more space between keywords that lists all the parameters that match any of the keywords.

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**.

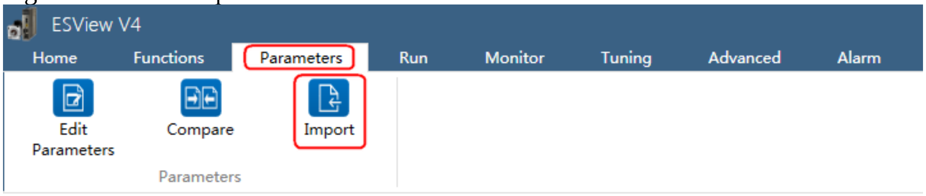
----End

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

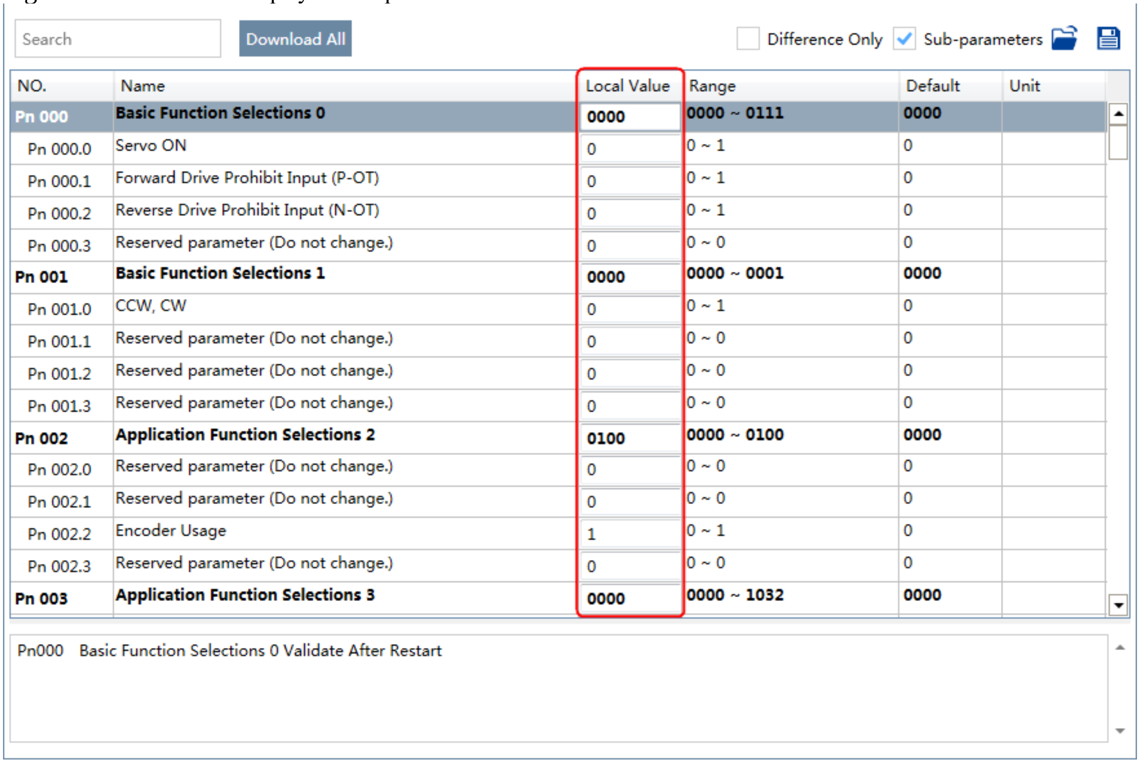


Step 2 Select a proper offline parameter file (**.esvpa*) in the pop-up **Open** dialog box.

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**	

Pn000 Basic Function Selections 0 Validate After Restart

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

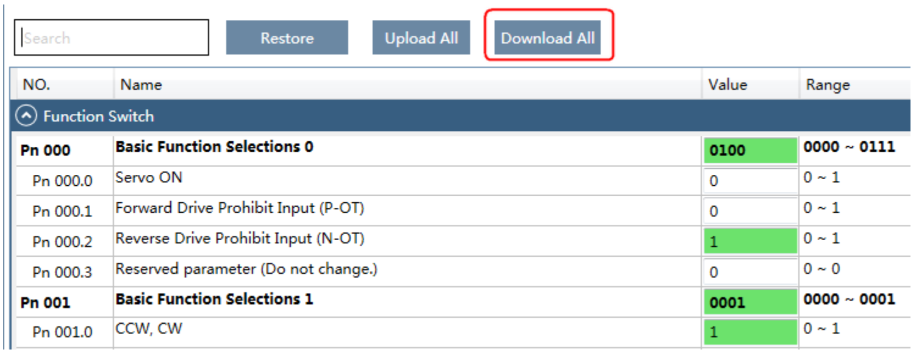
----End

Download Parameters

- Download All

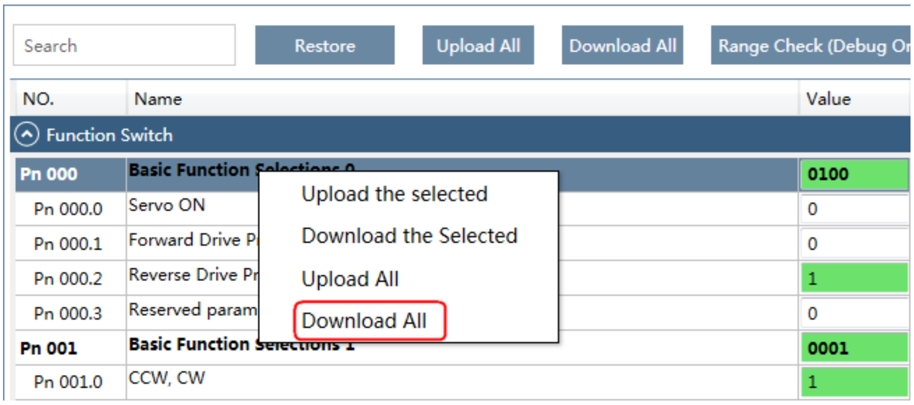
  In order to write all parameters of the parameters list into the Drive, you can:

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



NO.	Name	Value	Range
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

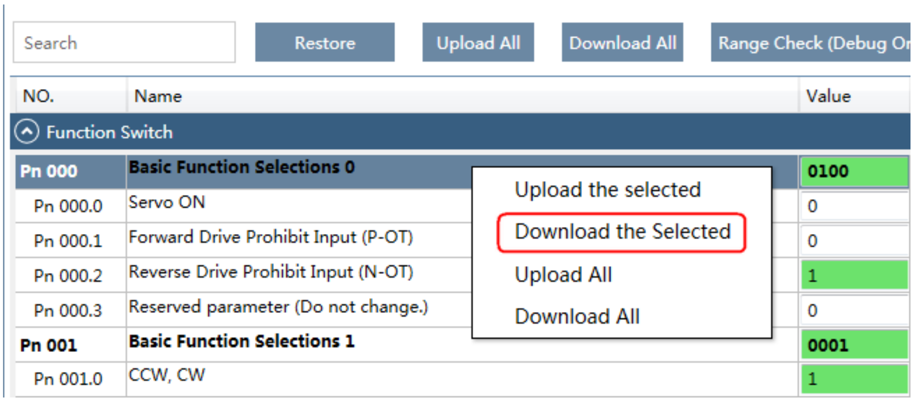
  – Right-click the parameters list where cannot be edited, and select **Download All** in the pop-up menu.



NO.	Name	Value
Pn 000	**Basic Function**	**0100**
Pn 000.0	Servo ON	0
Pn 000.1	Forward Drive P	0
Pn 000.2	Reverse Drive Pr	1
Pn 000.3	Reserved param	0
Pn 001	**Basic Function**	**0001**
Pn 001.0	CCW, CW	1

- 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.



NO.	Name	Value
Pn 000	**Basic Function Selections 0**	**0100**
Pn 000.0	Servo ON	0
Pn 000.1	Forward Drive Prohibit Input (P-OT)	0
Pn 000.2	Reverse Drive Prohibit Input (N-OT)	1
Pn 000.3	Reserved parameter (Do not change.)	0
Pn 001	**Basic Function Selections 1**	**0001**
Pn 001.0	CCW, CW	1

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

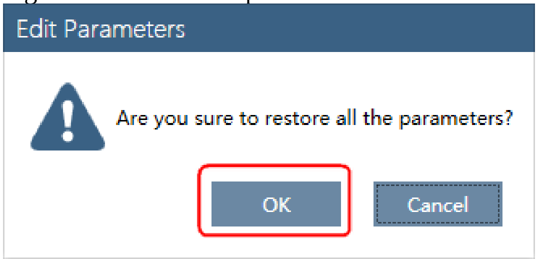
Make sure that it is necessary to restore the parameters as default setting before fulfilling the **Restore Parameters** function.

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


Edit Parameters

Are you sure to restore all the parameters?

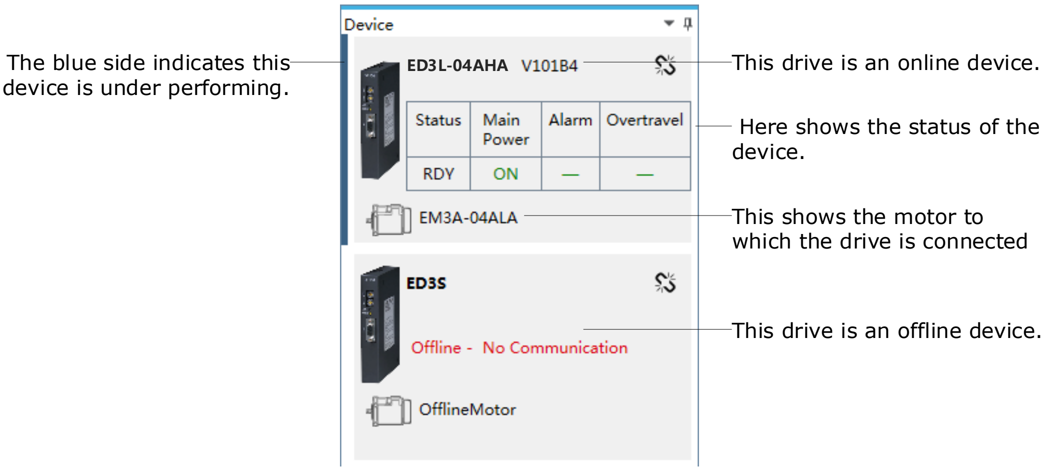
Step 3 *ESView V4* will send the **Restore Parameters** command to the Drive, and then the Drive will execute the **Restore Parameters**.

----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.



Status	Main Power	Alarm	Overtravel
RDY	ON	—	—

The blue side indicates this device is under performing.

This drive is an online device.

Here shows the status of the device.

This shows the motor to which the drive is connected

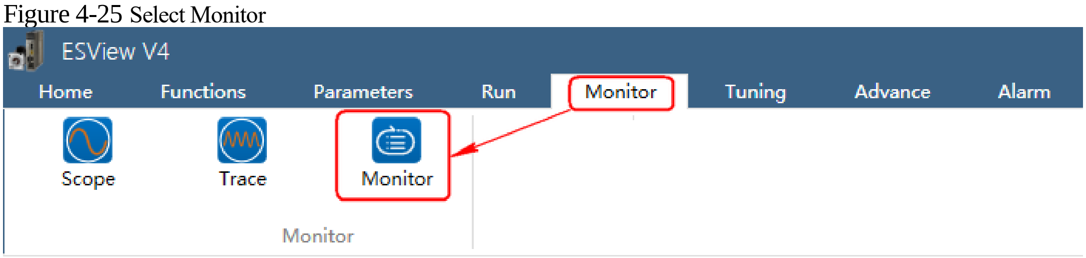
This drive is an offline device.

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

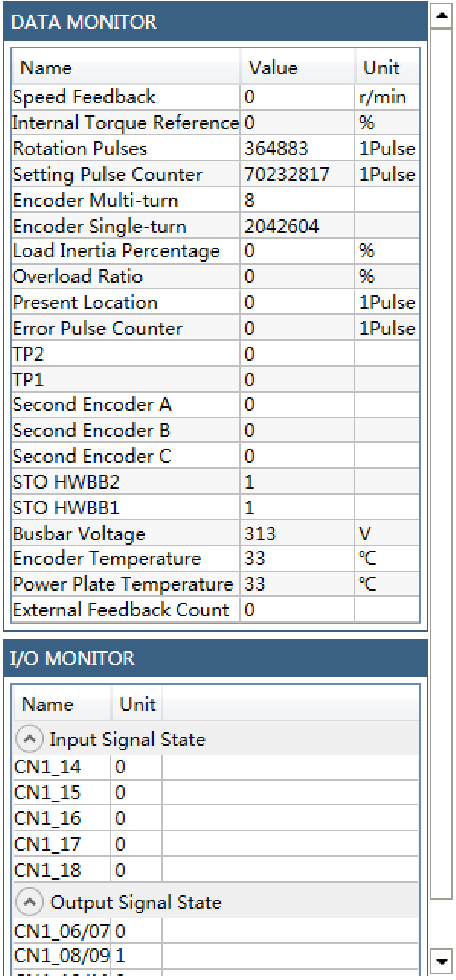


NOTE

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 Introduction

The ED3L Servodrive has the integrated safety function “Safe Torque Off” (STO) according to IEC 61800-5-2, which is equivalent to an uncontrolled stop in accordance with stop category 0 of IEC 60204-1, which can protect people from dangerous movements of the machine and reduce the risk of operator.

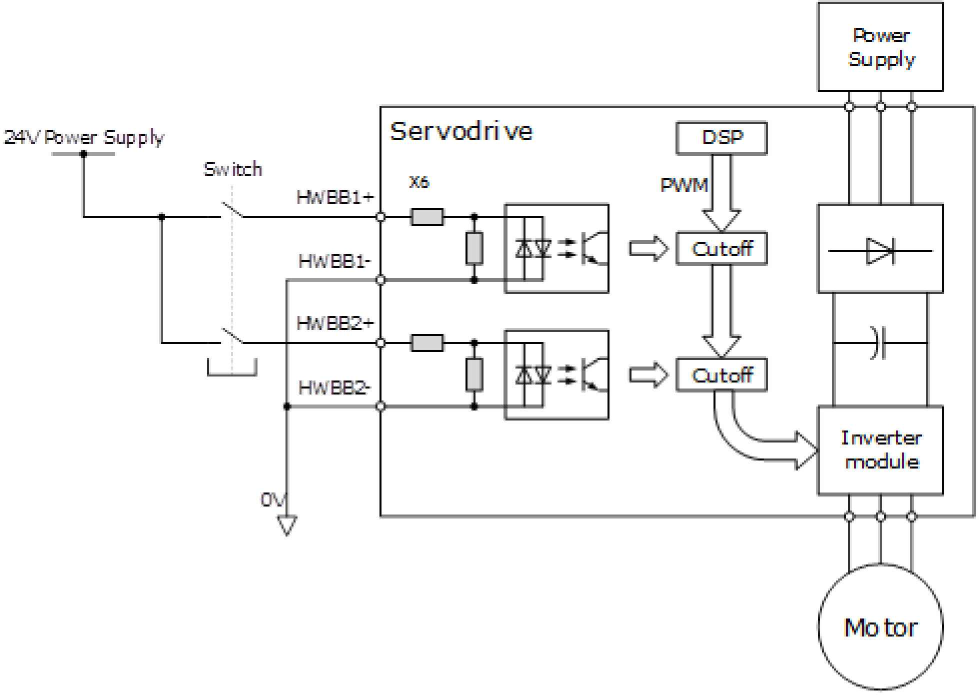
The safe torque off (STO) function is a safety function that shuts the motor current and turns off motor output torque by turning off the driving signal of the servo driver’s internal power transistor, when safety input signal is detected.

However, the safety function STO is not equivalent to the safety function “safe off” of IEC 60204-1, since it does not provide any galvanic insulation. This means that the motor terminals can still have dangerous voltage when in STO state.

5.1.1 Block Diagram

The circuit diagram of safety function is as shown in Figure 5-1.

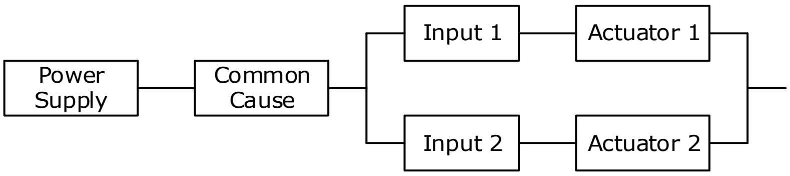
Figure 5-1 Circuit diagram of safety function



Close the Switch for turning ON HWBB1 and HWBB2, PWM signal can be allowed to pass by Cutoff circuit, which is, allowing the torque to output.
Open the Switch for turning OFF HWBB1 or HWBB2, PWM signal cannot be allowed to pass by Cutoff circuit, which is, forbidding the torque to output.

The reliability block diagram of safety function is as shown in Figure 5-2.

Figure 5-2 Reliability block diagram



5.1.2 Functions and Features

The functions or features of STO are as follows:

- The safe state is the hardware shutdown of all PWMs, which make the motor torque off.
- The architecture of the system is 1oo1 + 1oo2.
- The STO works in high demand mode of operation, and systematic capability is SC3.
- The PFH may amount to 0.018% of the complete safety loop, and it is $1.8*10^{-11}$.
- MTTFd of each channel is 3184 years.
- According to IEC 61508-6: 2010, MRT and MTTR are both 0.
- Failure rates are: λ (total failures) = 355.80 fit; λ_S (safe failures) = 283.38 fit;
  λ_{DD} (dangerous detected failures) = 71.69 fit;
  λ_{DU} (dangerous undetected failures) = 0.73 fit.
  [**NOTE**] The unit for failure rates is 1 **fit** (failures in time) = $1*10^{-9}$ h^{-1}, meaning one failure in 10^9 operation hours of the device.
- 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 of STO is no more than 30ms.
  Response time of STO is the time frame from the STO signal is triggered to the PWM signal is removed.
- (*) The diagnose test interval is less than 20ms for HFT=0, and is less than 1h for HFT>0.
- (*) According to IEC 61326-3-1 for the DS definition, the motor will stop within 200ms.
- According to IEC 13849: 2015, the CCF score is better than 65.
- (*) All detected faults will lead to safe state.
- (*) In single channel, diagnostic test interval + fault reaction time < 30ms.

(*) Input signal filtering time definition: when the input signal keeps low level more than 2ms, turns HWBB1 and HWBB2 OFF and the system will enter safe state.

CAUTION

- In order to prevent the accumulation of faults, based on the risk assessment of the machine or device, it is confirmed at a fixed time whether the function is lost.
  Regardless of the system safety level, the safety confirmation test is performed at least once in 20 years. The inspection items mainly include the items (*) added to the above characteristics.

5.1.3 Risk Assessment

The device manufacturer is responsible for the residual risks associated with all risk assessments. The following are residual risks associated with STO functions. ED3L Servodrive is not responsible for any damage or injury caused by residual risks.

WARNING

- Never touch the terminals while the power is on.
  Since the STO function only cuts off the torque output of the motor and does not cut off the physical connection between the drive and the motor, there is a risk of electric shock.
- Use products that have been safety-confirmed or meet safety specifications for parts used on safety circuits.
- Since the STO function can cut off the torque output of the motor, make sure that the servo motor does not move due to external forces.
- Please confirm whether the new product and the previously used product are the same model when replacing the Servodrive.
  Always confirm the performance of the function before running the system.
- Please conduct a risk assessment of the entire machine or device.
- When the power module inside the Servodrive has a short-circuit fault, the motor shaft may turn 0.5 rotations or less.
- Always supply power the STO input signals (HWBB1 and HWBB2) from a same source.
  If the power is supplied separately, the leakage current may cause the STO function to malfunction and unable to cuts off the torque output of the motor.

5.1.4 Alarms

If A30 (STO Disconnected) alarm or A31 (STO Circuit Failure) alarm occurs in the Drive, which means that the STO function circuit may be damaged. The user should troubleshoot to use the STO function again.

Alarm No.	Name	Description
A30	STO Disconnected	HWBB1 or HWBB2 is disconnected for more than 10 seconds. Check the wiring before using the STO function.
A31	STO Circuit Failure	The STO function circuit may be damaged. Please contact Trio or the Authorized Distributor.

5.2 Environmental Conditions

Item	Specification	
Operation	Temperature	Single drive: -5 ℃ to 55 ℃ Multiple drives, flush mounted: -5 ℃ to 40 ℃
	Humidity	5% to 95% RH (with no freezing or condensation)
Storage	Temperature	-20 ℃ to 85 ℃
	Humidity	5% to 95% RH (with no freezing or condensation)
Altitude	≤1000 m (Rated)	
IP	IP20	
Pollution Index	II	

Item	Specification
Overvoltage Category	III
Isolation Voltage	Input to Output: 2.7 kV; Input to Earth: 2.0 kV
Insulation Resistance	50 MΩ or more

⚠ **CAUTION**

- To avoid the risk of crosstalk to signal cables, please segregate the power interface cable from signal cables or state alternative mitigation methods.
- It is not recommended to use the device in public low voltage power supply systems.

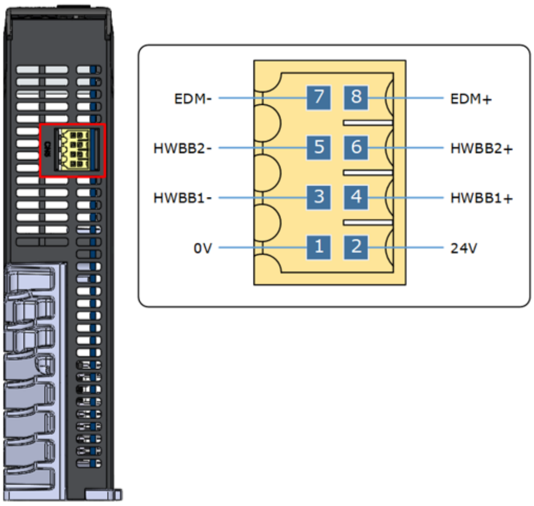
5.2.1 Applicable Standards

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

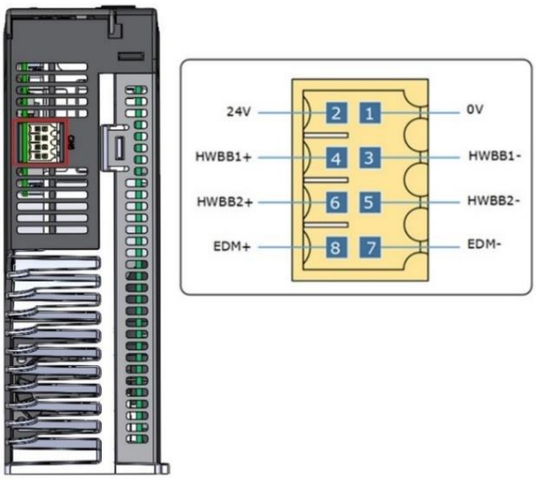
Item	Safety Specification
EMC Directive	IEC 61800-3: 2017 IEC 61000-4: 2017 IEC 61326-3-1: 2017 IEC 61800-5-2: 2016 Illustrate: The environment category is the second environment and the device category is C2.
Low Voltage Directive	EN 61800-5-1: 2007 + AMD1:2017
Functional Safety	IEC 61800-5-2: 2016 IEC 60204-1: 2016 IEC 61508: 2010 IEC 62061: 2015 ISO 13849-1: 2015
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

5.3 Terminals Arrangement (CN6)

Signal Diagram



50W ~ 400W



750W~7.5kW

WARNING

- Please use the PELV/SELV switching power supplying to the IO signal of the STO function.
- The external signal shall meet the Idle-current principle.

Pin	Signal	Name	Function
1	0 V	24 V Power Supply	– (Do not use these pins because they are connected to internal circuits)
2	24 V		
3	HWBB1-	HWBB1 Input	The STO function takes effect when the HWBB1 or the HWBB2 signals is turned OFF.
4	HWBB1+		
5	HWBB2-	HWBB2 Input	
6	HWBB2+		
7	EDM-	External Device Monitor Output	Turns ON when the HWBB1 signal or the HWBB2 signal is turned OFF.
8	EDM+		

Signal Specifications

The input specifications of the HWBB1 signal (CN6-3, CN6-4) and HWBB2 signal (CN6-5, CN6-6) are as follows.

Item	Characteristics	Description
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, CN6-8) output signal are as follows:

Item	Characteristics	Description
Maximum Allowable Voltage	35 V dc	–
Maximum Allowable Current	80 mA dc	–
Maximum ON Voltage Drop	1.0 V	Voltage between EDM+ and EDM- when current is 80 mA
Maximum Delay Time	5 ms	Time from a change in HWBB1 or HWBB2 until a change in EDM

5.4 Function Description

5.4.1 EDM (External Device Monitor)

The EDM (External Device Monitor) signal is used to monitor failures in the STO. Connect the monitor signal as a feedback signal, e.g., to the Safety Function Device.

The relationship among the signals of EDM, HWBB1, and HWBB2 is shown in Table 5-1.

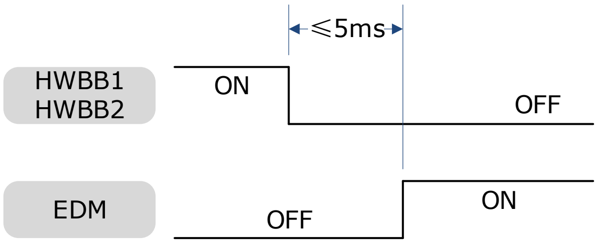
Table 5-1 The relationship among the signals of EDM, HWBB1, and HWBB2

Signal	Logic			
HWBB1	ON	ON	OFF	OFF
HWBB2	ON	OFF	ON	OFF
EDM	OFF	OFF	OFF	ON

WARNING

- The EDM signal is not a safety output. Use it only for monitoring for failures.

If an STO is requested by turning OFF input signals (HWBB1 and HWBB2) when the safety function is operating normally, the EDM output signal will be turned ON within 5 milliseconds.



5.4.2 Safe State

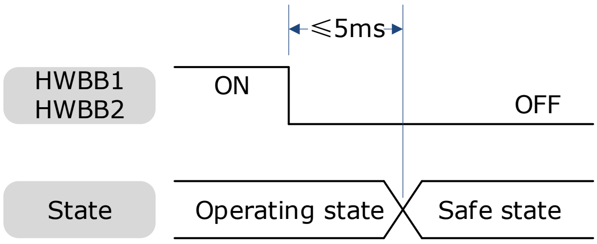
When the STO function takes effect, the Drive enters the safe state and the Panel Operator displays SAF, as is shown below.

The relationship between the State and the signals of HWBB1 and HWBB2 is shown in Table 5-2.

Table 5-2 The relationship between the State and the signals of HWBB1 and HWBB2

Item	Logic			
HWBB1	ON	ON	OFF	OFF
HWBB2	ON	OFF	ON	OFF
State	–	Alarm	Alarm	SAF

Turn OFF input signals (HWBB1 and HWBB2) for taking effect the STO function, the power supplied to the Motor will be cut off within 5 milliseconds.



Safety output signal from the safety controller and safety sensor may include L pulse for self-diagnosis. Make sure the off period of safety input signal less than 1 millisecond, and the safety input circuit does not detect this OFF event.

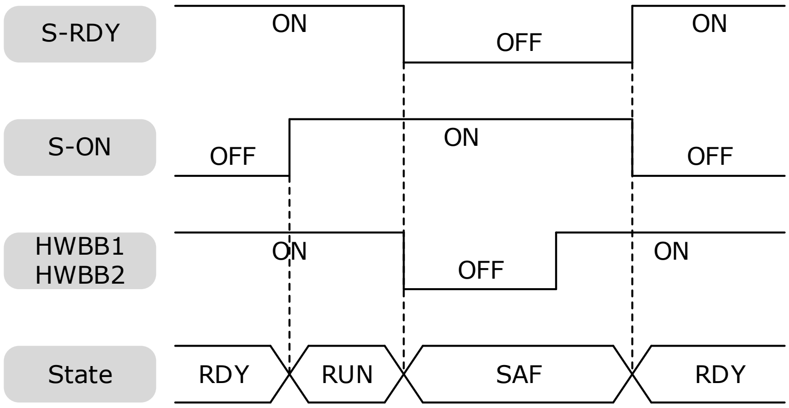
CAUTION

- Conditions for STO function reset is that both HWBB1 and HWBB2 are ON.

5.4.3 S-RDY (Servo Ready Output) Signal

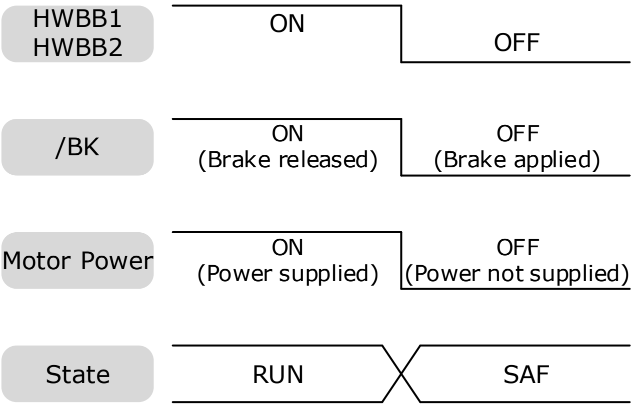
When the Drive is in Safe State, S-RDY (Servo Ready Output) signal is OFF.

When the HWBB1 and the HWBB2 signals are turned ON, and the Servo is OFF, the S-RDY signal will be turned ON, and the Drive will be in Ready State.



5.4.4 /BK (Brake Ouput) Signal

If the STO function takes effect when the HWBB1 or HWBB2 signal is OFF, the /BK (Brake) signal will turn OFF. At that time, the setting in Pn506 (Brake Reference-Servo OFF Delay Time) will be disabled.



5.4.5 Stopping Methods

The Drive will enter the safe state when the STO function takes effect, and the Motor will stop according to the setting of Pn003.0.

Parameter	Setting	Stopping Method	Statue after Stopping	When Enabled
Pn003.0	0	Dynamic Brake	Coasting	After restart
	1	Dynamic Brake	Dynamic Brake	
	2	Coasting	Coasting	

5.4.6 Reset Method for Deviation Counter

The Drive will enter the safe state when the STO function takes effect, and the Deviation Counter will reset according to the setting of Pn004.1.

Parameter	Setting	Reset Method	When Enabled
Pn004.1	0	Reset to zero when Servo is OFF or STO function takes effect.	After restart
	2	Reset to zero when Servo is OFF, or STO function takes effect, or Overtravel is occurred.	

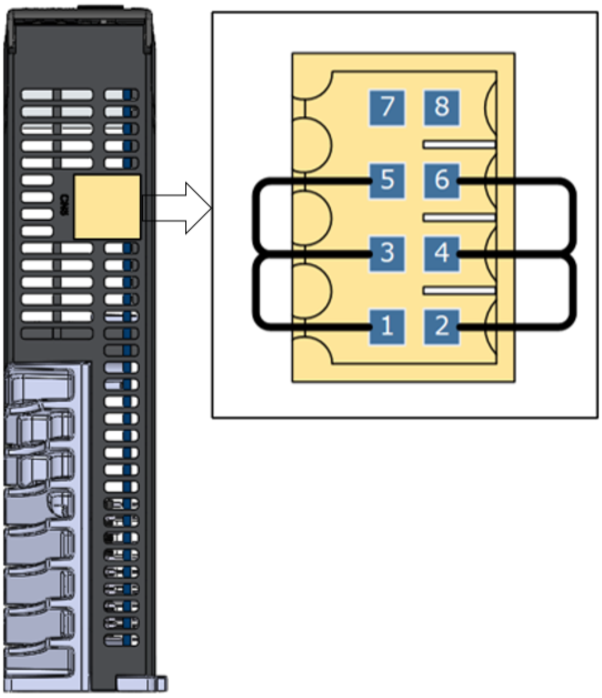
5.5 Safety Function Device Connection

5.5.1 Disconnecting a Safety Function Device

If a safety function device is not connected, keep the Safety Connector plugged into the CN6 port, and the shorting pins on the connector remain in the default state.

WARNING

- In this case, the STO function will be disabled and the Drive will not be able to implement the safety function by the Safety Function Device.



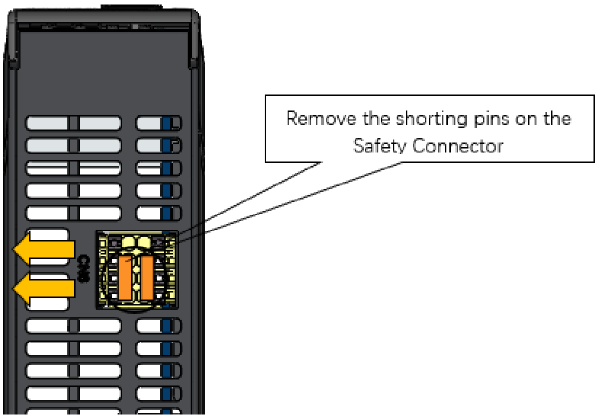
CAUTION

- If the shorting pins are removed and the Safety Function Device is not connected, the Drive will enter safe state and not supply the current to the Motor, so that the Motor cannot output torque. At that time, the Panel Operator will display **SAF**.

5.5.1 Connecting a Safety Function Device

Step 1 Remove the shorting pins on the Safety Connector as shown in Figure 5-3.

Figure 5-3 Remove the shorting pins

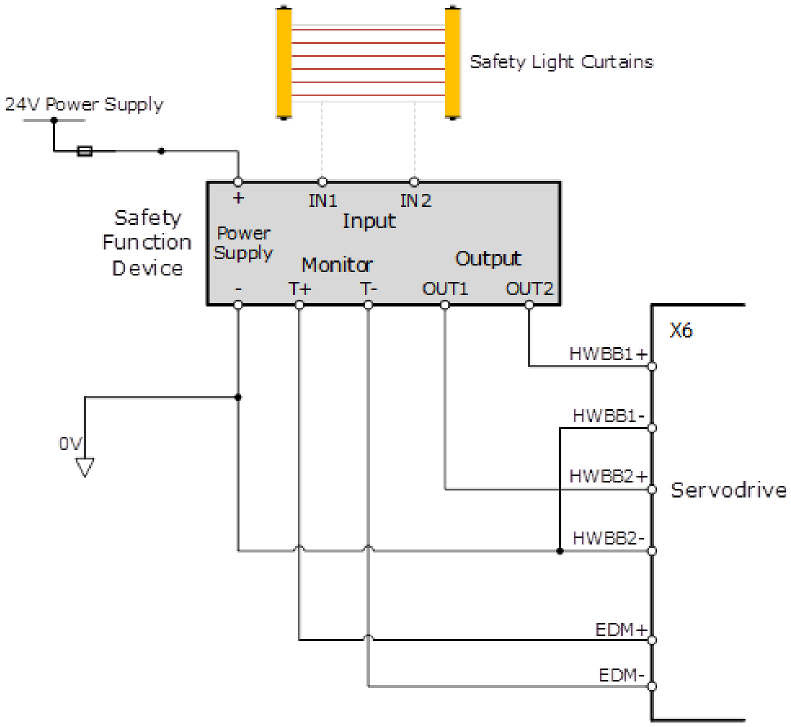


Remove the shorting pins on the Safety Connector

Step 2 Wiring the Safety Function Device

Connect the Safety Function Device to the CN6port according to the wiring example shown in Figure 5-4.

Figure 5-4 Wiring example for Safety Function Device



Use armored cables to protect the HWBB1+ and HWBB2+ from short circuits.
Use the EDM signal at the common emitter output, making sure that the current flows from EDM+ to EDM-.

When the safety grating is blocked, the HWBB1 and HWBB2 signals turn OFF, and the EDM signal is turned ON to enter the Safe State.

When the blocking of the safety grating is released, the HWBB1 and HWBB2 signals turn ON, and the Drive will enter the Operating State.

Step 3 Validating Safety Functions

When the system is commissioned, or maintenance operations are performed, or a Drive is replaced re-validation tests must be run to check the operation of the STO function. It is recommended that the results of any conformation testing are kept as a record for future reference.

- When the HWBB1 and HWBB2 signals turn OFF, confirm that the Panel Operator displays SAF and that the Motor does not operate.
- Monitor the ON/OFF status of the HWBB1 and HWBB2 signals.

If the ON/OFF status of the signals do not coincide with the display, the following must be considered:

- An error in the external device.
- Disconnection of the external wiring, short-circuiting in the external wiring.
- A failure in the Drive.

Find the cause and correct the problem.

Troubleshooting

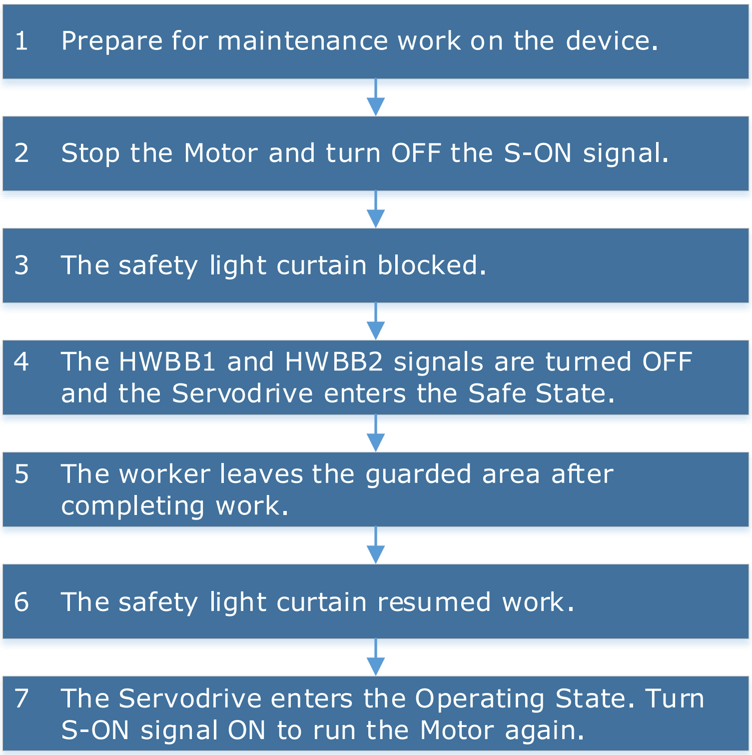
If any one of the input signal HWBB1 or HWBB2 turns OFF, the Drive will enter the Safe State. However, if other signal is still ON for more than 10 seconds, an alarm A30 (STO Disconnected) will occur. At that time, the following must be considered:

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

Find the cause and correct the problem.

5.6 Procedure

Taking the wiring of the Safety Function Device shown in Figure 5-4 as an example, use the STO function as follows.



1 Prepare for maintenance work on the device.

2 Stop the Motor and turn OFF the S-ON signal.

3 The safety light curtain blocked.

4 The HWBB1 and HWBB2 signals are turned OFF and the Servodrive enters the Safe State.

5 The worker leaves the guarded area after completing work.

6 The safety light curtain resumed work.

7 The Servodrive enters the Operating State. Turn S-ON signal ON to run the Motor again.

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.	
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.

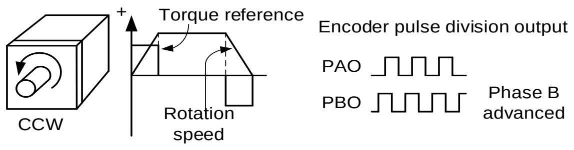
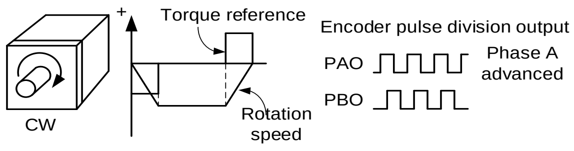
warn

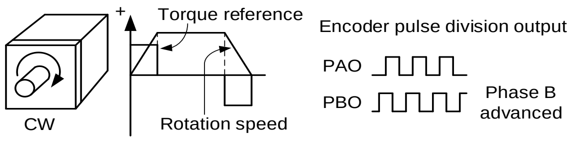
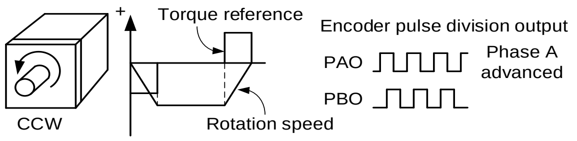
- When using AC power supply and DC power supply to connect to the driver, please make a terminal connection.
  Ac power supply should be connected to the L1/L2/L3 terminals and L1C/L2C terminals of the driver.
- DC power supply should be connected to the B1/decile terminal and one terminal and L1C/L2C 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	
		Reverse Reference	

Parameter	Setting	Reference	Diagram
	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

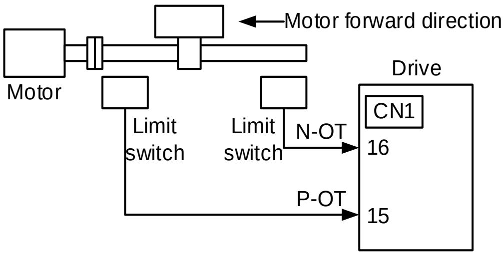
Overtravel is a safety function of the Drive that forces the Motor to stop in response to a signal input from a limit switch that is activated when a moving part of the machine exceeds the safe range of movement.

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 Settings for E-STOP

The E-Stop function refers to the function of forcing the stop of the servo motor by signals from the host device or external device。When using forced stop, the assignment of the forced stop input (E-Stop) signal is required（Pn509=n.XXXX/Pn510=n.□□□X）。There are three types of motor stop modes: DB brake stop, free stop and deceleration stop。

⚠ Attention

Do not assign 0xA to the input signal port without using the E-Stop function. Otherwise, please perform the shutdown through the E-Stop signal, and you cannot perform Quick Stop to the shutdown by the control word 0x6040 object.

Signal distribution

Class	Signal name	Connector pin number	Signal status	Meaning
Input	E-STOP	Allocate on demand	ON	The device is functioning properly
			OFF	The device is forced to stop

Note: For more information about THE DISTRIBUTION OF IO signals, see "6.8 IO Signal Assignment".

Force Stop feature selection of stop methods

The stop method of the forced stop function is selected by Pn003.2 (the stop method at the time of forced stop).

Number	Name	Range	Unit	Default	Illustrate	When to take effect
Pn003.2	The stop method when a stop is forced	0～1	-	0	[0] The motor is decelerated according to bus 402 protocol 605A and 6084/6085 objects [1] The motor is stopped according to the stop mode of the Pn327 and the deceleration time of the Pn328	Reboot

When setting servo OFF and strong stop

When the servo motor is stopped by setting the deceleration time of the servo motor, the stop mode (Pn327) and the deceleration time (Pn328) at the time of servo OFF and forced stop are set.

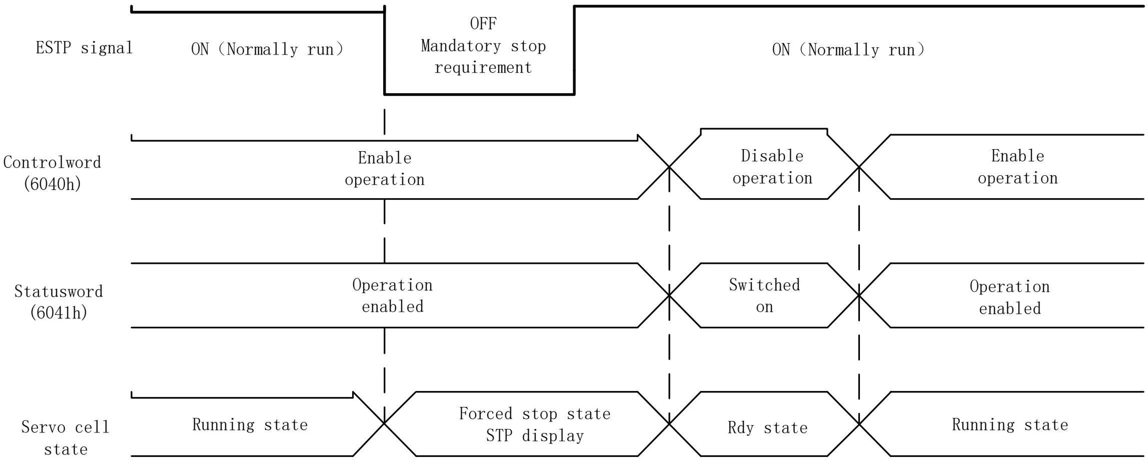
Number	Name	Range	Unit	Default	Illustrate	When to take effect
Pn327	How to stop when a stop is forced	0～6	-	0	[0] Set to 0 in line with 605A [1] Set to 1 in line with 605A [2] Set to 2 in line with 605A [3] Set to 0 in line with 605A [4] Set to 0 in line with 605A [5] Set to 5 in line with 605A [6] Set to 6 in line with 605A	Immediately
Pn328	Deceleration time at forced stop	0～65535	ms	1000	Under the stop command, the time required to accelerate and decelerate 1000rpm.	Immediately

The method from forced stop recovery

The recovery method for stopping operation by forced stop input (E-STOP) signal is as follows.

If the servo ON command is received when the E-STOP signal IS OFF, the forced stop state is maintained even if the E-STOP signal is set to ON.

Enter the servo OFF command (Disable Operation command), enter the rdy state, please enter the servo ON command (Enable Operation command) again.



6.5 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.

6.5.1 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	

6.5.2 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).

6.5.3 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.

6.5.4 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.

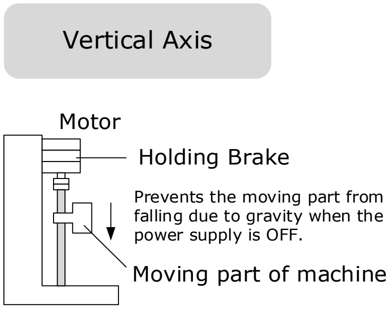
6.6 Holding Brake

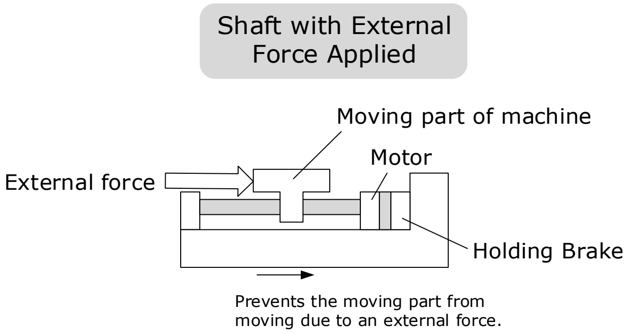
6.6.1 Function Description

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.



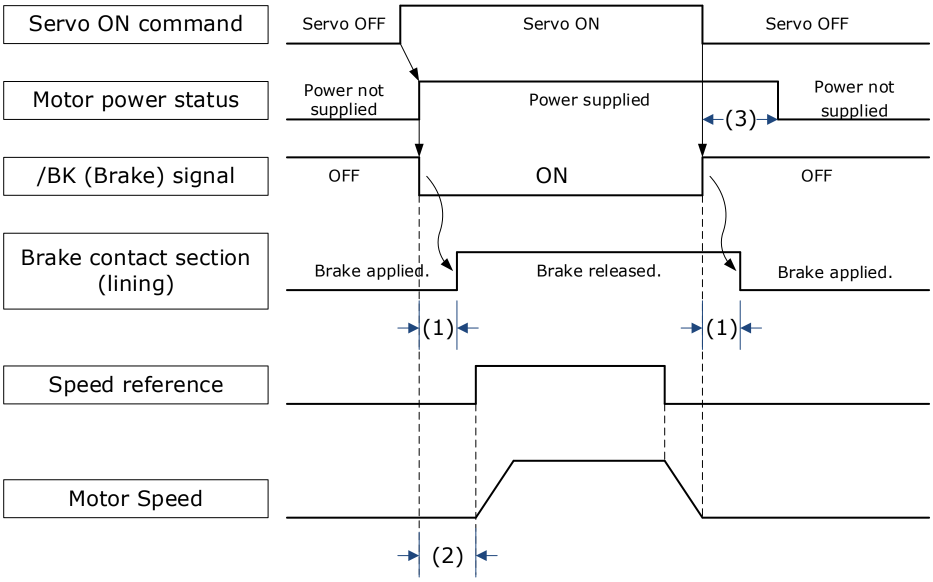


IMPORTANT

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.

6.6.2 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.

6.6.3 /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).

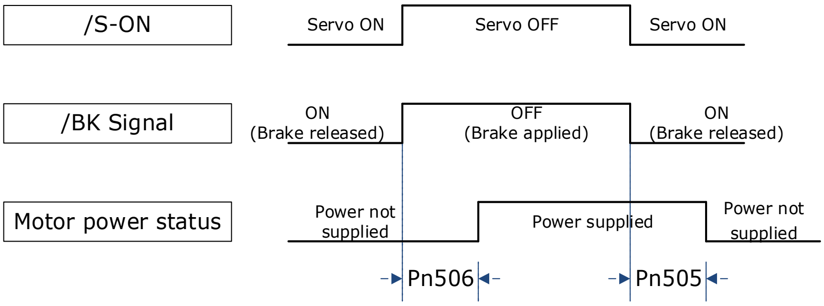
Type	Signal	Pin	Signal Status	Meaning
Output	/BK	Allocated by Pn511	ON	Releases the brake.
			OFF	Activates the brake.

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.

6.6.4 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.

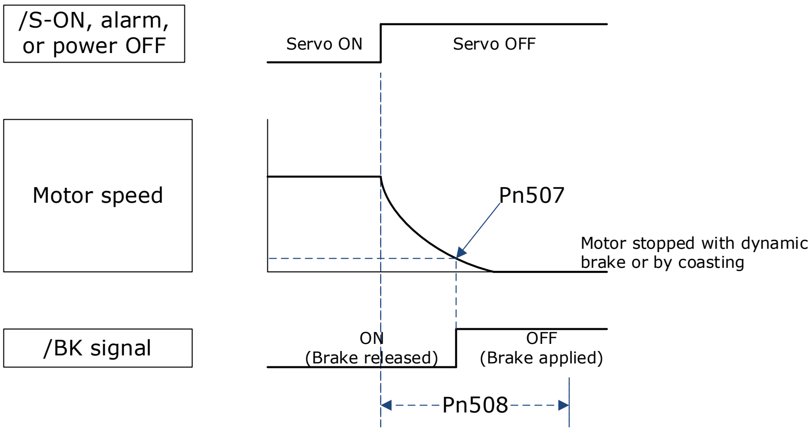
You can eliminate this slight motion by setting the servo OFF delay time (Pn506) so that power supply to the Motor is stopped after the brake is applied.

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.

6.6.5 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

6.7 Encoder Setting

6.7.1 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.

6.7.2 Encoder Alarm Resetting

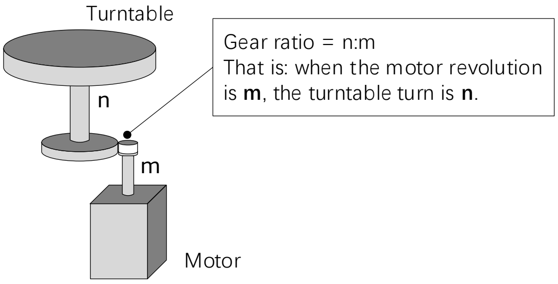
If alarm A.47 or A.48 occurs, replace the battery as soon as possible. After replacing the battery, perform the operation **Absolute encoder alarm reset** and **Fn010 (Absolute encoder multi-turn reset**.

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

6.7.3 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.

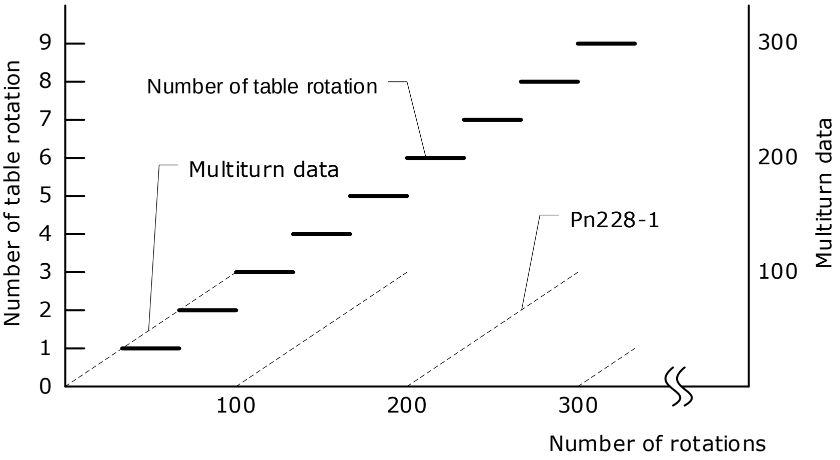


Because the turntable moves in only one direction, the upper limit to the number of revolutions that can be counted by an absolute encoder will eventually be exceeded.

