

Revision History

Date	Revision No.	Revised Contents
2019-05	01	First edition
2019-06	02	<ul style="list-style-type: none">• Addition: Object Dictionary List• Revision: Modify the product name to Summa series• Revision: Modify the section STO to meet CE certification requirements• Revision: Modify the main circuit terminal wiring method• Revision: Modify the contents of the section Parameter Setting Mode.

About this Manual

Purpose

This manual provides the information required for the Selection, Wiring, Connection, Settings, Trial Operation, Tuning and Functions of the Summa Series AC Servo Drive (referred to as **ED3S**).

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






Terms

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.
STO	The Safe Torque Off function provides a means for preventing the drive from generating torque in the motor, to protect people from dangerous movements of the machine and reduce the risk of operator