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 (OB 30A9h in EtherCAT) 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.

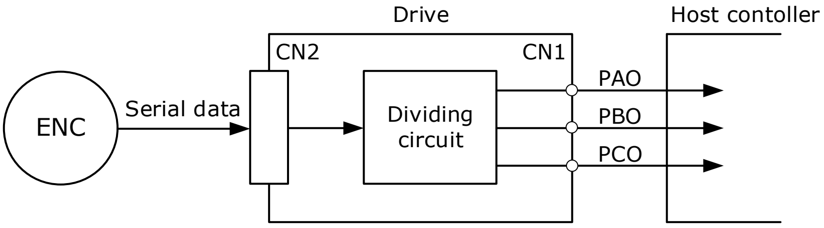
- When you use a single-turn absolute encoder
- When you set Pn002.2 = 1 (Use the encoder as an incremental encoder)

6.7.4 Encoder pulse dividing output

Pulse dividing signals

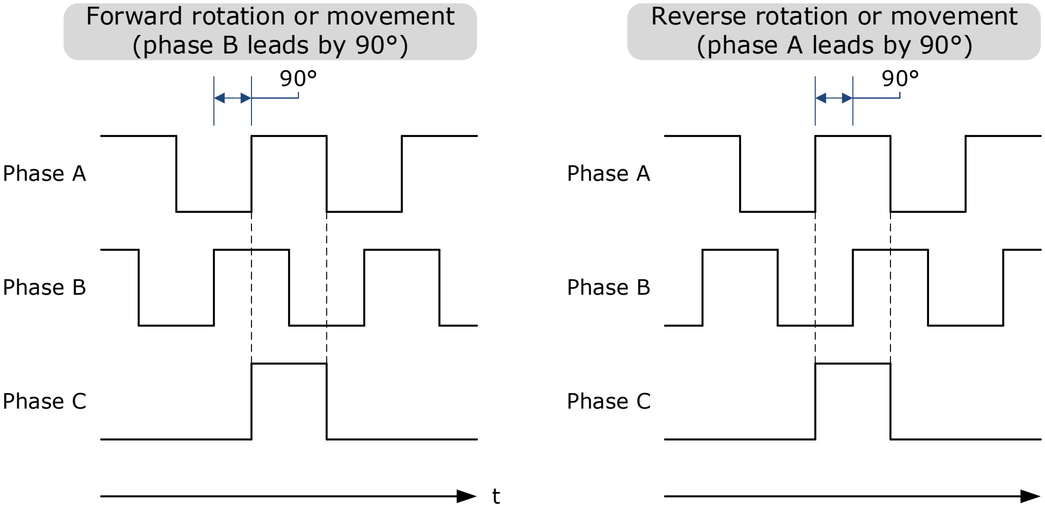
Encoder pulse dividing pulse output processes the signals sent from the encoder inside the driver, and outputs such signals to the outside in the form of two-phase pulses (Phase A, and Phase B) with 90° phase differential. It can be used as position feedback in the host controller.

Signal Name	Connector Pin Number	Name	Description
PAO+	CN1-23	Encoder pulse dividing output Phase A	PG pulse dividing (Pn200): the number of pulses when motor rotates a single revolution The phase differential between phase A and phase B here is electrical angle of 90°
PAO-	CN1-24		
PBO+	CN1-21	Encoder pulse dividing output Phase B	
PBO-	CN1-22		
PCO+	CN1-25	Encoder pulse dividing output Phase C	The actual phase C output of encoder
PCO-	CN1-26		



Note: Even in the reverse mode (Pn001.0=1), the pulse dividing output phase form is the same as the standard setting (Pn001.0=0).

Output Phase Form



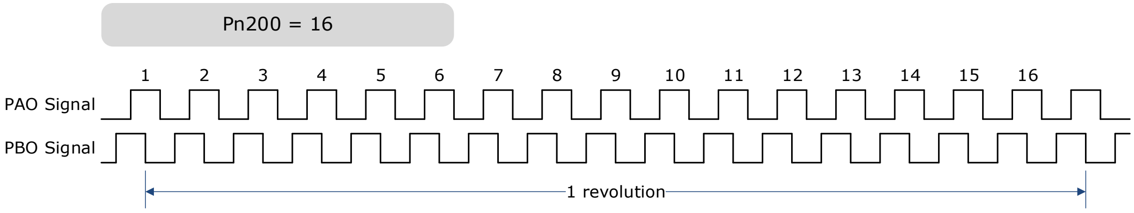
Pulse Dividing Ratio Setting

Encoder pulse dividing means that the divider converts data into the pulse density (Pn200) set by the user parameter based on the pulse data of the motor encoder, and outputs it. The setting unit is number of pulses/revolution.

No.	Name	Range	Unit	Default	When Enabled
Pn200	PG dividing ratio	16 to 16384	1 pulse	16384	After restart

- Set the number of pulses for PG output signals (PAO,/PAO,PBO,/PBO) externally from the servo drive through Pn200.
- Feedback pulses from the encoder per revolution are divided inside the servo drive by the number set in Pn200 before being output.
- Set the encoder pulse dividing ratio according to the system specifications of the machine or host controller.
- The setting of the encoder pulse dividing number is restricted by the encoder's resolution.

[Output Example] Pn200=16 (when 16 pulses are output per revolution), the output examples of signals of encoder pulse dividing output phase A (PAO) signal and encoder pulse dividing output phase B (PBO) are shown below.



6.8 I/O Signal Allocations

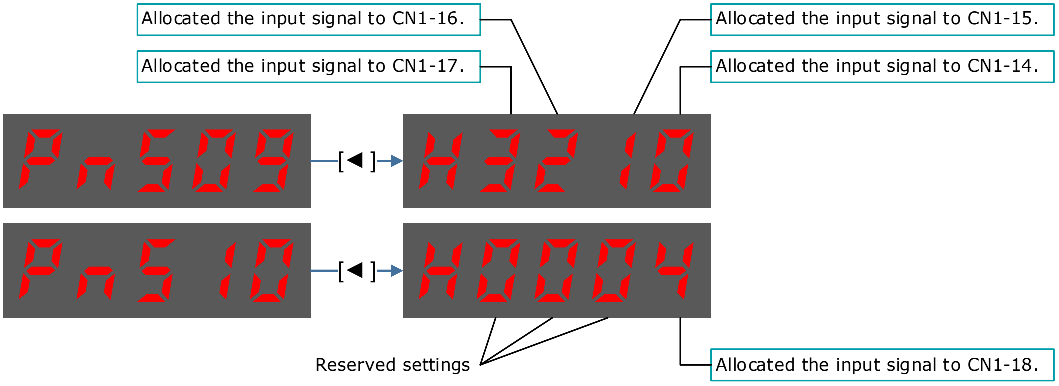
Functions are allocated to the pins on the I/O signal connector (CN1) in advance. You can change the allocations and the polarity for some of the connector pins. Function allocations and polarity settings are made with parameters.

6.8.1 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
E-STOP	Force stop input	A

Table 6-2 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

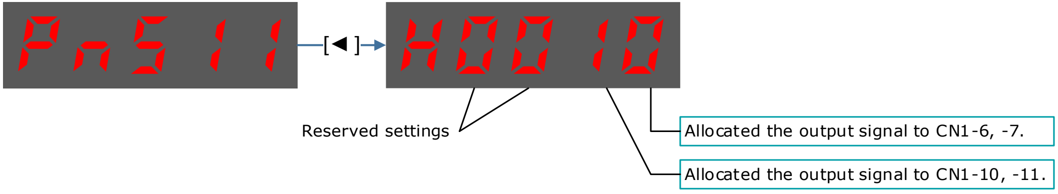
Input Signal	Name	Assigned Value
EXT2	Probe TouchProbe Input 2	9
E-STOP	Forced Stop Input	A

6.8.2 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.

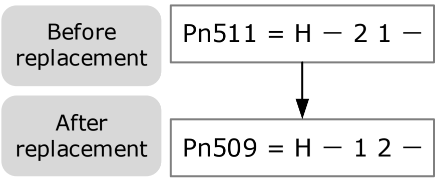
Table 6-3 Default Output signals

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
Reserved	_	C

Signal	Name	Value
PSO	Position Comparison	D

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 −

6.9 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.	6.9.1
External Torque Limits	The torque is limited with an input signal from the host station.	6.9.2
Limiting torque with EtherCAT command	The torque is limited with the settings of objects 60E0h (PosTorLimit) and 60E1h (NegTorLimit) in EtherCAT command.	8.8
Limiting torque with /CLT output signal	The torque is limited by the output signal /CLT (Allocated by Pn511).	–

NOTE

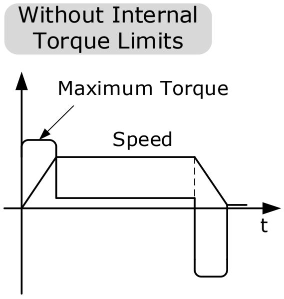
If you set a value that exceeds the maximum torque of the Motor, the torque will be limited to the maximum torque of the Motor.

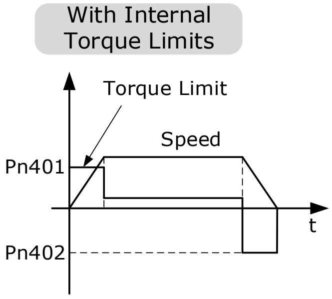
6.9.1 Internal Torque Limits

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.


Without Internal Torque Limits
Maximum Torque
Speed
t


With Internal Torque Limits
Torque Limit
Speed
Pn401
Pn402
t

6.9.2 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.

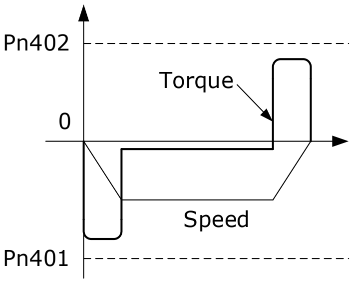
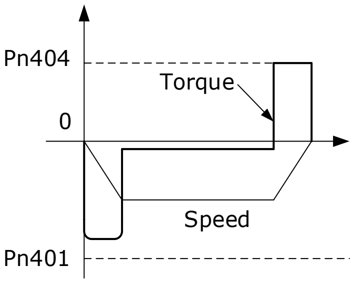
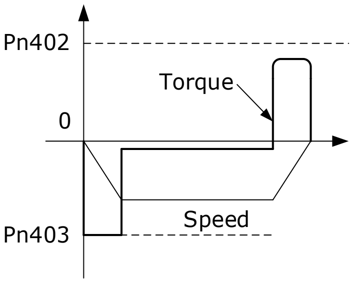
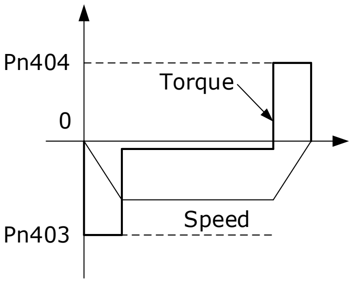
Setting the Torque Limits

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.

6.10 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.

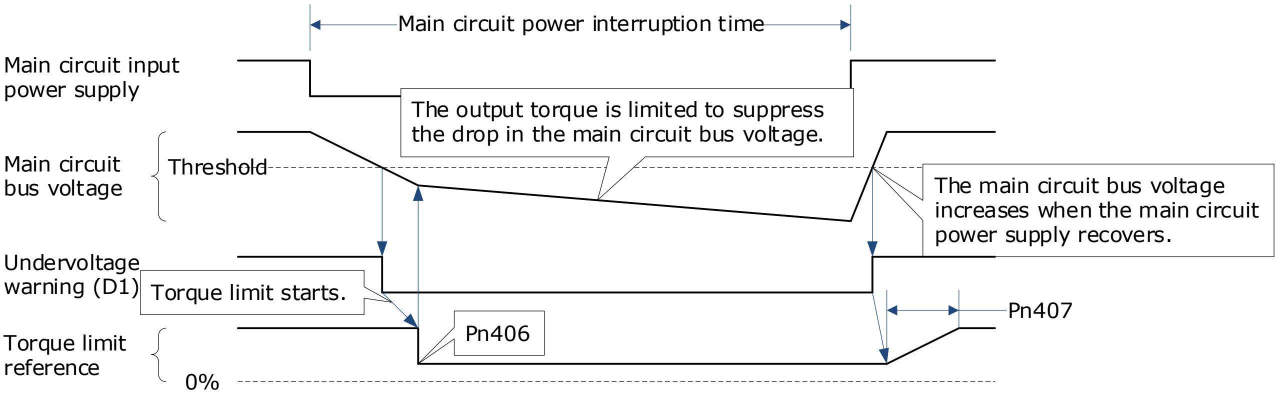
This function complies with the SEMI F47 standards for semiconductor manufacturing equipment.

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 EtherCAT Communications

7.1 Introduction

EtherCAT is a real-time Industrial Ethernet technology originally developed by Beckhoff Automation. The EtherCAT protocol which is disclosed in the IEC standard IEC61158 is suitable for hard and soft real-time requirements in automation technology, in test and measurement and many other applications.

The EtherCAT master sends a telegram that passes through each node. Each EtherCAT slave device reads the data addressed to it "on the fly" and inserts its data in the frame as the frame is moving downstream. The frame is delayed only by hardware propagation delay times. The last node in a segment (or drop line) detects an open port and sends the message back to the master using Ethernet technology's full duplex feature.

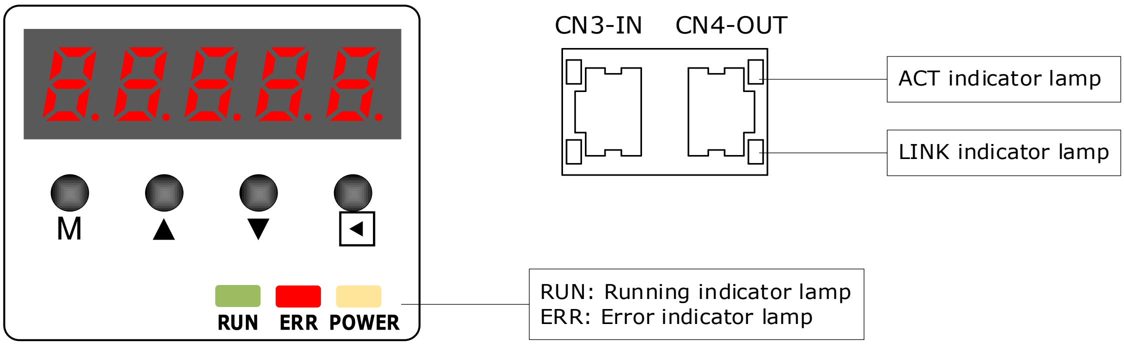
7.2 Specification

Item	Specifications
Applicable Communications Standards	IEC 61158 Type12, IEC 61800-7 CiA402 Drive Profile
Protocol	100BASE-TX (IEEE802.3)
Communications Connectors	● CN3-IN (RJ45): EtherCAT signal input connector ● CN4-OUT (RJ45): EtherCAT signal output connector
Cable	Category 5 (CAT5e SF/UTP)
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
EtherCAT 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 (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)

7.3 Communication Indication

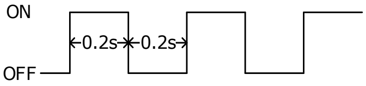
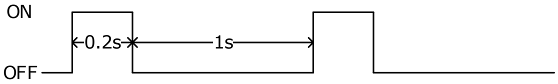
There are 3 indicator lamps on the panel Operator of the Drive to indicate the communication status of EtherCAT: RUN and ERR.

In addition, CN3-IN and CN4-OUT connectors have LINK and ACT indicators.



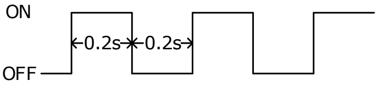
RUN Indicator

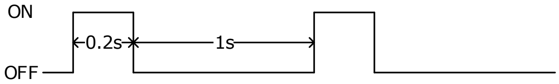
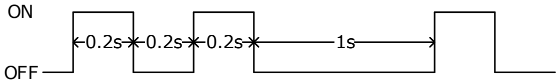
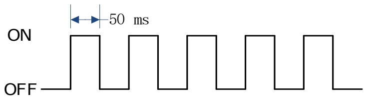
The RUN indicator shows the status of EtherCAT communications.

Indicator		Description
Status	Pattern	
Off	Never lit	EtherCAT is in Init state
Blinking		EtherCAT is in Pre-Operational state
Single flash		EtherCAT is in Safe-Operational state
On	Always lit	EtherCAT is in Operational state

ERR Indicator

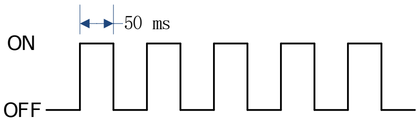
The ERR indicator shows the error status of EtherCAT communications.

Indicator		Description
Status	Pattern	
Off	Never lit	No error
Blinking		A change in state requested by the master could not be made due to register or object settings.

Indicator		Description
Status	Pattern	
Single flash		A synchronization error occurred and EtherCAT automatically went to Safe-Operational state
Double flash		An application (Sync Manager) watchdog timeout error occurred
Flickering		A boot error occurred
On	Always lit	A PDI watchdog timeout error occurred

LINK/ACT Indicator

The LINK/ACT indicators show whether Communications Cables are connected to the CN3-IN and CN4-OUT connectors and whether communications are active.

Indicator		Description
Status	Pattern	
Off	Never lit	A Communications Cable is not connected and the EtherCAT controller is not running
Flickering		Data communications are in progress
On	Always lit	A Communications Cable is connected, but data communications are not being performed

7.4 EtherCAT Slave Information

The drive publishes network accessible properties via an EtherCAT Slave Information (ESI) file. This is an XML based file which is used by the network master.

The ESI file for the ED3L Drive can be found on the official website of ESTUN and has the name: *ESTUN_SUMMA_SERVO_V1.****.xml*

NOTE: The asterisks (***) indicate the version number.

7.5 EtherCAT State Machine

A state machine is used to manage the communications states between the master and slave applications, shown in following figure. Normally, the state of the slave responds based on requests from the master.

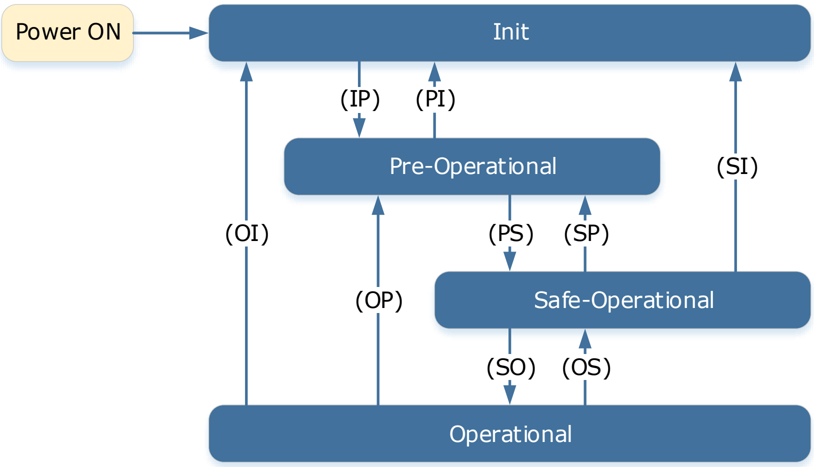


Table 7-1 lists the state transition and initialization process.

Table 7-1 Description of state or transition

State or Transition	Operation
Init (I)	• Mailbox communications are not available. • Process data communications are not available.
Init to Pre-Operational (IP)	• The master sets the DL address and Sync Manager Channels for mailbox communications. • The master initializes DC clock synchronization. • The master requests the Pre-Operational state. • The master sets the AL control register. • The slaves check whether the mailbox was initialized correctly.
Pre-Operational (P)	• Mailbox communications are available. • Process data communications are not available.
Pre-Operational to Safe-Operational (PS)	• The master sets the Sync Manager Channels and FMMU channels for process data. • The master uses SDOs to set the PDO mappings and the Sync Manager PDO Assignment parameters. • The master requests the Safe-Operational state. • The slaves check whether the Sync Manager channels for process data communications and, if required, the distributed clock settings are correct.
Safe-Operational (S)	Process data communications are possible. However, only the input data is available. The output data is still unavailable.
Safe-Operational to Operational (SO)	• The master sends available output data. • The master requests the Operational state.
Operational (O)	Process data communications are available.

7.6 Communications between Master and Slave

PDO

PDO is used to transfer cyclic data. This is data that is transferred between the master and slave every network cycle. Typically, this is data required for operation of the drive; Control Word, Status Word, Set Point, etc…

SDO

SDO is used to transfer non-cyclic data, such as communication parameter configuration, and Servo running parameter configuration. The CoE service type includes Emergency Message, SDO request and SDO response.

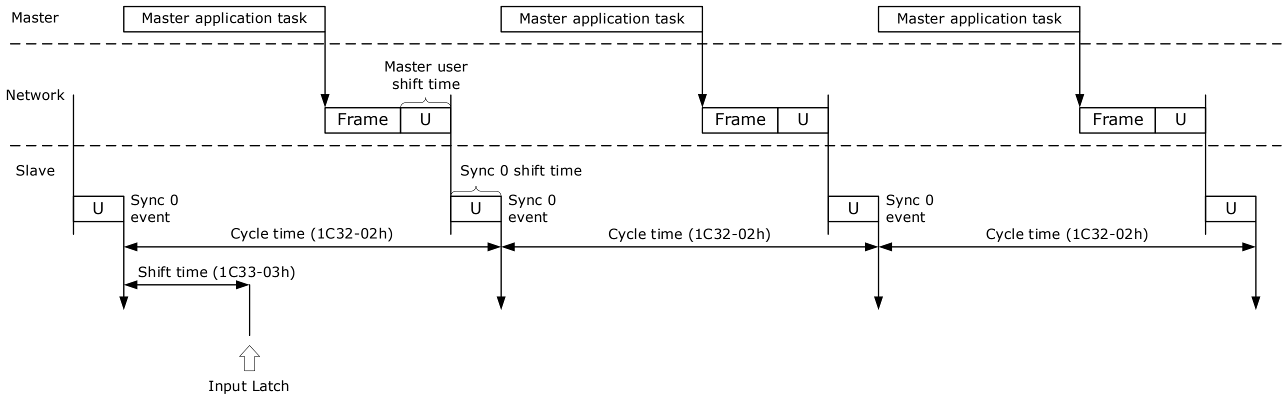
Emergency Message

When an alarm occurs in the Drive, the CoE service can trigger an emergency message to inform the user of the error code. The Motion Coordinator response to the emergency message can be set by the ECAT_MODE system parameter in the controller.

Distributed Clock

The synchronization of EtherCAT communications is based on a mechanism called a distributed clock. With the distributed clock, all devices are synchronized with each other by sharing the same reference clock. The slave devices synchronize the internal applications to the Sync0 events that are generated according to the reference clock.

The figure below shows a timing chart for DC synchronization.



NOTE: Only the object 1C33-03h can be set.

7.7 Relevant Settings

For correct operation using EtherCAT ensure the parameters below are set correctly.

Parameter	Name	Setting	Meaning
Pn006.0	Bus Selection	1	Use EtherCAT. [Default]

The Device Node Number can be used to force the axis number used by the controller.

Parameter	Name	Range	Unit	Default	When Enabled
Pn704	Device Node Number	0 to 127	–	0	After restart

Chapter 8 CiA402 Drive Profile

8.1 Gear Ratio

Reference units include position reference unit, velocity reference unit, and acceleration reference unit, which set the proportional relationship (gear ratio) between the reference unit (Pos unit, Vel unit, or Acc unit) and the encoder unit (inc) through the corresponding objects.

Name	Unit	Description
Reference units	Pos unit	Set by object 6093h. $1\,[Pos\ unit] = \frac{6093h - 01h}{6093h - 02h}\,[inc]$
	Vel unit	Set by object 6094h. $1\,[Vel\ unit] = \frac{6094h - 01h}{6094h - 02h}\,[inc]$
	Acc unit	Set by object 6097h. $1\,[Acc\ unit] = \frac{6097h - 01h}{6097h - 02h}\,[inc]$
Encoder unit	inc	The resolutions of the Motor encoder with different bit are as follows: ● The general incremental encoder outputs 10,000 pulses per 1 revolution ● The resolver outputs 65536 pulses per 1 revolution ● The 17-bit encoder outputs 131072 pulses per 1 revolution ● The 20-bit encoder outputs 1048576 pulses per 1 revolution ● The 23-bit encoder outputs 8388608 pulses per 1 revolution

IMPORTANT

The calculation of gear ratio must be reduced to without common divisor.

For Motor encoders with different bit, the setting ranges of the gear ratio are as following:

- Bit of Motor encoder < 20, the setting range is 0.001 to 4000
- Bit of Motor encoder = 21, the setting range is 0.001 to 8000
- Bit of Motor encoder = 22, the setting range is 0.001 to 16000
- Bit of Motor encoder = 23, the setting range is 0.001 to 32000
- Bit of Motor encoder = 24, the setting range is 0.001 to 64000

If the setting exceeds the above range, A07 (Electronic Gear Error) alarm will occur.

The Motor position feedback (encoder unit) and driving shaft position feedback (reference unit) is in the following relationship:

$$\text{Motor position feedback} = \text{Driving shaft position feedback} \times \text{Gear ratio}$$

Taking the load ball screw as an example: Minimum reference unit fc = 1 mm, Lead pB = 10 mm/r, Reduction ratio n = 5:1, 20-bit incremental encoder resolution P = 1048576;

The gear ratio is calculated as follows:

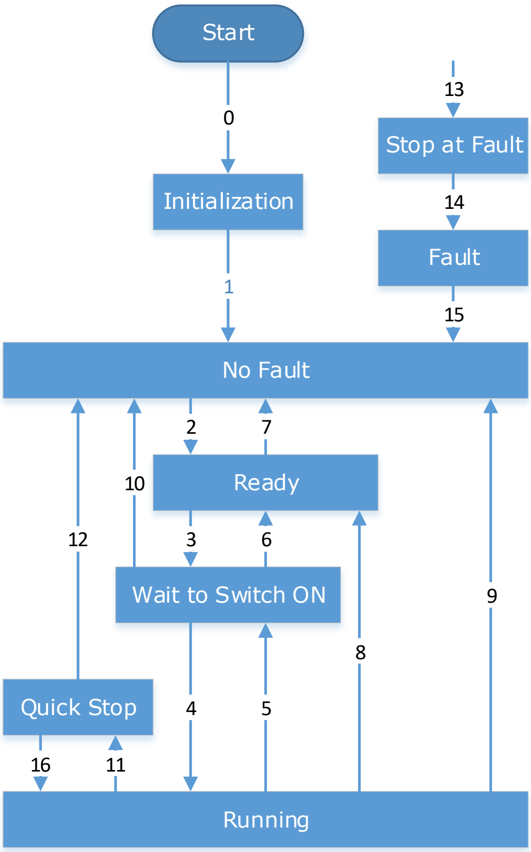
$$\text{Gear radio} = \frac{\text{Motor resolution P} \times \text{n}}{pB} = \frac{1048576 \times 5}{10} = 524288$$

Therefore, 6093-01h = 524288, 6093-01h = 1, which means that when the driving shaft displacement is 1, the Motor displacement is 524288.

8.2 Device Control

8.2.1 CiA402 State Machine

The Drive runs in the specified status only when it is instructed according to the flowchart defined in CiA402.



The states are described in the following table.

State	Description
Initialization	Initialization of the Drive and self-check has been done. Parameter settings or Drive functions cannot be implemented.
No Fault	No fault exists in the Drive or the fault has been eliminated. Parameter settings of the Drive is allowed.
Ready	The Drive is ready. Parameter settings of the Drive is allowed.
Wait to Switch ON	The Drive waits to switch on. Parameter settings of the Drive is allowed.
Running	The Drive is in normal running state; a certain drive mode is enabled; the Motor is energized, and rotates when the reference is not 0. Parameter settings of the Drive is allowed.
Quick Stop	The quick stop function is enabled, and the Drive executes quick stop. Parameter settings of the Drive is allowed.
Stop at Fault	A fault occurs, and the Drive stops. Parameter settings of the Drive is allowed.

State	Description
Fault	The stop process is completed, and all the drive functions are inhibited. Parameter setting is allowed for users to eliminate faults.

The control commands and state switchover are described as follows:

CiA402 State Switchover		Controlword (6040h)	Statusword (6041h)
0	Start → Initialization	Natural transition, and no control command is required.	0x0000
1	Initialization → No Fault	Natural transition, and no control command is required. If an error occurs during initialization, the Drive directly goes to state 13.	0x0250
2	No Fault → Ready	0x0006	0x0231
3	Ready → Wait to switch on	0x0007	0x0233
4	Wait to switch on → Running	0x000F	0x0237
5	Running → Wait to switch on	0x0007	0x0233
6	Wait to switch on → Ready	0x0006	0x0231
7	Ready → No Fault	0x0000	0x0250
8	Running → Ready	0x0006	0x0231
9	Ready → No Fault	0x0000	0x0250
10	Wait to switch on → No Fault	0x0000	0x0250
11	Running → Quick stop	0x0002	0x0217
12	Quick stop → No Fault	Set 605Ah to a value among 0 to 2. Natural transition is performed after stop, and no control command is required.	0x0250
13	Stop at fault	Once a fault occurs in any state other than *Fault*, the Drive automatically switchovers to the stop at fault state, without control command.	0x021F
14	Stop at fault → Fault	Natural transition after stop at fault, and no control command is required.	0x0218
15	Fault → No Fault	0x80	0x0250
16	Quick stop → Running	Set 605Ah to a value between 5 and 6. After the stop process is completed, 0x0F is sent after the stop process is completed.	0x0237

8.2.2 Stop Modes

The Drive supports 5 stop modes described as below sections.

Quick Stop Option Code (605Ah)

This object determines what operation will be performed if a Quick Stop is executed.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Ah	0	Quick Stop Option Code	INT16	RW	No	0, 1, 2, 5, 6 Default:2

The meanings of Value are as follows:

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn003.0)
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and moves to the No Fault state
2	Decelerates according to *Quick Stop Deceleration* (6085h) for decelerating to a stop and moves to the No Fault state
5	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and stays at the QuickStop state
6	Decelerates according to *Quick Stop Deceleration* (6085h) for decelerating to a stop and stays at the QuickStop state

605Bh (Shutdown Option Code)

This object defines the operation that is performed if there is a move from Operation Enable state to Ready state.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Bh	0	Shutdown Option Code	INT16	RW	No	0, 1 Default: 0

The meanings of Value are as follows:

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn003.0)
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and moves to the No Fault state

605Ch: Disable Operation Option Code

This object defines the operation that is performed if there is a move from Operation Enable state to Switched ON state.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Ch	0	Shutdown Option Code	INT16	RW	No	0, 1 Default: 0

The meanings of Value are as follows:

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn004.0)
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and moves to the No Fault state

605Dh: Halt Option Code

This object defines the operation that is performed if bit 8 (Halt) in *Controlword* is active.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Dh	0	Halt Option Code	INT16	RW	No	1, 2 Default: 1

The meanings of Value are as follows:

Value	Description
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop
2	Decelerates according to *Quick Stop Deceleration* (6085h) for decelerating to a stop

605Eh: Fault Reaction Option Code

This object defines the operation that is performed when an alarm is detected in the Servo System.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Eh	0	Halt Option Code	INT16	RW	No	0

The meaning of Value is as follows:

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn003.0)

8.3 Control Modes

The Drive supports 8 control modes as defined in 6502h.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6502h	0	Supported Drive Modes	UINT32	RO	No	0x03ED

Bit	Supported mode	Definition
0	Profile Position	1: Supported
1	Vl (Velocity mode)	0: Not supported
2	PV (Profile Velocity mode)	1: Supported
3	TQ (Torque Profile mode)	1: Supported
4	Reserved	0
5	HM (Homing mode)	1: Supported
6	IP (Interpolated Position mode)	1: Supported
7	CSP (Cyclic Sync Position mode)	1: Supported
8	CSV (Cyclic Sync Velocity mode)	1: Supported
9	CST (Cyclic Sync Torque mode)	1: Supported
10 to 31	Reserved	0

8.3.1 Modes of Operation

This object is used to select the operation mode. The Servo System gives the actual operation mode in the *Modes of Operation Display* object.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6060h	0	Modes of Operation	UINT8	RW	Yes	0 to 10 Default: 0

Value	Description
0	There is no mode change or no mode assigned
1	Profile Position Mode
2	–
3	Profile Velocity Mode
4	Profile Torque Mode
5	–

Value	Description
6	Homing Mode
7	Interpolated Position Mode
8	Cyclic Sync Position Mode
9	Cyclic Sync Velocity Mode
10	Cyclic Sync Torque Mode

8.3.2 Modes of Operation Display

This object gives the current mode of operation.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6061h	0	Modes of Operation Display	UINT8	RO	Yes	Default: 0

8.3.3 Mode Change

Note the following when changing the control mode.

- After changing from Position Control Mode (PP mode or CSP mode) to other modes, the unexecuted position command will be discarded.
- A ramp stop command is executed when changing from Speed Control Mode (PV mode or CSV mode) or Torque Control Mode (PT mode or CST mode) to other modes. And then, changes to other modes after the stop has been completed.
- It cannot be changed to other modes when the Servo is operating in the Homing Mode, except that the homing operation has been completed or interrupted (Fault or disabled).
- Servo running status, after changing from other modes to CSP mode, CSV mode or CST mode, please send the command at least 1ms interval to avoid loss of instruction or error.
- After changing the modes to Cyclic Sync Mode (CSP mode, CSV mode or CST mode), please wait 1 ms or more before sending the commands, in case losing command loss or error occurred.

8.3.4 Communication Cycle

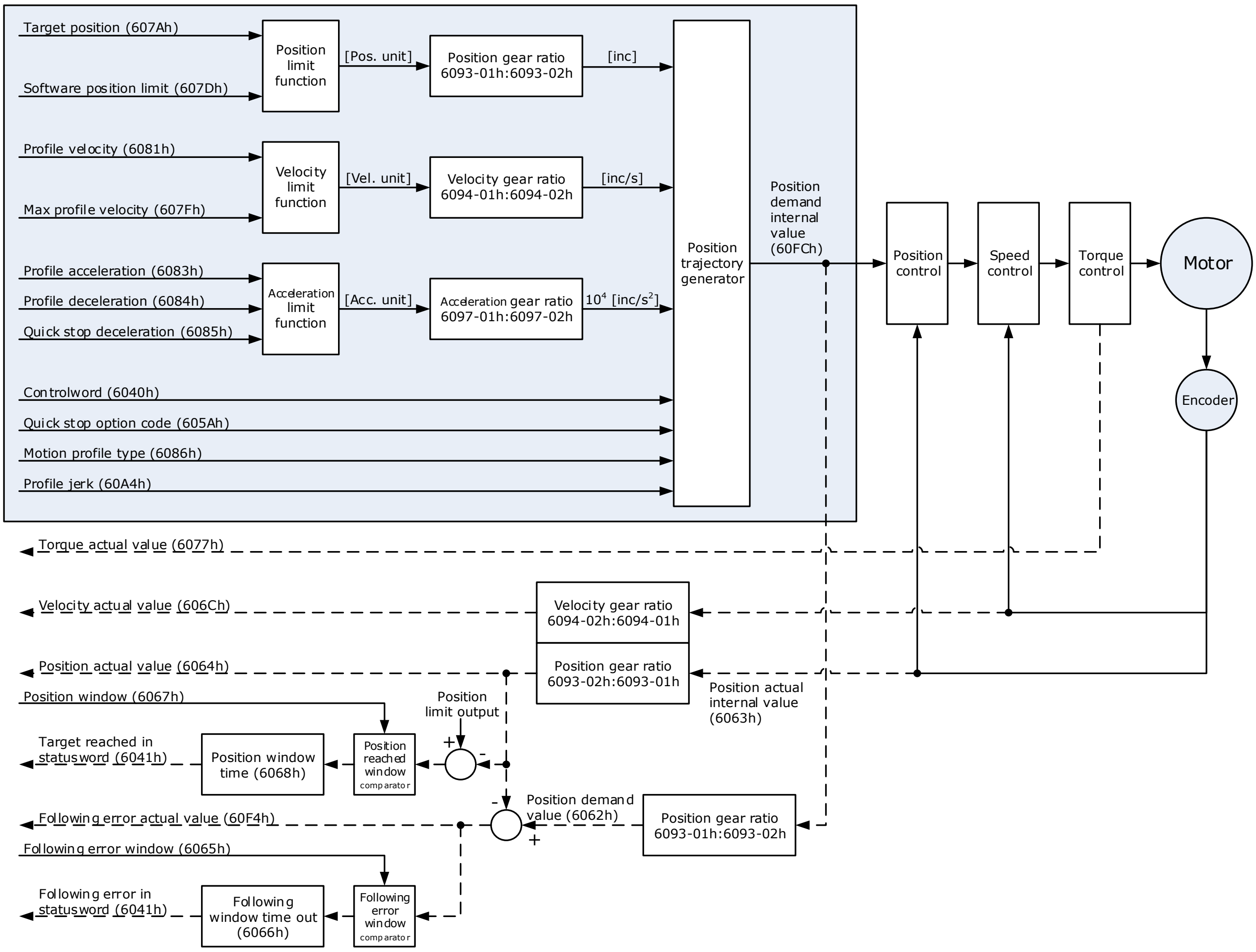
The communication Cycle Time of all Control Modes (PP, PV, PT, HM, IP, CSP, CSV, and CST) supports an integer multiple of 125µs (e.g. 125µs, 250µs, 500µs, 1ms, and so on).

8.4 Position Control

8.4.1 Profile Position (PP) Mode

In this mode of operation, the host control uses the trajectory generator (an operation profile calculation function) inside the Drive to perform PTP positioning operation. It executes trajectory generator, position control, speed control, and torque control based on the target position, profile velocity, profile acceleration, profile deceleration, and other information.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

<table>
<tr><th>Object</th><th>Bit</th><th>Name</th><th>Value</th><th colspan="2">Description</th></tr>
<tr><td rowspan="13">Controlword 6040h</td><td rowspan="2">0</td><td rowspan="2">Switch on</td><td>0</td><td>Disabled</td><td rowspan="8">If Bit0 to Bit3 are all 1, the Drive starts running.</td></tr>
<tr><td>1</td><td>Enabled</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Enable voltage</td><td>0</td><td>Disabled</td></tr>
<tr><td>1</td><td>Enabled</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Quick stop</td><td>0</td><td>Disabled</td></tr>
<tr><td>1</td><td>Enabled</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Enable operation</td><td>0</td><td>Disabled</td></tr>
<tr><td>1</td><td>Enabled</td></tr>
<tr><td>4</td><td>New set-point</td><td>0 → 1</td><td colspan="2">Starts positioning at the rising edge from 0 to 1 of the signals. In this timing, the value s of 607Ah, 6081h, 6083h, and 6084h are obtained.</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Change set immediately</td><td>0</td><td colspan="2">Starts the next positioning after the current positioning completes (target reached)</td></tr>
<tr><td>1</td><td colspan="2">Starts the next positioning immediately</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">abs/rel</td><td>0</td><td colspan="2">Treats the target position as an absolute value.</td></tr>
<tr><td>1</td><td colspan="2">Treats the target position as a relative value.</td></tr>
<tr><td rowspan="8">Statusword 6041h</td><td rowspan="2">10</td><td rowspan="2">Target reached</td><td>0</td><td colspan="2">● Halt (Bit 8 in Controlword) = 0: Target position not reached
● Halt (Bit 8 in Controlword) = 1: Axis decelerates</td></tr>
<tr><td>1</td><td colspan="2">● Halt (Bit 8 in Controlword) = 0: Target position reached
● Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">Set-point acknowledge</td><td>0</td><td colspan="2">Previous set-point already processed, waiting for new set-point</td></tr>
<tr><td>1</td><td colspan="2">Previous set-point still in process, set-point overwriting shall be accepted</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">Following error</td><td>0</td><td colspan="2">No following error</td></tr>
<tr><td>1</td><td colspan="2">Following error</td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">Homeflag</td><td>0</td><td colspan="2">Homing not completed</td></tr>
<tr><td>1</td><td colspan="2">Homing completed</td></tr>
</table>

NOTE: Bit10 of Statusword is set to 1 after the Quick Stop has been completed, and the Servo is in the Stop state.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
6062	00	Position Demand Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6063	00	Position Actual Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
6064	00	Position Actual Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6065	00	Following Error Window	RW	INT32	Reference unit	-2147483648 to 2147483647	1048576
6067	00	Position Window	RW	UINT32	Encoder unit	0 to 4294967295	734
6068	00	Position Window Time	RW	UINT16	ms	0 to 65535	–
606C	00	Velocity Actual value	RO	INT32	Reference unit	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
607A	00	Target Position	RW	INT32	Reference unit	-2147483648 to 2147483647	0
6083	00	Profile Acceleration	RW	UDINT32	Reference unit/s^2	0 to 4294967295	200000
6084	00	Profile Deceleration	RW	UDINT32	Reference unit/s^2	0 to 4294967295	200000
6093	01	numerator	RW	UINT32	–	0 to 4294967295	1
	02	divisor	RW	UINT32	–	0 to 4294967295	1
60E0	00	Positive Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
60E1	00	Negative Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
60F4	00	Following Error	RO	INT32	Reference unit	-2147483648 to 2147483647	–
60FC	00	Position Demand Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125
31CC	00	Position Loop Gain	RW	INT32	1/s	0 to 1000	40
31D4	00	Speed Feedforward	RW	INT32	%	0 to 100	0
31D5	00	Speed Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31D6	00	Torque Feedforward	RW	INT32	%	0 to 100	0
31D7	00	Torque Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31FC	00	Model Following Control Gain Correction	RW	INT32	%	20 to 500	100
31FE	00	Model Following Control Torque Feedforward	RW	INT32	%	0 to 200	100
3201	00	Limit for Load Oscillation Suppression	RW	INT32	rpm	0 to 1000	100
3169	00	Internal Torque Feedforward Method	RW	INT32	–	0 to 3	0
	02	Torque Feedforward Method	RW	INT32	–	0 to 3	0
	03	Speed Feedforward Method	RW	INT32	–	0 to 3	0

Recommended Configuration

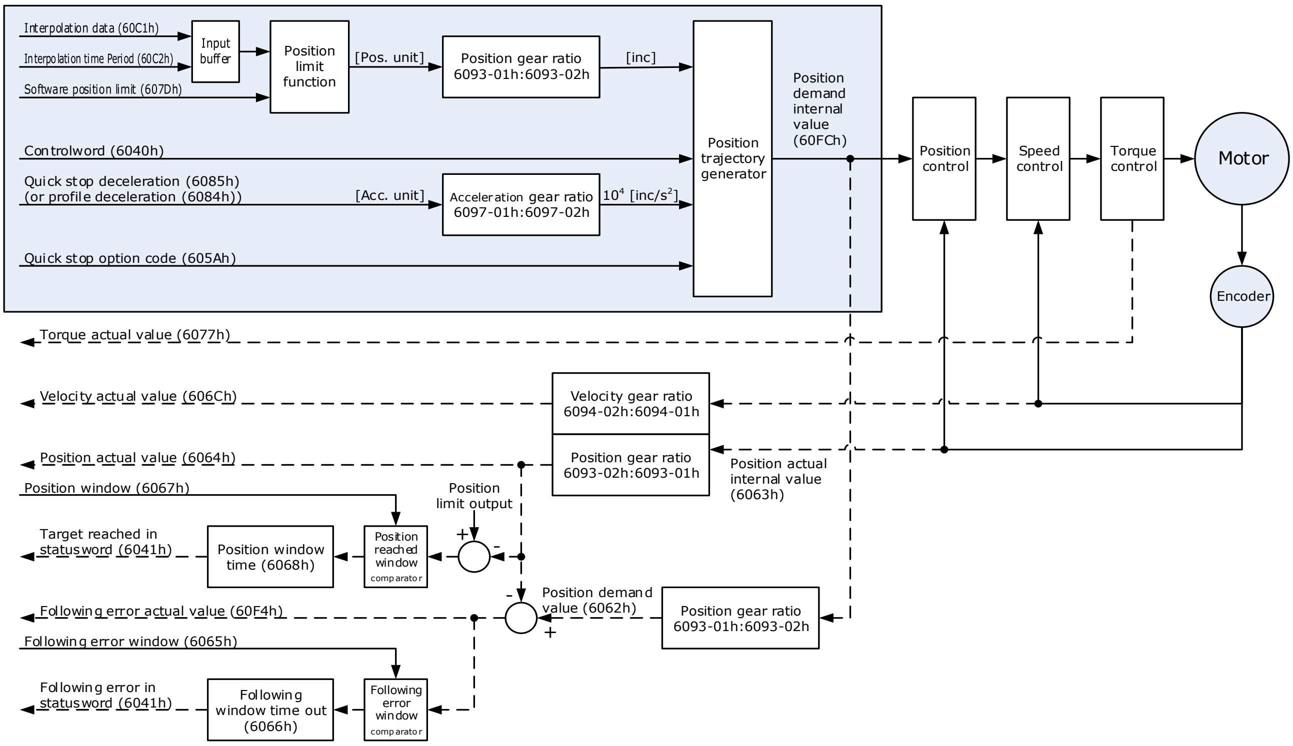
RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
607Ah: Target position	6064h: Position Actual Value	Mandatory
6081h: profile velocity	–	Mandatory
6083h: profile acceleration	–	Optional (cannot be 0)
6084h: profile deceleration	–	Optional (cannot be 0)
6060h: mode of operation	6061h: modes of operation display	Optional

8.4.2 Interpolated Position (IP) Mode

The Interpolated Position Mode is used to control multiple coordinated axes or to control a single axis that requires time interpolation of the set point data.

This mode normally uses a time (communications) synchronization mechanism to synchronize the Servo Drives. The Interpolation Time Period defines the update cycle of the Interpolation Data (i.e., the interpolation position). The interpolation processing in the Drive is based on this setting. The Interpolation Data is interpreted as an absolute value.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	
	1	Enable voltage	0	Disabled	
			1	Enabled	
	2	Quick stop	0	Disabled	
			1	Enabled	
	3	Enable operation	0	Disabled	
			1	Enabled	
	4	Enable	0	Disables interpolation.	

Object	Bit	Name	Value	Description
		interpolation	1	Enables interpolation.
	8	Halt	0	Enables Bit4
			1	Stops the axis according to *Halt Option Code* (605Dh)
Statusword 6041h	10	Target reached	0	Halt (Bit 8 in Controlword) = 0: Target position not reached Halt (Bit 8 in Controlword) = 1: Axis decelerates
			1	Halt (Bit 8 in Controlword) = 0: Target position reached. Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0.
	12	ip mode active	0	Interpolation inactive
			1	Interpolation active
	13	Following error	0	No following error
			1	Following error
	15	Homeflag	0	Homing not completed
			1	Homing completed

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
6062	00	Position Demand Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6063	00	Position Actual Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
6064	00	Position Actual Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6065	00	Following Error Window	RW	INT32	Reference unit	-2147483648 to 2147483647	1048576
6067	00	Position Window	RW	UINT32	Encoder unit	0 to 4294967295	734
6068	00	Position Window Time	RW	UINT16	ms	0 to 65535	–

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
606C	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
6077	00	Torque Actual value	RO	INT16	0.1%	-5000 to 5000	0
6093	01	numerator	RW	UINT32	–	0 to 4294967295	1
	02	divisor	RW	UINT32	–	0 to 4294967295	1
60B1	00	Velocity Offset	RW	INT32	Reference unit/s	-2147483648 to 2147483647	0
60B2	00	Torque Offset	RW	INT16	0.1%	–32768 to 32767	0
60C2	01	Interpolation time period value	RW	UINT8	–	1~250	–
	02	Interpolation time index	RW	INT8	s	-6~-3	-3
60F4	00	Following Error	RO	INT32	Reference unit	-2147483648 to 2147483647	–
60FC	00	Position Demand Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125
31CC	00	Position Loop Gain	RW	INT32	1/s	0 to 1000	40
31D4	00	Speed Feedforward	RW	INT32	%	0 to 100	0
31D5	00	Speed Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31D6	00	Torque Feedforward	RW	INT32	%	0 to 100	0
31D7	00	Torque Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31FC	00	Model Following Control Gain Correction	RW	INT32	%	20 to 500	100
31FE	00	Model Following Control Torque Feedforward	RW	INT32	%	0 to 200	100

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
3201	00	Limit for Load Oscillation Suppression	RW	INT32	rpm	0 to 1000	100
3169	00	Internal Torque Feedforward Method	RW	INT32	–	0 to 3	0
	02	Torque Feedforward Method	RW	INT32	–	0 to 3	0
	03	Speed Feedforward Method	RW	INT32	–	0 to 3	0

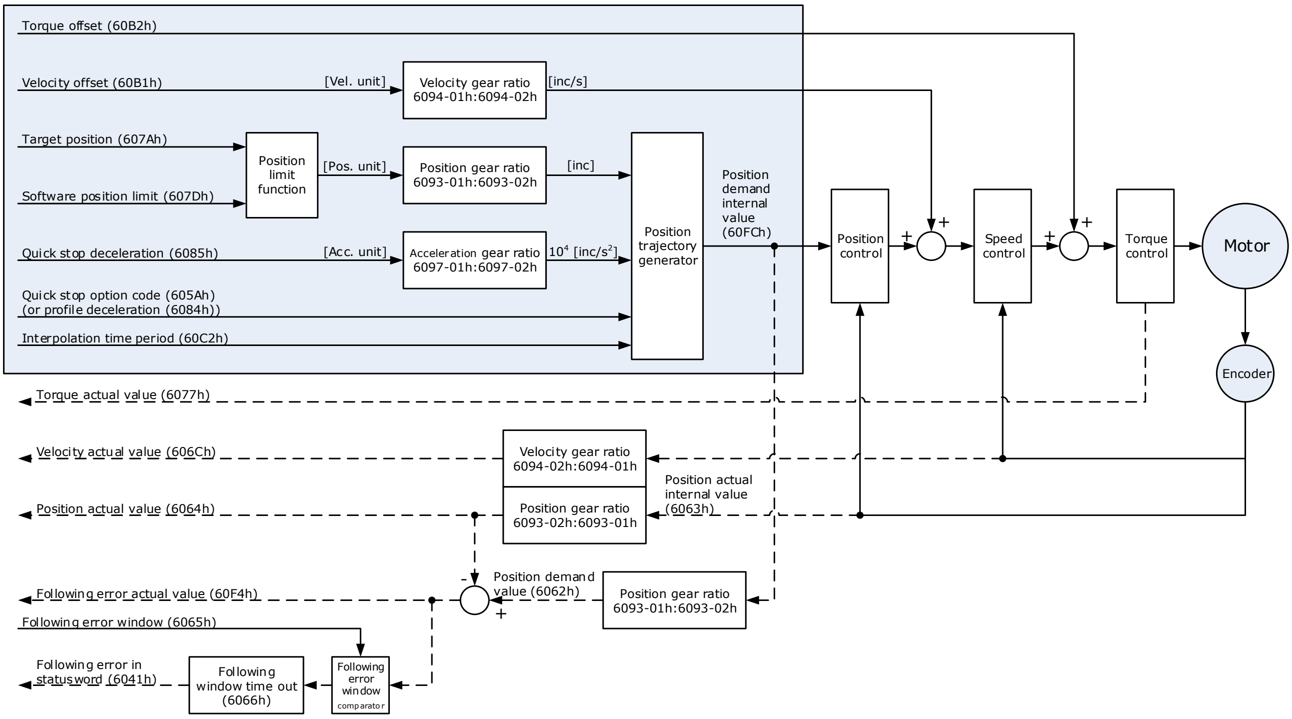
Recommended Configuration

RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
60C1-01h: 1st set-point	6064h: Position Actual Value	Mandatory
6060h: Mode of Operation	6061h: Modes of Operation Display	Optional

8.4.3 Cyclic Synchronous Position (CSP) Mode

In this mode of operation, the host controller generates the position references and gives the target position in 607Ah to the Drive using cyclic synchronization. Position control, speed control, and torque control are performed by the Drive.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	
	1	Enable voltage	0	Disabled	
			1	Enabled	
	2	Quick stop	0	Disabled	
			1	Enabled	
	3	Enable operation	0	Disabled	
			1	Enabled	
	8	Halt	0	Executes or continues operation.	
			1	Stops the axis according to *Halt Option Code* (605Dh)	
Statusword	10	Target reached	0	Reserved	

Object	Bit	Name	Value	Description
6041h	12	Drive follows the command value	0	Drive does not follow the target value (position, velocity or torque)
			1	Drive follows the target value (position, velocity or torque)
	13	Following error	0	No following error
			1	Following error
	15	Homeflag	0	Homing not completed
			1	Homing completed

NOTE: Only absolute position reference is supported in CSP mode.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
6062	00	Position Demand Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6063	00	Position Actual Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
6064	00	Position Actual Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6065	00	Following Error Window	RW	INT32	Reference unit	-2147483648 to 2147483647	1048576
6067	00	Position Window	RW	UINT32	Encoder unit	0 to 4294967295	734
6068	00	Position Window Time	RW	UINT16	ms	0 to 65535	–
606C	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
607A	00	Target Position	RW	INT32	Reference unit	-2147483648 to 2147483647	0
6083	00	Profile Acceleration	RW	UDINT32	Reference unit/s^2	0 to 4294967295	200000
6084	00	Profile Deceleration	RW	UDINT32	Reference unit/s^2	0 to 4294967295	200000

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
6093	01	numerator	RW	UINT32	–	0 to 4294967295	1
	02	divisor	RW	UINT32	–	0 to 4294967295	1
60B1	00	Velocity Offset	RW	INT32	Reference unit/s	-2147483648 to 2147483647	0
60B2	00	Torque Offset	RW	INT16	0.1%	–32768 to 32767	0
60F4	00	Following Error	RO	INT32	Reference unit	-2147483648 to 2147483647	–
60FC	00	Position Demand Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125
31CC	00	Position Loop Gain	RW	INT32	1/s	0 to 1000	40
31D4	00	Speed Feedforward	RW	INT32	%	0 to 100	0
31D5	00	Speed Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31D6	00	Torque Feedforward	RW	INT32	%	0 to 100	0
31D7	00	Torque Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31FC	00	Model Following Control Gain Correction	RW	INT32	%	20 to 500	100
31FE	00	Model Following Control Torque Feedforward	RW	INT32	%	0 to 200	100
3201	00	Limit for Load Oscillation Suppression	RW	INT32	rpm	0 to 1000	100
3169	00	Internal Torque Feedforward Method	RW	INT32	–	0 to 3	0
	02	Torque Feedforward Method	RW	INT32	–	0 to 3	0

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
	03	Speed Feedforward Method	RW	INT32	–	0 to 3	0

Recommended Configuration

RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
607Ah: Target Position	6064h: Position Actual Value	Mandatory
6060h: Mode of Operation	6061h: Modes of Operation Display	Optional

8.5 Homing

8.5.1 Homing (HM) Mode

This mode searches for the home and determines the position relationship between home and zero.

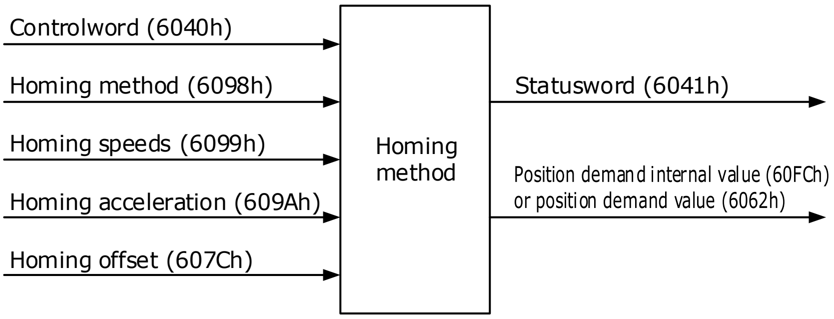
- Home: mechanical home reference point, that is, the encoder C-pulse.
- Zero: absolute zero point in the machine.

After homing is completed, the Motor stops at the home. The relationship between home and zero is set in 607Ch.

$$\text{Home} = \text{Zero} + 607\text{Ch (Home Offset)}$$

When 607Ch=0, the zero is the same as the home.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	

Object	Bit	Name	Value	Description
	1	Enable voltage	0	Disabled
			1	Enabled
	2	Quick stop	0	Disabled
			1	Enabled
	3	Enable operation	0	Disabled
			1	Enabled
	4	Homing operation start	0	Does not start homing
			1	Starts or continues homing
	8	Halt	0	Enables Bit4
			1	Stops the axis according to *Halt Option Code* (605Dh)
Statusword 6041h	10	Target reached	0	Target position not reached
			1	Target position reached
	12	Homing attained	0	Home failed
			1	Homing successful This flag bit is available when the Drive is in homing mode in running state and the target reached signal is active.
	13	Homing error	0	No home error
			1	Homing timeout or deviation excessive
	15	Homeflag	0	Homing not completed
			1	Homing completed This flag bit is set when the home signal is reached.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
6062	00	Position Demand Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
6064	00	Position Actual Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
6067	00	Position Window	RW	UINT32	Encoder unit	0 to 4294967295	734
6068	00	Position Window Time	RW	UINT16	ms	0 to 65535	–
606C	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
6098	00	Homing Method	RW	INT8	–	1 to 35	1
6099	01	Speed during search for switch	RW	UINT32	Reference unit/s	0 to 4294967295	5000
	02	Speed during search for zero	RW	UINT32	Reference unit/s	0 to 4294967295	100
609A	00	Home Acceleration	RW	UINT32	Reference unit/s^2	0 to 4294967295	1000000
60F4	00	Following Error	RO	INT32	Reference unit	-2147483648 to 2147483647	–

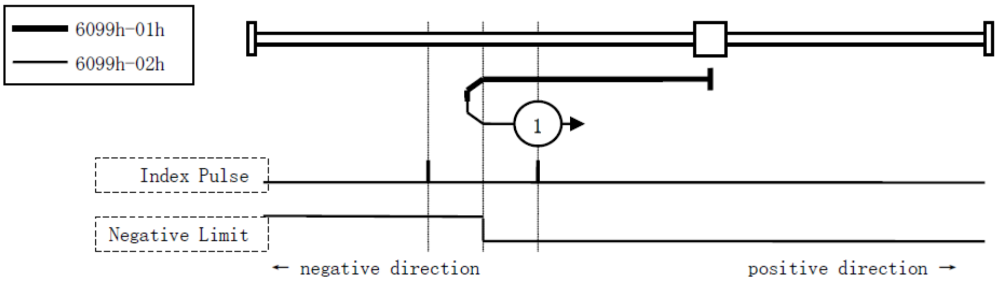
Recommended Configuration

RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
6098h: Homing Method	–	Optional
6099-01h: Speed during search for switch	–	Optional
6099-02h: Speed during search for zero	–	Optional
609A: Home Acceleration	–	Optional
–	6064h: Position Actual Value	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

8.5.2 Homing Methods

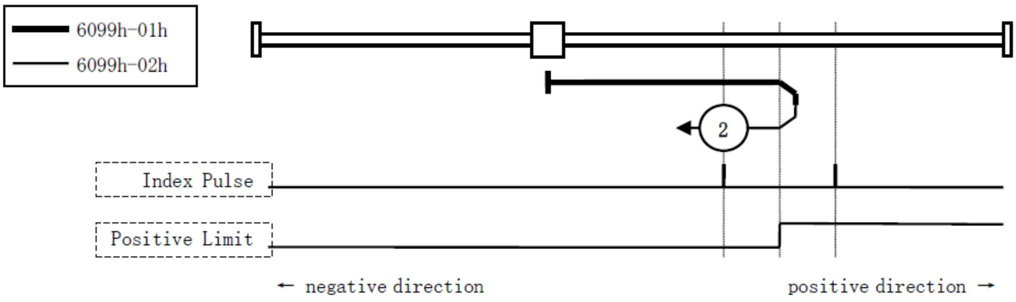
6098h=1 (Use C pulse and negative limit switch)

Servo drive needs to move at first toward negative direction fast till reaching the negative limit switch and then decelerate till stop. And then, servo motor will be bounced back slowly and find the target homing position. Under this homing method, the target homing position is the first C pulse away from the limit switch.



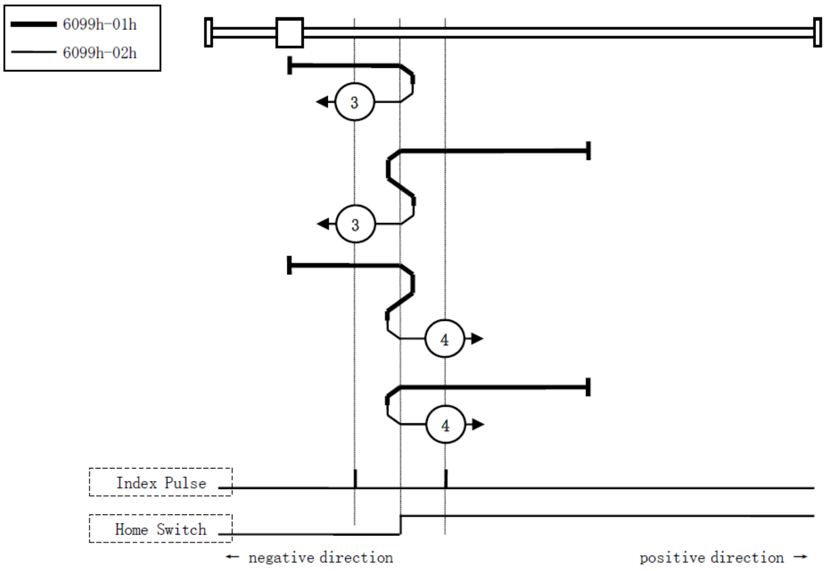
6098h=2 (Use C pulse and positive limit switch)

At first servo motor will move fast toward positive direction and decelerate to stop after reaching the positive limit switch. And then servo motor will be bounced back slowly to find homing position. Under this homing method, the target homing position is the first C pulse away from the limit switch.



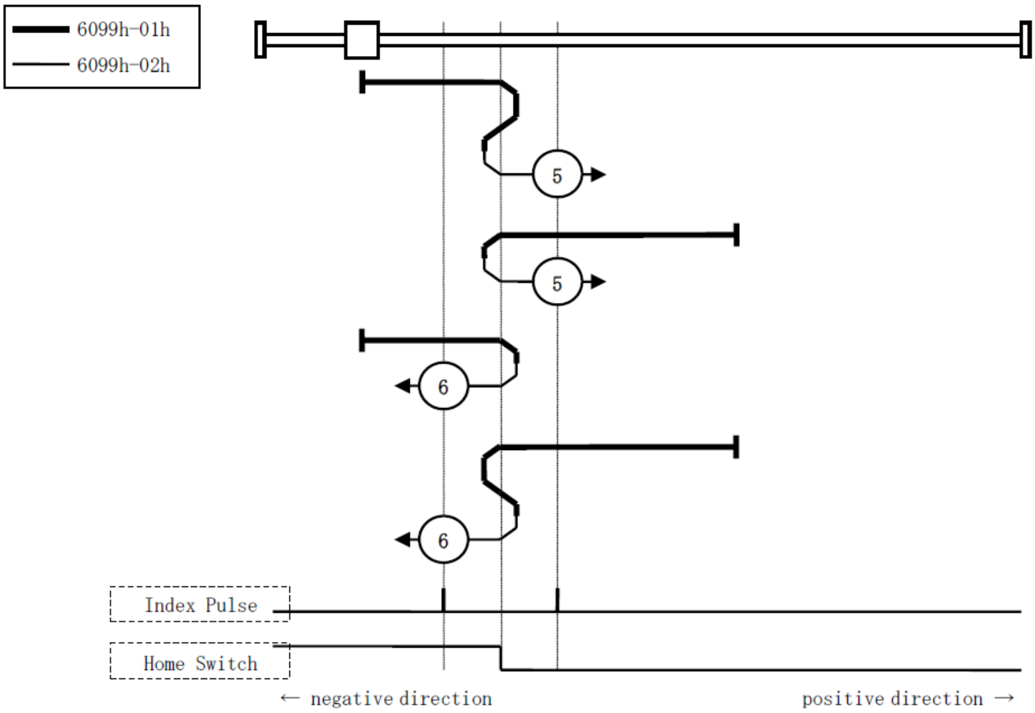
6098h=3 or 4 (Use C pulse and positive reference point limit switch)

It is used that reference point limit switch is on positive direction and negative direction is zero. That is on the end of movement positive direction. Servo drive’s initial moving direction is relied on the status of reference point limit switch. The target homing position is on the left side or right side of the reference limit switch. The distance between the reference position switch and homing position is one C pulse.



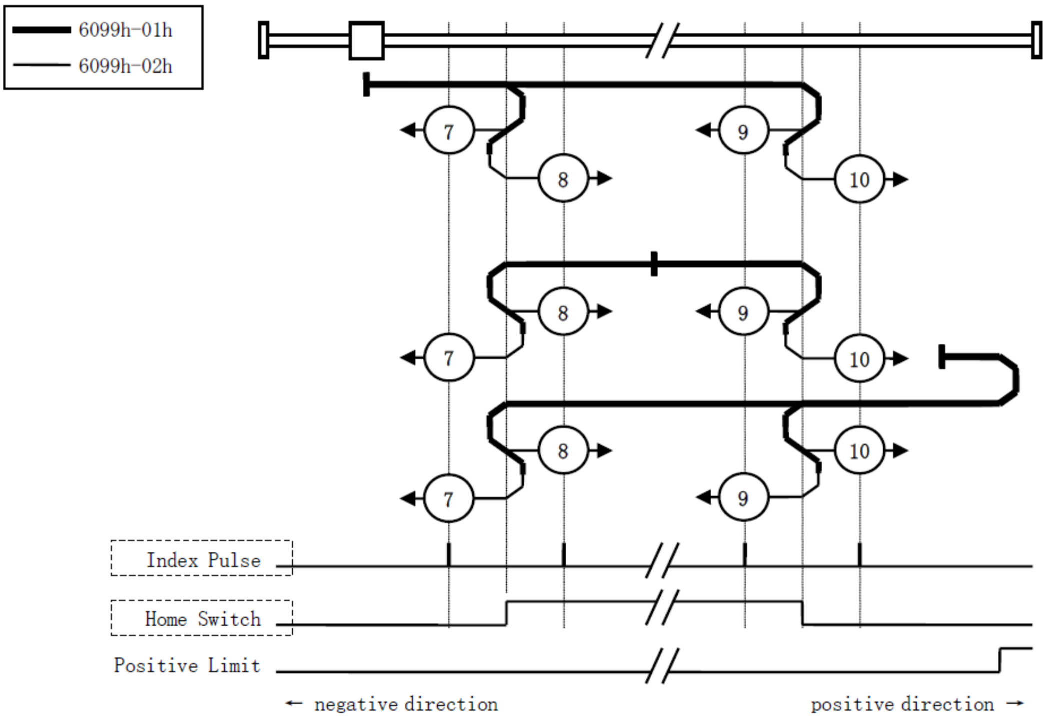
6098h=5 or 6 (Use C pulse and negative reference point limit switch)

It is used that reference point limit switch is on negative direction and positive direction is zero. That is on the edge of movement negative direction. Servo drive's initial moving direction is relied on the status of reference point limit switch. The target homing position is on the left side or right side of the reference limit switch. The distance between the reference position switch and homing position is one C pulse.



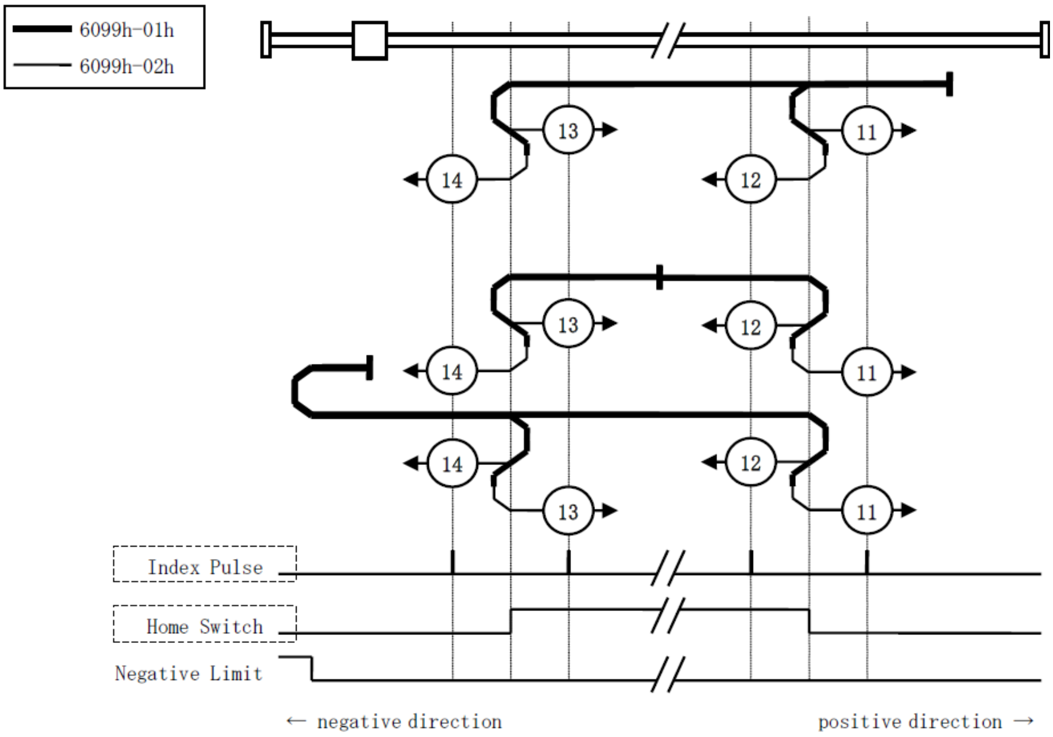
6098h=7 to 10 (Use C pulse, reference point limit switch and positive limit switch)

It is used that reference point limit switch is in the middle. And homing is according to C pulse , reference point limit switch and positive limit switch. The final mechanical point is the position of C pulse.



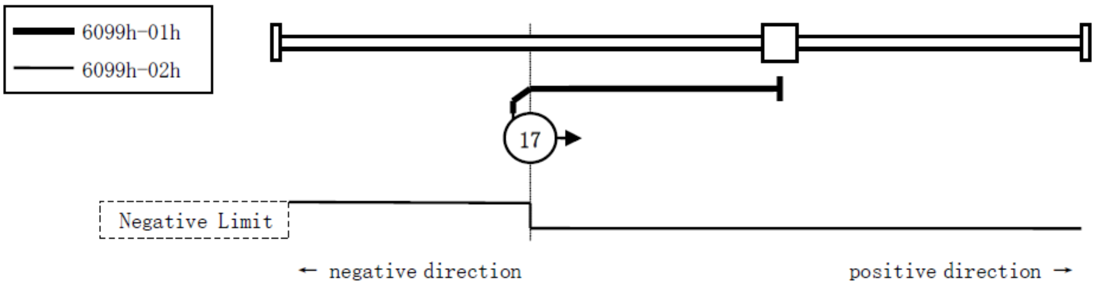
6098h=11 to 14 (Use C pulse, reference point limit switch and negative limit switch)

It is used that reference point limit switch is in the middle. And homing is according to C pulse, reference point limit switch and negative limit switch. The final mechanical point is the position of C pulse.



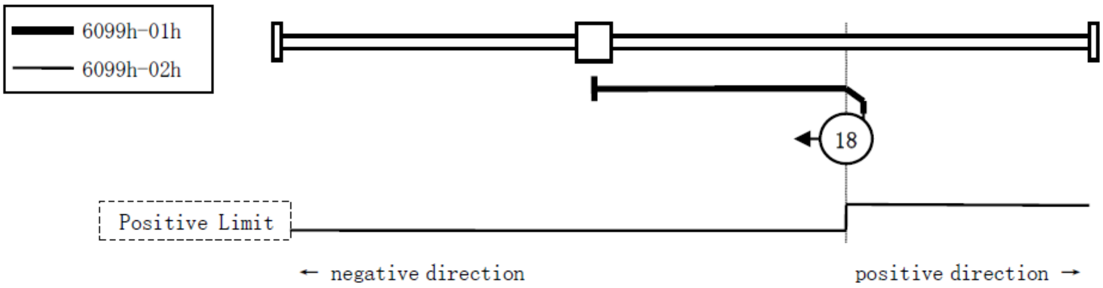
6098h=17 (Use negative limit switch)

It is similar to 6098h=1 (Use C pulse and negative limit switch), except that the target zero position no longer uses C-pulses and depends on negative limit switches.



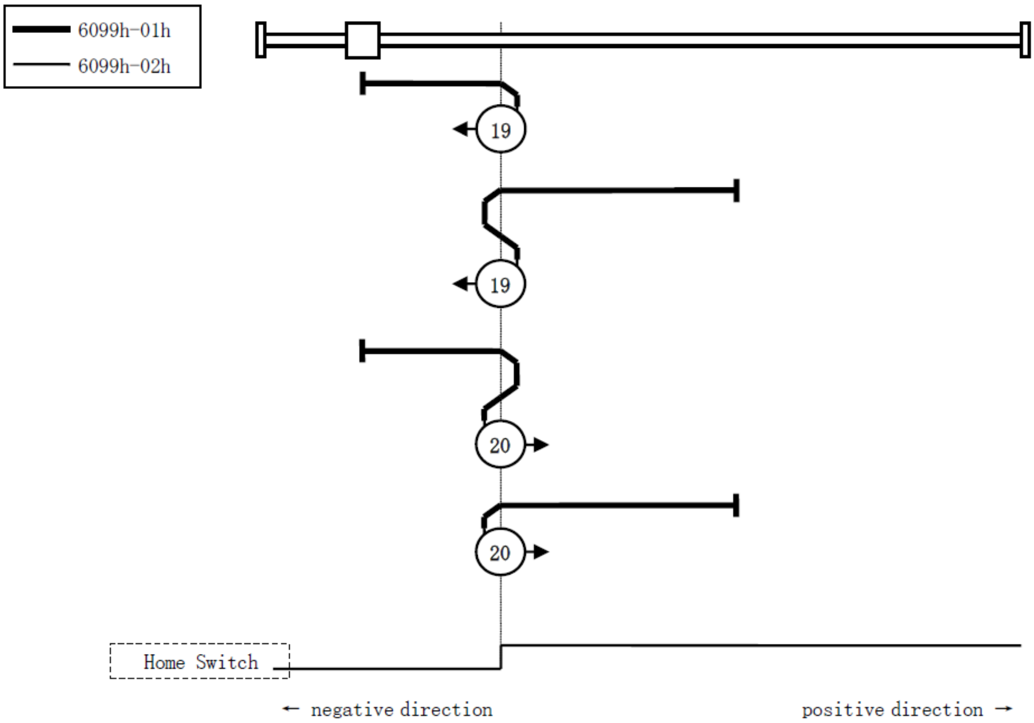
6098h=18 (Use positive limit switch)

It is similar to 6098h=2 (Use C pulse and positive limit switch), except that the target zero position no longer uses C-pulses and depends on positive limit switches.



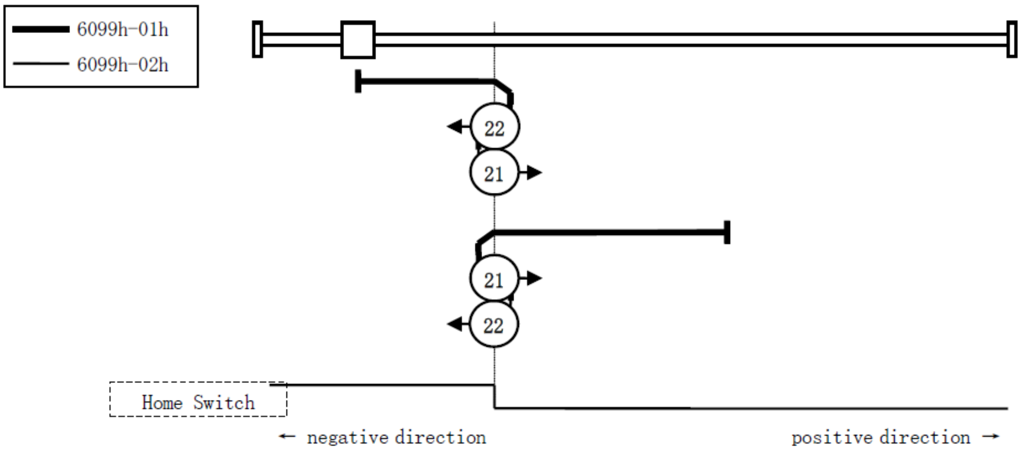
6098h=19 or 20 (Use reference point limit switch)

It is similar to 6098h=3 or 4 (Use C pulse and positive reference point limit switch), except that the target zero position no longer uses C-pulses and depends on reference point limit switches.



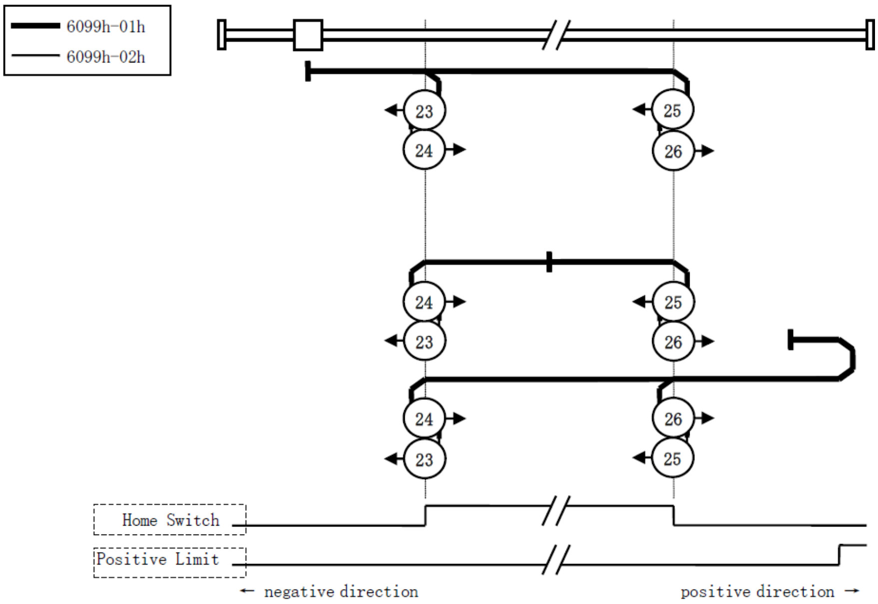
6098h=21 or 22 (Use reference point limit switch)

It is similar to 6098h=5 or 6 (Use C pulse and negative reference point limit switch), except that the target zero position no longer uses C-pulses and depends on reference point limit switches.



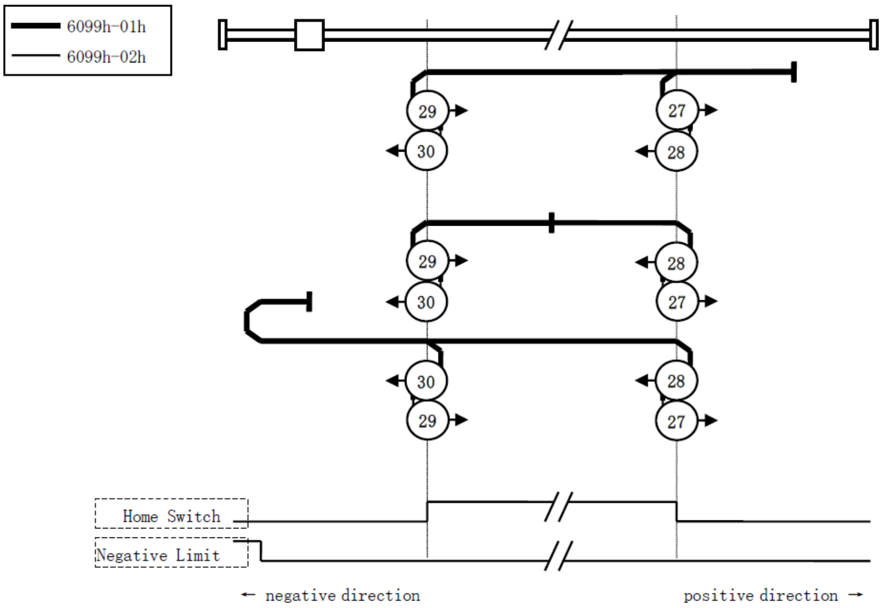
6098h=23 to 26

It is similar to 6098h=7 to 10 (Use C pulse, reference point limit switch and positive limit switch), except that the target zero position no longer uses C-pulses and depends on reference point limit switches and positive reference point limit.



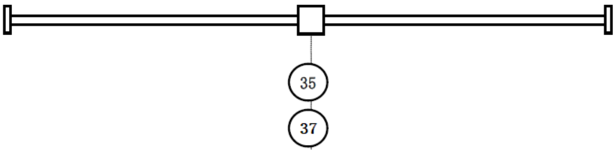
6098h=27 to 30

It is similar to 6098h=11 to 14 (Use C pulse, reference point limit switch and negative limit switch), except that the target zero position no longer uses C-pulses and depends on reference point limit switches and positive reference point limit.



6098h=35 or 37 (Homing on the current position)

In this method, the current position shall be taken to be the home position.



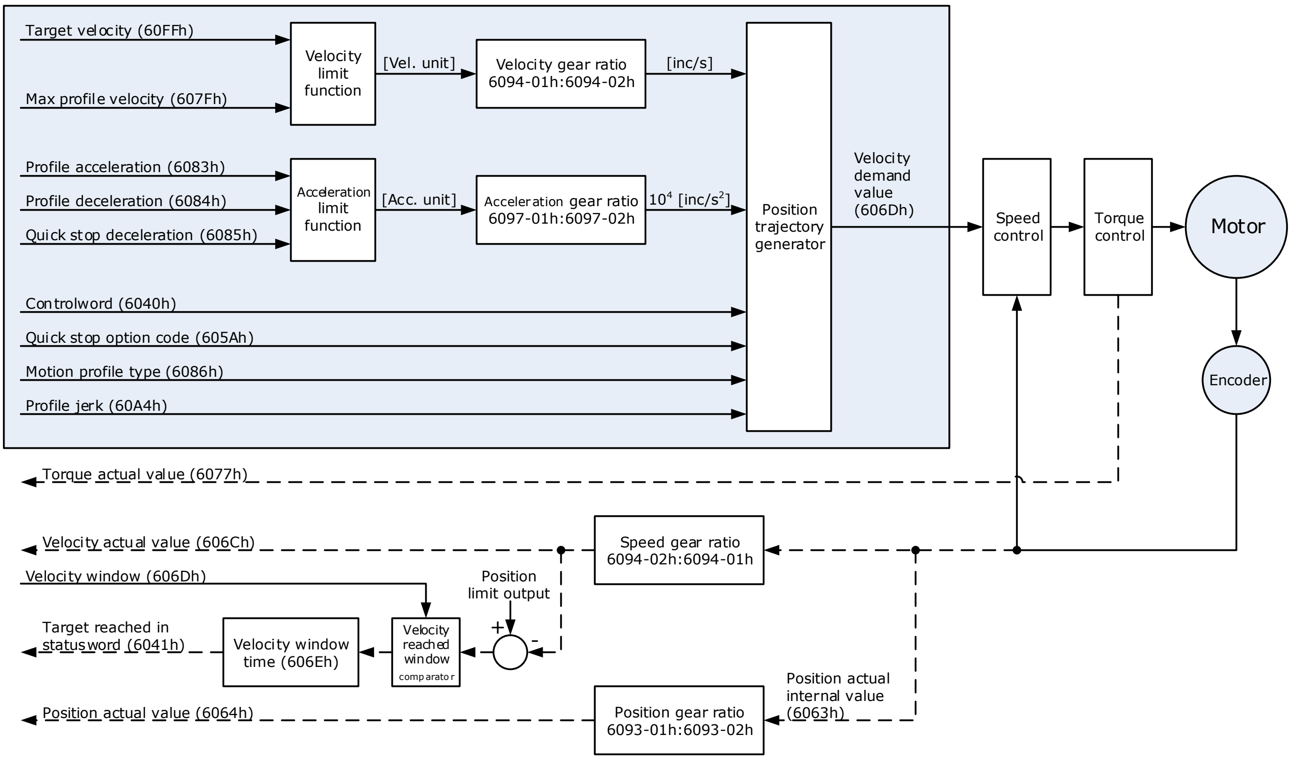
Note: Set 6098h as 37, allowing you perform Homing operation when Servo OFF.

8.6 Velocity Control

8.6.1 Profile Velocity (PV) Mode

In this mode of operation, the host controller gives the target speed, acceleration, and deceleration to the Drive. Speed control and torque control are performed by the Drive.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	
	1	Enable voltage	0	Disabled	
			1	Enabled	
	2	Quick stop	0	Disabled	
			1	Enabled	
	3	Enable operation	0	Disabled	
			1	Enabled	
	8	Halt	0	Executes or continues operation.	

Object	Bit	Name	Value	Description
			1	Stops the axis according to *Halt Option Code* (605Dh)
Statusword 6041h	10	Target reached	0	• Halt (Bit 8 in Controlword) = 0: Target position not reached • Halt (Bit 8 in Controlword) = 1: Axis decelerates
			1	• Halt (Bit 8 in Controlword) = 0: Target position reached • Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0
	12	Speed	0	Speed is not equal 0
			1	Speed is equal 0
	15	Homeflag	0	Homing not completed
			1	Homing completed

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
607F	00	Max Profile Velocity	RW	UINT32	Reference unit/s	0 to 4294967295	–
6063	00	Position Actual Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
6064	00	Position Actual Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
60FF	00	Target Velocity	RW	INT32	Reference unit/s	-2147483648 to 2147483647	0
606C	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
60E0	00	Positive Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
60E1	00	Negative Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125
31D4	00	Speed Feedforward	RW	INT32	%	0 to 100	0
31D5	00	Speed Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31D6	00	Torque Feedforward	RW	INT32	%	0 to 100	0
31D7	00	Torque Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31FC	00	Model Following Control Gain Correction	RW	INT32	%	20 to 500	100
31FE	00	Model Following Control Torque Feedforward	RW	INT32	%	0 to 200	100
3201	00	Limit for Load Oscillation Suppression	RW	INT32	rpm	0 to 1000	100
3169	00	Internal Torque Feedforward Method	RW	INT32	–	0 to 3	0
	02	Torque Feedforward Method	RW	INT32	–	0 to 3	0
	03	Speed Feedforward Method	RW	INT32	–	0 to 3	0

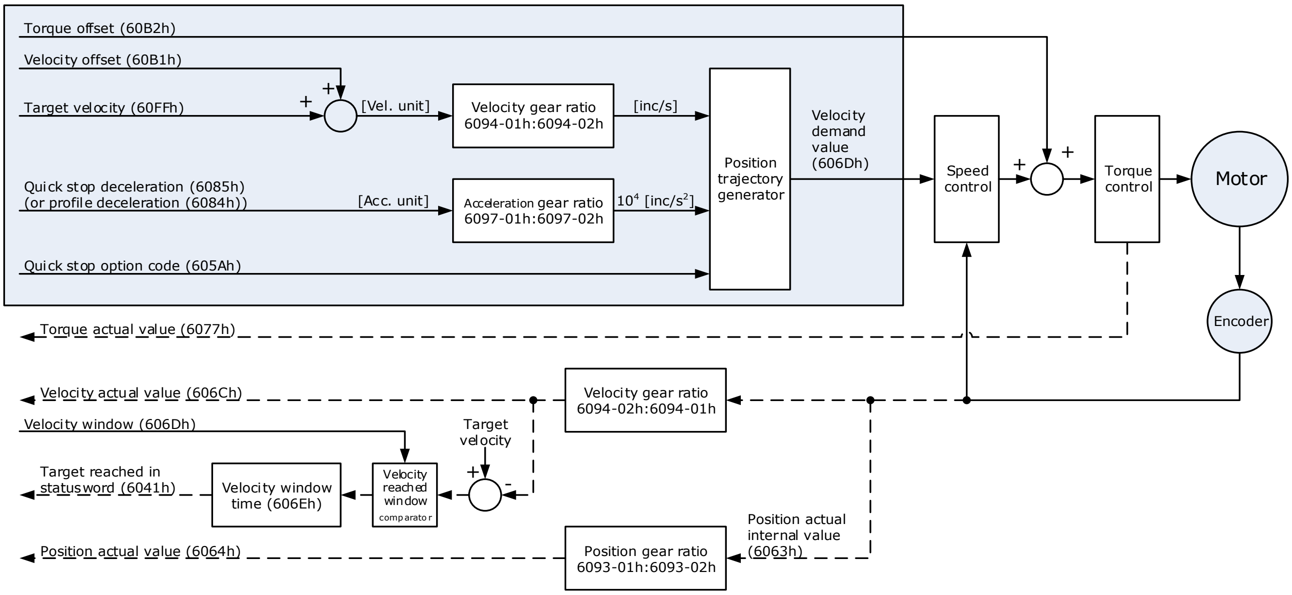
Recommended Configuration

RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
60FF: Target Velocity	–	Mandatory
–	6064h: Position Actual Value	Optional
–	606Ch: Velocity Actual value	Optional
6083h: Profile Acceleration	–	Optional
6084h: Profile Deceleration	–	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

8.6.2 Cyclic Synchronous Velocity (CSV) Mode

In this mode of operation, the host controller gives the target speed in 60FFh to the Drive using cyclic synchronization. Speed control and torque control are performed by the Drive.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	
	1	Enable voltage	0	Disabled	
			1	Enabled	
	2	Quick stop	0	Disabled	
			1	Enabled	
	3	Enable operation	0	Disabled	
			1	Enabled	
	8	Halt	0	Executes or continues operation.	
			1	Stops the axis according to *Halt Option Code* (605Dh)	
Statusword 6041h	10	Target reached	0	Reserved	
	12	Drive follows the command value	0	Drive does not follow the target value (position, velocity or torque)	
			1	Drive follows the target value (position, velocity or torque)	

Object	Bit	Name	Value	Description
	13	Following error	0	No following error
			1	Following error
	15	Homeflag	0	Homing not completed
			1	Homing completed

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation Display	RO	INT8	–	0 to 10	0
607F	00	Max Profile Velocity	RW	UINT32	Reference unit/s	0 to 4294967295	–
6063	00	Position Actual Internal Value	RO	INT32	Encoder unit	-2147483648 to 2147483647	–
6064	00	Position Actual Value	RO	INT32	Reference unit	-2147483648 to 2147483647	–
60FF	00	Target Velocity	RW	INT32	Reference unit/s	-2147483648 to 2147483647	0
606C	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
6083	00	Profile Acceleration	RW	UINT32	Reference unit/s^2	0 to 4294967295	0
6084	00	Profile Deceleration	RW	UINT32	Reference unit/s^2	0 to 4294967295	0
60B1	00	Velocity Offset	RW	INT32	Reference unit/s	-2147483648 to 2147483647	0
60B2	00	Torque Offset	RW	INT16	0.1%	–32768 to +32767	0
60E0	00	Positive Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
60E1	00	Negative Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125
31D4	00	Speed Feedforward	RW	INT32	%	0 to 100	0
31D5	00	Speed Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31D6	00	Torque Feedforward	RW	INT32	%	0 to 100	0
31D7	00	Torque Feedforward Filter Time	RW	INT32	0.1ms	0 to 640	0
31FC	00	Model Following Control Gain Correction	RW	INT32	%	20 to 500	100
31FE	00	Model Following Control Torque Feedforward	RW	INT32	%	0 to 200	100
3201	00	Limit for Load Oscillation Suppression	RW	INT32	rpm	0 to 1000	100
3169	00	Internal Torque Feedforward Method	RW	INT32	–	0 to 3	0
	02	Torque Feedforward Method	RW	INT32	–	0 to 3	0
	03	Speed Feedforward Method	RW	INT32	–	0 to 3	0

Recommended Configuration

RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
60FFh: Target Velocity	–	Mandatory
–	6064h: Position Actual Value	Optional
–	606Ch: Velocity Actual value	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

8.7 Torque Control

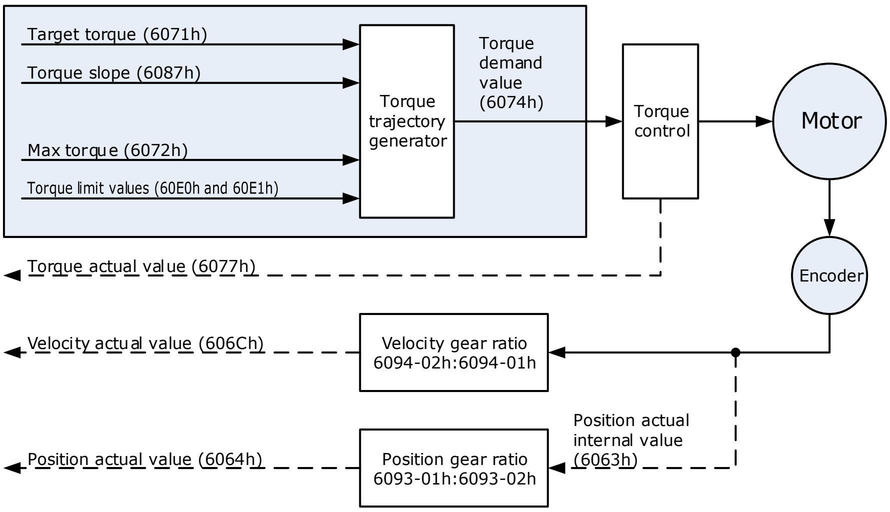
8.7.1 Profile Torque (PT) Mode

Important

PT mode settings： 6060h (Modes of operation)＝ “4”
Confirmation of PT mode： 6061h (Modes of operation display)＝ “4”

In this mode of operation, the host controller gives the target torque in 6071h and torque slope in 6087h to the Drive. Torque control is performed by the Drive. The Drive regulates the speed when the speed reaches the limit.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	
	1	Enable voltage	0	Disabled	
			1	Enabled	
	2	Quick stop	0	Disabled	
			1	Enabled	
	3	Enable operation	0	Disabled	
			1	Enabled	
	8	Halt	0	Executes or continues operation.	
			1	Stops the axis according to *Halt Option Code* (605Dh)	

Object	Bit	Name	Value	Description
Statusword 6041h	10	Target reached	0	• Halt (Bit 8 in Controlword) = 0: Target position not reached • Halt (Bit 8 in Controlword) = 1: Axis decelerates
			1	• Halt (Bit 8 in Controlword) = 0: Target position reached • Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0
	12	–	0	Reserved
	13	–	0	Reserved
	15	Homeflag	0	Homing not completed
			1	Homing completed

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
6071	00	Target Torque	RW	INT16	0.1%	-32768 to +32768	0
6072	00	Target Demand Value	RO	INT16	0.1%	–	–
6074	00	Target Demand Value	RO	INT16	0.1%	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
607F	00	Max Profile Velocity	RW	UINT32	Reference unit/s	0 to 4294967295	–
6087	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125

Recommended Configuration

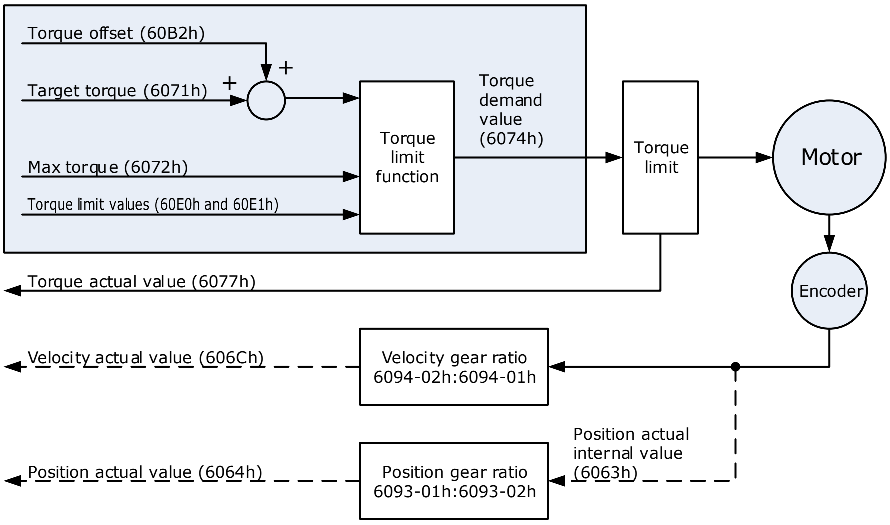
RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
6071h: Target Torque	–	Mandatory

RPDO	TPDO	Remarks
6087h: Target Slope	–	Optional
–	6064h: Position Actual Value	Optional
–	606Ch: Velocity Actual value	Optional
–	6077h: Torque actual value	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

8.7.2 Cyclic Synchronous Torque (CST) Mode

In this mode of operation, the host controller gives the target torque in 6071h to the Drive using cyclic synchronization. Torque control is performed by the Drive. The Drive regulates the speed when the speed reaches the limit.

Block Diagram



Speed Limit

The speed limit is determined by the smaller of 6080h value and 607F value.

Relevant Objects

Object	Bit	Name	Value	Description	
Controlword 6040h	0	Switch on	0	Disabled	If Bit0 to Bit3 are all 1, the Drive starts running.
			1	Enabled	
	1	Enable voltage	0	Disabled	
			1	Enabled	
	2	Quick stop	0	Disabled	
			1	Enabled	
	3	Enable operation	0	Disabled	

Object	Bit	Name	Value	Description
			1	Enabled
	8	Halt	0	Executes or continues operation.
			1	Stops the axis according to *Halt Option Code* (605Dh)
Statusword 6041h	10	Target reached	0	Reserved
	12	Drive follows the command value	0	Drive does not follow the target value (position, velocity or torque)
			1	Drive follows the target value (position, velocity or torque)
	13	Following error	0	No following error
			1	Following error
	15	Homeflag	0	Homing not completed
			1	Homing completed

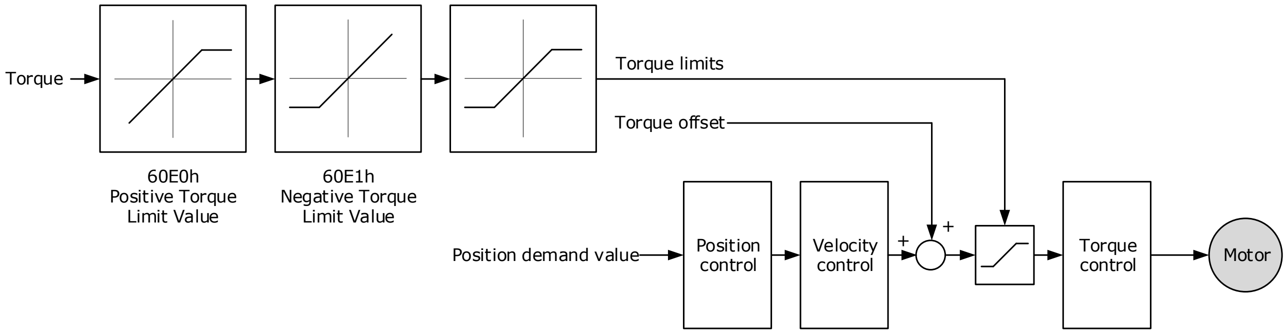
Index	Subindex	Name	Access	Data Type	Unit	Range	Default
603F	00	Error Code	RO	UINT16	–	0 to 65535	0
6040	00	Controlword	RW	UINT16	–	0 to 65535	0
6041	00	Statusword	RO	UINT16	–	0 to 0xFFFF	0
6060	00	Modes of operation	RW	INT8	–	0 to 10	0
6061	00	Modes of Operation display	RO	INT8	–	0 to 10	0
606C	00	Velocity Actual value	RO	INT32	Reference unit/s	–	–
6071	00	Target Torque	RW	INT16	0.1%	-32768 to +32768	0
6074	00	Target Demand Value	RO	INT16	0.1%	–	–
6077	00	Torque actual value	RO	INT16	0.1%	-5000 to 5000	0
60B2	00	Torque Offset	RW	INT16	0.1%	–32768 to +32767	0
60E0	00	Positive Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
60E1	00	Negative Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500
31CB	00	Speed Loop Integral Time	RW	INT32	0.1ms	1 to 5000	125

Recommended Configuration

RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
6071h: Target Torque	–	Mandatory
–	6064h: Position Actual Value	Optional
–	606Ch: Velocity Actual value	Optional
–	6077h: Torque actual value	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

8.8 Torque Limits

The following figure shows the block diagram for the torque limits. The torque is limited by the objects 60E0h and 60E1h.



Positive Torque Limit Value (60E0h)

This object sets the positive torque limit. Set the value in units of 0.1% of the Motor rated torque.

The positive torque limit value is the smaller of 6072h and 60E0h.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60E0	00	PosTorLimit	RW	UINT16	–	0 to 3000	3000

Negative Torque Limit Value (60E1h)

This object sets the negative torque limit. Set the value in units of 0.1% of the Motor rated torque.

The negative torque limit value is the smaller of 6072h and 60E1h.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60E1	00	NegTorLimit	RW	UINT16	–	0 to 3000	3000

8.9 Digital and Remote I/O Signals

Digital Inputs (60FDh)

This object gives the status of the digital inputs to CN1 on the Drive.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60FDh	0	Digital Inputs	UINT32	RO	Yes	–

Bit	Signal	Description
0	NOT	0: Switched off; 1: Switched on
1	POT	0: Switched off; 1: Switched on
2	Home switch	0: Switched off; 1: Switched on
3 to 15	–	Reserved
16	CN1-14	0: Switched off (Active); 1: Switched on (Inactive)
17	CN1-15	0: Switched off (Active); 1: Switched on (Inactive)
18	CN1-16	0: Switched off (Active); 1: Switched on (Inactive)
19	CN1-17	0: Switched off (Active); 1: Switched on (Inactive)
20	CN1-18	0: Switched off (Active); 1: Switched on (Inactive)
21 to 35	—	Reserved

📖 NOTE

If the corresponding bit of Pn509 and Pn510 has been set to **Remote**, the input signal on CN1 terminal is only used as remote input IO, and the Drive will ignore its status.

Digital Outputs (60FEh)

This object controls the status of both general-purpose output signals and remote output signals from CN1 on the Drive. 60FE-01h is used to control the status of the output signals. 60FE-02h determines which output signals in subindex 1 are enabled.

The Bit16 to Bit19 in 60FE-01h can only assign to the general-purpose output signals on CN1, and set the *Bit mask* (60EF-02h) to 1 for enabling them. And then, according to the settings of Pn509 and Pn510 to allocate the desired signals, also you can choose whether to reverse them by the setting of Pn516 and Pn517.

For the bits transmitted on the bus, you also need to set Pn512 and Pn513 to enable it.

The Bit24 to Bit27 in 60FE-01h can assign to the remote output signals on CN1, and according to the setting of Pn511 to allocate the desired signals, using as a remote IO for the master station.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60FEh	0	Digital outputs	UINT8	RO	No	2
	1	Physical outputs	UINT32	RW	Yes	0 to 0xFFFFFFFF Default: 0

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
	2	Bit mask	UINT32	RW	Yes	0 to 0xFFFFFFFF Default: 0

Bit	Signal	Description
0 to 15	–	Reserved
16	CN1-14	0: Switched off (Active), 1: Switched on (Inactive)
17	CN1-15	0: Switched off (Active), 1: Switched on (Inactive)
18	CN1-16	0: Switched off (Active), 1: Switched on (Inactive)
19	CN1-17	0: Switched off (Active), 1: Switched on (Inactive)
20	CN1-18	0: Switched off (Active), 1: Switched on (Inactive)
21 to 23	–	Reserved
24	Remote0	0: Switched off (Active), 1: Switched on (Inactive)
25	Remote1	0: Switched off (Active), 1: Switched on (Inactive)
26 to 31	–	Reserved

8.10 Touch Probe

You can latch the feedback position with the following trigger events.

- Trigger with Touch Probe Input 1 (EXT1 signal)
- Trigger with Touch Probe Input 2 (EXT2 signal)
- Trigger with encoder zero signal (phase C)

The following two touch probe latches can be used at the same time.

- Touch Probe Input 1
  - Latch control object: 60B8h (bits 0 to 7)
  - Latch status object: 60B9h (bits 0 to 7)
  - The latched position is always stored in touch probe 1 position value (60BAh and 60BBh).
  - Trigger signal: Encoder zero signal or EXT1 signal
- Touch Probe Input 2
  - Latch control object: 60B8h (bits 8 to 15)
  - Latch status object: 60B9h (bits 8 to 15)
  - The latched position is always stored in touch probe 2 position value (60BCh and 60BDh).
  - Trigger signal: Encoder zero signal or EXT2 signal

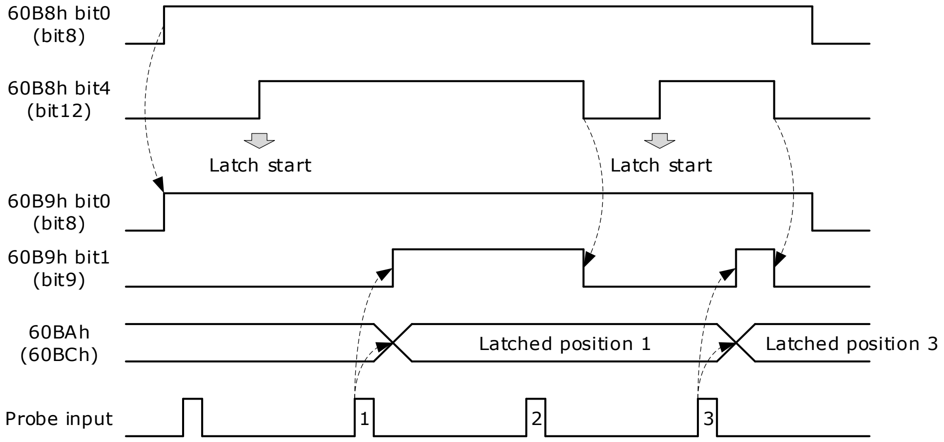
The relevant objects used in this function are as following:

Index	Subindex	Name	Access	Data Type	PDO Mapping	Default
60B8	00	Touch Probe Function	RW	UINT16	Yes	–

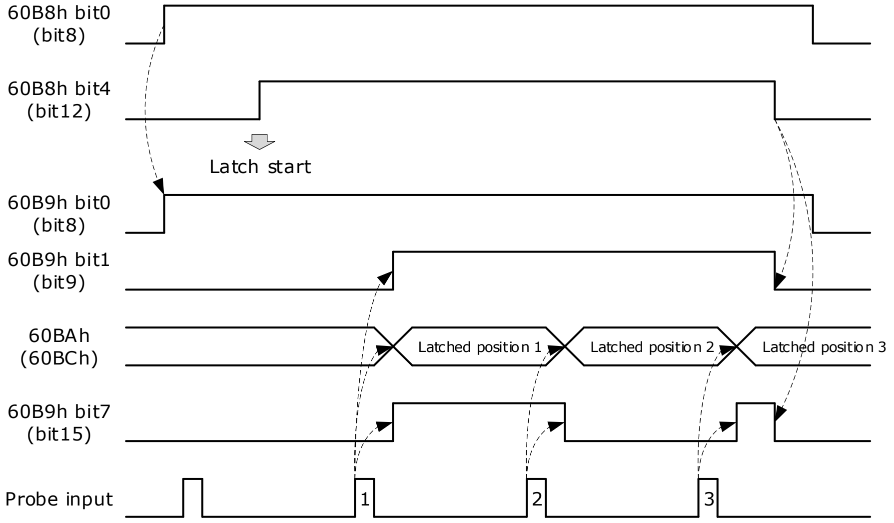
Index	Subindex	Name	Access	Data Type	PDO Mapping	Default
60B9	00	Touch Probe Status	RO	UINT16	Yes	–
60BA	00	Touch Probe Pos 1 Pos Value	RO	INT32	Yes	–
60BB	00	Touch Probe Neg 1 Pos Value	RO	INT32	Yes	–
60BC	00	Touch Probe Pos 2 Pos Value	RO	INT32	Yes	–
60BD	00	Touch Probe Neg 2 Pos Value	RO	INT32	Yes	–

The examples of execution procedure for a Touch Probe are as following:

- Single Trigger Mode (60B8h bit1=0, or bit9=0)



- Continuous Trigger Mode (60B8h bit1=1, or bit9=1)



60B8h: Touch Probe Function

This object sets the touch probes.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60B8	00	Touch Probe Function	RW	UINT16	–	0 to 0xFFFF	0

The data description is as following.

Bit	Value	Definition
0	0	Disables touch probe 1.
	1	Enables touch probe 1.
1	0	Single Trigger Mode (Latches the position at the first trigger event).
	1	Continuous Trigger Mode (Latches the position every trigger event).
2	0	Triggers on probe 1 input (CN1-1, EXT1 signal).
	1	Triggers on encoder zero signal (phase C).
3	0	Reserved
4	0	Disables the sampling at the rising edge of touch probe 1 input
	1	Enables the sampling at the rising edge of touch probe 1 input
5	0	Disables the sampling at the falling edge of touch probe 1 input
	1	Enables the sampling at the falling edge of touch probe 1 input
6, 7	0	Reserved
8	0	Disables touch probe 1.
	1	Enables touch probe 1.
9	0	Single Trigger Mode (Latches the position at the first trigger event).
	1	Continuous Trigger Mode (Latches the position every trigger event).
10	0	Triggers on probe 2 input (CN1-3, EXT2 signal).
	1	Triggers on encoder zero signal (phase C).
11	0	Reserved
12	0	Disables the sampling at the rising edge of touch probe 2 input
	1	Enables the sampling at the rising edge of touch probe 2 input
13	0	Disables the sampling at the falling edge of touch probe 2 input
	1	Enables the sampling at the falling edge of touch probe 2 input
14, 15	0	Reserved

60B9h: Touch Probe Status

This object gives the status of the touch probes.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60B9	00	Touch Probe Status	RO	UINT16	–	–	–

Bit	Value	Definition
0	0	Touch probe 1 is disabled.
	1	Touch probe 1 is enabled.
1	0	No latched position of the rising edge is stored for touch probe 1.
	1	A latch position of the rising edge is stored for touch probe 1.
2	0	No latched position of the falling edge is stored for touch probe 1.
	1	A latch position of the falling edge is stored for touch probe 1.
3 to 5	0	Reserved
6, 7	0 to 3	Record the number of the touch probe 1 executions in the Continuous Trigger Mode. Values are cycled between 0 and 3.
8	0	Touch probe 2 is disabled.
	1	Touch probe 2 is enabled.
9	0	No latched position of the rising edge is stored for touch probe 2.
	1	A latch position of the rising edge is stored for touch probe 2.
10	0	No latched position of the falling edge is stored for touch probe 2.
	1	A latch position of the falling edge is stored for touch probe 2.
11 to 13	0	Reserved
14, 15	0	Record the number of the touch probe 2 executions in the Continuous Trigger Mode. Values are cycled between 0 and 3.

60BAh: TouchProbePos1PosValue

This object gives the latched position of the rising edge for touch probe 1.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60BA	00	TouchProbePos1PosValue	RO	INT32	–	–	–

60BBh: TouchProbeNeg1PosValue

This object gives the latched position of the falling edge for touch probe 1.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60BB	00	TouchProbeNeg1PosValue	RO	INT32	–	–	–

60BCh: TouchProbePos2PosValue

This object gives the latched position of the rising edge for touch probe 2.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60BC	00	TouchProbePos2PosValue	RO	INT32	–	–	–

60BDh: TouchProbeNeg2PosValue

This object gives the latched position of the falling edge for touch probe 2.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60BD	00	TouchProbeNeg2PosValue	RO	INT32	–	–	–

Pn509.3、Pn510.0 parameter

Pn509.3 and Pn510.0 parameters are mainly used to distribute signals to PIN CN1-17 and PIN CN1-18 respectively, and the set values 8 and 9 correspond to EXT1 (Probe TouchProbe Input 1) and EXT2 (Probe TouchProbe Input 2), respectively.

Parameter	Name	Setpoint	Meaning	Nefault	When to take effect
Pn509.3	CN1-17 Distribute the signal	8	Probe TouchProbe enter 1	8	Reboot
		9	Probe TouchProbe enter 2		
		0~7	Other signals		
Pn510.0	CN1-18 Distribute the signal	8	Probe TouchProbe enter 1	9	
		9	Probe TouchProbe enter 2		
		0~7	Other signals		

Pn332 parameter

The Pn332 is primarily used to set the filter time of the TouchProbe function input pins。

Parameter	Name	Range	Unit	Default	When to take effect
Pn332	Touch probe Input signal filtering time	0～200	10 ns	20	Restart the unit

Pn516.3、Pn517.0 parameter

The user can choose whether to reverse the CN1-17 distribution signal and the CN1-18 distribution signal through Pn516.3 and Pn517.0 parameters, which generally needs to be set according to the actual input signal level used。

Parameter	Setpoint	Meaning	When to take effect
Pn516.3	0	No anti-CN1-17 distribution signal (effective at low levels)	Reboot
	1	Reverse CN1-17 distribution signal (effective at high level)	
Pn517.0	0	No anti-CN1-18 distribution signal (effective at low level)	
	1	Reverse CN1-18 distribution signal (effective at high level)	

8.11 Soft Limit Function

This object defines the absolute positions of the limits to the target position (position demand value). Every target position is checked against these limits.

The limit positions are specified in user-defined position reference units, the same as for target positions, and are always relative to the machine home position.

The limit values are corrected internally for the home offset as given below. The target positions are compared with the corrected values.

- Corrected minimum position limit = Min position limit – Home offset (607Ch)
- Corrected maximum position limit = Max position limit – Home offset (607Ch)

The software position limits are enabled at the following times:

- When homing is completed
- When an absolute encoder is connected

The software limits are enabled if Min position limit < Max position limit.

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
607D	00	Software position	RO	UINT8	–	0 to 65535	0
	01	Min position limit	RW	INT32	–	-2147483648 to 2147483647	–
	02	Max position limit	RW	INT32	–	-2147483648 to 2147483647	–

8.12 Position Comparison Function

The Position Comparison (PSO) function applies the real-time position data to compare it with the values stored in the data array in advance and, when the comparison condition holds, immediately outputs a DO signal with settable pulse width or settable level status for subsequent motion control.

8.12.1 Related Parameters

S/N	Name	Description	Parameter Range & Factory Default	Pn Parameter	When enabled
1	CN1O Pin Assign PSO1 Signal	Set to assign the PSO1 signal for the corresponding pin of D	Range: 0000~00DD, Factory default: 0010	Pn511	After restart

2	PSO1 Position Value Resolution	Number of pulses to be added to the position value for one revolution of the motor 0: 2e24 1: 2e23 2: 2e22 3: 2e21 4: 2e20 5: 2e19 6: 2e18 7: 2e17 8: 2e16 9: 2e15 10: 2e14	Range: 0~10, Factory default: 7	Pn600	After restart
3	PPSO1 Comparison Mode Selection	PSO mode setting: bit0: 0: Absolute position comparison mode 1: Incremental position comparison mode bit1: 0: Single comparison 1: Cyclic comparison	Range: b0000~b0011, Factory default: b0000	Pn601	PSO1 Function After bit0 is set to 1 from 0
4	PSOO1 Output Type Selection	Output type selection: 0: Initial level is low, active level is high 1: Initial level is high, active level is low	Range: 0~1, Factory default: 0	Pn602	After restart
5	PSO1 Output Polarity	Output type selection: 0: Pulse width output 1: Level output	Range: 0~1, Factory default: 0	Pn603	After restart
6	PSO1 Output Pulse Width Setting	Pulse output width Ranged from 1 to 10,000, in 100us.	Range: 1~10000, Factory default: 100	Pn604	PSO1 Function After bit0 is set to 1 from 0
7	PSO1 Output Delay Compensation Time	Time delay compensation time Ranged from 0 to 200, in 1us.	Range: 1~200, Factory default: 0	Pn605	
8	PSO1 Origin Offset	After setting the Origin, the current position is updated to the home offset value, ranged from -2e31 to 2e31-1	Range: -2147483648~2147483647, Factory default: 0	Pn606	
9	PSO1 Starting Point of Comparison		Range: 1~20, Factory default:1	Pn607	
10	PSO1 Ending Point of Comparison		Range: 1~20, Factory default:8	Pn608	

11	Attribute of PSO1 Comparison Point 1	①When the output mode is pulse output 0: Comparison logic skips the point 1: Traverses forward the comparison point and outputs 2: Traverses backward the comparison point and outputs 3: Reverses the comparison point forward and backward and outputs 4~6: Comparison logic skips the point ②When the output mode is level output 0: Comparison logic skips the point 1: Traverses forward the comparison point and outputs; the output level is active 2: Traverses backward the comparison point and outputs; the output level is active 3: Forward and reverse crossing of the comparison point and outputs; the output level is active 4: Traverses forward the comparison point and outputs; output level is initial one 5: Traverses backward the comparison point and outputs; the output level is the initial one 6: Traverses the comparison point forward and backward and outputs; the output level is the initial one	Range: 0~6, Factory default: 0	Pn609	
12	Target Position of PSO1 Comparison Point 1	The target position of Comparison Point 1	Range: -2147483648~2147483647, Factory default: 0	Pn610	
13	Attribute of PSO1 Comparison Point 2	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn611	
14	Target Position of PSO1 Comparison Point 2	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn612	
15	Attribute of PSO1 Comparison Point 3	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn613	
16	Target Position of PSO1 Comparison Point 3	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn614	

17	Attribute of PSO1 Comparison Point 4	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn615	
18	Target Position of PSO1 Comparison Point 4	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn616	
19	Attribute of PSO1 Comparison Point 5	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn617	
20	Target Position of PSO1 Comparison Point 5	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn618	
21	Attribute of PSO1 Comparison Point 6	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn619	
22	Target Position of PSO1 Comparison Point 6	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn620	
23	Attribute of PSO1 Comparison Point 7	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn621	
24	Target Position of PSO1 Comparison Point 7	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn622	
25	Attribute of PSO1 Comparison Point 8	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn623	
26	Target Position of PSO1 Comparison Point 8	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn624	
27	Attribute of PSO1 Comparison Point 9	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn625	PSO1 Function After bit0 is set to 1 from 0
28	Target Position of PSO1 Comparison Point 9	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn626	
29	Attribute of PSO1 Comparison Point 10	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn627	
30	Target Position of PSO1 Comparison Point 10	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn628	
31	Attribute of PSO1 Comparison Point 11	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn629	
32	Target Position of PSO1 Comparison Point 11	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn630	
33	Attribute of PSO1 Comparison Point 12	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn631	
34	Target Position of PSO1 Comparison Point 12	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn632	
33	Attribute of PSO1 Comparison Point 13	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn633	
34	Target Position of PSO1 Comparison Point 13	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn634	

35	Attribute of PSO1 Comparison Point 14	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn635	
36	Target Position of PSO1 Comparison Point 14	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn636	
37	Attribute of PSO1 Comparison Point 15	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn637	
38	Target Position of PSO1 Comparison Point 15	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn638	
39	Attribute of PSO1 Comparison Point 16	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn639	
40	Target Position of PSO1 Comparison Point 16	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn640	
41	Attribute of PSO1 Comparison Point 17	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn641	
42	Target Position of PSO1 Comparison Point 17	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn642	
43	Attribute of PSO1 Comparison Point 18	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn643	
44	Target Position of PSO1 Comparison Point 18	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn644	
45	Attribute of PSO1 Comparison Point 19	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn645	
46	Target Position of PSO1 Comparison Point 19	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn646	
47	Attribute of PSO1 Comparison Point 20	Consistent with Pn609	Range: 0~6, Factory default: 0	Pn647	
48	Target Position of PSO1 Comparison Point 20	Consistent with Pn610	Range: -2147483648~2147483647, Factory default: 0	Pn648	

S/N	Name	Specification	Definition	Attribute
1	PSO1 Function	bit0: comparison of output enable	0: Turn off the PSO1 comparison output and set PSO1 State bit0 to 0 1: After setting from 0 to 1, turn on the PSO1 comparison output and set PSO1 State bit0 to 1 at the same time	0x30B0 RW YES Uint16
		bit1: Origin setting	0: Set PSO1 State bit1 to 0 1: After setting from 0 to 1, update the current position to the home bias value (Pn606) and set PSO1 State bit1 to 1 after the update is done	
		bit2: Single adjustment of current position	0: Set PSO1 State bit2 to 0 1: After setting from 0 to 1, adjust the current position in real time and set PSO1 State bit2 to 1 after the adjustment is done	

2	PSO1 Current State Position Adjustment Value	PSO1 current position adjustment value	After PSO1 Function bit2 is changed from 0 to 1, the Current Position = Current Position + Adjusted Value	0x30B1 RW YES Uint16
3	PSO1 State	bit0: comparison output in progress	0: Comparison output not in progress 1: Comparison output in progress	0x30C0 RO YES Uint16 Un026
		bit1: Origin setting done	0: Origin setting not done 1: Origin setting done	
		bit2: Single adjustment of current position done	0: Current position not adjusted 1: Current position adjusted	
4	PSO1 Current State Target Comparison Point			0x30C1 RO YES Uint16 Un027
5	PSO1 Current Position			0x30C2 RO YES Uint16 Un028

8.12.2 PSO Function Operation

PSO ON

Set the PSO1 Function bit0 from 0 to 1 to turn on the PSO function. The target comparison point of PSO1 current state is the starting one, and PSO1 State bit0 is set to 1.

Set the PSO1 Function bit0 to 0 to turn off the PSO function. The current comparison status is reset and PSO1 State bit0 is set to 0.

Position Value Resolution

Pn600 is used to set the position value resolution for PSO. The resolution is defined as the number of pulses accumulated by the PSO1 position value for one revolution of the motor. The position value resolution for PSO does not need to be aligned with the encoder resolution, it is only associated with Pn600. The resolution of the position value can be reduced when the position value falls beyond the range of int32.

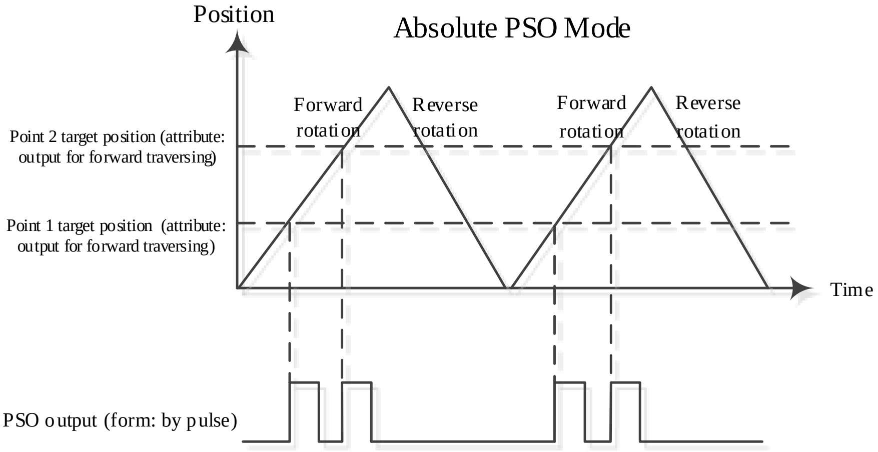
Comparison Mode Selection

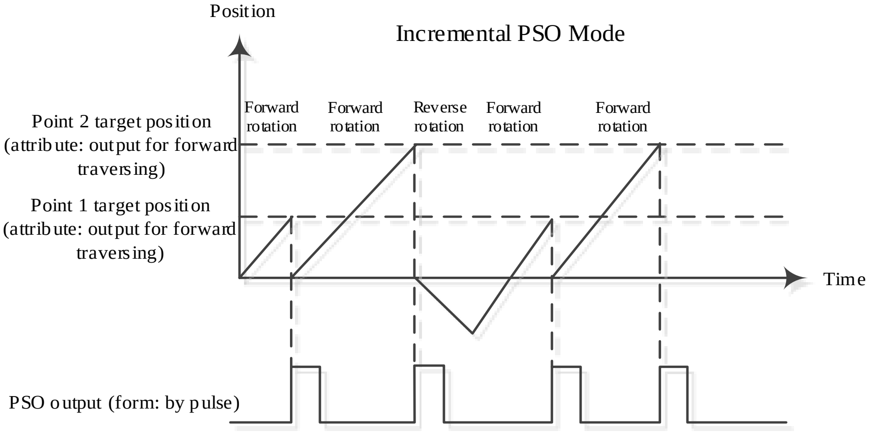
The Pn601 is used to set the comparison mode.

(1) Absolute and Incremental Comparison Mode

Set Pn601.0 to 0: By selecting the absolute position comparison mode, each target comparison point position is absolute. The current position is not reset after each comparison point is completed.

Set Pn601.0 to 1: By selecting the incremental position comparison mode, each target comparison point position is incremental. After each comparison point is completed, the current position is automatically reset and recounted.





(2) Single Comparison and Cyclic Comparison

Set Pn601.1 to 0: By selecting the Single Comparison mode, when the point comparison is ended, the comparison enable is turned off automatically and PSO1 State bit0 is set to 0. When setting PSO1 Function bit0 from 0 to 1, the PSO function is turned on again.

Set Pn601.1 to 1: By selecting the Cyclic Comparison mode, when the the point comparison is ended, the comparison enable is not turned off, and the comparison point of current state is reset to the starting one for cyclic comparison.

Output Level Polarity

Set Pn602 to adjust the output level polarity.

Set Pn602 to 0: initial level is low, while active level is high

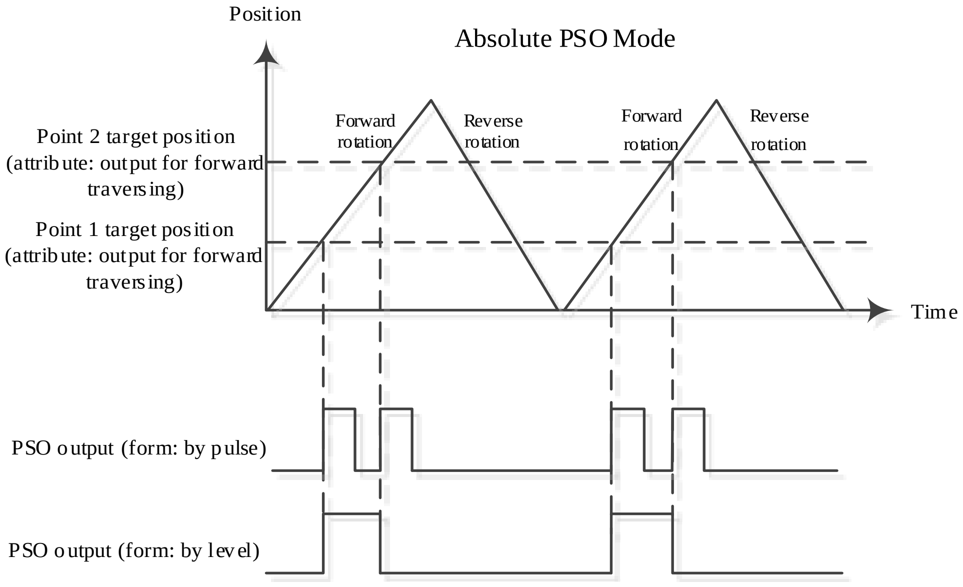
Set Pn602 to 1: initial level is high, while active level is low

Output Type Setting

Pn603 is used to set the output type of the PSO.

Set Pn603 to 0: The PSO outputs a pulse signal with a settable width.

Set Pn603 to 1: The PSO outputs a level signal with a settable level.



Pulse Output Width Setting

When the PSO output type is of a pulse width, the output pulse width can be set via the Pn604, ranging from 1 to 10,000, in 100μs.

Origin Setting

By setting PSO1 Function bit1 from 0 to 1, the current position is updated to the Origin Bias (Pn606), and PSO1 State bit1 is set to 1.

Set both the PSO1 Function bit1 and PSO1 State bit1 to 0.

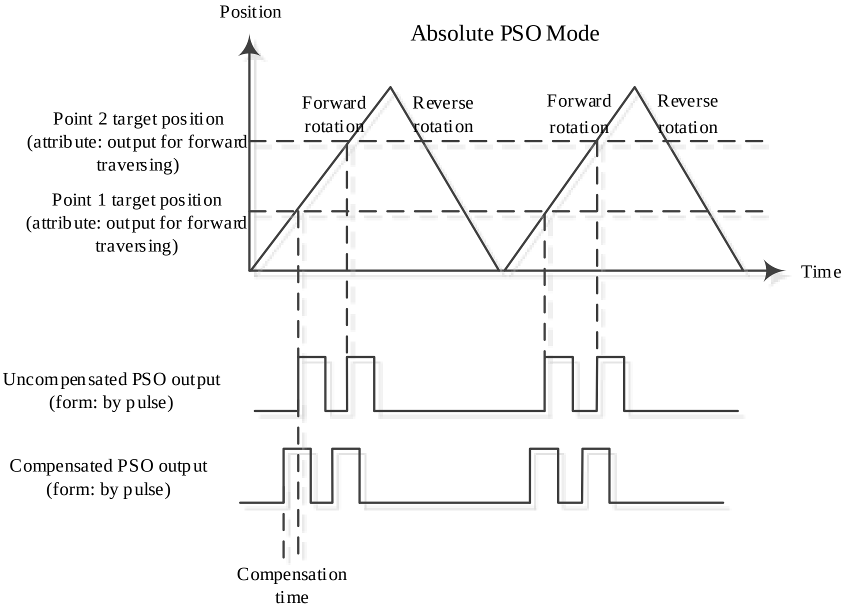
Single Adjustment of Current Position

After Setting PSO1 Function bit2 from 0 to 1, the current position is adjusted in real time, and the Current Position = Current Position + Adjustment Value (written via 0x30B1). Then, set the PSO1 State bit2 to 1.

Set both the PSO1 Function bit2 and PSO1 State bit2 to 0.

Time Delay Compensation

When the terminal device receiving the PSO DO signal has a response delay, or when there’s a delay in the transmission of the PSO DO signal, the delay compensation time can be set via the Pn605 and the PSO output will be output earlier, thereby offsetting the effect of the delay.



8.13 Absolute Encoder Settings (Fn010, Fn011)

Way to set the absolute encoders:

Set Pn002.2 to 0 when starting the machine initially.

When the alarms A.45~A.48 and A.51 occur, they must be cleared by means of Fn010 and Fn001.

Please use the panel operator or execute the Fn010 and Fn001 functions via the bus. The bus SDO clears the encoder multi-turn or alarm by following means:

- Execute the Fn010 function by writing 1 to object 0x3685, subindex 1 via SDO communication;
- Execute the Fn001 function by writing 1 to object 0x3685, subindex 2 via SDO communication;

Note

- Please perform the encoder setting operation in the Servo 0FF state.
- When an absolute encoder alarm is displayed (A.45~A.48, A.51), perform the Setup (Initialization) to disarm the alarm. Using the alarm reset (ALM-RST) input signal of servo drive does not disarm the alarm.
- In the event of an alarm monitored internally by the encoder, disconnect the power supply to disarm the alarm.

Chapter 9 Trial Operation

9.1 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.	6.7

9.2 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.

9.3 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.

9.3.1 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.

9.3.2 Applicable Tools

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

9.3.3 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.

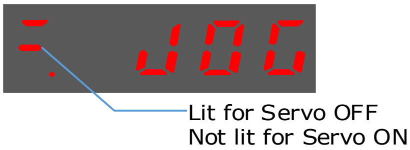
For the method of checking and setting parameters by using the Panel Operator, refers to the section **4.1.4 Parameter Setting Mode**.

Following the below steps to jog the Motor.

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

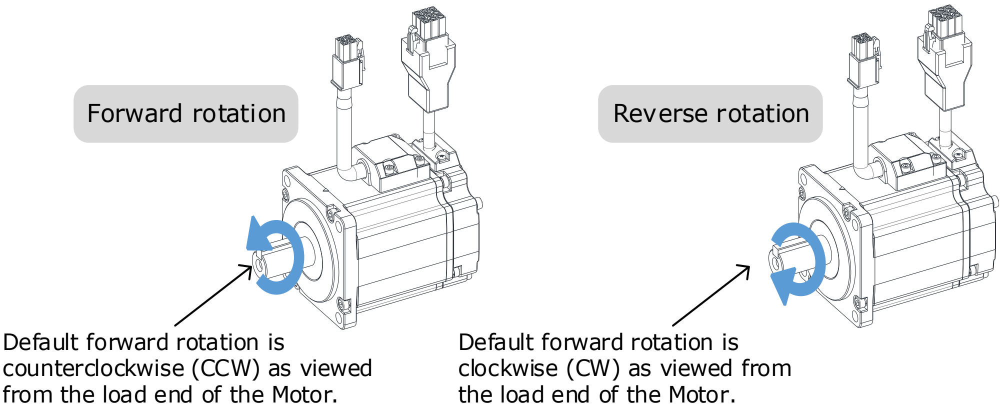
Step 2 Press [▲] key or [▼] key to select the function number Fn002.

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.

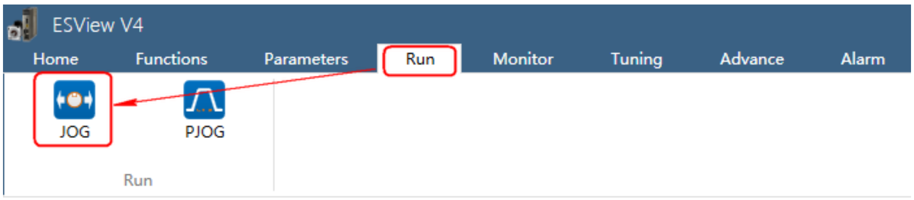
Step 6 Press the [◀] key to return to the display of the Fn002.

----End

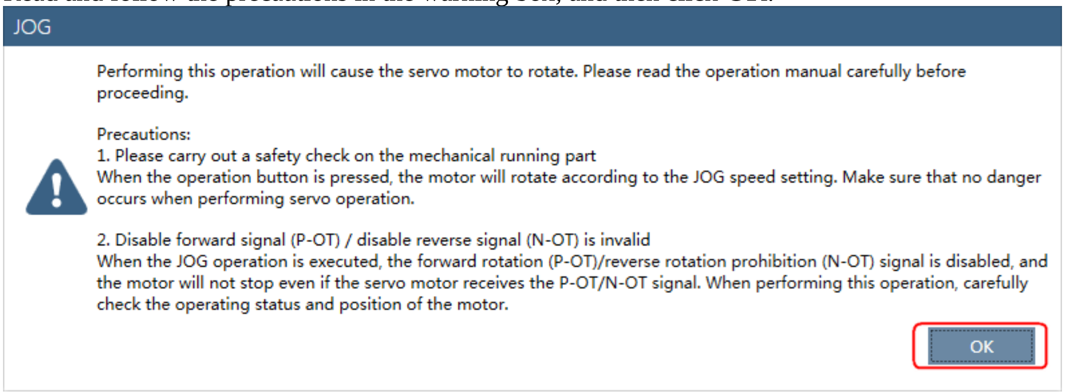
Use the ESView V4

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**.

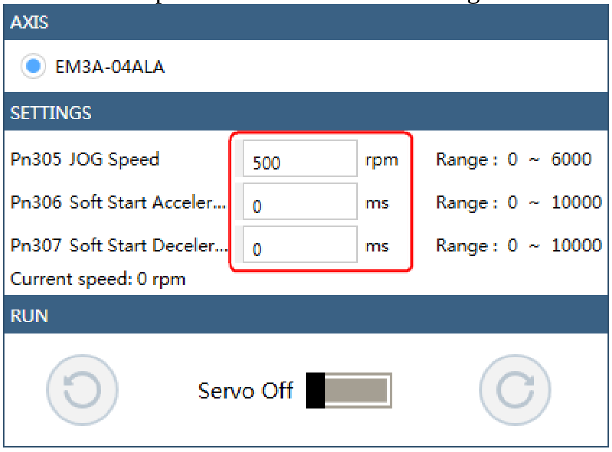


Performing this operation will cause the servo motor to rotate. Please read the operation manual carefully before proceeding.

Precautions:
1. Please carry out a safety check on the mechanical running part
When the operation button is pressed, the motor will rotate according to the JOG speed setting. Make sure that no danger occurs when performing servo operation.

2. Disable forward signal (P-OT) / disable reverse signal (N-OT) is invalid
When the JOG operation is executed, the forward rotation (P-OT)/reverse rotation prohibition (N-OT) signal is disabled, and the motor will not stop even if the servo motor receives the P-OT/N-OT signal. When performing this operation, carefully check the operating status and position of the motor.

Step 3 Set the below parameters on the **JOG** dialog box.



AXIS

● EM3A-04ALA

SETTINGS

Pn305 JOG Speed 500 rpm Range : 0 ~ 6000

Pn306 Soft Start Acceler... 0 ms Range : 0 ~ 10000

Pn307 Soft Start Deceler... 0 ms Range : 0 ~ 10000

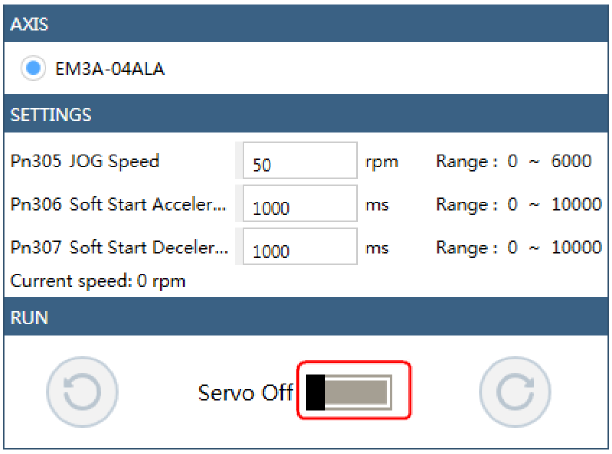
Current speed: 0 rpm

RUN

Servo Off

- **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.



AXIS

● EM3A-04ALA

SETTINGS

Pn305 JOG Speed 50 rpm Range : 0 ~ 6000

Pn306 Soft Start Acceler... 1000 ms Range : 0 ~ 10000

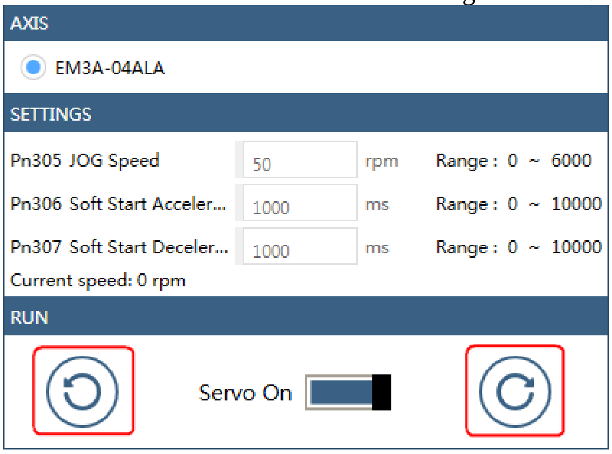
Pn307 Soft Start Deceler... 1000 ms Range : 0 ~ 10000

Current speed: 0 rpm

RUN

Servo Off

Step 5 Click the button ↺ or ↻ for running the Motor.



AXIS

● EM3A-04ALA

SETTINGS

Pn305 JOG Speed 50 rpm Range : 0 ~ 6000

Pn306 Soft Start Acceler... 1000 ms Range : 0 ~ 10000

Pn307 Soft Start Deceler... 1000 ms Range : 0 ~ 10000

Current speed: 0 rpm

RUN

Servo On

Click and hold the button ↺ or ↻ can run the Motor continuously, and the Motor can stop running when you release the button.

----End

9.4 Motor Operation with a Load

9.4.1 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.

9.4.2 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

9.4.3 Operation Procedure

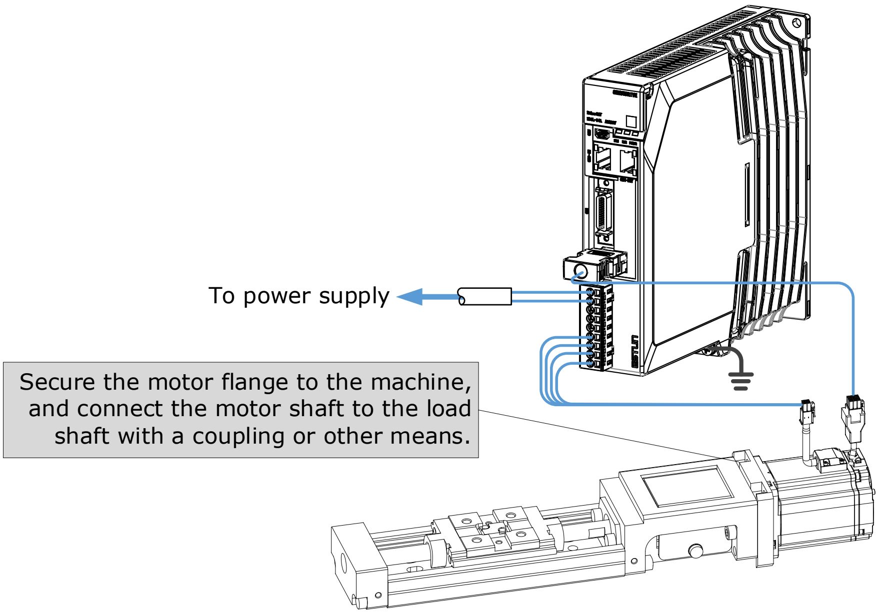
Step 1 Enable the overtravel signals.
Refers to the section 6.3 Overtravel Limit.

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 6.6 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

9.5 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.

9.5.1 Preparations

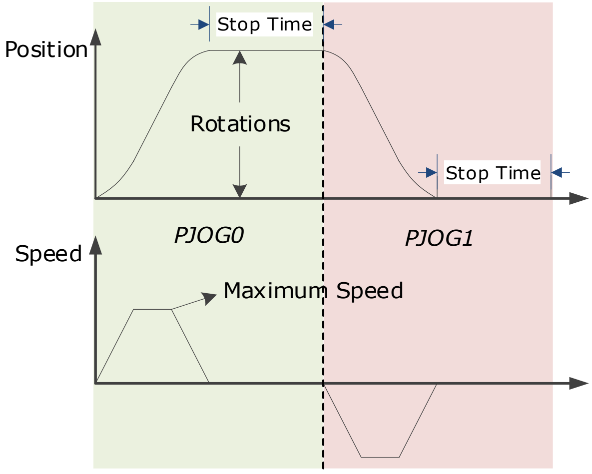
Always check the following before you execute program jogging.

- 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.

9.5.2 Operation Description

Program jogging operation consists of two operation patterns (PJOG0 and PJOG1), you can set their relevant parameters respectively. Figure 9-1 shows an example of position-speed timing diagram in PJOG operation.

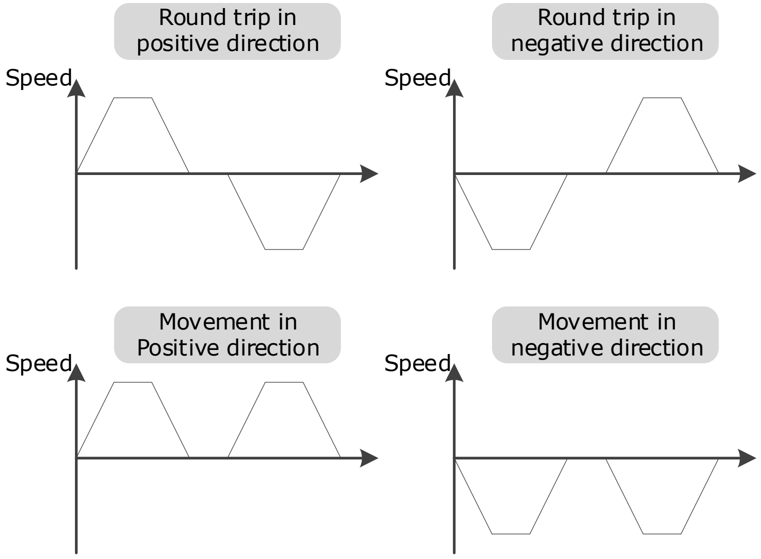
Figure 9-1 Position-speed timing diagram



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 9-2.

Figure 9-2 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.

9.5.3 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

9.5.4 Applicable Tools

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

9.5.5 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.

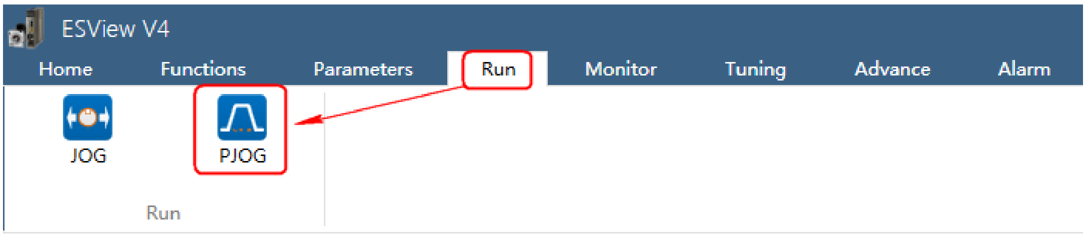
Step 5 Press [◄] key to return to the display of the Fn018.

----End

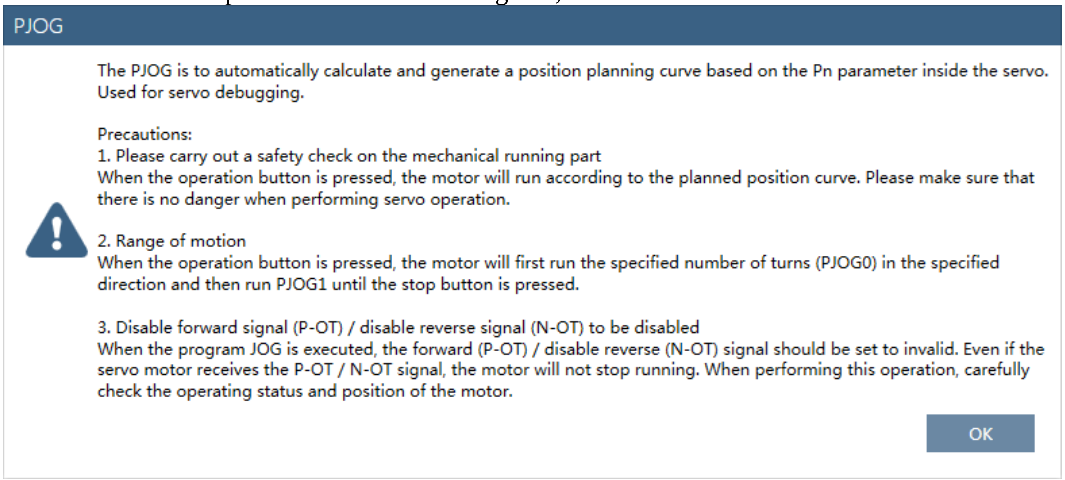
Use the ESView V4

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**.



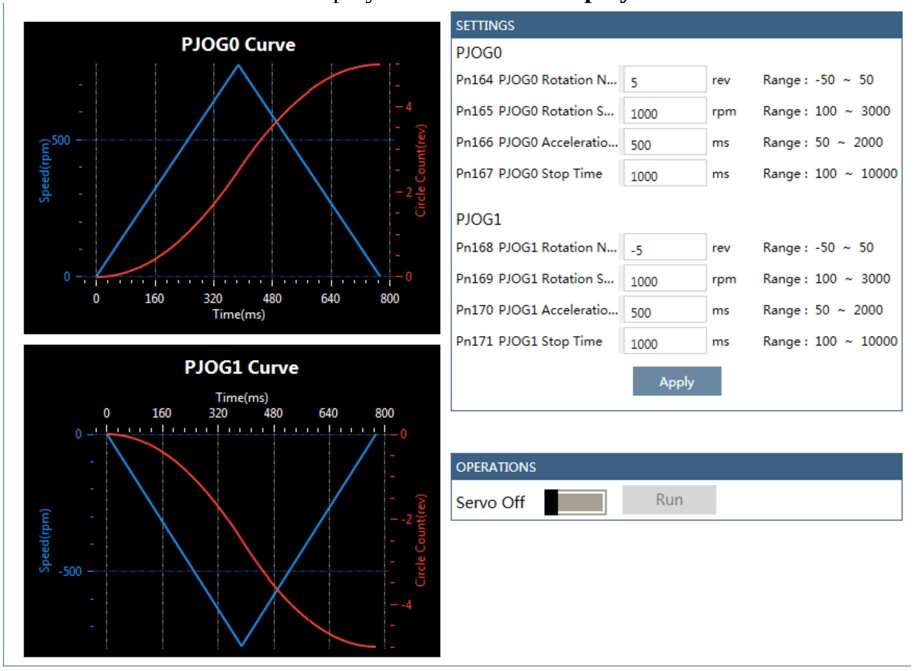
The PJOG is to automatically calculate and generate a position planning curve based on the Pn parameter inside the servo. Used for servo debugging.

Precautions:
1. Please carry out a safety check on the mechanical running part
When the operation button is pressed, the motor will run according to the planned position curve. Please make sure that there is no danger when performing servo operation.

2. Range of motion
When the operation button is pressed, the motor will first run the specified number of turns (PJOG0) in the specified direction and then run PJOG1 until the stop button is pressed.

3. Disable forward signal (P-OT) / disable reverse signal (N-OT) to be disabled
When the program JOG is executed, the forward (P-OT) / disable reverse (N-OT) signal should be set to invalid. Even if the servo motor receives the P-OT / N-OT signal, the motor will not stop running. When performing this operation, carefully check the operating status and position of the motor.

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



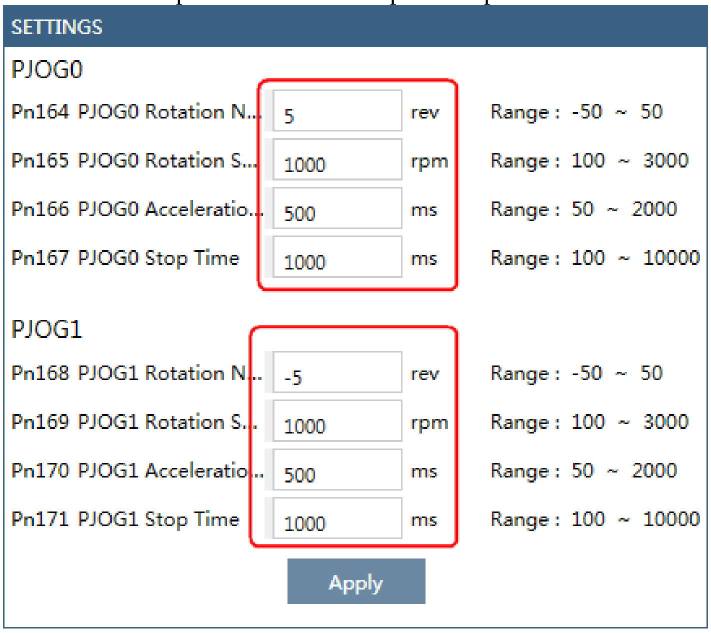
PJOG0

Pn164 PJOG0 Rotation N...	5	rev	Range : -50 ~ 50
Pn165 PJOG0 Rotation S...	1000	rpm	Range : 100 ~ 3000
Pn166 PJOG0 Acceleratio...	500	ms	Range : 50 ~ 2000
Pn167 PJOG0 Stop Time	1000	ms	Range : 100 ~ 10000

PJOG1

Pn168 PJOG1 Rotation N...	-5	rev	Range : -50 ~ 50
Pn169 PJOG1 Rotation S...	1000	rpm	Range : 100 ~ 3000
Pn170 PJOG1 Acceleratio...	500	ms	Range : 50 ~ 2000
Pn171 PJOG1 Stop Time	1000	ms	Range : 100 ~ 10000

Step 4 Set the relevant parameters for the operation patterns PJOG0 and PJOG1.



SETTINGS

PJOG0

Pn164 PJOG0 Rotation N...	5	rev	Range : -50 ~ 50
Pn165 PJOG0 Rotation S...	1000	rpm	Range : 100 ~ 3000
Pn166 PJOG0 Acceleratio...	500	ms	Range : 50 ~ 2000
Pn167 PJOG0 Stop Time	1000	ms	Range : 100 ~ 10000

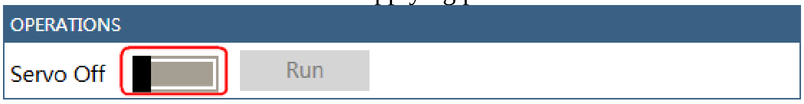
PJOG1

Pn168 PJOG1 Rotation N...	-5	rev	Range : -50 ~ 50
Pn169 PJOG1 Rotation S...	1000	rpm	Range : 100 ~ 3000
Pn170 PJOG1 Acceleratio...	500	ms	Range : 50 ~ 2000
Pn171 PJOG1 Stop Time	1000	ms	Range : 100 ~ 10000

- **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 10 Tuning

10.1 Overview

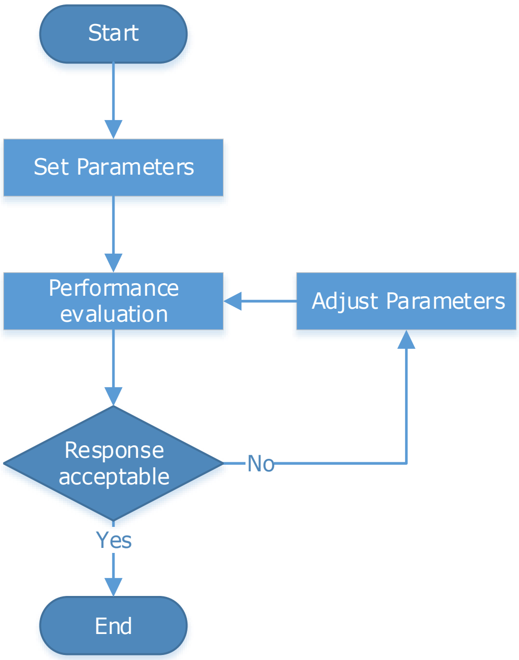
10.1.1 Basic Conception

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 10-1 shows the general flow.

Figure 10-1 General flow



Parameter Classification

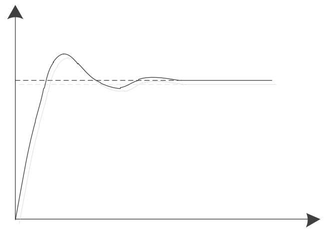
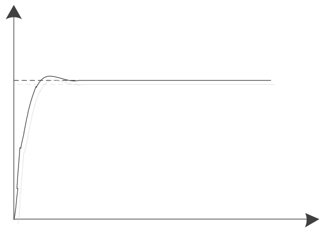
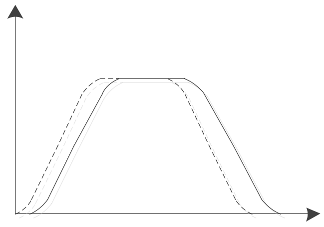
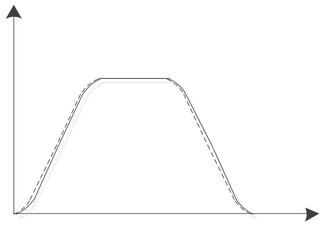
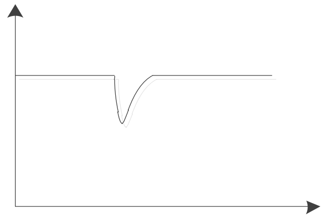
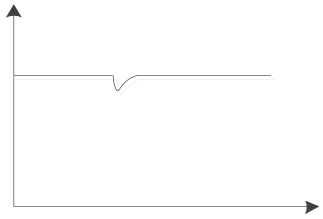
There are two types of parameters in the tuning.

- 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 10-1 shows the comparison of the graphics before and after tuning in the example indicators.

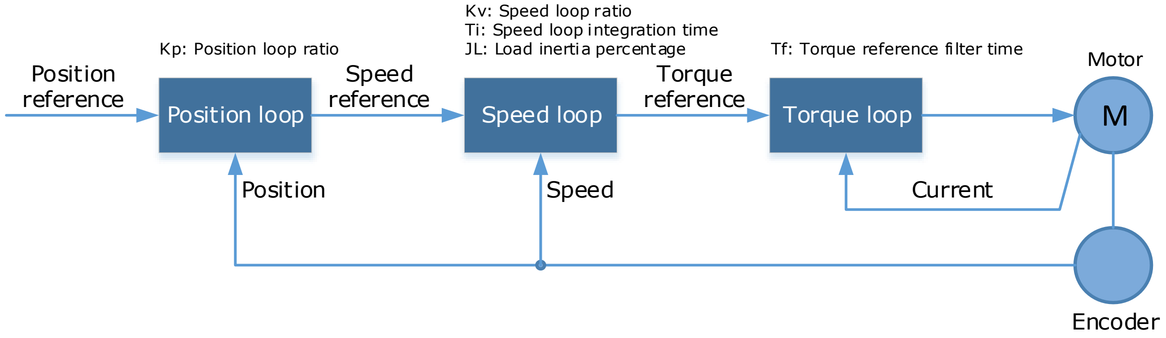
Table 10-1 Comparison of the graphics before and after tuning

Indicator	Before tuning	After tuning
Speed step response		
Position following		
Anti-load disturbance		

10.1.2 Control Block Diagram

It is necessary to learn the Servo control principle and Figure 10-2 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 10-2 Servo control block diagram

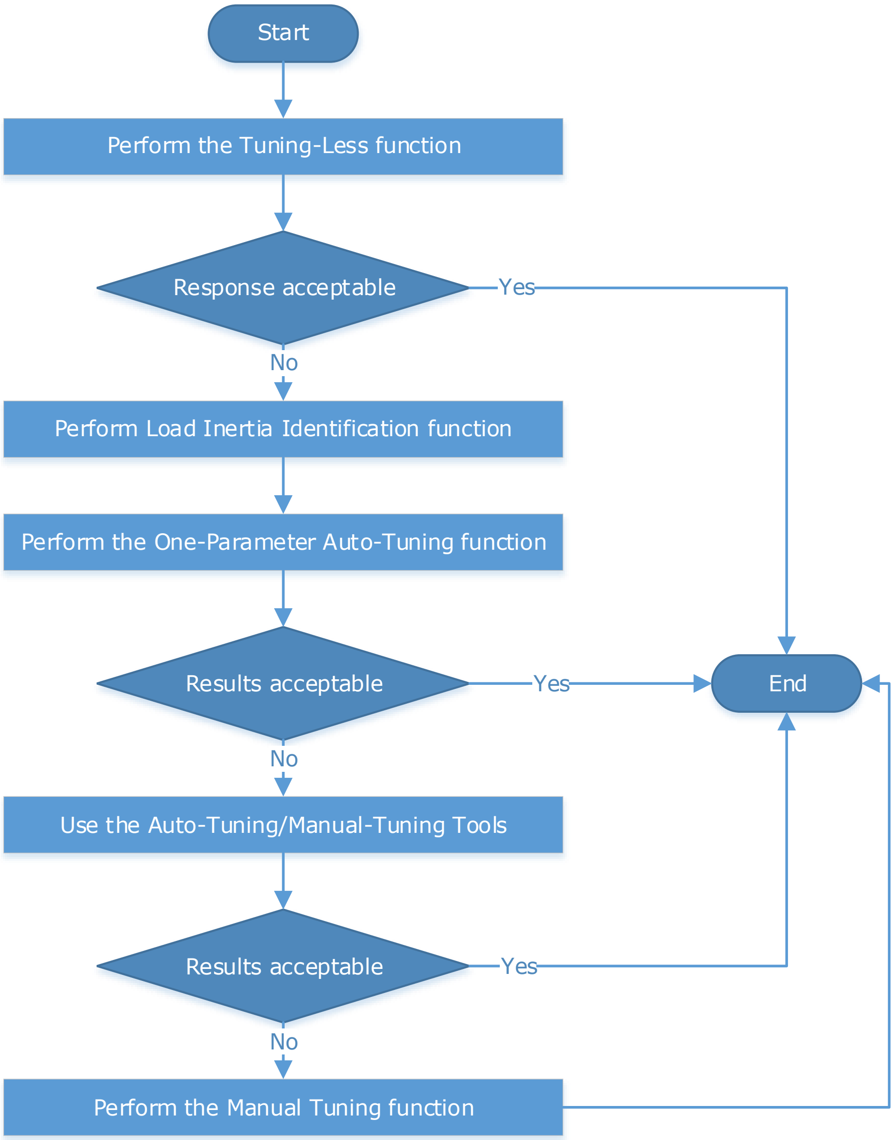


NOTE: only the basic tuning parameters during the tuning are shown in the figure.

10.1.3 Tuning Process

The Drive provides a variety of tuning methods, you can adjust the device according to the process shown in Figure 10-3, in order to obtain the desired Servo performance.

Figure 10-3 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.

10.1.4 Precautions Before Tuning

WARNING

- 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.

10.2 Tuning Modes

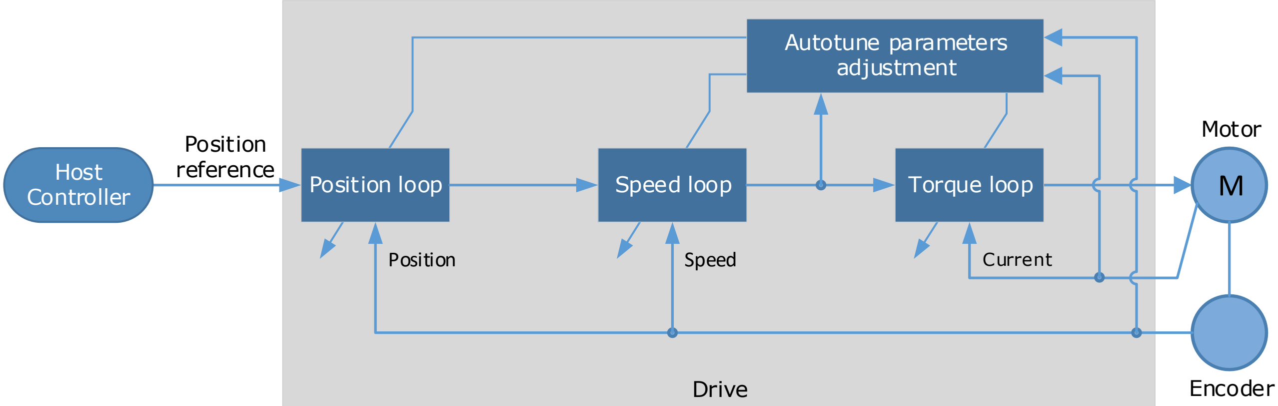
10.2.1 Tuning-Less

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 10-4 shows the block diagram in tuning-less.

Figure 10-4 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.

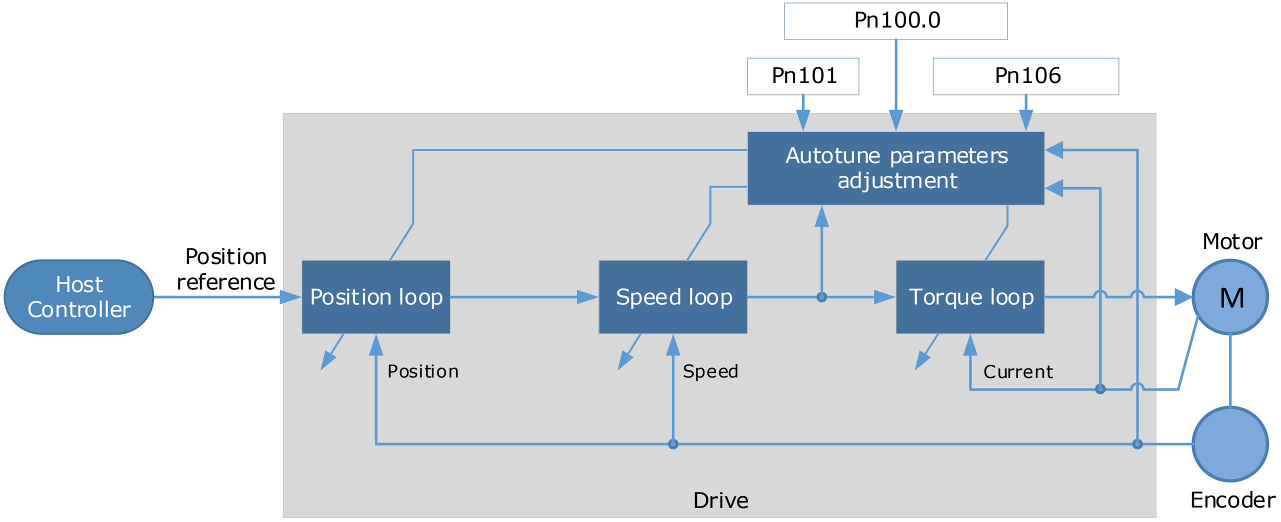
10.2.2 One-Parameter Auto-Tuning

Function Description

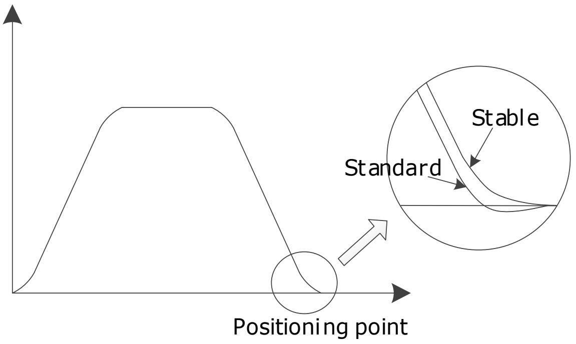
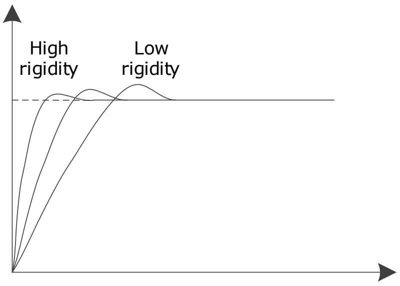
This tuning function is similar to the tuning-less function, using an Autotune parameters adjustment module that updates the position loop and speed loop parameters in real time based on the servo operating state (position, speed, current).

Only the parameter Pn101 (Servo Rigidity) needs to set in One-Parameter Auto-Tuning function, and Figure 10-5 shows the block diagram in One-Parameter Auto-Tuning.

Figure 10-5 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:

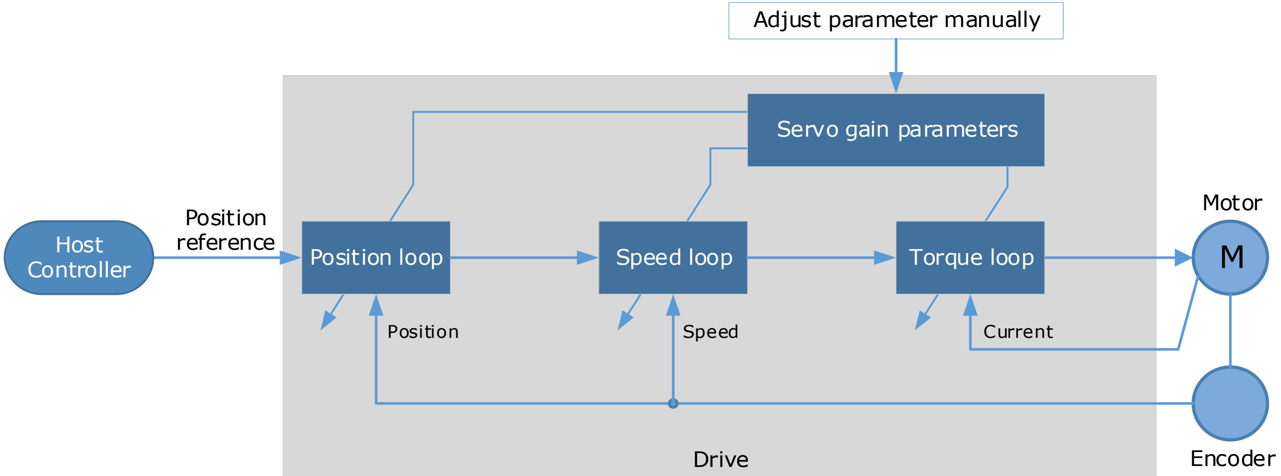
- Gain switch is disabled.
- Model Following Control Function is disabled.

10.2.3 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 10-6 shows the block diagram in Manual Tuning.

Figure 10-6 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 Torque loop → Speed loop → 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.

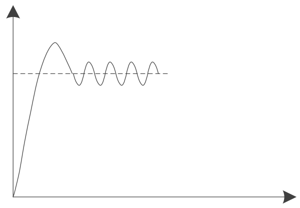
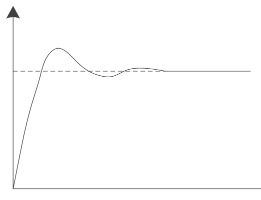
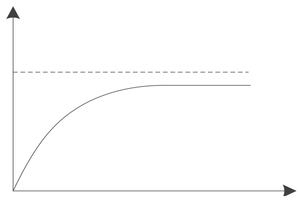
    You can calculate the load inertia percentage (difficult and complex) by yourself, or you can get it by the utility function Fn009 or by ESView V4, certainly, you can directly modify the parameters by the host controller.
  - Speed Loop Gain (Kv), Speed Loop Integral Time (Ti)

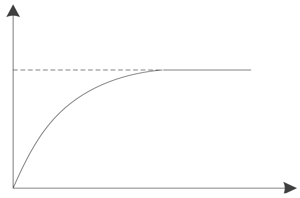
    The speed loop is controlled using a Proportional-Integral Controller that contains Speed Loop Gain and Speed Loop Integral Time. Both of them determine the speed loop bandwidth and anti-disturbance performance of the Servo.

    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 10-2 lists several commonly used adjustment methods based on the characteristics of the speed step response.

Table 10-2 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

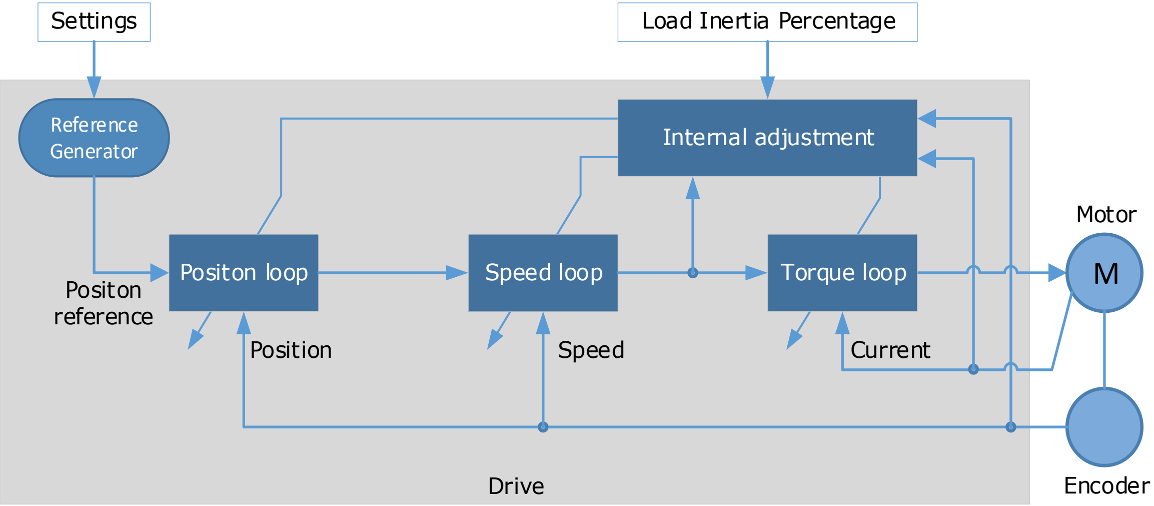
Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	5 [Default]	Set the **Tuning Mode** as **Manual tuning**.	After restart	Function
Pn102/Pn107	–	Speed Loop Gain	Immediately	Adjustment
Pn103/Pn108	–	Speed Loop Integral Time	Immediately	Adjustment
Pn104/Pn109	–	Position Loop Gain	Immediately	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.

10.3 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 10-7 shows the block diagram in using a tuning tool.

Figure 10-7 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.

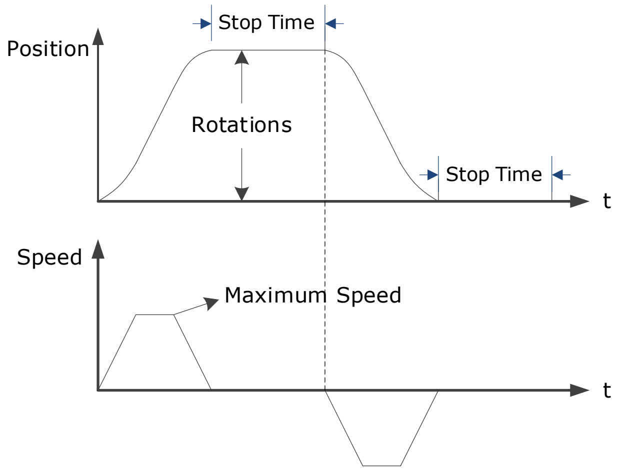
10.3.2 Auto-Tuning Tool

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.

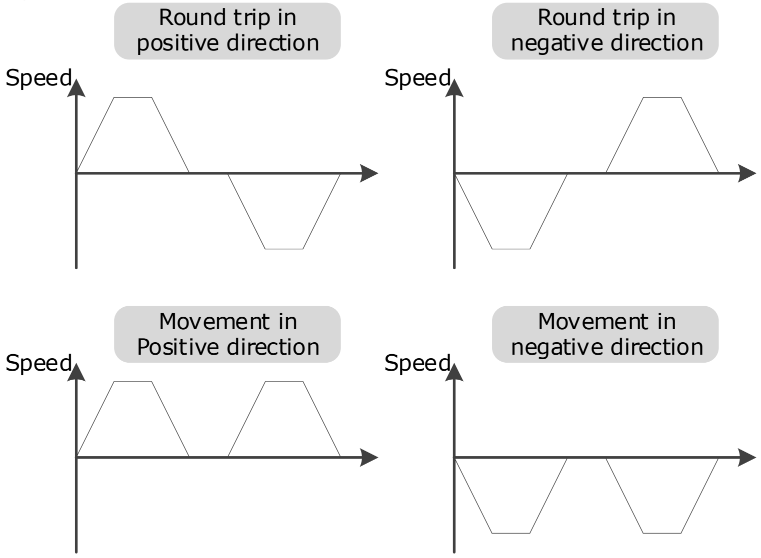
There are two operation patterns (POS0 and POS1), you can set their relevant parameters respectively. Figure 10-8 shows an example of position-speed timing diagram in PJOG operation.

Figure 10-8 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 10-9.

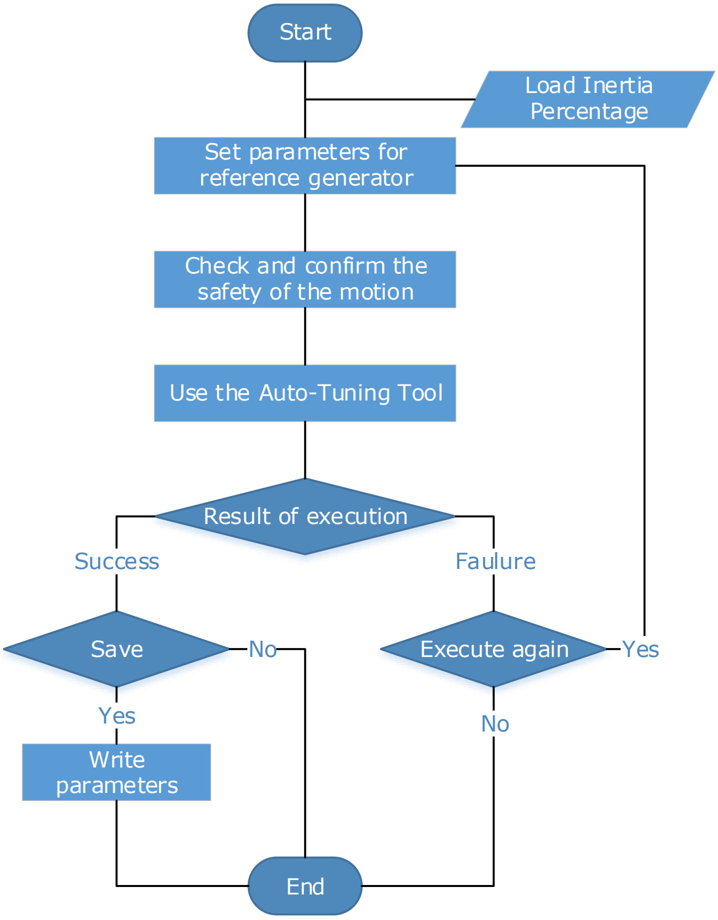
Figure 10-9 Operation by using Auto-Tuning Tool



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 10-10.

Figure 10-10 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.

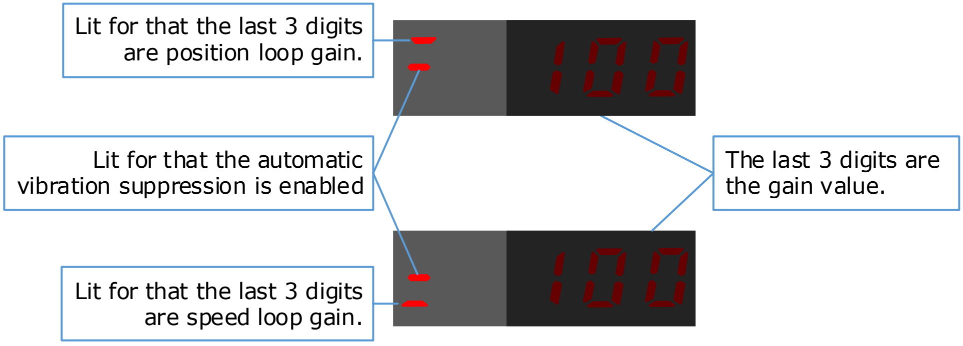
Step 1 Press [**M**] key several times to select the Utility Function Mode.

Step 2 Press [▲] key or [▼] key to select the function number Fn017.

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

Lit for that the adaptive notch filter is enabled

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.

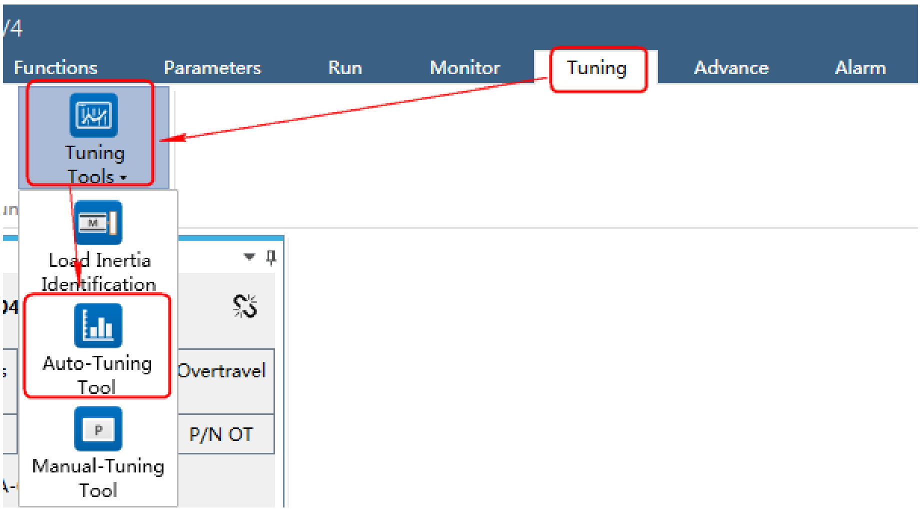
Step 6 Press [◀] key to return to the display of the Fn017.

----End

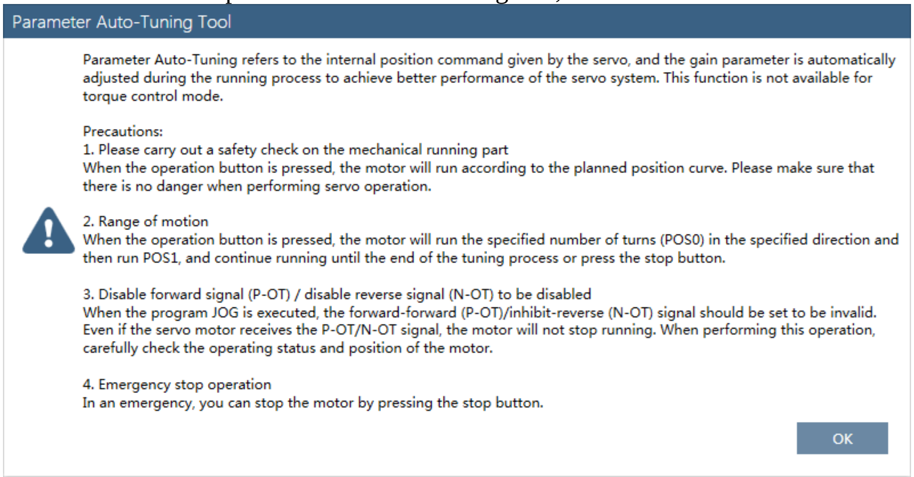
Operation Procedure: Use the ESView V4

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**.



Parameter Auto-Tuning Tool

Parameter Auto-Tuning refers to the internal position command given by the servo, and the gain parameter is automatically adjusted during the running process to achieve better performance of the servo system. This function is not available for torque control mode.

Precautions:
1. Please carry out a safety check on the mechanical running part
When the operation button is pressed, the motor will run according to the planned position curve. Please make sure that there is no danger when performing servo operation.

2. Range of motion
When the operation button is pressed, the motor will run the specified number of turns (POS0) in the specified direction and then run POS1, and continue running until the end of the tuning process or press the stop button.

3. Disable forward signal (P-OT) / disable reverse signal (N-OT) to be disabled
When the program JOG is executed, the forward-forward (P-OT)/inhibit-reverse (N-OT) signal should be set to be invalid. Even if the servo motor receives the P-OT/N-OT signal, the motor will not stop running. When performing this operation, carefully check the operating status and position of the motor.

4. Emergency stop operation
In an emergency, you can stop the motor by pressing the stop button.

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.

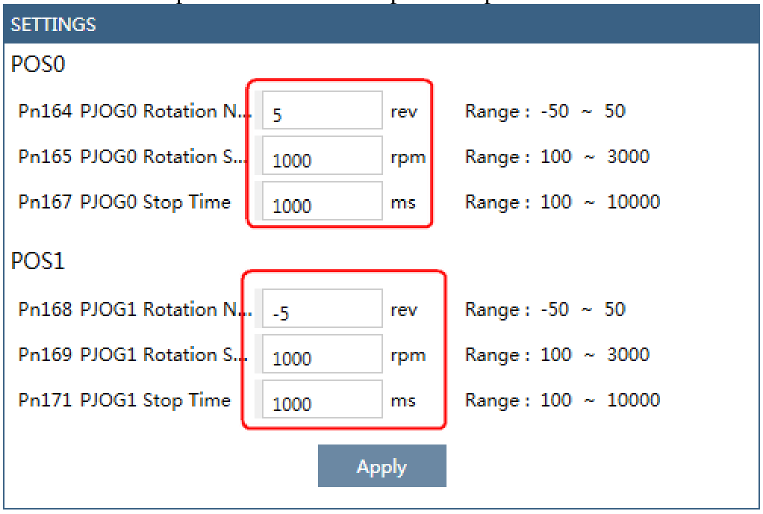
POS0

Pn164 PJOG0 Rotation N... 5 rev Range : -50 ~ 50
Pn165 PJOG0 Rotation S... 1000 rpm Range : 100 ~ 3000
Pn167 PJOG0 Stop Time 1000 ms Range : 100 ~ 10000

POS1

Pn168 PJOG1 Rotation N... -5 rev Range : -50 ~ 50
Pn169 PJOG1 Rotation S... 1000 rpm Range : 100 ~ 3000
Pn171 PJOG1 Stop Time 1000 ms Range : 100 ~ 10000

Step 5 Set the relevant parameters for the operation patterns POS0 and POS1.



SETTINGS

POS0

Pn164 PJOG0 Rotation N... 5 rev Range : -50 ~ 50
Pn165 PJOG0 Rotation S... 1000 rpm Range : 100 ~ 3000
Pn167 PJOG0 Stop Time 1000 ms Range : 100 ~ 10000

POS1

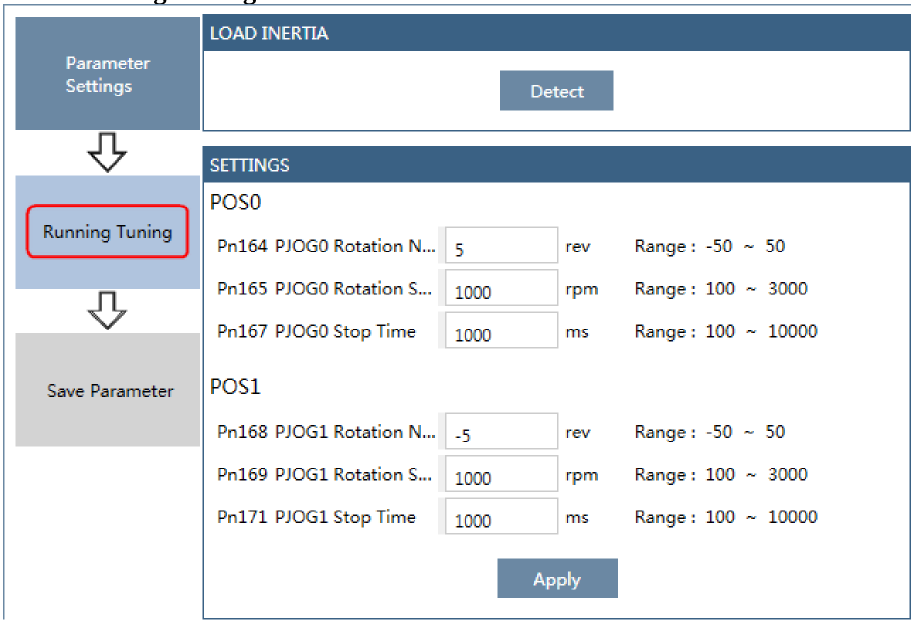
Pn168 PJOG1 Rotation N... -5 rev Range : -50 ~ 50
Pn169 PJOG1 Rotation S... 1000 rpm Range : 100 ~ 3000
Pn171 PJOG1 Stop Time 1000 ms Range : 100 ~ 10000

- **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**.



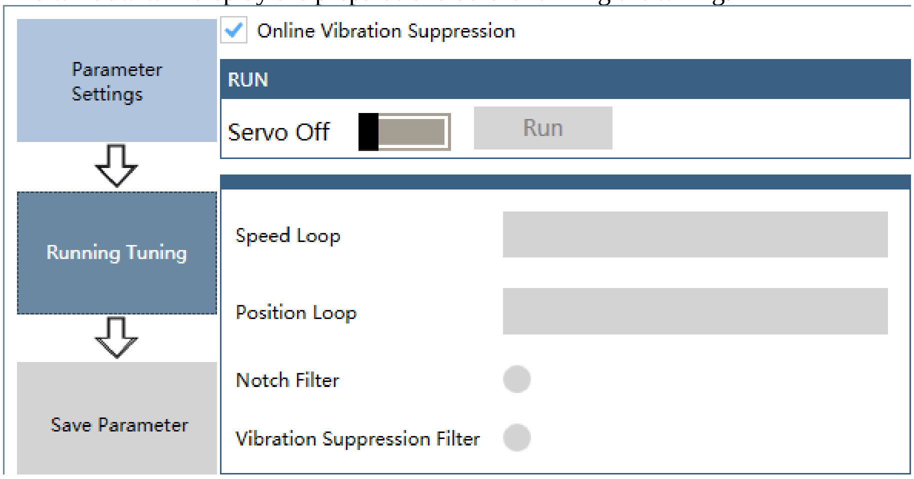
POS0

Pn164 PJOG0 Rotation N...	5	rev	Range : -50 ~ 50
Pn165 PJOG0 Rotation S...	1000	rpm	Range : 100 ~ 3000
Pn167 PJOG0 Stop Time	1000	ms	Range : 100 ~ 10000

POS1

Pn168 PJOG1 Rotation N...	-5	rev	Range : -50 ~ 50
Pn169 PJOG1 Rotation S...	1000	rpm	Range : 100 ~ 3000
Pn171 PJOG1 Stop Time	1000	ms	Range : 100 ~ 10000

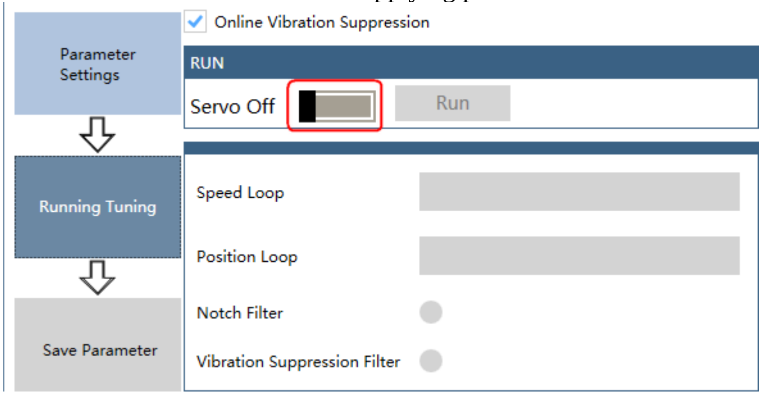
Step 8 The window will display the preparations before running the tuning.



☑ Online Vibration Suppression

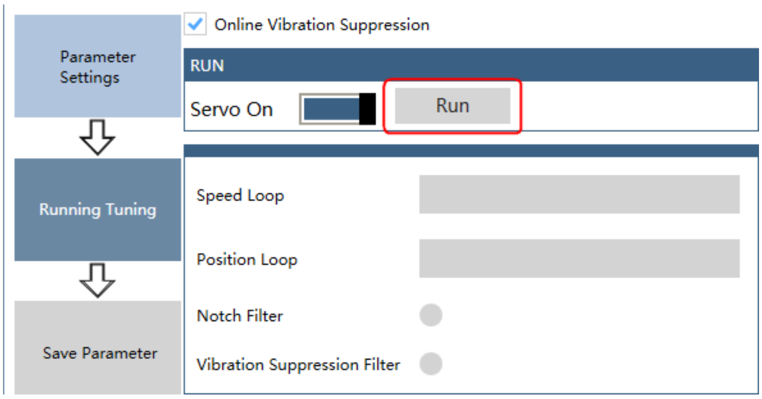
The setting will be written into the Drive automatically after you check or uncheck **Online Vibration Suppression** option.

Step 9 Click **Servo Off** / **Servo On** for supplying power to the Motor.



☑ Online Vibration Suppression

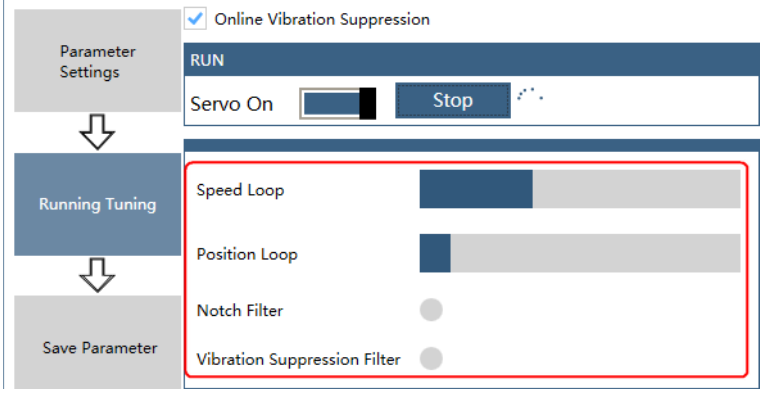
Step 10 Click **Run**.



☑ Online Vibration Suppression

Servo On

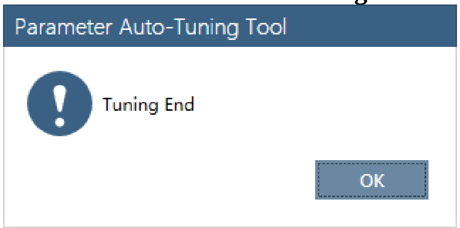
Step 11 The Motor will be run between the operation patterns POS0 and POS1.



☑ Online Vibration Suppression

Servo On

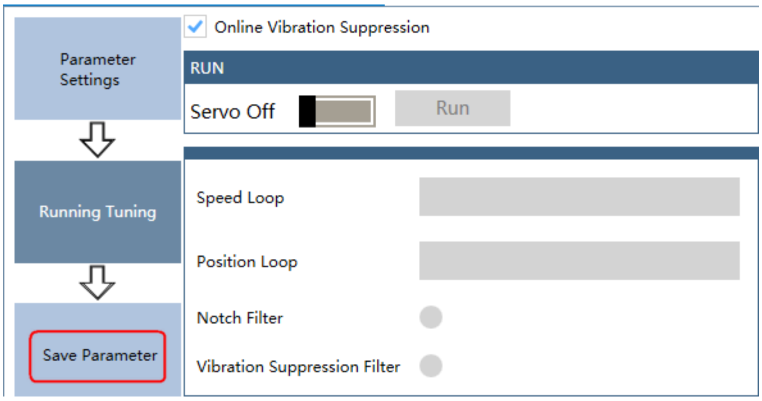
Step 12 Click **OK** when the **Auto-Tuning Tool** function has been completed.



Parameter Auto-Tuning Tool

Tuning End

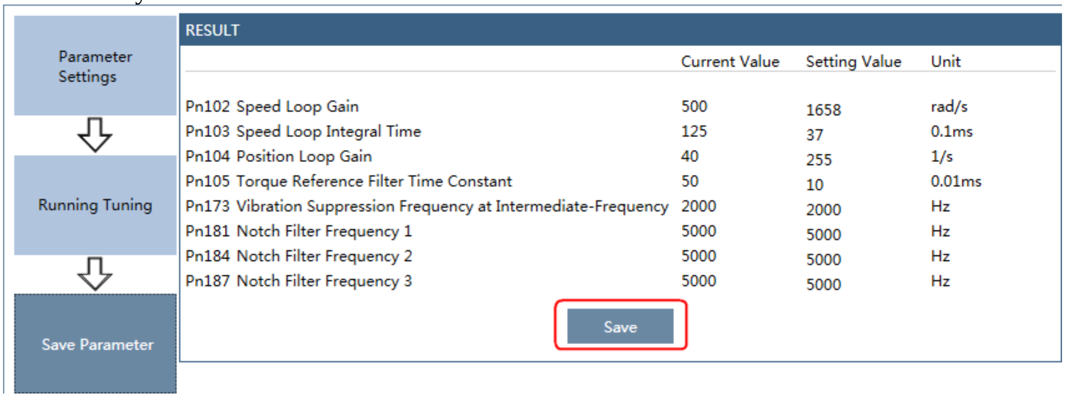
Step 13 Click **Save Parameter**.



☑ Online Vibration Suppression

Servo Off

Step 14 Check the **RESULT**, and click **Save**, the settings of parameters will be written into the Drive automatically.



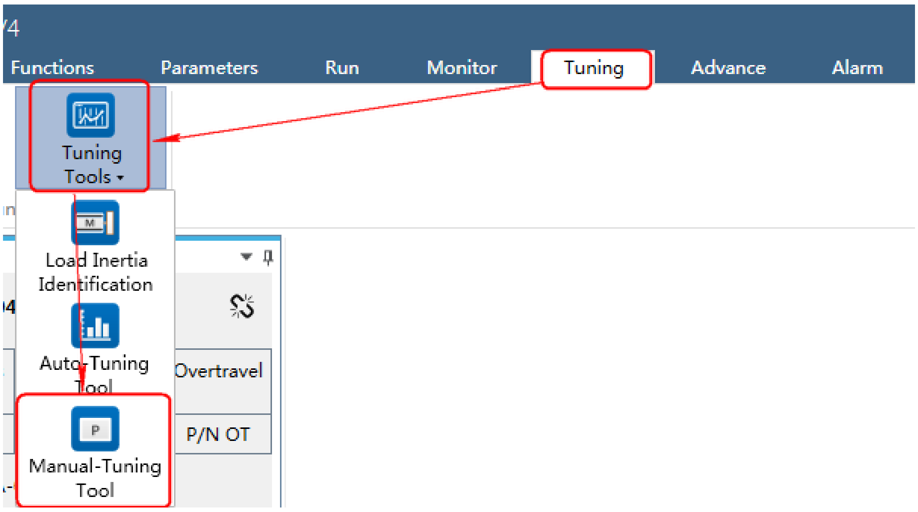
	Current Value	Setting Value	Unit
Pn102 Speed Loop Gain	500	1658	rad/s
Pn103 Speed Loop Integral Time	125	37	0.1ms
Pn104 Position Loop Gain	40	255	1/s
Pn105 Torque Reference Filter Time Constant	50	10	0.01ms
Pn173 Vibration Suppression Frequency at Intermediate-Frequency	2000	2000	Hz
Pn181 Notch Filter Frequency 1	5000	5000	Hz
Pn184 Notch Filter Frequency 2	5000	5000	Hz
Pn187 Notch Filter Frequency 3	5000	5000	Hz

----End

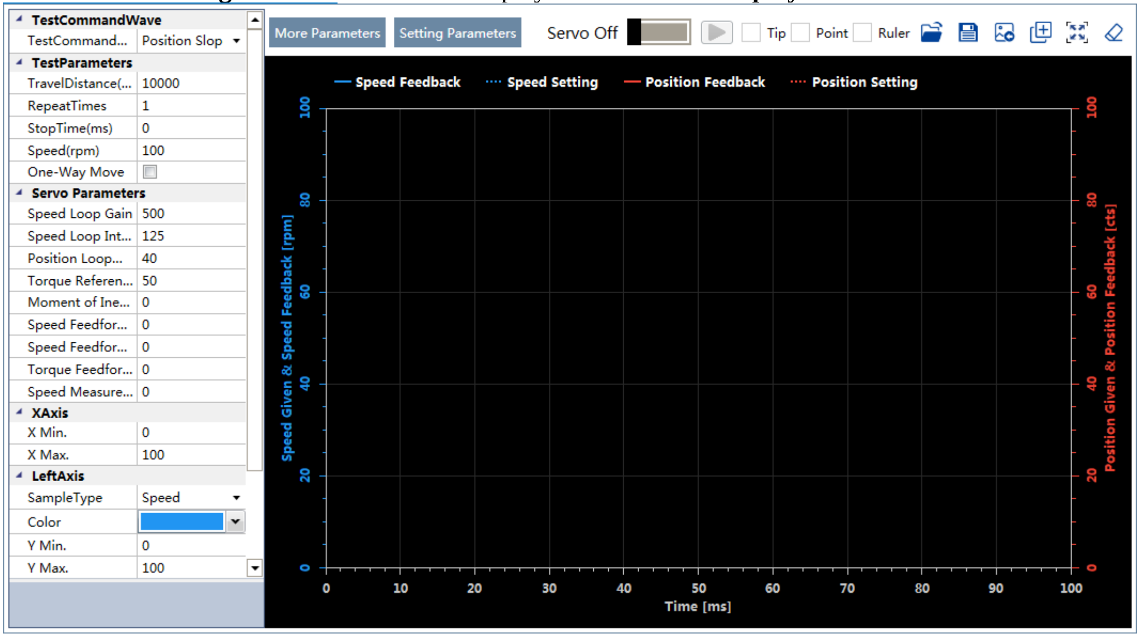
10.3.3 Manual-Tuning Tool

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.



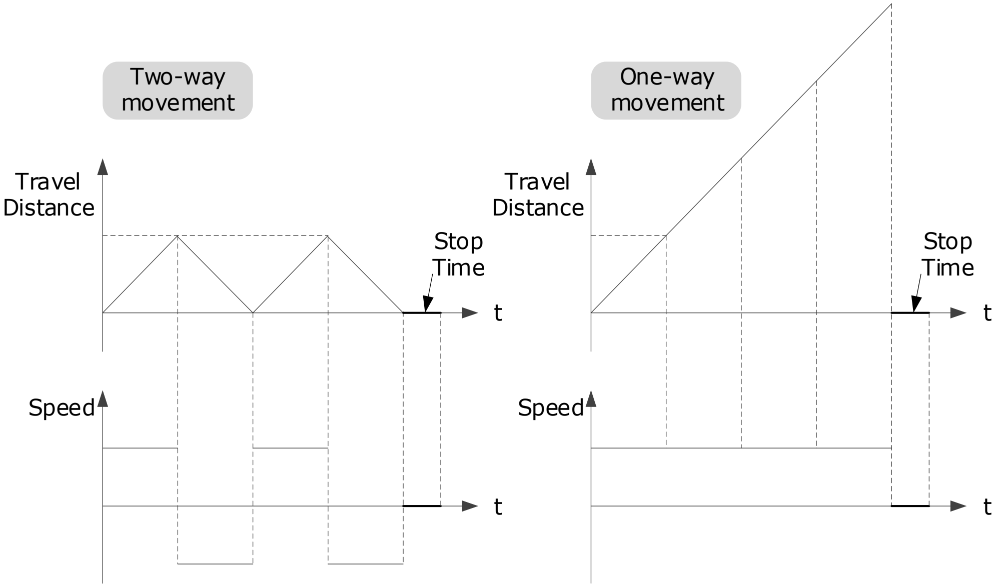
Step 2 The **Manual-Tuning Tool** window will be displayed in **Function Display Area**.



TestCommandWave	
TestCommand...	Position Slop
TestParameters	
TravelDistance(...	10000
RepeatTimes	1
StopTime(ms)	0
Speed(rpm)	100
One-Way Move	☐
Servo Parameters	
Speed Loop Gain	500
Speed Loop Int...	125
Position Loop...	40
Torque Referen...	50
Moment of Ine...	0
Speed Feedfor...	0
Speed Feedfor...	0
Torque Feedfor...	0
Speed Measure...	0
XAxis	
X Min.	0
X Max.	100
LeftAxis	
SampleType	Speed
Color	🟦
Y Min.	0
Y Max.	100

Step 3 Set the necessary parameters of the **Test Command**.

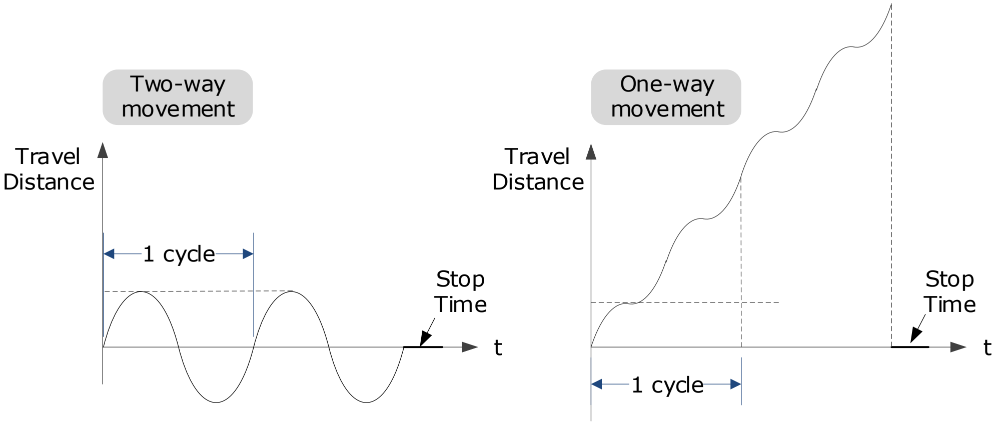
- Choose **Test Command Wave** as **Position Slope**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



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.

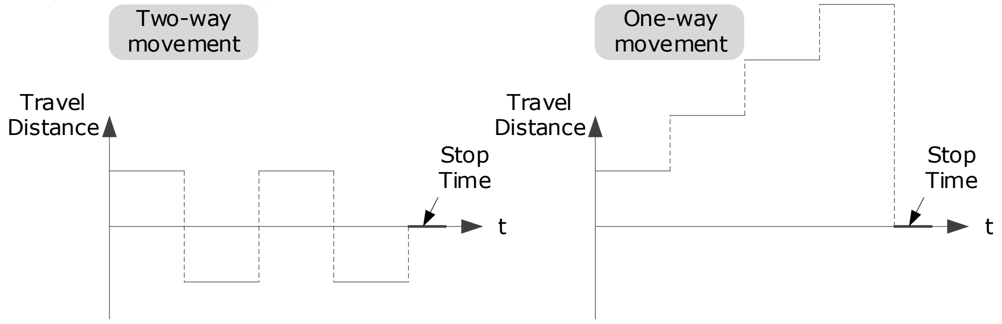
- Choose **Test Command Wave** as **Position Sine**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



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.

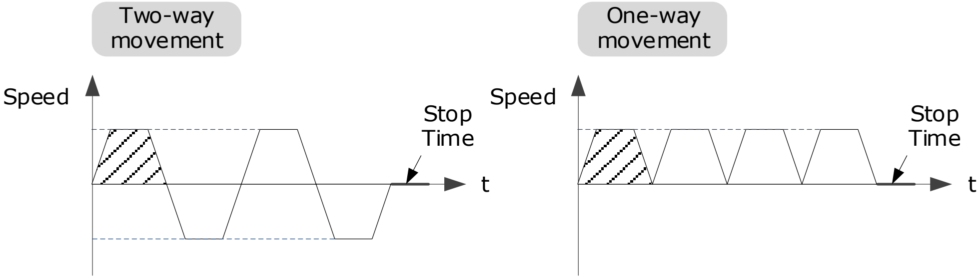
- Choose **Test Command Wave** as **Position Stepwise**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



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.

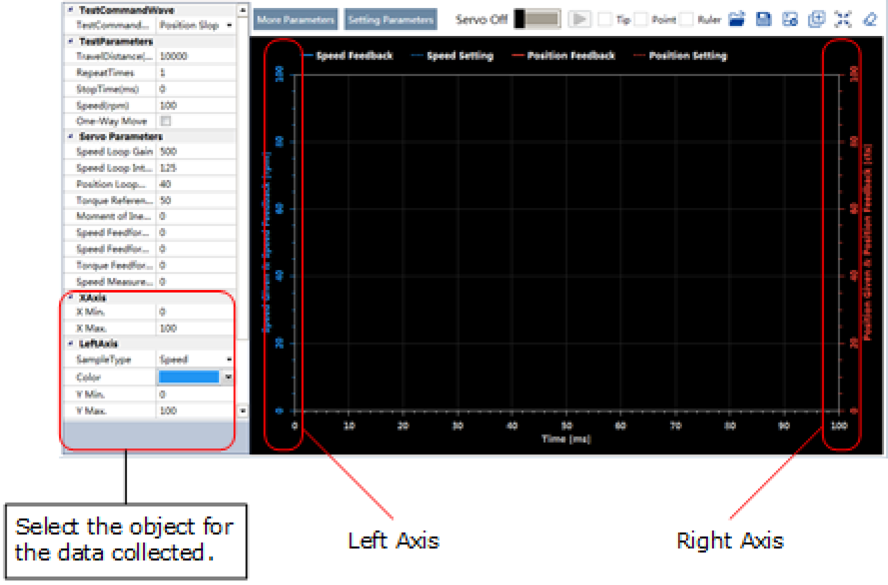
- Choose **Test Command Wave** as **Speed Trapezoid**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



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.



TestCommandWave
TestCommand... Position Slop
TestParameters
TravelDistance(... 10000
RepeatTimes 1
StopTime(ms) 0
Speed(rpm) 100
One-Way Move ☐
Servo Parameters
Speed Loop Gain 500
Speed Loop Int... 125
Position Loop... 40
Torque Referen... 50
Moment of Ine... 0
Speed FeedFor... 0
Speed FeedFor... 0
Torque FeedFor... 0
Speed Measure... 0
XAxis
X Min. 0
X Max. 100
LeftAxis
SampleType Speed
Color 🟦
Y Min. 0
Y Max. 100

- 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.

Set the common-used gain parameters

Click **More Parameters** to set the details parameters

TestCommandWave	
TestCommand...	Position Step
TestParameters	
TravelDistance(...	10000
RepeatTimes	1
StopTime(ms)	0
Speed(rpm)	100
One Way Move	☐
Servo Parameters	
Speed Loop Gain	500
Speed Loop Int...	125
Position Loop...	40
Torque Referen...	50
Moment of Ine...	0
Speed Feedfor...	0
Speed Feedfor...	0
Torque Feedfor...	0
Speed Measure...	0
XAxis	
X Min.	0
X Max.	100
LeftAxis	
SampleType	Speed
Color	🟦
Y Min.	0
Y Max.	100

The parameters that may be used are shown in Table 10-3.

Table 10-3 The parameters that may be used

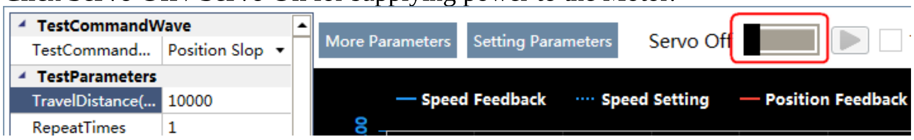
Type	Parameter	Name	Range	Unit	Default	When Enabled
Gain	Pn102	Speed Loop Gain	1 to 10000	rad/s	500	Immediately
	Pn103	Speed Loop Integral Time	1 to 5000	0.1ms	125	Immediately
	Pn104	Position Loop Gain	0 to 1000	1/s	40	Immediately
	Pn105	Torque Command Filter Time	0 to 2500	0.01ms	50	Immediately
	Pn106	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

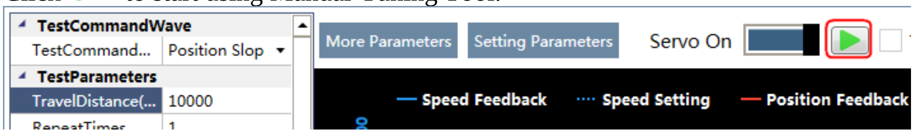
Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn183	Width of Notch Filter 1	0 to 15	–	2	Immediately
	Pn184	Frequency of Notch Filter 2	50 to 5000	Hz	5000	Immediately
	Pn185	Depth of Notch Filter 2	0 to 23	–	0	Immediately
	Pn186	Width of Notch Filter 2	0 to 15	–	2	Immediately
	Pn187	Frequency of 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.



TestCommandWave
TestCommand... Position Slop
TestParameters
TravelDistance(... 10000
RepeatTimes 1

Step 7 Click ▶ to start using Manual-Tuning Tool.

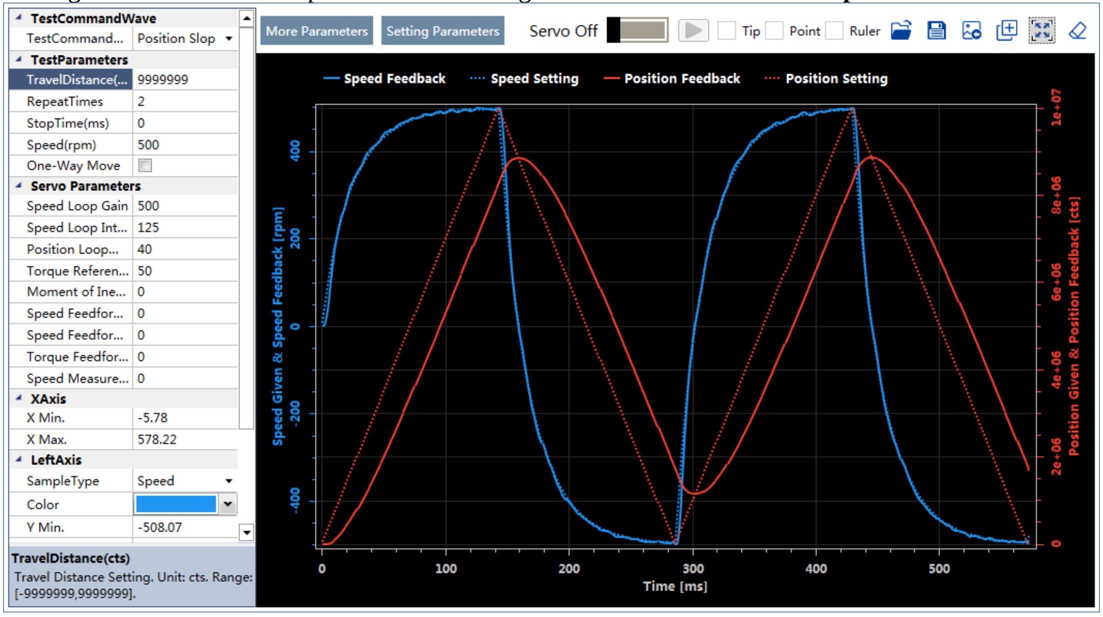


TestCommandWave
TestCommand... Position Slop
TestParameters
TravelDistance(... 10000
RepeatTimes 1

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.

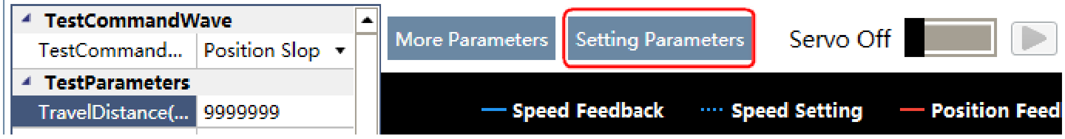


TestCommandWave	
TestCommand...	Position Slop
TestParameters	
TravelDistance(...	9999999
RepeatTimes	2
StopTime(ms)	0
Speed(rpm)	500
One-Way Move	☐
Servo Parameters	
Speed Loop Gain	500
Speed Loop Int...	125
Position Loop...	40
Torque Referen...	50
Moment of Ine...	0
Speed Feedfor...	0
Speed Feedfor...	0
Torque Feedfor...	0
Speed Measure...	0
XAxis	
X Min.	-5.78
X Max.	578.22
LeftAxis	
SampleType	Speed
Color	🟦
Y Min.	-508.07

TravelDistance(cts)
Travel Distance Setting. Unit: cts. Range: [-9999999,9999999].

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.



TestCommandWave	
TestCommand...	Position Slop
TestParameters	
TravelDistance(...	9999999

----End

10.4 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

10.5 Additional Adjustment Functions

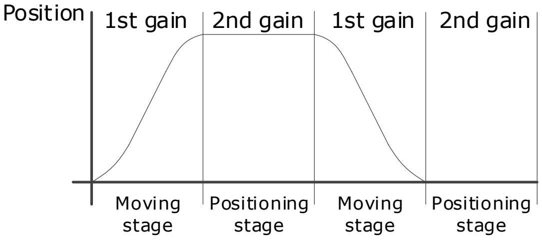
10.5.1 Gain Switching

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 10-11 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 10-11 Gain switching example

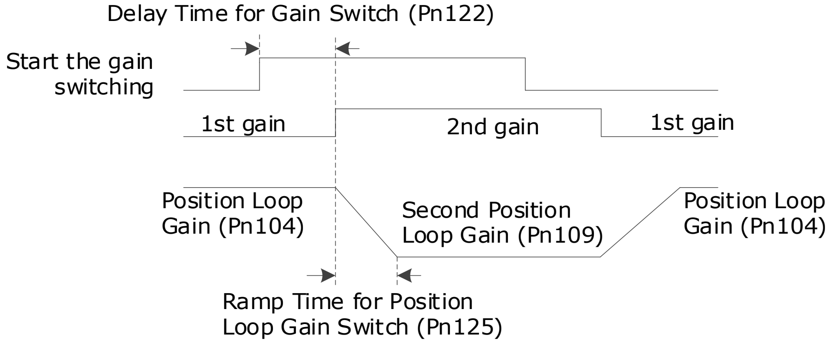


The parameters of the first gain and the second gain are as follows.

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 10-12 shows a timing diagram for the gain switching.

Figure 10-12 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.

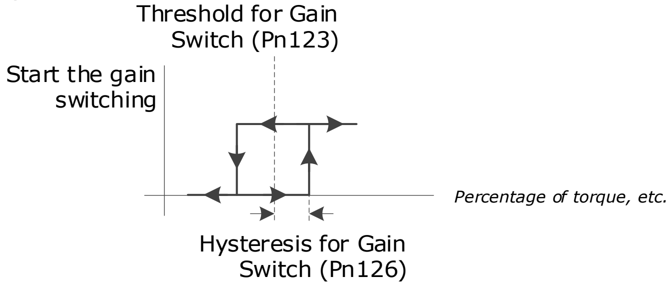
Parameter	Setting	Meaning	When Enabled	Classification
Pn121	0 [Default]	Fixed to first group gains.	After restart	Function
	1	Use external signal (G-SEL) as the condition.		
	2	Use torque reference as the condition (threshold setting: Pn117).		
	3	Use position deviation counter as the condition (threshold 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 10-13 shows the diagram for this setting.

  Figure 10-13 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

10.5.2 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.

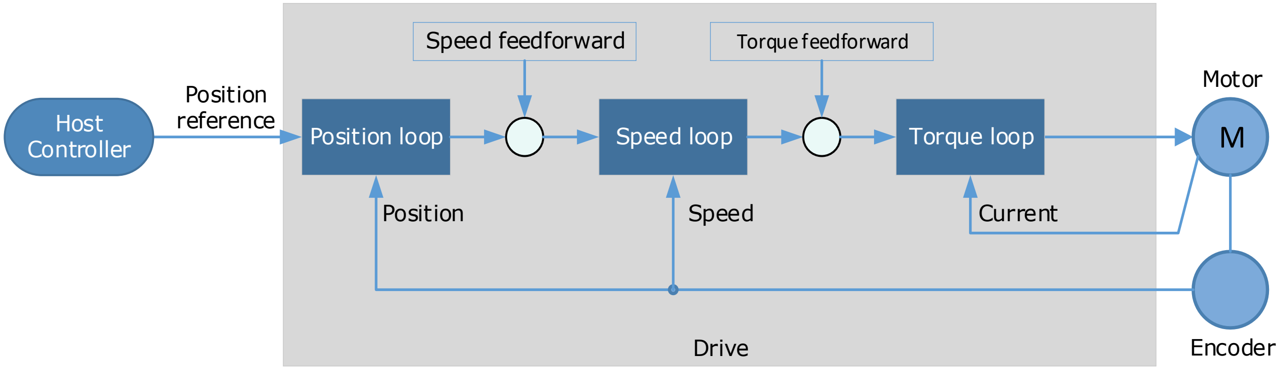
10.5.3 Feedforward

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 10-14 shows the block diagram in the feedforward function.

Figure 10-14 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 EtherCAT 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 EtherCAT 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

10.5.4 Friction Compensation

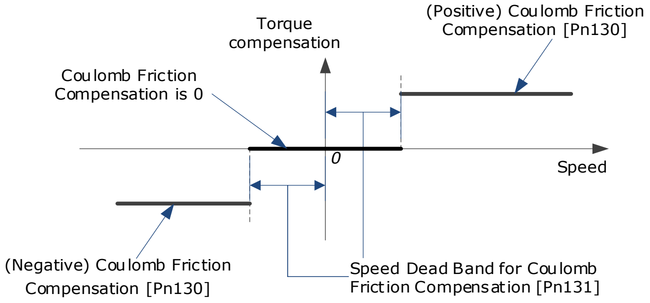
The load friction must exist in the transmission system. However, severe load friction may cause low-speed crawling, waveform distortion at speed zero-crossing, positioning lag, etc., which can affect the dynamic and static performance of the Servo system.

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.

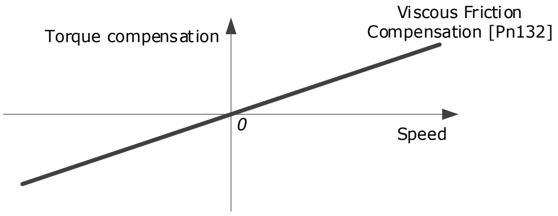
You can set Coulomb Friction Compensation (Pn130) manually, and its direction is consistent with the direction of rotation speed. In addition, it is necessary to set Speed Dead Band for Coulomb Friction Compensation (Pn131) to avoid the Motor changing the compensation direction frequently near zero speed, in this case, the Friction Compensation in the Dead Band is 0, as is shown in Figure 10-15.

Figure 10-15 Friction compensation diagram



The viscous friction compensation is a linear relationship with the Motor speed, as is shown in Figure 10-16. You can set the Viscous Friction Compensation by Pn132.

Figure 10-16 Relationship between viscous friction and speed



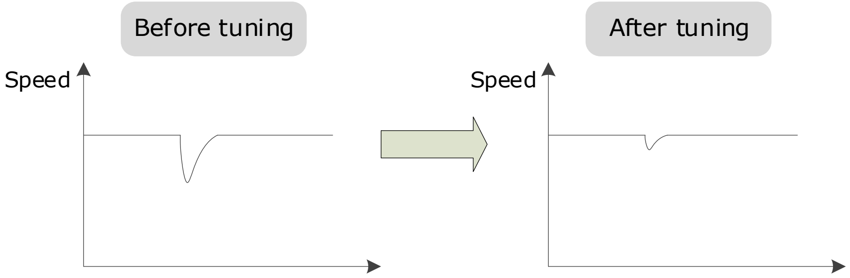
Parameter	Setting	Meaning	When Enabled	Classification
Pn130	–	Coulomb Friction Compensation	Immediately	Adjustment
Pn131	–	Speed Dead Band for Coulomb Friction Compensation	Immediately	Adjustment
Pn132	–	Viscous Friction Compensation	Immediately	Adjustment

10.5.5 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)

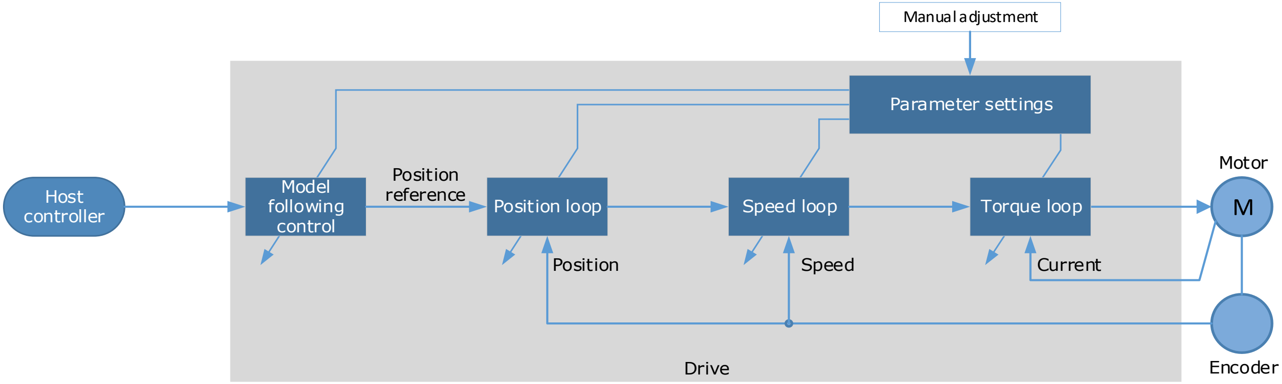
In addition, you can adjust the bandwidth of the load torque observer via Load Torque Observer Gain (Pn161). Increase the setting of Pn161 for making the observed torque closer to the actual torque, but overshooting will be likely to occur.

Parameter	Setting	Meaning	When Enabled	Classification
Pn160	–	Load Torque Compensation	Immediately	Adjustment
Pn161	–	Load Torque Observer Gain	Immediately	Adjustment

10.5.6 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 10-17 shows the block diagram in model following control.

Figure 10-17 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 10.2.3 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.

10.6 Vibration Suppression

10.6.1 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 10-18 shows the block diagram of using the notch filters.

Figure 10-18 Block diagram of using the notch filters

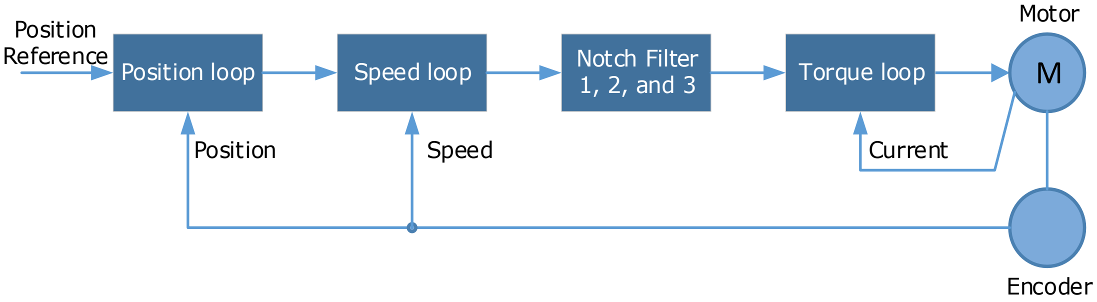
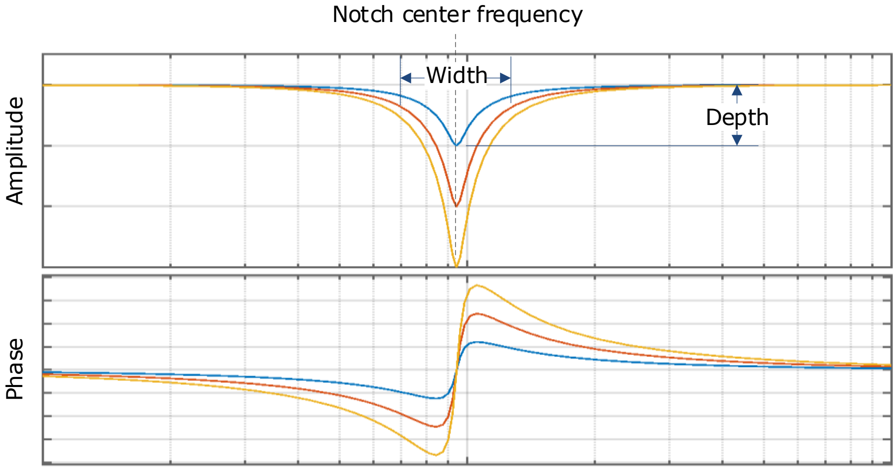


Figure 10-19 shows the relevant parameters for the notch filter. Since the notch filter can attenuate the signal at the notch frequency, if you set a proper frequency (Pn181, Pn184 or Pn187), depth (n182, Pn185 or Pn188) and width (n183, Pn186 or Pn189), the vibration signal in the torque reference can be filtered.

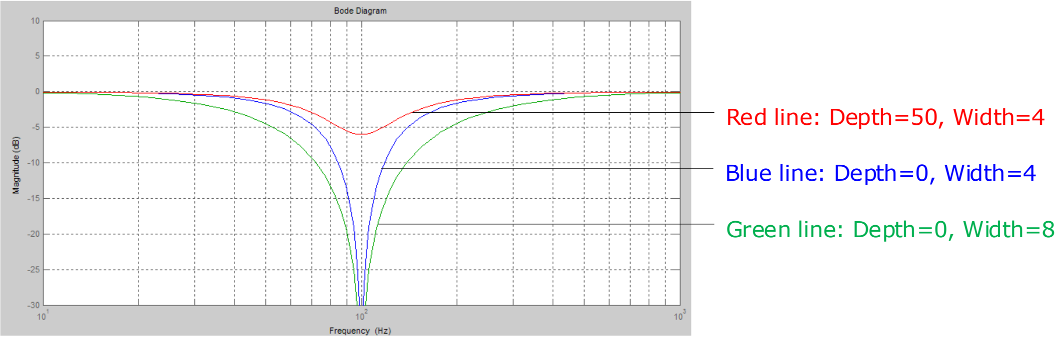
Figure 10-19 Diagram of notch filter parameters



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

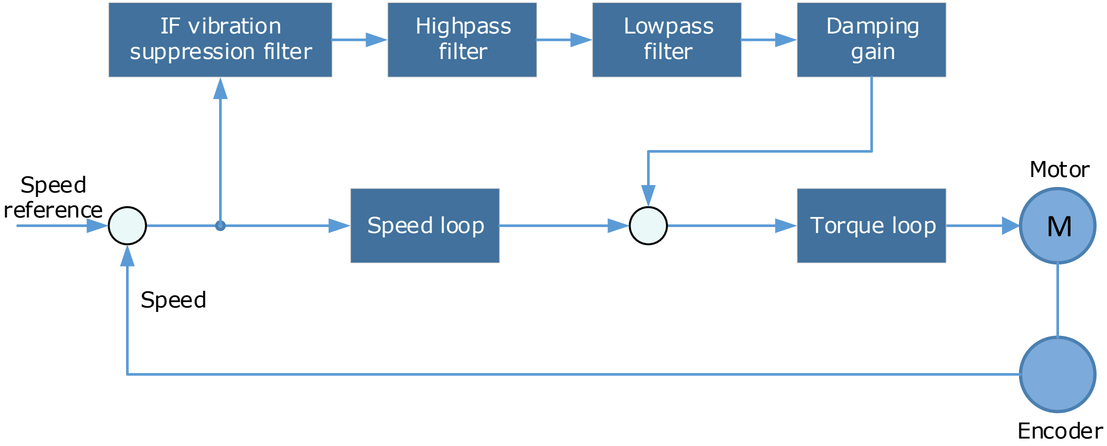
- Set the frequency of notch filter to 5000, indicating the notch filter is unavailable.
- The setting range of the depth is from 0 to 23.
- The setting range of the width is from 0 to 15.



10.6.2 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 10-20 shows the block diagram of using the IF vibration suppression filter.

Figure 10-20 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.

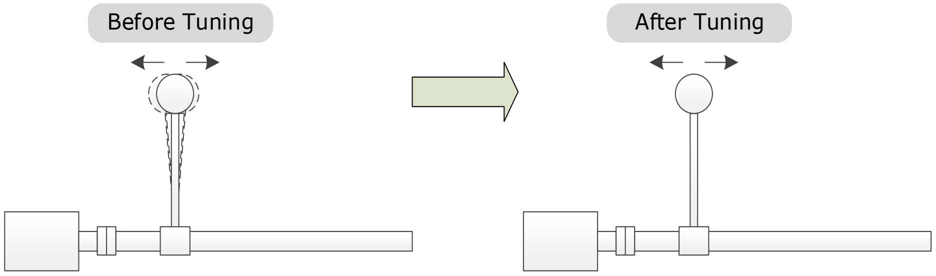
Parameter	Setting	Meaning	When Enabled	Classification
Pn173	–	Frequency of Vibration Suppression Filter	Immediately	Adjustment
Pn174	–	Adjust Bandwidth of Vibration Suppression Filter	Immediately	Adjustment
Pn175	–	Vibration Suppression	Immediately	Adjustment
Pn176	–	Lowpass Filter Time for Vibration 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.

10.6.3 Load Oscillation Suppression

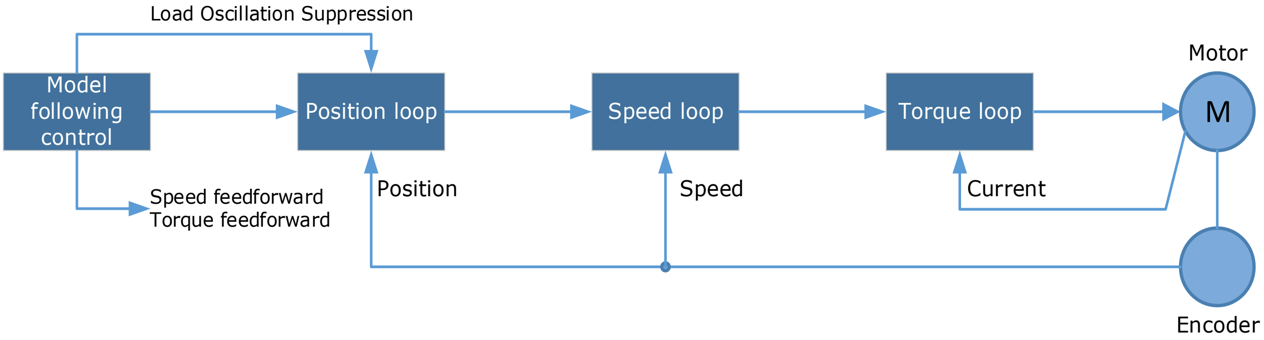
Use the Load Oscillation Suppression function for suppressing low frequency jitter at the end of the load during position control, as is shown in Figure 10-21.

Figure 10-21 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 10-22 shows the block diagram of using the Load Oscillation Suppression.

Figure 10-22 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.

10.6.4 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

10.7 Diagnostic Tools

10.7.1 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.

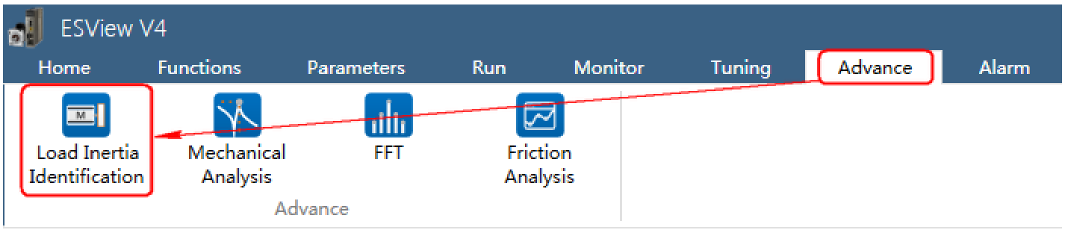
Step 6 Press [▲] key to write the detection value to the parameter Pn106 (Load Inertia Percentage).

Step 7 Press [◀] key to return to the display of the Fn009.

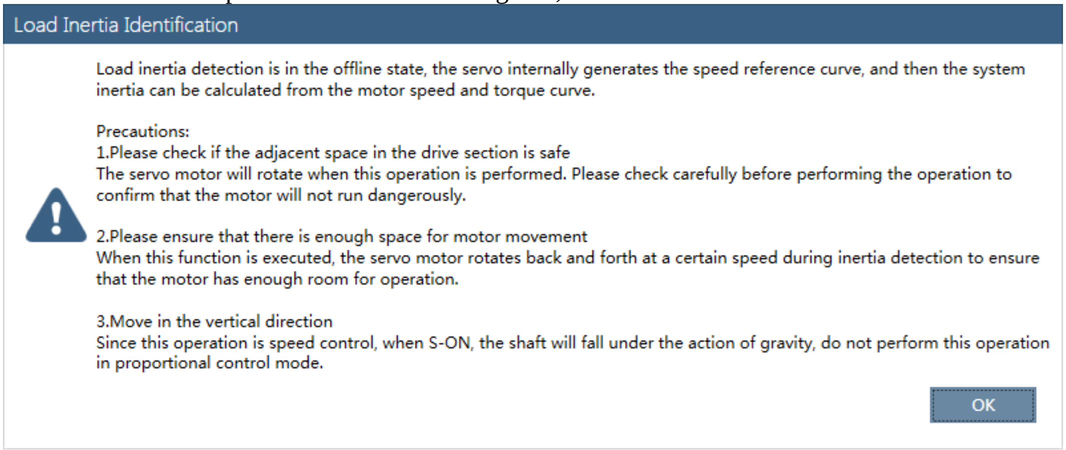
Use the ESView V4

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**.



Load Inertia Identification

Load inertia detection is in the offline state, the servo internally generates the speed reference curve, and then the system inertia can be calculated from the motor speed and torque curve.

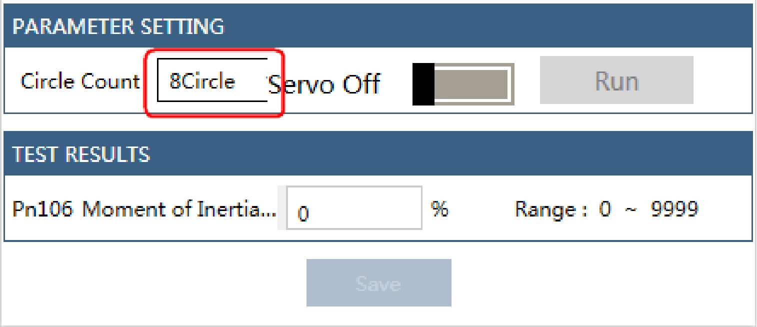
Precautions:

1.Please check if the adjacent space in the drive section is safe
The servo motor will rotate when this operation is performed. Please check carefully before performing the operation to confirm that the motor will not run dangerously.

2.Please ensure that there is enough space for motor movement
When this function is executed, the servo motor rotates back and forth at a certain speed during inertia detection to ensure that the motor has enough room for operation.

3.Move in the vertical direction
Since this operation is speed control, when S-ON, the shaft will fall under the action of gravity, do not perform this operation in proportional control mode.

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.



PARAMETER SETTING

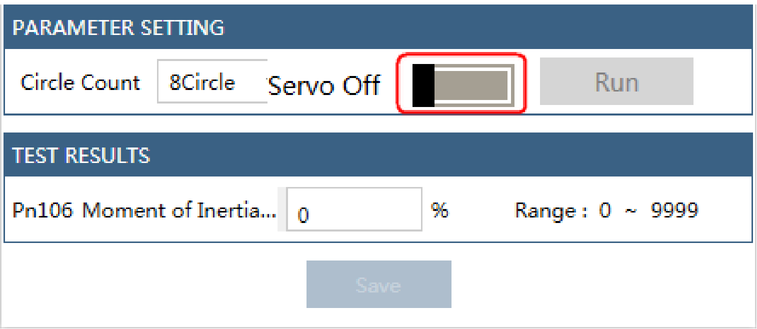
Circle Count: 8Circle

Servo Off

TEST RESULTS

Pn106 Moment of Inertia...: 0 % Range : 0 ~ 9999

Step 4 Click **Servo Off** / **Servo On** for supplying power to the Motor.



PARAMETER SETTING

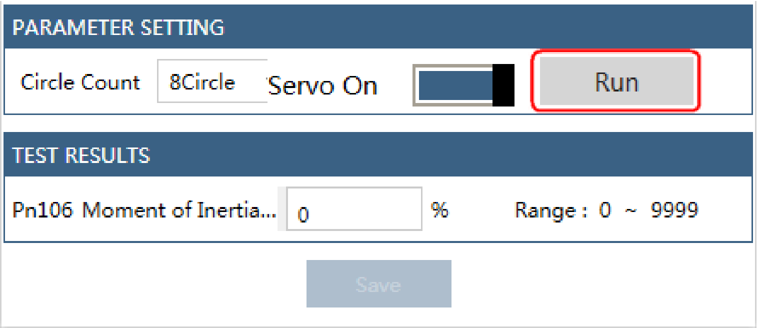
Circle Count: 8Circle

Servo Off

TEST RESULTS

Pn106 Moment of Inertia...: 0 % Range : 0 ~ 9999

Step 5 Click **Run**.



PARAMETER SETTING

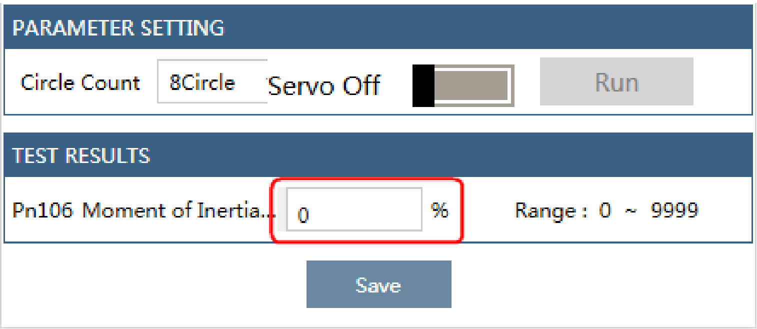
Circle Count: 8Circle

Servo On

TEST RESULTS

Pn106 Moment of Inertia...: 0 % Range : 0 ~ 9999

Step 6 When the **Load Inertia Identification** function has been completed, the result will be displayed in the textbox.



PARAMETER SETTING

Circle Count: 8Circle

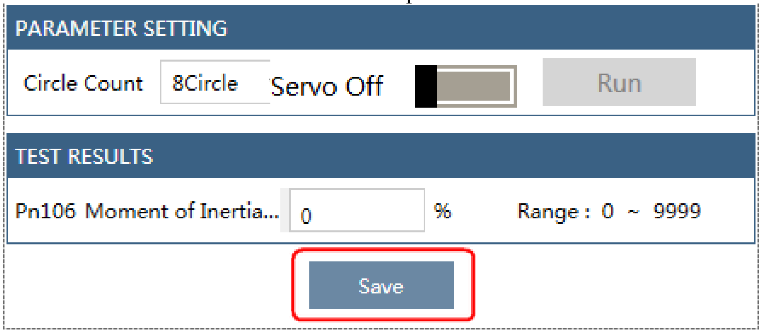
Servo Off

TEST RESULTS

Pn106 Moment of Inertia... 0 %

Range : 0 ~ 9999

Step 7 Click Save to write the value into the parameter Pn106 of the Drive.



PARAMETER SETTING

Circle Count: 8Circle

Servo Off

TEST RESULTS

Pn106 Moment of Inertia... 0 %

Range : 0 ~ 9999

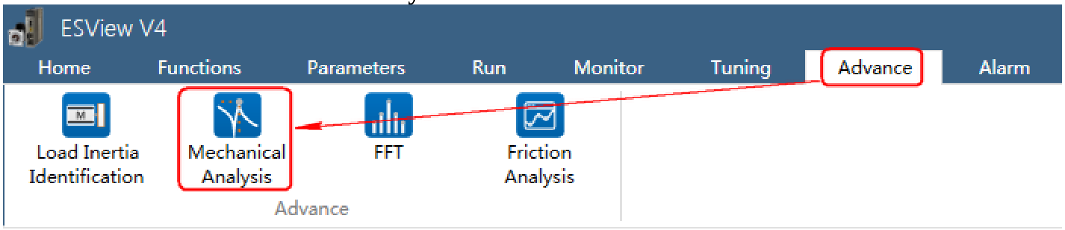
----End

10.7.2 Mechanical Analysis

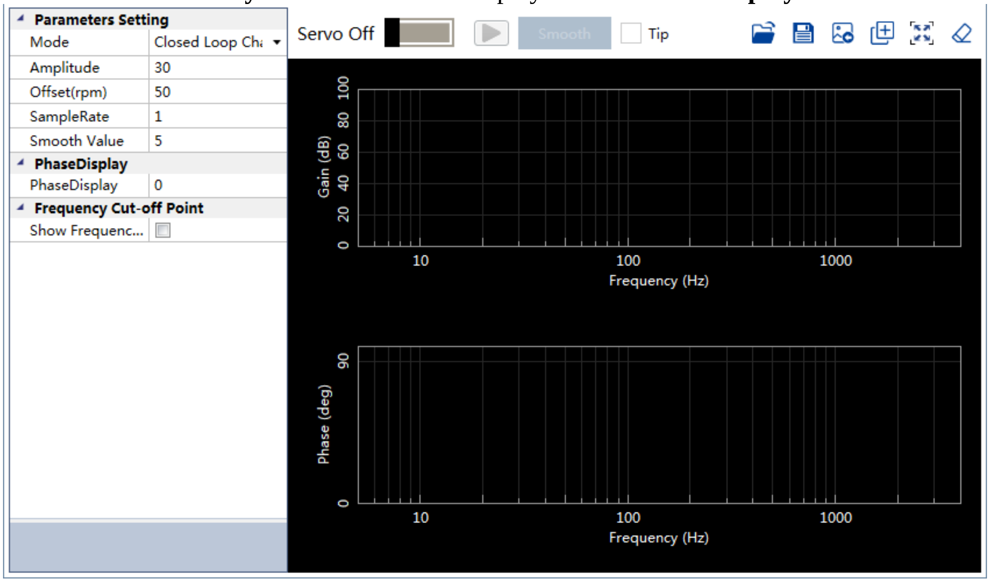
CAUTION Stop the Motor running before performing this function.

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**.



Parameters Setting

Mode	Closed Loop Chi
Amplitude	30
Offset(rpm)	50
SampleRate	1
Smooth Value	5

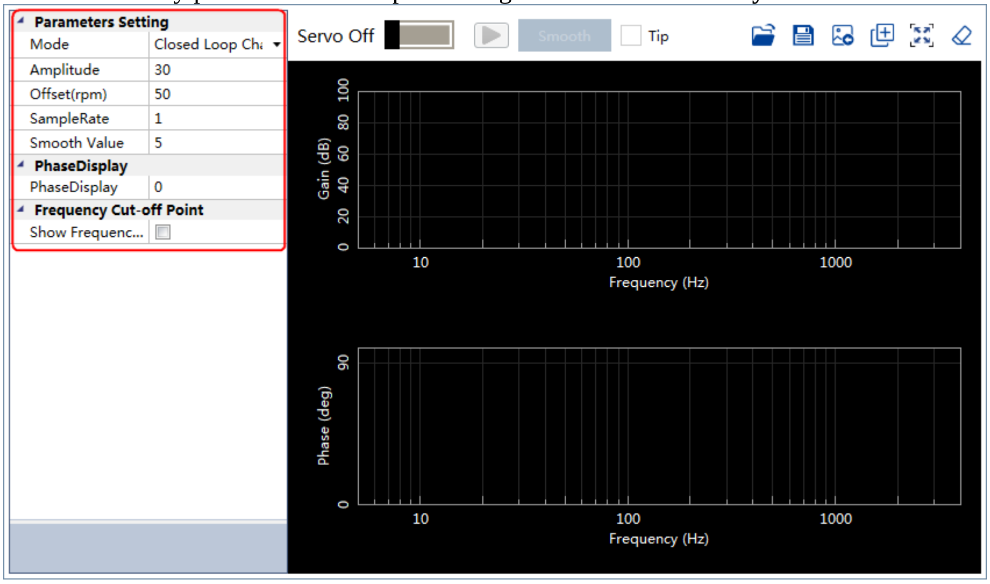
PhaseDisplay

PhaseDisplay	0

Frequency Cut-off Point

Show Frequenc...	☐

Step 3 Set the necessary parameters before performing the **Mechanical Analysis** function.



Parameters Setting

Mode	Closed Loop Chi
Amplitude	30
Offset(rpm)	50
SampleRate	1
Smooth Value	5

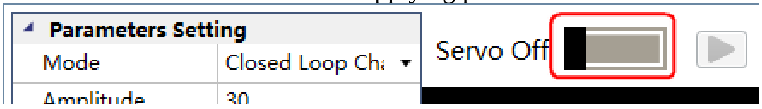
PhaseDisplay

PhaseDisplay	0

Frequency Cut-off Point

Show Frequenc...	☐

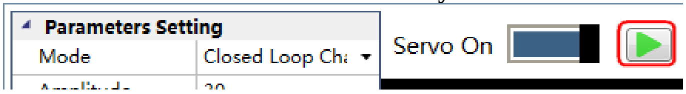
Step 4 Click **Servo Off** / **Servo On** for supplying power to the Motor.



Parameters Setting

Mode	Closed Loop Chi
Amplitude	30

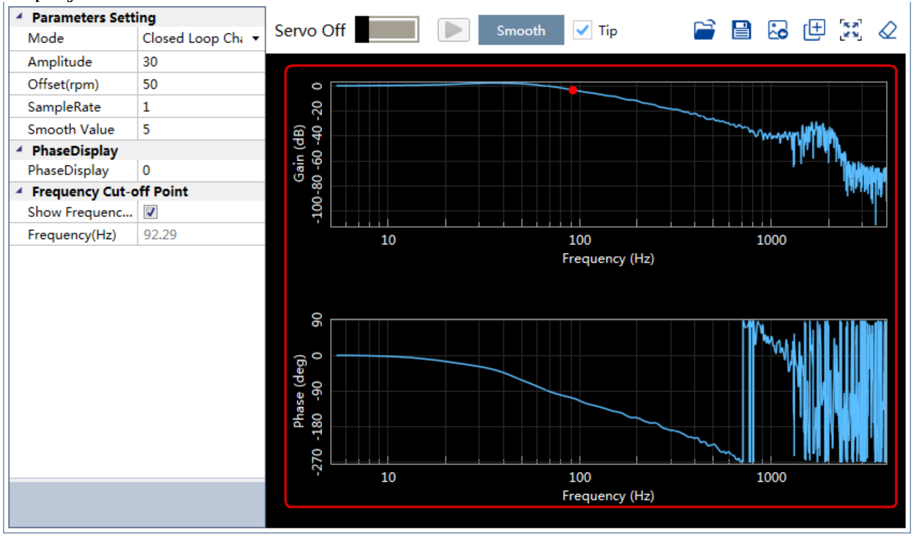
Step 5 Click ▶ to start the **Mechanical Analysis** function.



Parameters Setting

Mode	Closed Loop Chi

Step 6 When the **Mechanical Analysis** function has been completed, the waveform graphics of the data result is displayed in the window.



Parameters Setting

Mode	Closed Loop Chi
Amplitude	30
Offset(rpm)	50
SampleRate	1
Smooth Value	5

PhaseDisplay

PhaseDisplay	0

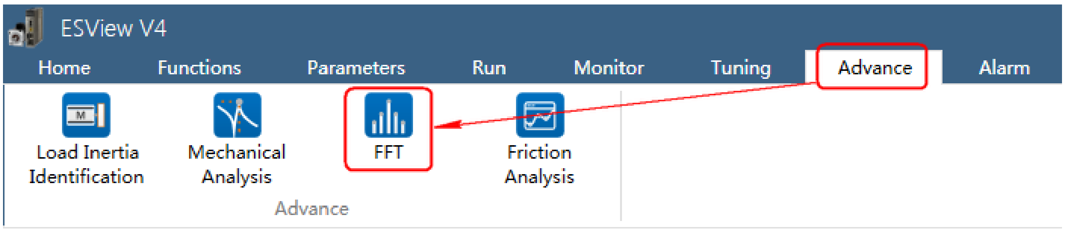
Frequency Cut-off Point

Show Frequenc...	☑
Frequency(Hz)	92.29

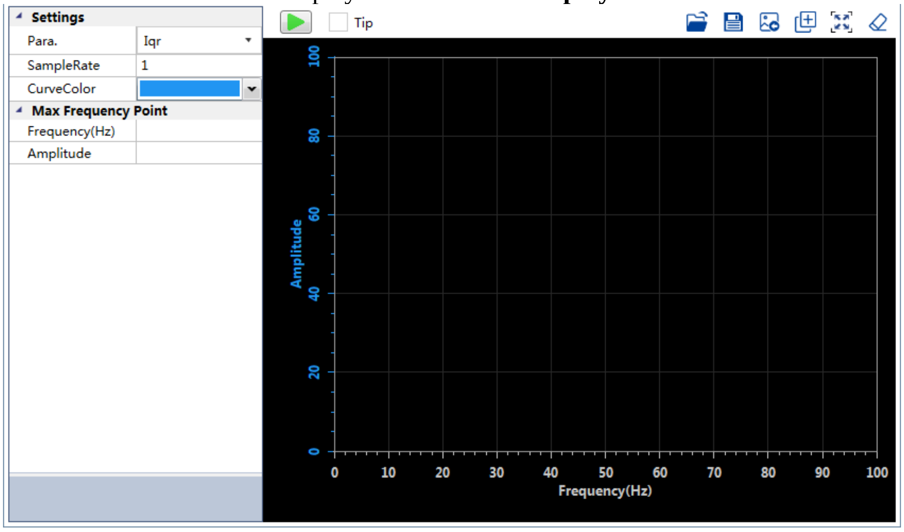
10.7.3 FFT

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.

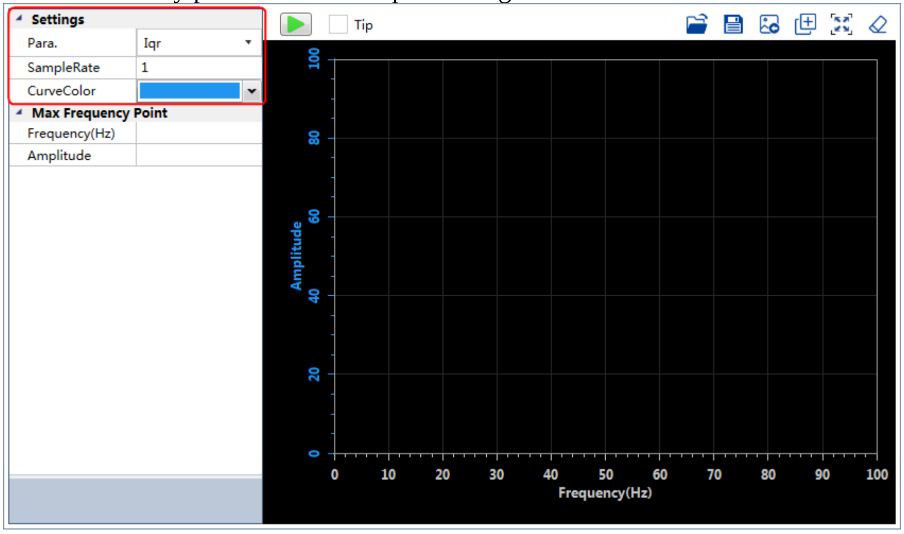


Step 2 The **FFT** window will be displayed in **Function Display Area**.



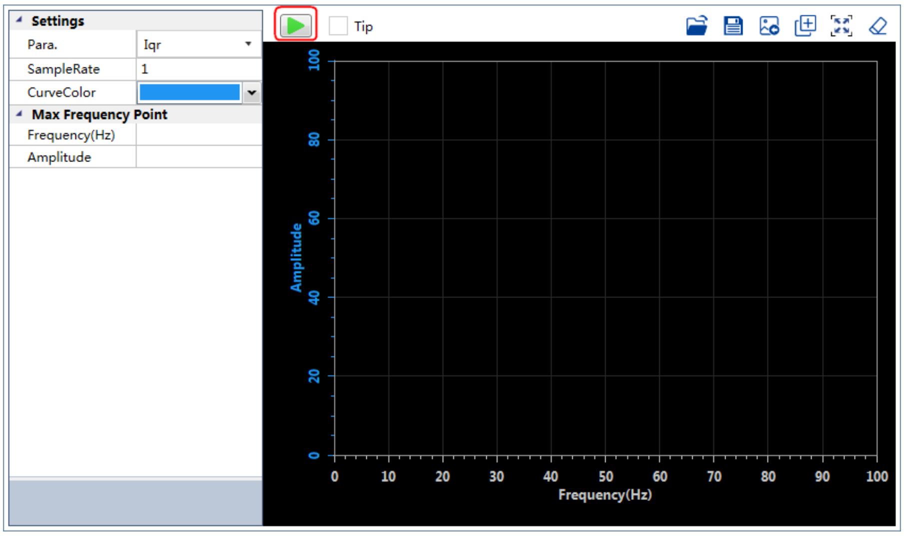
Settings
Para. Iqr
SampleRate 1
CurveColor
Max Frequency Point
Frequency(Hz)
Amplitude

Step 3 Set the necessary parameters before performing the FFT function.



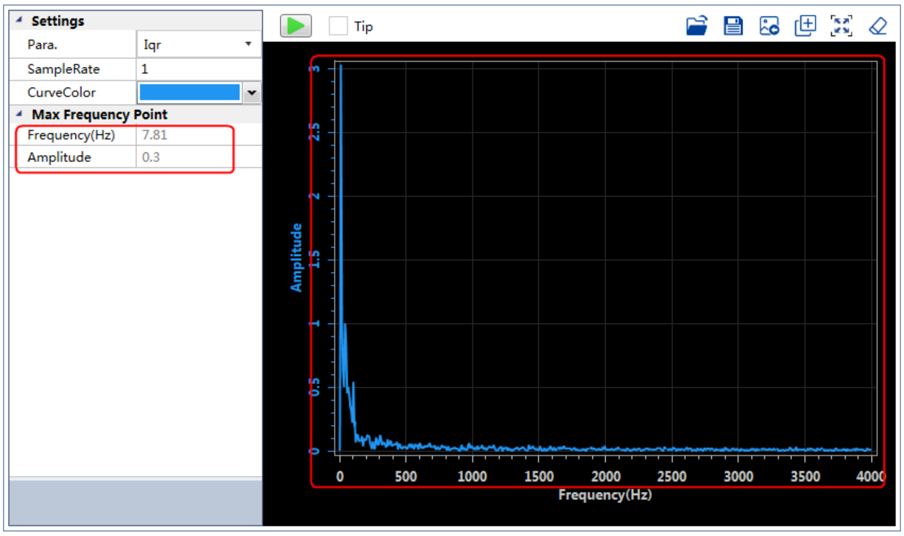
Settings
Para. Iqr
SampleRate 1
CurveColor
Max Frequency Point
Frequency(Hz)
Amplitude

Step 4 Click ▶ to start the FFT function.



Settings	
Para.	Iqr
SampleRate	1
CurveColor	🟦
Max Frequency Point	
Frequency(Hz)	
Amplitude	

Step 5 When the **FFT** function has been completed, the waveform graphics of the data result is displayed in the window.



Settings	
Para.	Iqr
SampleRate	1
CurveColor	🟦
Max Frequency Point	
Frequency(Hz)	7.81
Amplitude	0.3

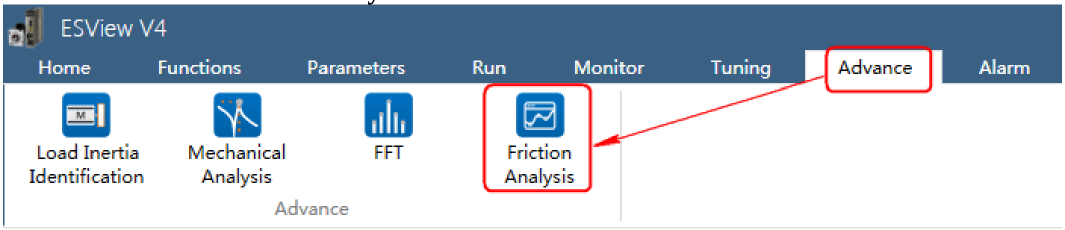
10.7.4 Friction Analysis

CAUTION

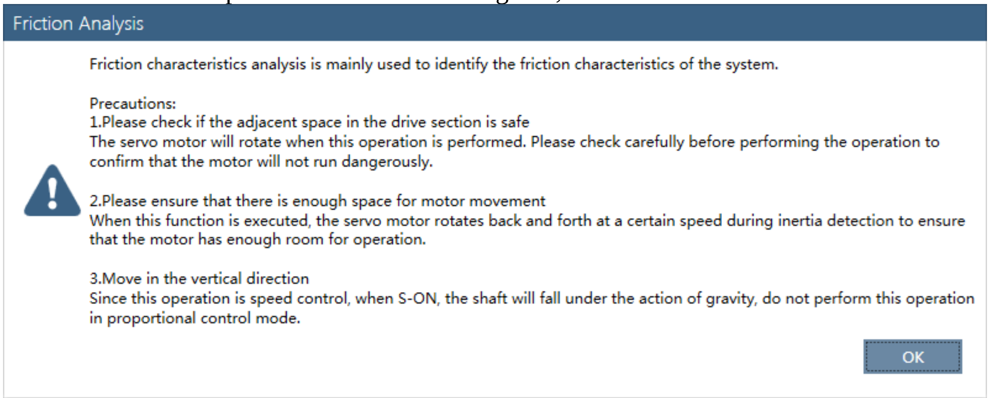
Stop the Motor running before performing this function.

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**.



Friction Analysis

Friction characteristics analysis is mainly used to identify the friction characteristics of the system.

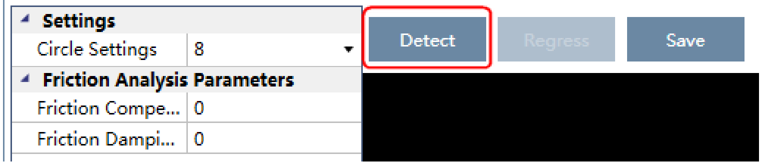
Precautions:
1.Please check if the adjacent space in the drive section is safe
The servo motor will rotate when this operation is performed. Please check carefully before performing the operation to confirm that the motor will not run dangerously.

2.Please ensure that there is enough space for motor movement
When this function is executed, the servo motor rotates back and forth at a certain speed during inertia detection to ensure that the motor has enough room for operation.

3.Move in the vertical direction
Since this operation is speed control, when S-ON, the shaft will fall under the action of gravity, do not perform this operation in proportional control mode.

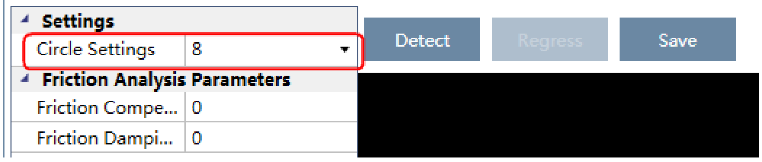
Step 3 The **Friction Analysis** window will be displayed in **Function Display Area**.

Step 4 Click **Detect** to perform Load Inertia Identification function if necessary.



Settings
Circle Settings 8
Friction Analysis Parameters
Friction Compe... 0
Friction Dampi... 0

Step 5 Set **Circle Settings** for the Motor rotation when performing **Friction Analysis** function.



Settings
Circle Settings 8
Friction Analysis Parameters
Friction Compe... 0
Friction Dampi... 0

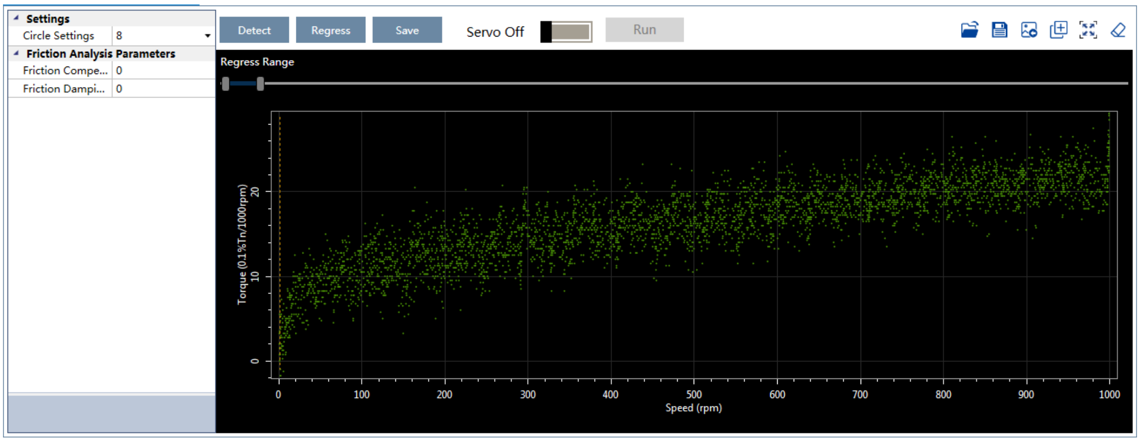
Step 6 Click **Servo Off** / **Servo On** for supplying power to the Motor.

Settings
Circle Settings 8
Friction Analysis Parameters
Friction Compe... 0
Friction Dampi... 0

Step 7 Click **Run**.

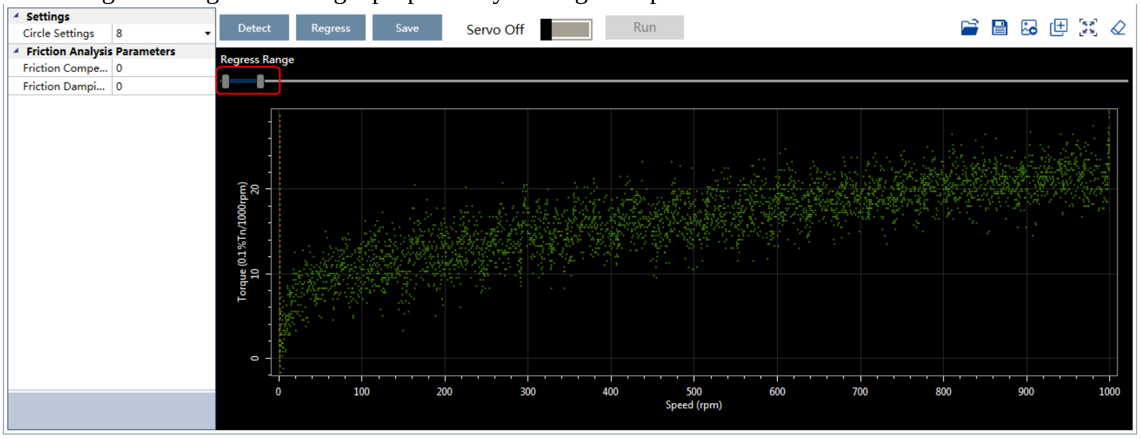
Settings
Circle Settings 8
Friction Analysis Parameters
Friction Compe... 0
Friction Dampi... 0

Step 8 When the **Friction Analysis** function has been completed, the waveform graphics of the data result is displayed in the window.



Settings
Circle Settings 8
Friction Analysis Parameters
Friction Compe... 0
Friction Dampi... 0

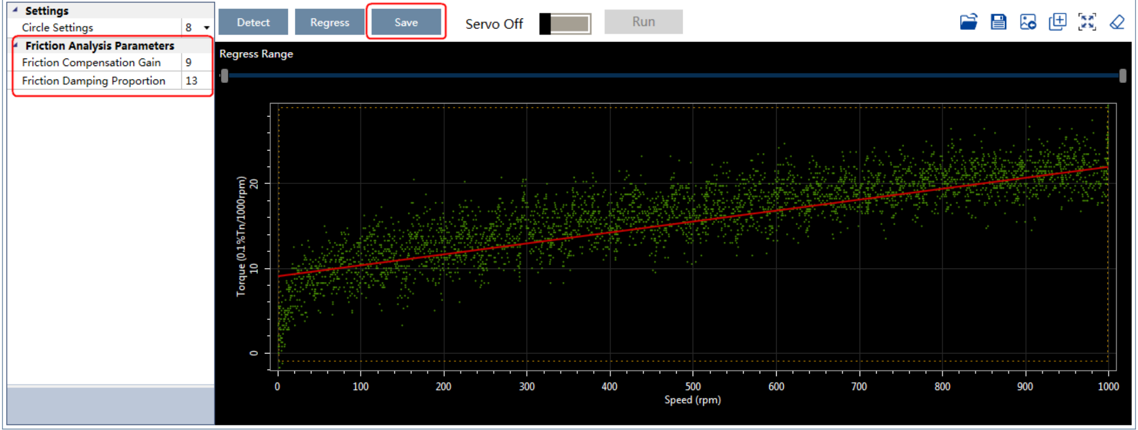
Step 9 Move Regress Range for setting a proper analysis range of Speed.



Settings
Circle Settings 8
Friction Analysis Parameters
Friction Compe... 0
Friction Dampi... 0

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.



Settings

Circle Settings	8

Friction Analysis Parameters

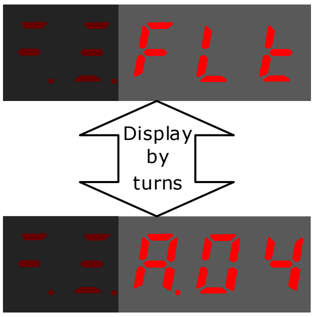
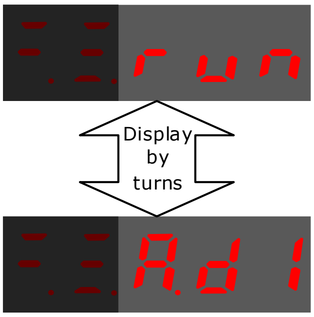
Friction Compensation Gain	9
Friction Damping Proportion	13

----End

Chapter 11 Alarm Displays

11.1 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 6.5.1 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 6.5.3 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. 

11.2 Troubleshooting methods

11.2.1 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.

Possible causes	Confirm the method	Action
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 (Fn001).
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.
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 EtherCAT 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.	Change drive selection, running methods and institutions to reduce the use frequency of db.
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.
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.

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.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
The drive requires an external braking resistor	Confirm the connection of the external regenerative resistor and check the setpoints of Pn535 and Pn536.	After connecting the external braking resistor, set Pn535 and Pn536 to the appropriate values.
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.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.

Possible causes	Confirm the method	Action
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.1E：The main charge circuit is faulty

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.	After connecting the external braking resistor, set Pn535 and Pn536 to the appropriate values.
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.
The external regenerative resistance value or regenerative resistance capacity is insufficient, or it is in a continuous regeneration state	Again, the operating conditions or capacity are confirmed.	Change the regeneration resistance value and regenerative resistance capacity. Adjust the operating conditions again.
Continuously bear negative loads and are in a state of continuous regeneration	Confirm the load applied to the motor in operation.	Revisiting the system, which includes servo, mechanical, and operating conditions.
The capacity set in Pn536 (discharge resistor power) is less than the capacity of the external regenerative resistor	Confirm the connection of the regenerative resistor and the value of Pn536.	Corrects the setpoint of Pn536.

Possible causes	Confirm the method	Action
The value set in Pn535 (Discharge Resistor Resistance) is less than the external regenerative resistance value	Confirm the connection of the regenerative resistor and the value of Pn535.	Corrects the setpoint of Pn535.
The external regeneration resistance value is too large	Confirm that the regeneration resistance value is correct.	Change it to the correct resistance value and capacity.
Drive failure	Confermtat Tregnatien Rescisteins Valleus Correcht.	Replace the drive.

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.

Possible causes	Confirm the method	Action
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".
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.

Possible causes	Confirm the method	Action
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 EtherCAT 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 EtherCAT communication.	–	Reboot the drive to re-establish EtherCAT communication.

A.71：SM Event synchronization event premature

Possible causes	Confirm the method	Action
EtherCAT communication error due to noise.	–	Check the EtherCAT wiring and implement noise countermeasures.
The controller does not update process data during a fixed period of time.	Examine the process data specified by the controller.	Modify the controller's configuration so that it can update process data during a fixed period.

Possible causes	Confirm the method	Action
The EtherCAT communication cable or connector wiring is faulty.	Check the EtherCAT communication cables and connector wiring.	Modify the wiring.

A.72：SM Event synchronization event timed out

Possible causes	Confirm the method	Action
EtherCAT communication error due to noise.	–	Check the EtherCAT wiring and implement noise countermeasures.
The controller does not update process data during a fixed period of time.	Examine the process data specified by the controller.	Modify the controller's configuration so that it can update process data during a fixed period.
The EtherCAT communication cable or connector wiring is faulty.	Check the EtherCAT communication cables and connector wiring.	Modify the wiring.

A.73：EtherCAT processor internal error

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.74：The position is set in the Cubic interpolation algorithm with a period error

Possible causes	Confirm the method	Action
Synchronization timing (Sync0) fluctuations in EtherCAT communication	–	Reboot the drive to re-establish EtherCAT communication.

A.75：There was an error setting for the synchronization period

Possible causes	Confirm the method	Action
Synchronization timing (Sync0) fluctuations in EtherCAT communication	–	Reboot the drive to re-establish EtherCAT communication.
The setting of object 60C2 is not an integer multiple of 125μs	Check the setpoint of object 60C2	Correctly set object 60C2.

A.76：The acceleration object is set to 0 in PP/PV mode

Possible causes	Confirm the method	Action
The setpoints for objects 6083, 6084, 6085 are incorrect	The setpoints for objects 6083, 6084, 6085 (not 0).	Correctly set objects 6083, 6084, 6085.

A.77：OP mode process data watchdog communication timed out

Possible causes	Confirm the method	Action
Detects whether the master controller sends process data properly	The data transmission interval is detected by the wireshark packet capture software	Reboot the drive to re-establish EtherCAT communication.
Whether the network cable is loose	Check whether the network cable is plugged in tightly	Reseat the network cable

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.

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.

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.
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”.

Cause	Way of confirmation	Solution
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)

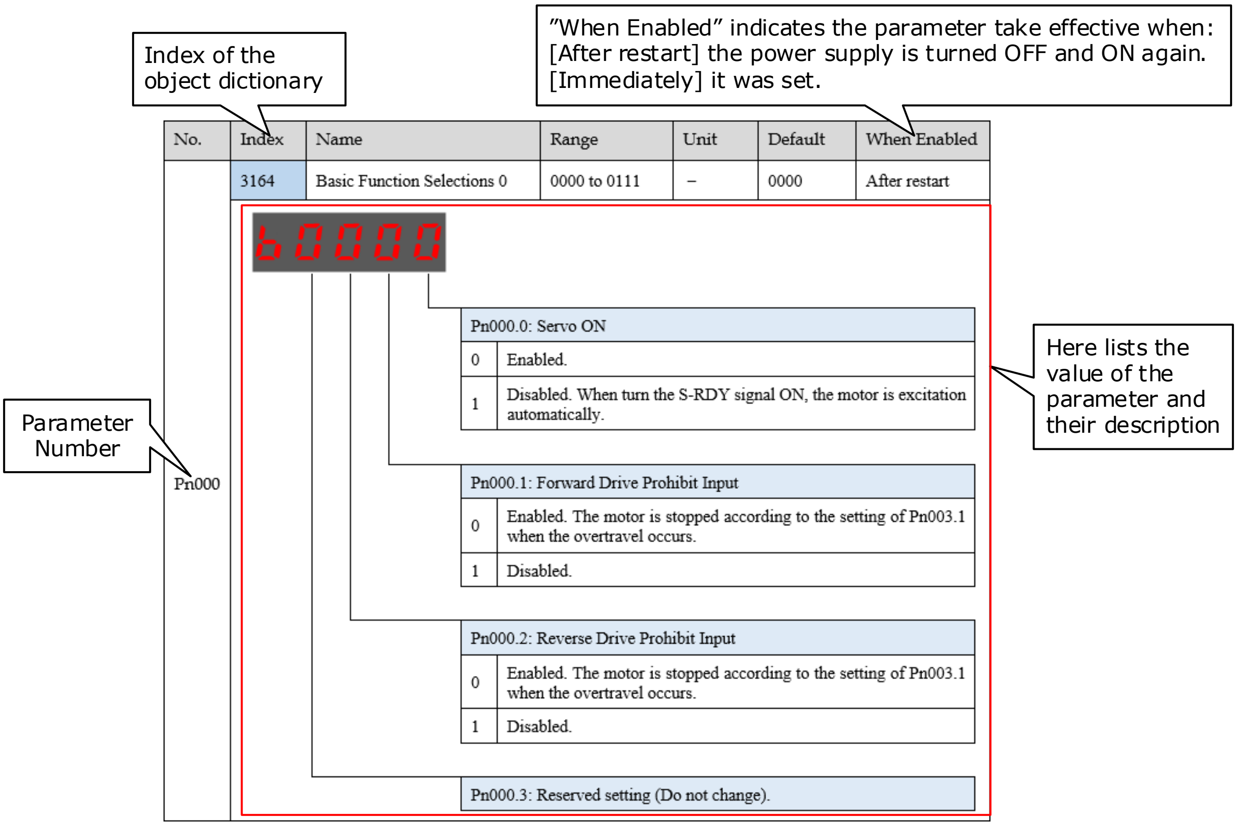
Cause	Way of confirmation	Solution
Poor battery connection, or not connected	Confirm battery installation	Install the battery correctly
Battery voltage below 3.0V	Measure the battery voltage	Replace the battery and clear the alarm. See “3.5.3 Installing or Replacing the Battery”.
Drive failure	Re-apply 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 12 Parameters

12.1 Interpreting the Parameter Lists



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).

12.2 Parameters Detailed

<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">Pn000</td><td>3164</td><td>Basic Function Selections 0</td><td>0000 to 0111</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">

<table>
<tr><th colspan="2">Pn000.0: Servo ON</th></tr>
<tr><td>0</td><td>Enabled.</td></tr>
<tr><td>1</td><td>Disabled. When turn the S-RDY signal ON, the Motor is excitation automatically.</td></tr>
</table>
<table>
<tr><th colspan="2">Pn000.1: Forward Drive Prohibit Input</th></tr>
<tr><td>0</td><td>Enabled. The Motor is stopped according to the setting of Pn003.1 when the overtravel occurs.</td></tr>
<tr><td>1</td><td>Disabled.</td></tr>
</table>
<table>
<tr><th colspan="2">Pn000.2: Reverse Drive Prohibit Input</th></tr>
<tr><td>0</td><td>Enabled. The Motor is stopped according to the setting of Pn003.1 when the overtravel occurs.</td></tr>
<tr><td>1</td><td>Disabled.</td></tr>
</table>
<table>
<tr><th>Pn000.3: Reserved setting (Do not change).</th></tr>
</table>
</td></tr>
<tr><td rowspan="2">Pn001</td><td>3165</td><td>Basic Function Selections 1</td><td>0000 to 0001</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">

<table>
<tr><th colspan="2">Pn001.0: CCW, CW</th></tr>
<tr><td>0</td><td>Use CCW as the forward direction.</td></tr>
<tr><td>1</td><td>Use CW as the forward direction.</td></tr>
</table>
<table>
<tr><th>Pn001.1: Reserved setting (Do not change).</th></tr>
</table>
<table>
<tr><th>Pn001.2: Reserved setting (Do not change).</th></tr>
</table>
<table>
<tr><th>Pn000.3: Reserved setting (Do not change).</th></tr>
</table>
</td></tr>
</table>

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	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.

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	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.

No.	Index	Name	Range	Unit	Default	When Enabled
Pn006	316A	Application Function Selections 6	0000 to 0001	–	0001	After restart

Pn006.0: Bus Selection

0	Do not use the Bus. Select the control method by the setting of Pn005.1.
1	Use EtherCAT.

Pn006.1: Reserved setting (Do not change).

Pn006.2: Reserved setting (Do not change).

Pn006.3: Reserved setting (Do not change).

No.	Index	Name	Range	Unit	Default	When Enabled
Pn007	316B	Application Function Selections 7	0000 to 1120	–	0010	After restart

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

<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">Pn008</td><td>316C</td><td>Initial Display Selection When Power On</td><td>0 to 9999</td><td>–</td><td>0010</td><td>After restart</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td rowspan="2">Pn009</td><td>316D</td><td>Application Function Selections 9</td><td>0000 to 0001</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">
<table><tr><th colspan="2">Pn009.0: Shared DC Bus Function</th></tr><tr><td>0</td><td>Disabled.</td></tr><tr><td>1</td><td>Enabled.</td></tr></table>
Pn009.1: Reserved setting (Do not change).
Pn009.2: Reserved setting (Do not change).
Pn009.3: Reserved setting (Do not change).</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">Pn100</td><td>31C8</td><td>Tuning Function</td><td>0001 to 1105</td><td>–</td><td>0001</td><td>After restart</td></tr>
<tr><td colspan="6">


<table>
<tr><th colspan="2">Pn100.0: Tuning Mode</th></tr>
<tr><td>1</td><td>Tuning-less</td></tr>
<tr><td>2</td><td>Reserved setting (Do not change).</td></tr>
<tr><td>3</td><td>One-parameter auto-tuning</td></tr>
<tr><td>4</td><td>Reserved setting (Do not change).</td></tr>
<tr><td>5</td><td>Manual tuning</td></tr>
</table>
<table>
<tr><th>Pn100.1: Reserved setting (Do not change).</th></tr>
</table>
<table>
<tr><th colspan="2">Pn100.2: Automatic Vibration Suppression Selection</th></tr>
<tr><td>0</td><td>Disabled.</td></tr>
<tr><td>1</td><td>Enabled.</td></tr>
</table>
<table>
<tr><th colspan="2">Pn100.3: Damping Selection (This parameter is available when the One-parameter auto-tuning function is selected.)</th></tr>
<tr><td>0</td><td>Standard: Short positioning time, but prone to overshoot.</td></tr>
<tr><td>1</td><td>Stable: Stable positioning, but long positioning time.</td></tr>
</table>
</td></tr>
<tr><td rowspan="2">Pn101</td><td>31C9</td><td>Servo Rigidity</td><td>0 to 500</td><td>Hz</td><td>40</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter determines the response characteristic of the servo system.
The performance can be improved by increasing this value, and decrease if vibration occurs.</td></tr>
<tr><td rowspan="2">Pn102</td><td>31CA</td><td>Speed Loop Gain</td><td>1 to 10000</td><td>rad/s</td><td>500</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter determines the bandwidth of the speed loop.</td></tr>
<tr><td rowspan="2">Pn103</td><td>31CB</td><td>Speed Loop Integral Time</td><td>1 to 5000</td><td>0.1ms</td><td>125</td><td>Immediately</td></tr>
<tr><td colspan="6">Reduce this value can shorten positioning time and speed response time.</td></tr>
<tr><td rowspan="2">Pn104</td><td>31CC</td><td>Position Loop Gain</td><td>0 to 1000</td><td>1/s</td><td>40</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter determines the bandwidth of position loop.
Increase this value can improve the stiffness of positioning, decrease if the system vibrates.</td></tr>
</table>

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.					

<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">Pn116</td><td>31D8</td><td>P/PI Switch Mode</td><td>0 to 4</td><td>–</td><td>0</td><td>After restart</td></tr>
<tr><td colspan="6">[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.</td></tr>
<tr><td rowspan="2">Pn117</td><td>31D9</td><td>Torque Reference Threshold for P/PI Switch</td><td>0 to 300</td><td>%</td><td>200</td><td>Immediately</td></tr>
<tr><td colspan="6">The threshold is used to switch speed controller from PI to P. This value is a percentage of torque reference.</td></tr>
<tr><td rowspan="2">Pn118</td><td>31DA</td><td>Deviation Counter Threshold for P/PI Switch</td><td>0 to 10000</td><td>1 pulse</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">The threshold is used to switch speed controller from PI to P. This value is a pulse number.</td></tr>
<tr><td rowspan="2">Pn119</td><td>31DB</td><td>Acceleration Reference Threshold for P/PI Switch</td><td>0 to 3000</td><td>10 rpm/s</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">The threshold is used to switch speed controller from PI to P. This value is an acceleration reference.</td></tr>
<tr><td rowspan="2">Pn120</td><td>31DC</td><td>Speed Reference Threshold for P/PI Switch</td><td>0 to 10000</td><td>rpm</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">The threshold is used to switch speed controller from PI to P. This value is a speed reference.</td></tr>
<tr><td rowspan="2">Pn121</td><td>31DD</td><td>Gain Switch Mode</td><td>0 to 10</td><td>–</td><td>0</td><td>After restart</td></tr>
<tr><td colspan="6">[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.</td></tr>
<tr><td rowspan="2">Pn122</td><td>31DE</td><td>Delay Time for Gain Switch</td><td>0 to 20000</td><td>0.1 ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">The delay time for gain switching after the condition has satisfied.</td></tr>
</table>

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
	–					

<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">Pn170</td><td>320E</td><td>Acc./Dec. Time for PJOG1</td><td>50 to 2000</td><td>ms</td><td>500</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn171</td><td>320F</td><td>Stop Time for PJOG1</td><td>100 to 10000</td><td>ms</td><td>1000</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn172</td><td>3210</td><td>Turns for Inertia Identification</td><td>0 to 1</td><td>–</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">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</td></tr>
<tr><td rowspan="2">Pn173</td><td>3211</td><td>Frequency of Vibration Suppression Filter</td><td>100 to 2000</td><td>Hz</td><td>2000</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn174</td><td>3212</td><td>Adjust Bandwidth of Vibration Suppression Filter</td><td>1 to 100</td><td>–</td><td>30</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn175</td><td>3213</td><td>Vibration Suppression</td><td>0 to 500</td><td>–</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn176</td><td>3214</td><td>Lowpass Filter Time for Vibration Suppression</td><td>0 to 50</td><td>0.1ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn177</td><td>3215</td><td>Highpass Filter Time for Vibration Suppression</td><td>0 to 1000</td><td>0.1ms</td><td>1000</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn178</td><td>3216</td><td>Damping of Vibration Suppression Filter</td><td>0 to 500</td><td>–</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn179</td><td>3217</td><td>Amplitude Threshold for Vibration Detection</td><td>5 to 500</td><td>–</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">This parameter is used for automatic vibration suppression.</td></tr>
</table>

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 value of Pn228 minus 1 is the setting for the multiturn limit 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">Pn304</td><td>3294</td><td>Inner Speed Reference</td><td>-6000 to 6000</td><td>rpm</td><td>500</td><td>Immediately</td></tr>
<tr><td colspan="6">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).</td></tr>
<tr><td rowspan="2">Pn305</td><td>3295</td><td>Jogging Speed</td><td>0 to 6000</td><td>rpm</td><td>500</td><td>Immediately</td></tr>
<tr><td colspan="6">To set a speed for the Motor in JOG operation, and the rotation direction is determined by the reference.</td></tr>
<tr><td rowspan="2">Pn306</td><td>3296</td><td>Soft Start Acceleration Time</td><td>0 to 10000</td><td>ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">To set ramp acceleration time per 1000 rpm.</td></tr>
<tr><td rowspan="2">Pn307</td><td>3297</td><td>Soft Start Deceleration Time</td><td>0 to 10000</td><td>ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">To set ramp deceleration time per 1000 rpm.</td></tr>
<tr><td rowspan="2">Pn308</td><td>3298</td><td>Speed Reference Filter Time</td><td>0 to 10000</td><td>ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">To set speed reference filter time.</td></tr>
<tr><td rowspan="2">Pn309</td><td>3299</td><td>S-Curve Rise Time</td><td>0 to 10000</td><td>ms</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">To set a rise time for transiting from one speed point to another speed point in the S-curve.</td></tr>
<tr><td rowspan="2">Pn310</td><td>329A</td><td>Speed Reference Smooth Mode Selection</td><td>0 to 3</td><td>–</td><td>0</td><td>After restart</td></tr>
<tr><td colspan="6">[0] Ramp
[1] S-Curve
[2] Primary filtering
[3] Secondary filtering</td></tr>
<tr><td rowspan="2">Pn311</td><td>329B</td><td>S-Curve Selection</td><td>0 to 3</td><td>–</td><td>0</td><td>After restart</td></tr>
<tr><td colspan="6">To set the transition form of the S-curve.</td></tr>
<tr><td rowspan="2">Pn323</td><td>32A7</td><td>Overspeed Detection Threshold</td><td>1 to 8000</td><td>–</td><td>8000</td><td>Immediately</td></tr>
<tr><td colspan="6">A03 alarm occurs if the Motor velocity exceeds this threshold.</td></tr>
<tr><td rowspan="2">Pn332</td><td>32B0</td><td>Touch Probe Digital Input Filtering Time</td><td>0 to 1000</td><td>10ns</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
<tr><td rowspan="2">Pn401</td><td>32F5</td><td>Forward Internal Torque Limit</td><td>0 to 350</td><td>%</td><td>350</td><td>Immediately</td></tr>
<tr><td colspan="6">–</td></tr>
</table>

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>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn509	3361	Digital Input Signal Allocations 1	0000 to 7777	–	3210	After restart

Pn509.0: Allocate signal to CN1-14	
0	S-ON
1	P-OT
2	N-OT
3	P-CL
4	N-CL
5	G-SEL
6	HmRef
7	Remote

Pn509.1: Allocate signal to CN1-15
0 to 7: same as the allocation of CN1-14.

Pn509.2: Allocate signal to CN1-16
0 to 7: same as the allocation of CN1-14.

Pn509.3: Allocate signal to CN1-17	
0 to 7: same as the allocation of CN1-14.	
8	EXT1
9	EXT2

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
9	EXT2

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>
<tr><td rowspan="2">Pn514</td><td>3366</td><td>Digital Input Signals Filter Time</td><td>0 to 1000</td><td>1 cycle</td><td>1</td><td>Immediately</td></tr>
<tr><td colspan="6">To set a filtering time for the input signals. If you increase this setting, the signal changes on the input port will be delayed.</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">Pn515</td><td>3367</td><td>Alarm Output Signal Filter Time</td><td>0 to 3</td><td>2 cycle</td><td>1</td><td>Immediately</td></tr>
<tr><td colspan="6">To set a filtering time for the alarm signals.
If you increase this setting, the alarm will be delayed.</td></tr>
<tr><td rowspan="2">Pn516</td><td>3368</td><td>Digital Input Signal Inverts 1</td><td>0000 to 1111</td><td>–</td><td>0000</td><td>After restart</td></tr>
<tr><td colspan="6">

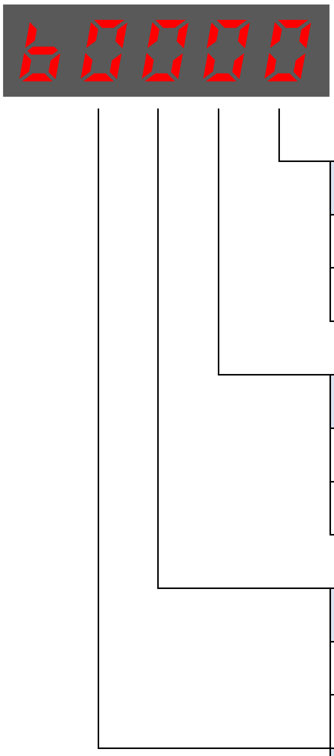

<table>
<tr><th colspan="2">Pn516.0: CN1-14 inverse selection</th></tr>
<tr><td>0</td><td>The signal is not inverted.</td></tr>
<tr><td>1</td><td>The signal is inverted.</td></tr>
</table>
<table>
<tr><th colspan="2">Pn516.1: CN1-15 inverse selection</th></tr>
<tr><td>0</td><td>The signal is not inverted.</td></tr>
<tr><td>1</td><td>The signal is inverted.</td></tr>
</table>
<table>
<tr><th colspan="2">Pn516.2: CN1-16 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">Pn516.3: CN1-17 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>
</td></tr>
</table>

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
	The warning of serial encoder related alarms can be ignored if the alarms occurred within this setting.					
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.					

<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">Pn521</td><td>336D</td><td>Alarm Masks</td><td>0000 to 0011</td><td>–</td><td>0011 (400W and below)
0010 (other power)</td><td>After restart</td></tr>
<tr><td colspan="6">


<table>
<tr><th colspan="2">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)</th></tr>
<tr><td>0</td><td>Do not mask.</td></tr>
<tr><td>1</td><td>Mask (when A15 is masked, the bleeder resistor will not work even if a bleeder battery is connected)</td></tr>
</table>
<table>
<tr><th colspan="2">Pn521.1: A06 Mask</th></tr>
<tr><td>0</td><td>Do not mask.</td></tr>
<tr><td>1</td><td>Ignore the alarm.</td></tr>
</table>
<table>
<tr><th>Pn521.2: Reserved setting (Do not change).</th></tr>
</table>
<table>
<tr><th>Pn521.3: Reserved setting (Do not change).</th></tr>
</table>
</td></tr>
<tr><td rowspan="2">Pn525</td><td>3371</td><td>Motor Overload Detection Start Threshold</td><td>100 to 150</td><td>%</td><td>100</td><td>Immediately</td></tr>
<tr><td colspan="6">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.</td></tr>
</table>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn528	3374	Digital Output Signal Inverts	0000 to 1111	–	0000	Immediately
	 Pn516.0: CN1-6, 7 inverse selection 0 The signal is not inverted. 1 The signal is inverted. Pn516.1: CN1-8, 9 inverse selection 0 The signal is not inverted. 1 The signal is inverted. Pn516.2: Reserved setting (Do not change). Pn516.3: CN1-12, 13 inverse selection 0 Not inverted 1 Inverted					
Pn529	3375	Torque Reaches Status Detection Torque Threshold	3 to 300	%	100	Immediately
	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.					
Pn530	3376	Torque Reaches Status Detection Time Threshold	1 to 1000	ms	10	Immediately
	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.					
Pn535	337B	Discharging Resistor Resistance	10 to 300	Ω	–	After restart
	To set the resistance value for the braking. This setting is not reset when the default setting is restored.					
Pn536	337C	Discharging Resistor Power	0 to 2000	W	–	After restart
	To set the power value for the braking resistor. This setting is not reset when the default setting is restored.					

<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">Pn538</td><td>337E</td><td>Momentary Power Interruption Hold Time</td><td>0 to 50</td><td>1 cycle</td><td>1</td><td>Immediately</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td rowspan="2">Pn541</td><td>3381</td><td>Current Threshold for Detecting Abnormal Operation</td><td>0 to 400</td><td>% In</td><td>200</td><td>Immediately</td></tr>
<tr><td colspan="6">Set a percentage threshold for the current to detect that the Motor has been operating abnormally.</td></tr>
<tr><td rowspan="2">Pn542</td><td>3382</td><td>Acceleration Threshold for Detecting Abnormal Operation</td><td>0 to 1000</td><td>krpm/s</td><td>50</td><td>Immediately</td></tr>
<tr><td colspan="6">Set a threshold for the acceleration to detect that the Motor has been operating abnormally.</td></tr>
<tr><td rowspan="2">Pn600</td><td>33BC</td><td>PSO Position Value Resolution</td><td>0 ~ 10</td><td>–</td><td>7</td><td>After restart</td></tr>
<tr><td colspan="6">The number of pulses accumulated by the PSO position value for one revolution of the motor</td></tr>
<tr><td rowspan="2">Pn601</td><td>33BD</td><td>PSO Mode Setting</td><td>b0000 ~ b0011</td><td>–</td><td>0</td><td>Immediately</td></tr>
<tr><td colspan="6">

<table>
<tr><th colspan="2">Pn601.0: PSO Type</th></tr>
<tr><td>0</td><td>Absolute PSO</td></tr>
<tr><td>1</td><td>Incremental PSO</td></tr>
</table>
<table>
<tr><th colspan="2">Pn601.1: Number of PSO</th></tr>
<tr><td>0</td><td>Single comparison</td></tr>
<tr><td>1</td><td>Cyclic comparison</td></tr>
</table>
<table>
<tr><th>Pn601.2: Reserved</th></tr>
<tr><td>Reserved</td></tr>
</table>
<table>
<tr><th>Pn601.3: Reserved</th></tr>
<tr><td>Reserved</td></tr>
</table></td></tr>
</table>

No.	Index	Name	Range	Unit	Default	When Enabled
Pn602	33BE	PSO Output Polarity	0 ~ 1	–	0	After restart
	PSO output polarity 0: Initial level is low, while active level is high 1: Initial level is high, while active level is low					
Pn603	33BF	PSO Output Form	0 ~ 1	–	0	After restart
	PSO Output Form 0: Pulse output 1: Level output					
Pn604	33C0	PSO Output Pulse Width	0 ~ 10000	us	100	Immediately
	Pulse output width Ranged from 1 to 10,000, in 100us.					
Pn605	33C1	Delay Compensation Time	0 ~ 200	us	0	Immediately
	Delay compensation time Ranged from 0 to 200, in 1us.					
Pn606	33C2	PSO Origin Bias	-2147483648 ~ 2147483647	pulse	0	Immediately
	After setting the Origin, the current position of the PSO is updated to the Origin Bias value, ranged from -2147483648 to 2147483647					
Pn607	33C3	PSO Starting Point	1~8	–	1	Immediately
	The starting comparison point of PSO					
Pn608	33C4	PSO Ending Point	1~20	–	8	Immediately
	The ending comparison point of PSO					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn609	33C5	Attribute of PSO1 Comparison Point 1	0~6	–	0	Immediately
	①When the output mode is pulse output 0: Comparison logic skips the point 1: Traverses forward the comparison point and outputs 2: Traverses backward the comparison point and outputs 3: Reverses the comparison point forward and backward and outputs 4~6: Comparison logic skips the point ②When the output mode is level output 0: Comparison logic skips the point 1: Traverses forward the comparison point and outputs; the output level is active 2: Traverses backward the comparison point and outputs; the output level is active 3: Forward and reverse crossing of the comparison point and outputs; the output level is active 4: Traverses forward the comparison point and outputs; output level is initial one 5: Traverses backward the comparison point and outputs; the output level is the initial one 6: Traverses the comparison point forward and backward and outputs; the output level is the initial one					
Pn610	33C6	Target Position of PSO1 Comparison Point 1	-2147483648 ~ 2147483647	–	0	Immediately
	The target position of PSO1 Comparison Point 1					
Pn611	33C7	Attribute of PSO1 Comparison Point 2	0~6	–	0	Immediately
	The same as Pn609					
Pn612	33C8	Target Position of PSO1 Comparison Point 2	-2147483648 ~ 2147483647	–	0	Immediately
	The target position of PSO1 Comparison Point 2					
Pn613	33C9	Attribute of PSO1 Comparison Point 3	0~6	–	0	Immediately
	The same as Pn609					
Pn614	33CA	Target Position of PSO1 Comparison Point 3	-2147483648 ~ 2147483647	–	0	Immediately
	The target position of PSO1 Comparison Point 3					
Pn615	33CB	Attribute of PSO1 Comparison Point 4	0~6	–	0	Immediately
	The same as Pn609					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn616	33CC	Target Position of PSO1 Comparison Point 4	-2147483648 ~ 2147483647	–	0	Immediately
	The target position of PSO1 Comparison Point 4					
Pn617	33CD	Attribute of PSO1 Comparison Point 5	0~6	–	0	Immediately
	The same as Pn609					
Pn618	33CE	Target Position of PSO1 Comparison Point 5	-2147483648 ~ 2147483647	–	00	Immediately
	The target position of PSO1 Comparison Point 5					
Pn619	33CF	Attribute of PSO1 Comparison Point 6	0~6	–	0	Immediately
	The same as Pn609					
Pn620	33D0	Target Position of PSO1 Comparison Point 6	-2147483648 ~ 2147483647	–	0	Immediately
	The target position of PSO1 Comparison Point 6					
Pn621	33D1	Attribute of PSO1 Comparison Point 7	0~6	–	0	Immediately
	The same as Pn609					
Pn622	33D2	Target Position of PSO1 Comparison Point 7	-2147483648 ~ 2147483647	–	0	Immediately
	The target position of PSO1 Comparison Point 7					
Pn623	33D3	Attribute of PSO1 Comparison Point 8	0~6	–	0	Immediately
	The same as Pn609					
Pn624	33D4	Target Position of PSO1 Comparison Point 8	-2147483648 ~ 2147483647	–		Immediately
	The target position of PSO1 Comparison Point 8					
Pn704	3424	Device Node Number	0 to 127	–	1	After restart
	To set the device node number in EtherCAT communication.					
Pn720	3434	Homing Method	1 to 35	–	1	Immediately
	Mapping to the object 6098h in CiA402.					

No.	Index	Name	Range	Unit	Default	When Enabled
Pn721	3435	Speed during Search for Switch	1 to 2147483647	0.1 rpm	5000	Immediately
	Mapping to the object 6099-01h in CiA402.					
Pn722	3436	Speed during Search for Zero	1 to 2147483647	0.1 rpm	100	Immediately
	Mapping to the object 6099-02h in CiA402.					
Pn723	3437	Homing Acceleration	1 to 2147483647	0.1 rpm/s	1000000	Immediately
	Mapping to the object 609Ah in CiA402.					
Pn724	3438	Home Offset	-2147483648 to 2147483647	1 pulse	0	Immediately
	Mapping to the object 607Ch in CiA402.					
Pn725	3439	Electronic Gear Ratio (Numerator)	1 to 1073741824	–	1	Immediately
	Mapping to the object 6093-01h in CiA402.					
Pn726	343A	Electronic Gear Ratio (Denominator)	1 to 1073741824	–	1	Immediately
	Mapping to the object 6093-02h in CiA402.					

Chapter 13 Object Dictionary

13.1 General Objects

Device Type (1000h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1000h	0	Device Type	UINT32	RO	No	0x00020192

The data description is as following.

Bit	Data	Description
0 to 15	Device profile number	0192 (DS402)
16 to 31	Additional information	0002 (Servodrive)

Error Register (1001h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1001h	0	Error Register	UINT8	RO	No	0x00000000

The data description is as following.

Bit	Data	M / O
0	Generic error	M
1	Current.	O
2	Voltage.	O
3	Temperature.	O
4	Communication error (timeout, error status).	O
5	Device specification specified.	O
6	Reserved (always 0b).	O
7	Manufacturer specified.	O

Pre-defined error field (1003h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1003h	0	Number of entries	USINT	RO	No	– (1)
	1	Error field 1	UDINT	RO	No	–
	2	Error field 2	UDINT	RO	No	–
	3	Error field 3	UDINT	RO	No	–
	4	Error field 4	UDINT	RO	No	–
	5	Error field 5	UDINT	RO	No	–
	6	Error field 6	UDINT	RO	No	–
	7	Error field 7	UDINT	RO	No	–
	8	Error field 8	UDINT	RO	No	–

(1): This value indicates the maximum number of times the alarm occurs when the servo is turned on, and the maximum value is 8.

The data description is as following.

Bit	Data	Description
0 to 15	Error code	Alarm No.
16 to 31	Additional information	Emergency code which is relative to the error code.

Store parameters (1010h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1010h	0	Highest subindex supported	UINT8	RO	NO	–
	1	Reserved	UINT32	RO	NO	–
	2	Reserved	UINT32	RO	NO	–
	3	Save application parameters	UINT32	RW	NO	–

Save the value of the object into the relevant parameter by writing a specific signature to 1010-03h. So that, the servo can load the value of the parameter to the relevant object as an initial value.

The signature is **save**.

	MSB			LSB
character	e	v	a	s
hex	65h	76h	61h	73h

The relationship between Index and Parameter State by saving is described as below.

Index	Data	Relevant Parameter
607C-00h	Home offset	Pn724
6093-01h	numerator	Pn725
6093-02h	divisor	Pn726
6098-00h	Homing method	Pn720
6099-01h	Speed during search for switch	Pn721
6099-02h	Speed during search for zero	Pn722
609A-00h	Homing acceleration	Pn723

In the case of 1010-03h, the data description is as following.

Bit	Data	Description
0	Cmd	0b: CANopen device does not save parameters autonomously
		1b: CANopen device saves parameters autonomously
1	Auto	0b: CANopen device does not save parameters on command
		1b: CANopen device saves parameters on command
2 to 31	Reserved	00 0000 0000 0000 0000 0000 0000 0000

NOTE: Commands that save objects to FRAM can only be executed when it is not in Servo ON state.
Save Autonomously means you don't need to write **save** to the object when the slave saves the object value to FRAM.

Identity Object (1018h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1018h	0	Number of entries	USINT	RO	NO	4
	1	Vendor ID	UDINT	RO	NO	0x0000060A
	2	Product code	UDINT	RO	NO	0x0000ED31
	3	Revision number (1)	UDINT	RO	NO	–
	4	Serial number (2)	UDINT	RO	NO	0x00000000

(1): The revision number is stored as follows:
The major version identifies a specific CANopen over EtherCAT (CoE) behavior. If the CoE functionality is expanded, the major version has to be increased. The minor version number identifies different versions with the same behavior.
(2): Serial number is not used (always 0).

13.2 PDO Mapping Objects

The CANopen over EtherCAT (CoE) protocol allows the user to map objects to process data objects (PDOs) in order to use the PDOs for real-time data transfer.

Objects can be combined in PDO data via PDO Mapping and PDO Assignment.

The data description of PDO Mapping Objects is as following.

Bit	Data	Description
0 to 7	Length	–
8 to 15	Sub-Index	–
16 to 31	Object index	–

The objects mapped to PDOs can be changed only when the EtherCAT (CoE) Network Module is in the Pre-Operational state.

There are 4 receiving PDOs (RxPDOs) and 4 transmit PDOs (TxPDOs). Each PDO Mapping can be assigned up to 8 objects, and the total assignment is not more than 32 bytes.

The procedure of PDO mapping is as following:

1. Disable the assignments between the Sync Manager and PDOs:
   Set subindex 00h in objects 1C12h and 1C13h to 0.
2. Disable the assignments of PDOs:
   Set subindex 00h in objects (1600h to 1603h) and (1A00h to 1A03h) to 0.
3. Set all of the mapping entries for the PDO mapping objects:
   Set objects (1600h to 1603h) and (1A00h to 1A03h).
4. Set the number of mapping entries for the PDO mapping objects:
   Set subindex 00h in objects (1600h to 1603h) and (1A00h to 1A03h).
5. Set the assignments between the Sync Manager and PDOs:
   Set subindex 01h in objects 1C12h and 1C13h.
6. Enable the assignments between the Sync Manager and PDOs:
   Set subindex 00h in objects 1C12h and 1C13h to 1.

1st Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1600h	0	Number of entries	USINT	RW	NO	2
	1	Mapping entry 1	UDINT	RW	NO	0x60400010
	2	Mapping entry 2	UDINT	RW	NO	0x60FF0020
	3	Mapping entry 3	UDINT	RW	NO	–
	4	Mapping entry 4	UDINT	RW	NO	–
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

2nd Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1601h	0	Number of entries	USINT	RW	NO	2
	1	Mapping entry 1	UDINT	RW	NO	0x60400010
	2	Mapping entry 2	UDINT	RW	NO	0x60FF0020
	3	Mapping entry 3	UDINT	RW	NO	–
	4	Mapping entry 4	UDINT	RW	NO	–
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

3rd Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1602h	0	Number of entries	USINT	RW	NO	4
	1	Mapping entry 1	UDINT	RW	NO	0x60400010
	2	Mapping entry 2	UDINT	RW	NO	0x60FF0020
	3	Mapping entry 3	UDINT	RW	NO	0x60B80010
	4	Mapping entry 4	UDINT	RW	NO	0x60FE0120
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

4th Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1603h	0	Number of entries	USINT	RW	NO	1
	1	Mapping entry 1	UDINT	RW	NO	0x60400010
	2	Mapping entry 2	UDINT	RW	NO	–
	3	Mapping entry 3	UDINT	RW	NO	–
	4	Mapping entry 4	UDINT	RW	NO	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

1st Transmit PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1A00h	0	Number of entries	USINT	RW	NO	3
	1	Mapping entry 1	UDINT	RW	NO	0x60410010
	2	Mapping entry 2	UDINT	RW	NO	0x606C0020
	3	Mapping entry 3	UDINT	RW	NO	0x60770010
	4	Mapping entry 4	UDINT	RW	NO	–
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

2nd Transmit PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1A01h	0	Number of entries	USINT	RW	NO	3
	1	Mapping entry 1	UDINT	RW	NO	0x60410010
	2	Mapping entry 2	UDINT	RW	NO	0x606C0020
	3	Mapping entry 3	UDINT	RW	NO	0x60770010
	4	Mapping entry 4	UDINT	RW	NO	–
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

3rd Transmit PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1A02h	0	Number of entries	USINT	RW	NO	8
	1	Mapping entry 1	UDINT	RW	NO	0x60410010
	2	Mapping entry 2	UDINT	RW	NO	0x60640020
	3	Mapping entry 3	UDINT	RW	NO	0x60770010
	4	Mapping entry 4	UDINT	RW	NO	0x60F40020
	5	Mapping entry 5	UDINT	RW	NO	0x60B90010
	6	Mapping entry 6	UDINT	RW	NO	0x60BA0020
	7	Mapping entry 7	UDINT	RW	NO	0x60BC0020
	8	Mapping entry 8	UDINT	RW	NO	0x60FD0020

4th Transmit PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1A03h	0	Number of entries	USINT	RW	NO	1
	1	Mapping entry 1	UDINT	RW	NO	0x60410010
	2	Mapping entry 2	UDINT	RW	NO	–
	3	Mapping entry 3	UDINT	RW	NO	–
	4	Mapping entry 4	UDINT	RW	NO	–
	5	Mapping entry 5	UDINT	RW	NO	–
	6	Mapping entry 6	UDINT	RW	NO	–
	7	Mapping entry 7	UDINT	RW	NO	–
	8	Mapping entry 8	UDINT	RW	NO	–

Sync Manage2 PDO Assignment

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1C12h	0	Number of assigned PDOs	USINT	RW	NO	1
	1	Index of assigned RxPDO 1	UINT16	RW	NO	0x1602
	2	Index of assigned RxPDO2	UINT16	RW	NO	0x0000

Sync Manage3 PDO Assignment

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
1C13h	0	Number of assigned PDOs	USINT	RW	NO	1
	1	Index of assigned TxPDO 1	UINT16	RW	NO	0x1A02
	2	Index of assigned TxPDO 2	UINT16	RW	NO	0x0000

13.3 Parameters Table

SinglePos (30A5h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
30A5h	0	SinglePos	UINT32	RO	TxPDO	0x0000

MultiPos (30A6h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
30A6h	0	MultiPos	UINT32	RO	TxPDO	0x0000

Pn000 Basic Function Selections 0 (3164h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
3164h	0	Pn000 Basic Function Selections 0	INT32	RW	No	0x0000

NOTE: Other parameters are the same as 3164h, refers to Chapter 12Parameters.

13.4 Device Control

Error Code (603Fh)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
603Fh	0	Error Code	UINT16	RO	TxPDO	0x0000

Bit	Data	Description
0 to 7	Alarm No	The alarm number that corresponds to the axis.
8 to 15	Axis No	The axis number of the Servo, sorted from 0.

Controlword (6040h)

This object controls the device and operation mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6040h	0	Controlword	UINT16	RW	Yes	0x0000

Bit	Data	Description
0	Switch on	–
1	Enable voltage	–
2	Quick stop	–
3	Enable operation	–
4 to 6	Operation mode specific	–
7	Fault reset	–
8	halt	–
9, 10	Reserved	–
11 to 15	Manufacture specific	–

Bit0 to Bit3, and Bit7: These bits function as the control command for the Servo Drive’s state.

Command	Bit of the controlword					
	Bit7	Bit3	Bit2	Bit1	Bit0	Transitions
Shutdown	0	–	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	–	–	0	–	7, 9, 10, 12
Quick stop	0	–	0	1	–	7, 9, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16

Command	Bit of the controlword					
	Bit7	Bit3	Bit2	Bit1	Bit0	Transitions
Fault reset	↑	–	–	–	–	15

The description of Bit4 and Bit5 in PP mode is as following.

Bit5	Bit4	Description
0	0 → 1	Start the next positioning after the current positioning completes (target reached)
1	0 → 1	Start the next positioning immediately

The description of Bit6 and Bit8 in PP mode is as following.

Bit	Data	Value	Description
6	Abs / rel	0	Regards the target position as an absolute value
		1	Regards the target position as a relative value
8	Halt	0	Executes or continues positioning
		1	Stops the axis according to *Halt Option Code* (605Dh)

The description of Bit4, Bit5, Bit6 and Bit8 in HM mode is as following.

Bit	Data	Value	Description
4	Homing operation start	0	Does not start homing
		1	Starts or continues homing
5	–	0	Reserved
8	–	0	Reserved
8	Halt	0	Enables Bit4
		1	Stops the axis according to *Halt Option Code* (605Dh)

The description of Bit4, Bit5, Bit6 and Bit8 in CSP, CSV or CST mode is as following.

Bit	Data	Value	Description
4	–	0	Reserved
5	–	0	Reserved
6	–	0	Reserved
8	Halt	0	Executes or continues operation.

Bit	Data	Value	Description
		1	Stops the axis according to *Halt Option Code* (605Dh)

The description of Bit4, Bit5, Bit6 and Bit8 in IP mode is as following.

Bit	Data	Value	Description
4	Enable interpolation	0	Disables interpolation
		1	Enables interpolation
5	–	0	Reserved
8	–	0	Reserved
8	Halt	0	Enables Bit4
		1	Stops the axis according to *Halt Option Code* (605Dh)

The description of Bit4, Bit5, Bit6 and Bit8 in PV mode is as following.

Bit	Data	Value	Description
4	–	0	Reserved
5	–	0	Reserved
6	–	0	Reserved
8	Halt	0	Executes or continues operation.
		1	Stops the axis according to *Halt Option Code* (605Dh)

Statusword (6041h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6041h	0	Statusword	UINT16	RO	TxPDO	0x0000

Bit	Data	Description
0	Ready	–
1	Switched on	–
2	Running	–
3	Fault	–
4	Voltage enabled	–
5	Quick stop	–
6	No Fault	–

Bit	Data	Description
7	Warning	–
8	Reserved	–
9	Remote	–
10	Target reached	–
11	Internal limit active	–
12, 13	Operation mode specific	–
14	Reserved	–
15	Homeflag	–

Bit0 to Bit7: Current State of Servo Drive:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Servo State
–	0	–	–	0	0	0	0	Initialization
–	1	–	–	0	0	0	0	No Fault
–	0	1	–	0	0	0	1	Ready
–	0	1	–	0	0	1	1	Switched on
–	0	1	–	0	1	1	1	Running
–	0	0	–	0	1	1	1	Quick Stop
–	0	–	–	1	1	1	1	Stop at Fault
–	0	–	–	1	0	0	0	Fault
–	–	–	1	–	–	–	–	Main Power On
1	–	–	–	–	–	–	–	Warning occurs

Bit11: The internal limit is activated (set to 1) when the N-OT or P-OT signal was activated.

The description of Bit10, Bit12 and Bit13 in PP mode is as following.

Bit	Data	Value	Description
10	Target reached	0	Halt (Bit 8 in Controlword) = 0: Target position not reached Halt (Bit 8 in Controlword) = 1: Axis decelerates
		1	Halt (Bit 8 in Controlword) = 0: Target position reached Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0
12	Set-point acknowledge	0	Previous set-point already processed, waiting for new set-point
		1	Previous set-point still in process, set-point overwriting shall be accepted

Bit	Data	Value	Description
13	Following error	0	No following error
		1	Following error

The description of Bit10, Bit12 and Bit13 in HM mode is as following.

Bit13	Bit12	Bit10	Description
Homing error	Homing attained	Target reached	
0	0	0	Homing procedure is in progress
0	0	1	Homing procedure is interrupted or not started
0	1	0	Homing is attained, but target is not reached
0	1	1	Homing procedure is completed successfully
1	0	0	Homing error occurred, velocity is not 0
1	0	1	Homing error occurred, velocity is 0

The description of Bit10, Bit12 and Bit13 in CSP, CSV or CST mode is as following.

Bit	Data	Value	Description
10	Target reached	0	Reserved
12	Drive follows the command value	0	Drive does not follow the target value (position, velocity or torque)
		1	Drive follows the target value (position, velocity or torque)
13	Following error	0	No following error
		1	Following error

The description of Bit10, Bit12 and Bit13 in IP mode is as following.

Bit	Data	Value	Description
10	Target reached	0	Halt (Bit 8 in Controlword) = 0: Target position not reached Halt (Bit 8 in Controlword) = 1: Axis decelerates
		1	Halt (Bit 8 in Controlword) = 0: Target position reached Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0
12	IP mode active	0	Interpolation inactive
		1	Interpolation active
13	Following error	0	No following error
		1	Following error

The description of Bit10, Bit12 and Bit13 in PV mode is as following.

Bit	Data	Value	Description
10	Target reached	0	Halt (Bit 8 in Controlword) = 0: Target position not reached Halt (Bit 8 in Controlword) = 1: Axis decelerates
		1	Halt (Bit 8 in Controlword) = 0: Target position reached Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0
12	Speed	0	Speed is not equal 0
		1	Speed is equal 0
13	–	0	Reserved

The description of Bit10, Bit12 and Bit13 in PT mode is as following.

Bit	Data	Value	Description
10	Target reached	0	Halt (Bit 8 in Controlword) = 0: Target position not reached Halt (Bit 8 in Controlword) = 1: Axis decelerates
		1	Halt (Bit 8 in Controlword) = 0: Target position reached Halt (Bit 8 in Controlword) = 1: Velocity of axis is 0
12	–	0	Reserved
13	–	0	Reserved

Quick Stop Option Code (605Ah)

This object determines what operation will be performed if a Quick Stop is executed.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Ah	0	Quick Stop Option Code	INT16	RW	No	0, 1, 2, 5, 6 Default:2

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn003.0)
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and moves to the No Fault state
2	Decelerates according to *Quick Stop Deceleration* (6085h) for decelerating to a stop and moves to the No Fault state
5	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and stays at the QuickStop state
6	Decelerates according to *Quick Stop Deceleration* (6085h) for decelerating to a stop and stays at the QuickStop state

Shutdown Option Code (605Bh)

This object defines the operation that is performed if there is a move from Operation Enable state to Ready state.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Bh	0	Shutdown Option Code	INT16	RW	No	0, 1 Default: 0

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn003.0)
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and moves to the No Fault state

Disable Operation Option Code (605Ch)

This object defines the operation that is performed if there is a move from Operation Enable state to Switched ON state.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Ch	0	Shutdown Option Code	INT16	RW	No	0, 1 Default: 0

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn004.0)
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop and moves to the No Fault state

Halt Option Code (605Dh)

This object defines the operation that is performed if bit 8 (Halt) in *Controlword* is active.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Dh	0	Halt Option Code	INT16	RW	No	1, 2 Default: 1

Value	Description
1	Decelerates according to *Profile Deceleration* (6084h) for decelerating to a stop
2	Decelerates according to *Quick Stop Deceleration* (6085h) for decelerating to a stop

605Eh (Fault Reaction Option Code)

This object defines the operation that is performed when an alarm is detected in the Servo System.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
605Eh	0	Halt Option Code	INT16	RW	No	0

Value	Description
0	Disables the Servo (Servo OFF, and stops the axis according to the setting of Pn003.0)

Modes of Operation (6060h)

This object is used to select the operation mode. The Servo System gives the actual operation mode in the *Modes of Operation Display* object.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6060h	0	Modes of Operation	UINT8	RW	Yes	0 to 10 Default: 0

Value	Description
0	There is no mode change or no mode assigned
1	Profile Position Mode
2	–
3	Profile Velocity Mode
4	Profile Torque Mode
5	–
6	Homing Mode
7	Interpolated Position Mode
8	Cyclic Sync Position Mode
9	Cyclic Sync Velocity Mode
10	Cyclic Sync Torque Mode

Modes of Operation Display (6061h)

This object gives the current mode of operation.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6061h	0	Modes of Operation Display	UINT8	RO	Yes	Default: 0

Supported Drive Modes (6502h)

This object gives the operation modes that are supported by the device.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6502h	0	Supported Drive Modes	UINT32	RO	No	0x03ED

Bit	Supported mode	Definition
0	Profile Position	1: Supported
1	Vl (Velocity mode)	0: Not supported
2	PV (Profile Velocity mode)	1: Supported
3	TQ (Torque Profile mode)	1: Supported
4	Reserved	0
5	HM (Homing mode)	1: Supported
6	IP (Interpolated Position mode)	1: Supported
7	CSP (Cyclic Sync Position mode)	1: Supported
8	CSV (Cyclic Sync Velocity mode)	1: Supported
9	CST (Cyclic Sync Torque mode)	1: Supported
10 to 31	Reserved	0

13.5 Profile Position Mode

Target Position (607Ah)

This object contains the target position for the Profile Position Mode or Cyclic Sync Position Mode.

In Profile Position Mode, the value of this object is interpreted as either an absolute or relative value depending on the Abs/Rel Flag in *Controlword*. In Cyclic Sync Position Mode, the value is always interpreted as an absolute value.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
607Ah	0	Target Position	INT32	RW	Yes	Default: 0

Software Position Limit (607Dh)

This object defines the absolute positions of the limits to the target position (position demand value). Every target position is checked against these limits.

The limit positions are specified in user-defined position reference units, the same as for target positions, and are always relative to the machine home position.

The limit values are corrected internally for the home offset as given below. The target positions are compared with the corrected values.

- Corrected minimum position limit = Min position limit – Home offset (607Ch)
- Corrected maximum position limit = Max position limit – Home offset (607Ch)

The software position limits are enabled at the following times:

- When homing is completed
- When an absolute encoder is connected

The software limits are enabled if Min position limit < Max position limit.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
607Dh	0	Software position limit	UINT8	RO	No	Default: 2
	1	Min position limit	INT32	RW	No	-2147483648 to 2147483647
	2	Max position limit	INT32	RW	No	

Max Profile Velocity (607Fh)

This object defines the maximum speed during a Profile Mode operation.

However, the Servo will regard the minimum value between 607Fh and 6080h as the maximum speed during a Profile Mode operation.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
607Fh	0	Max Profile Velocity	UINT32	RW	Yes	Default: read from the Motor Unit: 0.1 rpm

Max Motor Speed (6080h)

This object defines the maximum speed for protecting the Motor.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6080h	0	Max Motor Speed	UINT32	RW	Yes	0 to rated speed Default: read from the Motor Unit: 1 rpm

Profile Velocity (6081h)

This object contains the final movement speed at the end of acceleration for a Profile Mode operation.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6081h	0	Profile Velocity	UINT32	RW	Yes	0 to 200000 Default: 10000 Unit: 0.1 rpm

Profile Acceleration (6083h)

This object specifies the acceleration rate for PP Mode and PV Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6083h	0	Profile Acceleration	UINT32	RW	Yes	0 to 4294967295 Default: 200000 Unit: 0.1 rpm/s

Profile Deceleration (6084h)

This object specifies the acceleration rate for PP Mode and PV Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6084h	0	Profile Deceleration	UINT32	RW	Yes	0 to 4294967295 Default: 200000 Unit: 0.1 rpm/s

Quick Stop Deceleration (6085h)

This object contains the deceleration rate that is used to stop the Motor if the *Quick Stop Option Code* (605Ah) is set to 2 and the Quick Stop command is given, or *Halt Option Code* (605Dh) is set to 2 and the Halt command is given.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6085h	0	Quick Stop Deceleration	UINT32	RW	Yes	0 to 4294967295 Default: 200000 Unit: 0.1 rpm/s

Motion Profile Type (6086h)

This object specifies the motion profile for the trajectory generator.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6086h	0	Motion Profile Type	INT16	RW	Yes	0, 2 Default: 0

Value	Description
-32768 to -1	Not supported
0	Speed ramp (Trapezoidal profile)
1	Not supported
2	S-curve

Profile jerk (60A4h)

This object is regarded as the jerk in PP mode only if *Motion Profile Type* (6086h) is set to 2.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60A4h	0	Highest subindex supported	UINT8	RO	No	1
	1	Profile jerk 1	UINT32	RW	No	0 to 4294967295 Default: 200000 Unit: 0.1 rpm/s

13.6 Homing Mode

Home Offset (607Ch)

This object contains the offset between the zero position for the application and the machine home position (found during homing).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
607Ch	0	Home Offset	INT32	RW	Yes	-2147483648 to 2147483647

Homing Method (6098h)

This object specifies the homing method.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6098h	0	Homing Method	INT8	RW	Yes	Default: Pn720

Value	Description
-128 to 0	Reserved for manufacturer
1	Homing with the negative limit switch and index pulse
2	Homing with the positive limit switch and index pulse

Value	Description
3, 4	Homing with positive home switch and index pulse
5, 6	Homing with negative home switch and index pulse
7 to 14	Homing with home switch and index pulse
17	Homing with the negative limit switch
18	Homing with the positive limit switch
19, 20	Homing with positive home switch
21, 22	Homing with negative home switch
23 to 30	Homing with home switch
35	Homing on the current position

Homing Speeds (6099h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6099h	0	Homing speeds	UINT8	RO	No	2
	1	Speed during search for switch	UINT32	RW	Yes	0 to 4294967295 Default: Pn721 Unit: 0.1 rpm
	2	Speed during search for zero	UINT32	RW	Yes	0 to 4294967295 Default: Pn722 Unit: 0.1 rpm

NOTE: This value is limited by 607Fh and 6080h.

Homing Acceleration (609Ah)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
609Ah	0	Home Acceleration	UINT32	RW	Yes	0 to 4294967295 Default: Pn723

13.7 Position Control Function

Position Demand Value (6062h)

This object specifies the current reference position in user position reference units.

This value is 0 in Velocity Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6062h	0	Position Demand Value	INT32	RO	Yes	-2147483648 to 2147483647

Position Actual Internal Value (6063h)

This object gives the current feedback position in encoder pulse units.

- For the absolute encoder and the homing operation has been completed, this value represents the actual position value of the Motor encoder.
- For the incremental encoder or the homing operation has not been completed, this value represents the number of pulses (encoder units).

This value is 0 in Velocity Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6063h	0	Position Actual Internal Value	INT32	RO	Yes	-2147483648 to 2147483647

Position Actual Value (6064h)

This object gives the current feedback position in user position reference units.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6064h	0	Position Actual Value	INT32	RO	Yes	-2147483648 to 2147483647

Following Error Window (6065h)

This object defines the detection range for the following error (bit 13 of *statusword*).

If the position deviation exceeds the following error window for the *following error time out* (6066h), bit13 in *statusword* changes to 1 to indicate following error.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6065h	0	Following Error Window	INT32	RW	Yes	-2147483648 to 2147483647

Following Error Time Out (6066h)

If the position deviation exceeds the *following error window* for the time specified in this object, bit-13 in *statusword* changes to 1 to indicate following error.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6066h	0	Following Error Time Out	UINT16	RW	Yes	0 to 65536 Unit: ms

Following Error Actual Value (60F4h)

This object provides the current following error.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60F4h	0	Following Error	INT32	RO	Yes	-2147483648 to 2147483647

Position Window (6067h)

This object defines the positioning completed width for the target position. When the Servo Drive has completed outputting the reference to the target position and the time specified in *position window time* (6068h) has passed after the distance between the target position and the position actual value is within the value of this object, bit-10 (target reached) in *statusword* changes to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6067h	0	Position Window	UINT32	RW	Yes	0 to 4294967295

Position Window Time (6068h)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6068h	0	Position Window Time	UINT16	RW	Yes	0 to 65536 Unit: ms

Position Demand Internal Value (60FCh)

This object gives the output of the trajectory generator during position control (the position that is input to the position loop). The value is given in encoder pulses.

This value is 0 in Velocity Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60FCh	0	Position Demand Internal Value	INT32	RO	TxPDO	-2147483648 to 2147483647

13.8 Interpolated Position Mode

Interpolation sub mode select (60C0h)

This object is used to select the submode for the Interpolated Position Mode and Cyclic Sync Position Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60C0h	0	Interpolation sub mode select	INT16	RW	No	-1, 0 Default: 0

Value	Description
-1	Cubic Interpolated
0	Linear Interpolated

Interpolation Data Record (60C1h)

This object gives the interpolation position reference for Interpolated Position Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60C1h	0	Highest sub-index supported	UINT8	RO	No	2
	1	1st set-point	INT32	RW	Yes	-2147483648 to 2147483647

Interpolation Time Period (60C2h)

The Interpolation Time Period indicates the period of updating 607Ah or 60C1-01h. In the CSP or IP mode, if the DC synchronization mode is selected, the value must be the same as the DC synchronization period; and if the SM2 Event mode is selected, the value of 1C32-02h is consistent with the interpolation period and the actual SM2 Event period, otherwise Sync Error will occur.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60C2h	0	Highest sub-index supported	UINT8	RO	No	2
	1	Interpolation time period value	INT32	RW	No	1 to 250 Default: 4
	2	Interpolation time index	INT8	RW	No	-6 to -3 Default: -3

NOTE: Interpolation time = (Interpolation time period (60C2h: 01)) × $10^{\text{Interpolation time index (60C2h: 02)}}$ [s]
The interpolation period must be an integer multiple of 125us and greater than 125us.

13.9 Cyclic Synchronous Position Mode

Velocity Offset (60B1h)

In Cyclic Synchronous Position Mode, this object contains the speed feedforward value.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60B1h	0	Velocity Offset	INT32	RW	Yes	-2147483648 to 2147483647 Default: 0

Torque Offset (60B2h)

In Cyclic Synchronous Position Mode or Cyclic Synchronous Velocity Mode, this object contains the torque feedforward value.
In Cyclic Synchronous Torque Mode, this object contains the offset value to add to the torque reference.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60B2h	0	Torque Offset	INT16	RW	Yes	-32768 to 32767 Default: 0 [0.1%]

13.10 Profile Velocity/Cyclic Synchronous Velocity Mode

Velocity sensor actual value (6069h)

This object contains the current speed from encoder.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6069h	0	Velocity sensor actual value	INT32	RO	Yes	–

Velocity Demand Value (606Bh)

This object contains the output value from the velocity trajectory generator or the output value from the position control function (i.e., the input reference for the speed loop).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
606Bh	0	Velocity Demand value	INT32	RO	Yes	–

Velocity Actual Value (606Ch)

This object contains the Motor speed.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
606Ch	0	Velocity Actual value	INT32	RO	Yes	–

Velocity Window (606Dh)

This object sets the speed coincidence detection width.

When the time specified in *Velocity Window Time* (606Eh) has passed after the difference between the target speed and the *Velocity Actual Value* is within the setting of the *Velocity Window*, Bit10 in *Statusword* is set to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
606Dh	0	Velocity Window	UINT16	RW	Yes	0 to 65535 Default: 0

Velocity Window Time (606Eh)

When the time specified in *Velocity Window Time* (606Eh) has passed after the difference between the target speed and the *Velocity Actual Value* is within the setting of the *Velocity Window*, Bit10 in *Statusword* is set to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
606Eh	0	Velocity Window Time	UINT16	RW	Yes	0 to 65535 Default: 0

Velocity Threshold (606Fh)

When the time specified in Velocity Threshold Time (6070h) has passed after the *Velocity Actual Value* is greater than *Velocity Threshold* (606F), Bit12 in *Statusword* is set to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
606Fh	0	Velocity Threshold	UINT16	RW	Yes	0 to 65535 Default: 0

Velocity Threshold Time (6070h)

When the time specified in Velocity Threshold Time (6070h) has passed after the *Velocity Actual Value* is greater than *Velocity Threshold* (606F), Bit12 in *Statusword* is set to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6070h	0	Velocity threshold time	UINT16	RW	Yes	0 to 65535 Default: 0

Target Velocity (60FFh)

This object specifies the target speed for Profile Velocity Mode or Cyclic Synchronous Velocity Mode in user defined speed reference units.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60FFh	0	Target Velocity	INT32	RW	Yes	-2147483648 to 2147483647 Default: 0

13.11 Profile Torque / Cyclic Synchronous Torque Mode

Target Torque (6071h)

This object specifies the input torque reference value for Torque Control Mode. Set the value in units of 0.1% of the Motor rated torque.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6071h	0	Target Torque	INT16	RW	Yes	-32768 to 32768 Default: 0 [0.1%]

Torque Demand Value (6074h)

This object gives the currently output torque reference value. The value is given in units of 0.1% of the Motor rated torque.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6074h	0	Target Demand Value	INT16	RO	Yes	–

Torque Slope (6087h)

This object sets the torque output slope to use in Profile Torque Mode. Set the value as the rate of change per second (0.1%/s) in respect to the Motor rated torque.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6087h	0	Target Slope	UINT32	RW	Yes	0 to 4294967295 Default: 100

Torque Actual Value (6077h)

This object contains the torque reference output value.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6077h	0	Torque actual value	INT16	RO	Yes	–

13.12 Torque Limit Function

Max. Torque (6072h)

This object sets the maximum output torque for the Motor in PT mode. Set the value in units of 0.1% of the Motor rated torque.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
6072h	0	Max Torque	UINT16	RW	Yes	0 to 65535 Default: 3000

Positive Torque Limit Value (60E0h)

This object sets the positive torque limit. Set the value in units of 0.1% of the Motor rated torque.

The positive torque limit value is the smaller of 6072h and 60E0h.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60E0h	0	Positive Torque Limit Value	UINT16	RW	Yes	0 to 65535

Negative Torque Limit Value (60E1h)

This object sets the negative torque limit. Set the value in units of 0.1% of the Motor rated torque.

The negative torque limit value is the smaller of 6072h and 60E1h.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60E1h	0	Negative Torque Limit Value	UINT16	RW	Yes	0 to 65535

13.13 Digital Inputs/Outputs

Digital Inputs (60FDh)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60FDh	0	Digital Inputs	UINT32	RO	Yes	–

Bit	Signal	Description
0	NOT	0: Switched off; 1: Switched on
1	POT	0: Switched off; 1: Switched on
2	Home switch	0: Switched off; 1: Switched on
3 to 15	–	Reserved

Bit	Signal	Description
16	CN1-14	0: Switched off (Active); 1: Switched on (Inactive)
17	CN1-15	0: Switched off (Active); 1: Switched on (Inactive)
18	CN1-16	0: Switched off (Active); 1: Switched on (Inactive)
19	CN1-17	0: Switched off (Active); 1: Switched on (Inactive)
20	CN1-18	0: Switched off (Active); 1: Switched on (Inactive)
21 to 35	—	Reserved

If the corresponding bit of Pn509 and Pn510 has been set to **Remote**, the input signal on CN1 terminal is only used as remote input IO, and the Drive will ignore its status.

Digital Outputs (60FEh)

This object controls the status of both general-purpose output signals and remote output signals from CN1 on the Drive. 60FE-01h is used to control the status of the output signals. 60FE-02h determines which output signals in subindex 1 are enabled.

The Bit16 to Bit19 in 60FE-01h can only assign to the general-purpose output signals on CN1, and set the *Bit mask* (60EF-02h) to 1 for enabling them. And then, according to the settings of Pn509 and Pn510 to allocate the desired signals, also you can choose whether to reverse them by the setting of Pn516 and Pn517.

For the bits transmitted on the bus, you also need to set Pn512 and Pn513 to enable it.

The Bit24 to Bit27 in 60FE-01h can assign to the remote output signals on CN1, and according to the setting of Pn511 to allocate the desired signals, using as a remote IO for the master station.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
60FEh	0	Digital outputs	UINT8	RO	No	2
	1	Physical outputs	UINT32	RW	Yes	0 to 0xFFFFFFFF Default: 0
	2	Bit mask	UINT32	RW	Yes	0 to 0xFFFFFFFF Default: 0

Bit	Signal	Description
0 to 15	–	Reserved
16	CN1-14	0: Switched off (Active), 1: Switched on (Inactive)
17	CN1-15	0: Switched off (Active), 1: Switched on (Inactive)
18	CN1-16	0: Switched off (Active), 1: Switched on (Inactive)
19	CN1-17	0: Switched off (Active), 1: Switched on (Inactive)
20	CN1-18	0: Switched off (Active), 1: Switched on (Inactive)
21 to 23	–	Reserved

Bit	Signal	Description
24	Remote0	0: Switched off (Active), 1: Switched on (Inactive)
25	Remote1	0: Switched off (Active), 1: Switched on (Inactive)
26 to 31	–	Reserved

13.14 Object Dictionary List

Group 1000h

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
1003	Pre-defined error field							
	00	Number of entries	UINT8	RO	No	–	–	–
	01	Standard error field 1	UINT32	RO	No	–	–	–
	02	Standard error field 2	UINT32	RO	No	–	–	–
	03	Standard error field 3	UINT32	RO	No	–	–	–
	04	Standard error field 4	UINT32	RO	No	–	–	–
	05	Standard error field 5	UINT32	RO	No	–	–	–
	06	Standard error field 6	UINT32	RO	No	–	–	–
	07	Standard error field 7	UINT32	RO	No	–	–	–
	08	Standard error field 8	UINT32	RO	No	–	–	–
1009								Dependent on hardware version
		Indicates the manufacturer’s hardware version.						
100A								Dependent on software version
		Indicates the manufacturer’s software version.						
1010	Store parameters Indicates storage parameters							
	00	Highest sub-index supported	UINT8	RO	No	–	–	–
	01	Reserved	UINT32	RO	No	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
		Indicates to save all parameters.						
	02	Reserved	UINT32	RO	No	–	–	–
		Indicates to save communication parameters.						
	03	save application parameters	UINT32	RW	No	–	–	–
1018	Identity Object Indicates information concerning the device.							
	00	Number of entries	UINT8	RO	No	–	–	–
	01	Vender ID	UINT32	RO	No	–	–	–
	02	Product code	UINT32	RO	No	–	–	–
	03	Revision number	UINT32	RO	No	–	–	–
	04	Serial number	UINT32	RO	No	–	–	–
10F1	The error settings.							
	00							
		Indicates the number of entries for the object.						
	01							
		The local error reaction.						
	02							
		Indicates a synchronous error counter limit.						
10F8								Dependant on system time
		Indicates the system time.						
1600	1st Receive PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UwINT32	RW	No	–	–	–
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
	09							

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
		Sets the 9th mapping object. The setting instructions are the same as those for 1600h:01h.						
	0A							
		Sets the 10th mapping object. The setting instructions are the same as those for 1600h:01h.						
1601	2nd Receive PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UINT32	RW	No	–	–	–
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
1602	3rd Receive PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UINT32	RW	No	–	–	–
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
1603	4th Receive PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UINT32	RW	No	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
1A00	1st Receive PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UINT32	RW	No	–	–	–
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
1A01	2nd Transmit PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UINT32	RW	No	–	–	–
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
1A02	3rd Transmit PDO Mapping							
	00	Number of entries	UINT8	RW	No	–	–	–
	01	Mapping entry 1	UINT32	RW	No	–	–	–
	02	Mapping entry 2	UINT32	RW	No	–	–	–
	03	Mapping entry 3	UINT32	RW	No	–	–	–
	04	Mapping entry 4	UINT32	RW	No	–	–	–
	05	Mapping entry 5	UINT32	RW	No	–	–	–
	06	Mapping entry 6	UINT32	RW	No	–	–	–

<table>
<tr><th>Index</th><th>Subindex</th><th>Name</th><th>Data Type</th><th>Access</th><th>PDO Mapping</th><th>Unit</th><th>Range</th><th>Default</th></tr>
<tr><td rowspan="2"></td><td>07</td><td>Mapping entry 7</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>08</td><td>Mapping entry 8</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="10">1A03</td><td colspan="8">4thTransmit PDO Mapping</td></tr>
<tr><td>00</td><td>Number of entries</td><td>UINT8</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>01</td><td>Mapping entry 1</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>02</td><td>Mapping entry 2</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>03</td><td>Mapping entry 3</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>04</td><td>Mapping entry 4</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>05</td><td>Mapping entry 5</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>06</td><td>Mapping entry 6</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>07</td><td>Mapping entry 7</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>08</td><td>Mapping entry 8</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="4">1C12</td><td colspan="8">Sync Manager PDO assignment 2</td></tr>
<tr><td>00</td><td>Number of assigned PDOs</td><td>UINT8</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>01</td><td>Index of assigned RxPDO 1</td><td>UINT16</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>02</td><td>Index of assigned RxPDO 2</td><td>UINT16</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="4">1C13</td><td colspan="8">Sync Manager PDO assignment 3</td></tr>
<tr><td>00</td><td>Number of assigned PDOs</td><td>UINT8</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>01</td><td>Index of assigned TxPDO 1</td><td>UINT16</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>02</td><td>Index of assigned TxPDO 2</td><td>UINT16</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="7">1C32</td><td colspan="8">Sync Man 2 Synchronization
The sync parameters of Sync Management 2.</td></tr>
<tr><td rowspan="2">00</td><td>Number of elements</td><td>UINT8</td><td>RO</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td colspan="7">Indicates the number of entries of the object.</td></tr>
<tr><td rowspan="2">01</td><td>Synchronization type</td><td>UINT16</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td colspan="7">Indicates the synchronization type.</td></tr>
<tr><td rowspan="2">02</td><td>Cycle time/ns</td><td>UINT16</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td colspan="7">Indicates the cycle time.</td></tr>
</table>

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
	03							
		Indicates the shift time.						
	04							
		Indicates the synchronization type supported.						
	05							
		Indicates the minimum cycle time.						
	06							
		Indicates the calculation and copy time.						
	08							
		Indicates the Get Cycle Time.						
	09							
		Indicates the delay time.						
	0Ah							
		Indicates the Sync0 cycle time.						
	0Bh							
		Indicates the missed SM events.						
	0Ch							
		The cycle time is too short.						
	20h							
		Indicates the synchronization error.						
1C33	Sync Man 3 Synchronization The sync parameters of Sync Management 3.							
	00	Number of elements	UINT8	RO	No	–	–	–
		Indicates the number of entries of the object.						
	01	Synchronization type	UINT16	RW	No	–	–	–
		Indicates the synchronization type.						
	02	Cycle time/ns	UINT16	RW	No	–	–	–
		Indicates the cycle time.						
	03							
		Indicates the shift time.						
	04h							
		Indicates the synchronization type supported.						
	05h							

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
		Indicates the minimum cycle time.						
	06h							
		Indicates the calculation and copy time.						
	08h							
		Indicates the Get Cycle Time.						
	09h							
		Indicates the delay time.						
	0Ah							
		Indicates the Sync0 cycle time.						
	0Bh							
		Indicates the missed SM events.						
	0Ch							
		The cycle time is too short.						
	20h							
		Indicates the synchronization error.						

Group 3000h

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
30A5	–	SinglePos	DINT	RO	No	–	–	–
30A6	–	MultiPos	UDINT	RO	No	–	–	–
30A8	–	ExtEncoderPosition	INT32	RO	Yes	1 pulse	-2^{31}～$(2^{31}-1)$	–
3164	Pn000	Basic Function Selections 0	INT32	RW	No	–	0000 to 0111	0000
3165	Pn001	Basic Function Selections 1	INT32	RW	No	–	0000 to 0001	0000
3166	Pn002	Application Function Selections 2	INT32	RW	No	–	0000 to 0100	0000
3167	Pn003	Application Function Selections 3	INT32	RW	No	–	0000 to 1032	0000
3168	Pn004	Application Function Selections 4	INT32	RW	No	–	0000 to 0025	0000
3169	Pn005	Application Function Selections 5	INT32	RW	No	–	00d0 to 33d3	00d0
316A	Pn006	Application Function Selections 6	INT32	RW	No	–	0000 to 0001	0001

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
316B	Pn007	Application Function Selections 7	INT32	RW	No	–	0000 to 1120	0010
316C	Pn008	Initial Display Selection When Power On	INT32	RW	No	–	0 to 9999	0010
316D	Pn009	Application Function Selections 9	INT32	RW	No	–	0000 to 0001	0000
31C8	Pn100	Tuning Function	INT32	RW	No	–	0001 to 1105	0001
31C9	Pn101	Servo Rigidity	INT32	RW	No	Hz	0 to 500	40
31CA	Pn102	Speed Loop Gain	INT32	RW	No	rad/s	1 to 10000	500
31CB	Pn103	Speed Loop Integral Time	INT32	RW	No	0.1ms	1 to 5000	125
31CC	Pn104	Position Loop Gain	INT32	RW	No	1/s	0 to 1000	40
31CD	Pn105	Torque Command Filter Time	INT32	RW	No	0.01ms	0 to 2500	50
31CE	Pn106	Load Inertia Percentage	INT32	RW	No	%	0 to 9999	0
31CF	Pn107	Second Speed Loop Gain	INT32	RW	No	rad/s	1 to 10000	250
31D0	Pn108	Second Speed Loop Integral Time	INT32	RW	No	rad/s	1 to 5000	200
31D1	Pn109	Second Position Loop Gain	INT32	RW	No	1/s	0 to 1000	40
31D2	Pn110	Second Torque Reference Filter Time	INT32	RW	No	0.01ms	0 to 2500	100
31D4	Pn112	Speed Feedforward	INT32	RW	No	%	0 to 100	0
31D5	Pn113	Speed Feedforward Filter Time	INT32	RW	No	0.1ms	0 to 640	0
31D6	Pn114	Torque Feedforward	INT32	RW	No	%	0 to 100	0
31D7	Pn115	Torque Feedforward Filter Time	INT32	RW	No	0.1ms	0 to 640	0
31D8	Pn116	P/PI Switch Mode	INT32	RW	No	–	0 to 4	0
31D9	Pn117	Torque Reference Threshold for P/PI Switch	INT32	RW	No	%	0 to 300	200
31DA	Pn118	Deviation Counter Threshold for P/PI Switch	INT32	RW	No	1 pulse	0 to 10000	0
31DB	Pn119	Acceleration Reference Threshold for P/PI Switch	INT32	RW	No	10 rpm/s	0 to 3000	0
31DC	Pn120	Speed Reference Threshold for P/PI Switch	INT32	RW	No	rpm	0 to 10000	0
31DD	Pn121	Gain Switch Mode	INT32	RW	No	–	0 to 10	0

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
31DE	Pn122	Delay Time for Gain Switch	INT32	RW	No	0.1 ms	0 to 20000	0
31DF	Pn123	Threshold for Gain Switch	INT32	RW	No	–	0 to 20000	0
31E0	Pn124	Speed Threshold for Gain Switch	INT32	RW	No	rpm	0 to 2000	0
31E1	Pn125	Ramp Time for Position Loop Gain Switch	INT32	RW	No	0.1 ms	0 to 20000	0
31E2	Pn126	Hysteresis for Gain Switch	INT32	RW	No	–	0 to 20000	0
31E3	Pn127	Low Speed Filter	INT32	RW	No	1 cycle	0 to 100	0
31E6	Pn130	Coulomb Friction Compensation	INT32	RW	No	0.1%Tn	0 to 3000	0
31E7	Pn131	Speed Dead Band for Coulomb Friction Compensation	INT32	RW	No	rpm	0 to 100	0
31E8	Pn132	Viscous Friction Compensation	INT32	RW	No	0.1%Tn/1000rpm	0 to 1000	0
31EB	Pn135	Encoder Speed Filter Time	INT32	RW	No	0.01ms	0 to 30000	4
31FA	Pn150	Model Following Control Function	INT32	RW	No	–	0000 to 0002	0000
31FB	Pn151	Model Following Control Gain	INT32	RW	No	1/s	10 to 1000	50
31FC	Pn152	Model Following Control Gain Correction	INT32	RW	No	%	20 to 500	100
31FD	Pn153	Model Following Control Speed Feedforward	INT32	RW	No	%	0 to 200	100
31FE	Pn154	Model Following Control Torque Feedforward	INT32	RW	No	%	0 to 200	100
31FF	Pn155	Load Oscillation Frequency	INT32	RW	No	0.1 Hz	50 to 500	100
3200	Pn156	Filter Time for Load Oscillation Suppression	INT32	RW	No	0.1 ms	2 to 500	10
3201	Pn157	Limit for Load Oscillation Suppression	INT32	RW	No	rpm	0 to 1000	100
3204	Pn160	Load Torque Compensation	INT32	RW	No	%	0 to 100	0
3205	Pn161	Load Torque Observer Gain	INT32	RW	No	Hz	0 to 1000	200
3206	Pn162	Feedback Speed Selection	INT32	RW	No	–	0 to 1	0

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
3208	Pn164	Turns for PJOG0	INT32	RW	No	rotation	-50 to 50	5
3209	Pn165	Max Speed for PJOG0	INT32	RW	No	rpm	100 to 3000	1000
320A	Pn166	Acc./Dec. Time for PJOG0	INT32	RW	No	ms	50 to 2000	500
320B	Pn167	Stop Time for PJOG0	INT32	RW	No	ms	100 to 10000	1000
320C	Pn168	Turns for PJOG1	INT32	RW	No	rotation	-50 to 50	5
320D	Pn169	Max Speed for PJOG1	INT32	RW	No	rpm	100 to 3000	1000
320E	Pn170	Acc./Dec. Time for PJOG1	INT32	RW	No	ms	50 to 2000	500
320F	Pn171	Stop Time for PJOG1	INT32	RW	No	ms	100 to 10000	1000
3210	Pn172	Turns for Inertia Identification	INT32	RW	No	–	0 to 1	0
3211	Pn173	Frequency of Vibration Suppression Filter	INT32	RW	No	Hz	100 to 2000	2000
3212	Pn174	Adjust Bandwidth of Vibration Suppression Filter	INT32	RW	No	–	1 to 100	30
3213	Pn175	Vibration Suppression	INT32	RW	No	–	0 to 500	100
3214	Pn176	Lowpass Filter Time for Vibration Suppression	INT32	RW	No	0.1 ms	0 to 50	0
3215	Pn177	Highpass Filter Time for Vibration Suppression	INT32	RW	No	0.1 ms	0 to 1000	1000
3216	Pn178	Damping of Vibration Suppression Filter	INT32	RW	No	–	0 to 500	100
3217	Pn179	Amplitude Threshold for Vibration Detection	INT32	RW	No	–	5 to 500	100
3218	Pn180	Frequency Threshold for Vibration Detection	INT32	RW	No	–	0 to 100	100
3219	Pn181	Frequency of Notch Filter 1	INT32	RW	No	Hz	50 to 5000	5000
321A	Pn182	Depth of Notch Filter 1	INT32	RW	No	–	0 to 23	0
321B	Pn183	Width of Notch Filter 1	INT32	RW	No	–	0 to 15	2
321C	Pn184	Frequency of Notch Filter 2	INT32	RW	No	Hz	50 to 5000	5000
321D	Pn185	Depth of Notch Filter 2	INT32	RW	No	–	0 to 23	0
321E	Pn186	Width of Notch Filter 2	INT32	RW	No	–	0 to 15	2

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
321F	Pn187	Frequency of Notch Filter 3	INT32	RW	No	Hz	50 to 5000	5000
3220	Pn188	Depth of Notch Filter 3	INT32	RW	No	–	0 to 23	0
3221	Pn189	Width of Notch Filter 3	INT32	RW	No	–	0 to 15	2
322C	Pn200	Pulse Numbers for PG Frequency Division	INT32	RW	No	1 pulse	16 to 16384	16384
3236	Pn210	External Encoder Setting 1	INT32	RW	No	–	0000 to 1111	0000
3237	Pn211	External Encoder Setting 2	INT32	RW	No	–	0000 to 0001	0001
3238	Pn212	Resolution of External Encoder	INT32	RW	No	1 pulse	1 to 2^{20}	10000
3239	Pn213	Position Deviation Threshold between Encoder and External Encoder	INT32	RW	No	1 pulse	0 to 2^{27}	1000
323A	Pn214	Position Deviation Clear between Encoder and External Encoder	INT32	RW	No	%	0 to 100	0
3294	Pn304	Inner Speed Reference	INT32	RW	No	rpm	-6000 to 6000	500
3295	Pn305	Jogging Speed	INT32	RW	No	rpm	0 to 6000	500
3296	Pn306	Soft Start Acceleration Time	INT32	RW	No	ms	0 to 10000	0
3297	Pn307	Soft Start Deceleration Time	INT32	RW	No	ms	0 to 10000	0
3298	Pn308	Speed Reference Filter Time	INT32	RW	No	ms	0 to 10000	0
3299	Pn309	S-Curve Rise Time	INT32	RW	No	ms	0 to 10000	0
329A	Pn310	Speed Reference Smooth Mode Selection	INT32	RW	No	–	0 to 3	0
329B	Pn311	S-Curve Selection	INT32	RW	No	–	0 to 3	0
32A7	Pn323	Overspeed Detection Threshold	INT32	RW	No	–	1 to 8000	8000
32AF	Pn331	Touch Probe Signal Allocation	INT32	RW	No	–	0000 to 0022	0010
32B0	Pn332	Touch Probe Digital Input Filtering Time	INT32	RW	No	10ns	0 to 1000	0
32B1	Pn333	Touch probe Signal Inverts	INT32	RW	No	–	0000 to 0011	0000
32F5	Pn401	Forward Internal Torque Limit	INT32	RW	No	%	0 to 350	350

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
32F6	Pn402	Reverse Internal Torque Limit	INT32	RW	No	%	0 to 350	350
32F7	Pn403	Forward External Torque Limit	INT32	RW	No	%	0 to 350	100
32F8	Pn404	Reverse External Torque Limit	INT32	RW	No	%	0 to 350	100
32F9	Pn405	Reverse Brake Torque Limit	INT32	RW	No	%	0 to 350	300
32FA	Pn406	Torque Limit at Main Circuit Voltage Drop	INT32	RW	No	%	0 to 100	50
32FB	Pn407	Release Time for Torque Limit at Main Circuit Voltage Drop	INT32	RW	No	ms	0 to 1000	100
32FC	Pn408	Speed Limit during Torque Control	INT32	RW	No	rpm	0 to 6000	1500
3358	Pn500	Position Arrival Tolerance	INT32	RW	No	1 pulse	0 to 50000	10
3359	Pn501	Speed Arrival Tolerance	INT32	RW	No	rpm	0 to 100	0
335B	Pn503	Rotation Status Detection Threshold	INT32	RW	No	rpm	0 to 3000	20
335C	Pn504	Position Deviation Counter Overflow Threshold	INT32	RW	No	1 pulse	1 to $10*2^{23}$	–
335D	Pn505	Servo ON Waiting Time	INT32	RW	No	ms	-2000 to 2000	0
335E	Pn506	Servo OFF Waiting Time	INT32	RW	No	10 ms	0 to 500	0
335F	Pn507	Brake Enable Speed Threshold	INT32	RW	No	rpm	10 to 100	100
3360	Pn508	Brake Enable Waiting Time	INT32	RW	No	10 ms	10 to 100	50
3361	Pn509	Digital Input Signal Allocations 1	INT32	RW	No	–	0000 to 7777	3210
3362	Pn510	Digital Input Signal Allocations 2	INT32	RW	No	–	0000 to 0007	0004
3363	Pn511	Digital Output Signal Allocations	INT32	RW	No	–	0000 to 0bbb	0210
3364	Pn512	Digital Input Signals (Low Bits) from Bus Master	INT32	RW	No	–	0000 to 1111	0000
3365	Pn513	Digital Input Signals (High Bits) from Bus Master	INT32	RW	No	–	0000 to 1111	0000
3366	Pn514	Digital Input Signals Filter Time	INT32	RW	No	1 cycle	0 to 1000	1
3367	Pn515	Alarm Output Signal Filter Time	INT32	RW	No	2 cycle	0 to 3	1

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
3368	Pn516	Digital Input Signal Inverts 1	INT32	RW	No	–	0000 to 1111	0000
3369	Pn517	Digital Input Signal Inverts 2	INT32	RW	No	–	0000 to 0001	0000
336A	Pn518	Dynamic Braking Time	INT32	RW	No	0.5ms	50 ~ 20000	20000
336B	Pn519	Serial Encoder Communication Error Tolerance	INT32	RW	No	1 cycle	0 to 10000	3
336C	Pn520	Position Arrival Status Detection Time Threshold	INT32	RW	No	0.1 ms	0 to 60000	500
336D	Pn521	Alarm Masks	INT32	RW	No	–	0000 to 0011	0000
3371	Pn525	Motor Overload Detection Start Threshold	INT32	RW	No	%	100 to 150	100
3374	Pn528	Digital Output Signal Inverts	INT32	RW	No	–	0000 to 1111	0000
3375	Pn529	Torque Reaches Status Detection Torque Threshold	INT32	RW	No	%	3 to 300	100
3376	Pn530	Torque Reaches Status Detection Time Threshold	INT32	RW	No	ms	1 to 1000	10
3379	Pn533	Current Threshold when DB Brake Circuit is Damaged	INT32	RW	No	mA	1 ~ 9999	300
337A	Pn534	Alarm Threshold in case of Excessive IPM Junction Temperature	INT32	RW	No	℃	1 ~ 200	135
337B	Pn535	Discharging Resistor Resistance	INT32	RW	No	Ω	10 to 300	–
337C	Pn536	Discharging Resistor Power	INT32	RW	No	W	0 to 2000	–
337E	Pn538	Momentary Power Interruption Hold Time	INT32	RW	No	1 cycle	0 to 50	1
337F	Pn539	Pump-up Opening Delay Time	INT32	RW	No	ms	0 ~ 100	4
3380	Pn540	Pump-up Closing Delay Time	INT32	RW	No	ms	0 ~ 100	4
33BC	Pn600	PSO Position Value Resolution	INT32	RW	No	—	0 ~ 10	7
33BD	Pn601	PSO Mode Comparison	INT32	RW	No	—	b0000 ~ b0011	0
33BE	Pn602	PSO Output Polarity	INT32	RW	No	—	0 ~ 1	0
33BF	Pn603	PSO Output Form	INT32	RW	No	—	0 ~ 1	0

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
33C0	Pn604	PSO Output Pulse Width	INT32	RW	No	—	0 ~ 10000	100
33C1	Pn605	Delay Compensation Time	INT32	RW	No	us	0 ~ 200	0
33C2	Pn606	PSO Origin Bias	INT32	RW	No	us	-2147483648 ~ 2147483647	0
33C3	Pn607	PSO Starting Point	INT32	RW	No	pulse	1~8	1
33C4	Pn608	PSO Ending Point	INT32	RW	No	—	1~20	8
33C5	Pn609	Attribute of PSO1 Comparison Point 1	INT32	RW	No	—	0~6	0
33C6	Pn610	Target Position of PSO1 Comparison Point 1	INT32	RW	No	—	-2147483648 ~ 2147483647	0
33C7	Pn611	Attribute of PSO1 Comparison Point 2	INT32	RW	No	—	0~6	0
33C8	Pn612	Target Position of PSO1 Comparison Point 2	INT32	RW	No	—	-2147483648 ~ 2147483647	0
33C9	Pn613	Attribute of PSO1 Comparison Point 3	INT32	RW	No	—	0~6	0
33CA	Pn614	Target Position of PSO1 Comparison Point 3	INT32	RW	No	—	-2147483648 ~ 2147483647	0
33CB	Pn615	Attribute of PSO1 Comparison Point 4	INT32	RW	No	—	0~6	0
33CC	Pn616	Target Position of PSO1 Comparison Point 4	INT32	RW	No	—	-2147483648 ~ 2147483647	0
33CD	Pn617	Attribute of PSO1 Comparison Point 5	INT32	RW	No	—	0~6	0
33CE	Pn618	Target Position of PSO1 Comparison Point 5	INT32	RW	No	—	-2147483648 ~ 2147483647	00
33CF	Pn619	Attribute of PSO1 Comparison Point 6	INT32	RW	No	—	0~6	0
33D0	Pn620	Target Position of PSO1 Comparison Point 6	INT32	RW	No	—	-2147483648 ~ 2147483647	0
33D1	Pn621	Attribute of PSO1 Comparison Point 7	INT32	RW	No	—	0~6	0

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
33D2	Pn622	Target Position of PSO1 Comparison Point 7	INT32	RW	No	—	-2147483648 ~ 2147483647	0
33D3	Pn623	Attribute of PSO1 Comparison Point 8	INT32	RW	No	—	0~6	0
33D4	Pn624	Target Position of PSO1 Comparison Point 8	INT32	RW	No	—	-2147483648 ~ 2147483647	0
3424	Pn704	Device Node Number	INT32	RW	No	–	0 to 127	1
3434	Pn720	Homing Method	INT32	RW	No	–	1 to 35	1
3435	Pn721	Speed during Search for Switch	INT32	RW	No	0.1 rpm	1 to 2147483647	5000
3436	Pn722	Speed during Search for Zero	INT32	RW	No	0.1 rpm	1 to 2147483647	100
3437	Pn723	Homing Acceleration	INT32	RW	No	0.1 rpm/s	1 to 2147483647	100
3438	Pn724	Home Offset	INT32	RW	No	1 pulse	-2147483648 to 2147483647	0
3439	Pn725	Electronic Gear Ratio (Numerator)	INT32	RW	No	–	1 to 1073741824	1
343A	Pn726	Electronic Gear Ratio (Numerator)	INT32	RW	No	–	1 to 1073741824	1
3685h	Clear the encoder alarm.							
	00h							
		The number of entries of the object.						
	01h							
		Clear all encoder alarms.						
	02h							
		Clear the multi-turn alarm.						
30B0h								
		bit Description 0 Compare output enable 1 Set the origin 2 Adjust current position in a single time						
30B1h		PSO1 Current Position Adjusting Value						
		The adjusting value of current position value of PSO1.						
30C0								

<table>
<tr><th>Index</th><th>Parameter</th><th>Name</th><th>Data Type</th><th>Access</th><th>PDO Mapping</th><th>Unit</th><th>Range</th><th>Default</th></tr>
<tr><td>h</td><td></td><td colspan="7"><table><tr><th>bit</th><th>Description</th></tr><tr><td>0</td><td>Comparison output in progress</td></tr><tr><td>1</td><td>Origin setting done</td></tr><tr><td>2</td><td>Single adjustment of current position done</td></tr></table></td></tr>
<tr><td rowspan="2">30C1h</td><td></td><td>PSO1 Current Satus Target Comparison Point</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="7"></td></tr>
<tr><td rowspan="2">30C2h</td><td></td><td>The current position of PSO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="7"></td></tr>
</table>

Group 6000h

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
603F	00	Error code	UINT16	RW	Yes	–	–	–
		Indicates the alarm number of the drive. For yje encoder disconnection alarm, 0x0050 is displayed.						
6040	00	Control word	UINT16	RW	Yes	–	–	–
		Each bit of the Controlword in CST mode is defined by default. See the description of Controlword in “7.2 Device Control” for details.						
6041	00	Status word	UINT16	RO	Yes	–	–	–
		bit13、bit12、bit10 (operation mode specific)： The definitions differ in the following control modes.						
605A	00	Quick stop option code	INT16	RW	No	–	–	–
605B	00	Shutdown option code	INT16	RW	No	–	–	–
605C	00	Disable operation option code	INT16	RW	No	–	–	–
605D	00	Stop option code	INT16	RW	No	–	–	–
605E	00	Fault reaction option code	UINT16	RW	No	–	–	–
6060	00	Modes of operation	INT8	RW	Yes	–	–	–
6061	00	Modes of operation display	INT8	RO	Yes	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
6062	00	Position demand value	INT32	RO	Yes	position units	–	–
6063	00	Position actual value	INT32	RO	Yes	inc	–	–
		Indicates the actual position of the motor upon conversion by the position command unit (electronic gear ratio).						
6064	00	Position actual value	INT32	RO	Yes	position units	–	–
6065	00	Following error window	UINT32	RW	Yes	position units	–	–
		If the value of the object is set to 0xFFFFFFFF, no following error detection judgement will be made and the Statusword bit13 will always be 0.						
6066	00	Following error time out	UINT16	RW	Yes	ms	–	–
6067	00	Position window	UINT32	RW	Yes	position units	–	–
		If the value of the object is set to 0xFFFFFFFF, no position positioning completion judgement will be made and the Statusword bit10 will always be 0.						
6068	00	Position window time	UINT16	RW	Yes	ms	–	–
6069	00	Velocity sensor actual value	UINT16	RW	Yes	speed units	–	–
606B	00	Velocity demand value	INT32	RO	Yes	speed units	–	–
606C	00	Velocity actual value	INT32	RO	Yes	speed units	–	–
606D	00	Velocity window	UINT16	RW	Yes	speed units	–	–
606E	00	Velocity window time	UINT16	RW	Yes	ms	–	–
606F	00	Velocity threshold	UINT16	RW	Yes	speed units	–	–
6070	00	Velocity threshold time	UINT16	RW	Yes	ms	–	–
6071	00	Target Torque	INT16	RW	Yes	–	–	–
6072	00	Max Torque	UINT16	RW	Yes	–	–	–
6074		Indicates the torque command that has been entered under servo enable.						
6077	00	Torque actual value	INT16	RO	Yes	–	–	–
6078	00	Current actual value	INT16	RO	Yes	–	–	–
607A	00	Target position	INT32	RW	Yes	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
607C	00	Home offset	INT32	RW	Yes	–	–	–
607D	Software Position Limit							
	00	Number of entries	UINT8	RO	No	–	–	–
	01	Min position limit	INT32	RW	No	position units	–	–
	02	Max position limit	INT32	RW	No	position units	–	–
607E	00	Polarity	USINT	RW	No	–	–	–
607F	00	Max profile velocity	UINT32	RW	Yes	speed units	–	–
6080		Sets the maximum speed to be read from the motor.						
6081	00	Profile velocity	UINT32	RW	Yes	speed units	–	–
6082	00	End velocity	UINT32	RW	Yes	speed units	–	–
6083	00	Profile acceleration	UINT32	RW	Yes	acceleration units	–	–
6084	00	Profile deceleration	UINT32	RW	Yes	acceleration units	–	–
6085	00	Quick stop deceleration	UINT32	RW	Yes	acceleration units	–	–
6086	00	Motion profile type	INT16	RO	Yes	–	–	–
6087	00	Torque Slope	UINT32	RW	Yes	–	–	–
6093	Position factor							
	00	Number of entries	UINT32	RW	No	–	–	–
	01	numerator	UINT32	RW	No	–	–	–
	02	divisor	UINT32	RW	No	–	–	–
6094	Velocity encoder factor							
	00	Number of entries	UINT32	RW	No	–	–	–
	01	numerator	UINT32	RW	No	–	–	–
	02	divisor	UINT32	RW	No	–	–	–
6097	Acceleration factor							
	00	Number of entries	UINT32	RW	No	–	–	–
	01	numerator	UINT32	RW	No	–	–	–

<table>
<tr><th>Index</th><th>Subindex</th><th>Name</th><th>Data Type</th><th>Access</th><th>PDO Mapping</th><th>Unit</th><th>Range</th><th>Default</th></tr>
<tr><td></td><td>02</td><td>divisor</td><td>UINT32</td><td>RW</td><td>No</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>6098</td><td>00</td><td>Homing method</td><td>INT8</td><td>RW</td><td>Yes</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="4">6099</td><td colspan="8">Homing speeds</td></tr>
<tr><td>00</td><td>Number of entries</td><td>UINT8</td><td>RW</td><td>Yes</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>01</td><td>Speed during search for switch</td><td>UINT32</td><td>RW</td><td>Yes</td><td>speed units</td><td>–</td><td>–</td></tr>
<tr><td>02</td><td>Speed during search for zero</td><td>UINT32</td><td>RW</td><td>Yes</td><td>speed units</td><td>–</td><td>–</td></tr>
<tr><td rowspan="2">60C0</td><td rowspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Indicates the interpolation method selection in IP mode:
<table>
<tr><th>Value</th><th>Definition</th></tr>
<tr><td>0</td><td>Linear interpolation。</td></tr>
<tr><td>1</td><td>Cubic interpolation。</td></tr>
</table></td></tr>
<tr><td rowspan="2">60F4</td><td rowspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Indicates a real-time position following error.</td></tr>
</table>

Chapter 14

14.1 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	

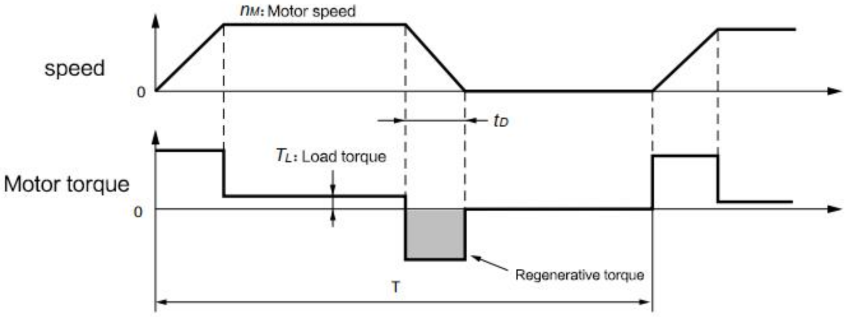
	EM3J-02AFA		
	EM3J-02AKA		
	EM3J-02ATA		
	EM3A-04ALA	0.244	
	EM3A-04AFA		
	EM3A-04AKA		
	EM3A-04ATA		
	EM3J-04ALA	0.64	
	EM3J-04AFA		
	EM3J-04AKA		
	EM3J-04ATA		
ED3L-1010A	EM3A-08ALA	0.909	45.92
	EM3A-08AFA		
	EM3J-08ALA	1.64	
	EM3J-08AFA		
	EM3A-10AKA	1.14	
	EM3A-10ATA		
	EM3G-09ALA	11.9	

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

$$E_k = Es\text{-}Ec\text{-}E_L\text{-}E_P \qquad (13\text{-}3)$$

（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.

$$Pr=\frac{5(E_S\text{-}E_C)}{T} \qquad (13\text{-}5)$$

◆ 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: $$Pa=\frac{2(E_S\text{-mgh-}E_C)}{T} \quad (13\text{-}6)$$

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.

$$Pr=\frac{5(E_S\text{-mgh-}E_C)}{T} \quad (13\text{-}7)$$

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).

$$E_S=\frac{(5+1)\times 0.909\times 10^{-4}\times 5000^2}{182}J=74.92J \quad (13\text{-}8)$$

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)

$$E_S=\frac{(10+1)\times 0.909\times 10^{-4}\times 5000^2}{182}J=137.35J \quad (13\text{-}9)$$

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:

$$Pr=\frac{5\times(137.35\text{-}31.56)}{2}W=265W \quad (13\text{-}10)$$

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.

14.2 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

Number	Date	Version	Describe
1	2021-01	V1.00	First release
2	2021-03	V1.01	Modify known errata
3	2021-03	V1.02	• Modify the description of the zero return method • Modify some object dictionaries • Modify the description of the upper limit value for the number of rotations
4	2021-06	V1.03	• Add relevant information for 1.5kW and 2kW drives.； • Added compatibility information for EM3G motors.；
5	2022-01	V1.04	• New E-STOP function description and related parameters；
6	2022-02	V1.05	• Information on adding a 4kW driver； • Revised section page numbers； • Modify some object dictionaries
7	2022-08	V1.06	• Added - FS02 driver • Modify some images • E-STOP modify
8	2022-12	V1.07	• New ED3L driver discharge resistor selection • Add encoder cable estimation • New IO signal cable selection and additional wiring • Revise the 50-400W basic connection diagram • Modify the parameter table of the holding brake
9	2023-07	V1.08	• Basic connection diagram added 21-26 PG frequency division • Add - FSO2 driver pin distribution • Revise some errors

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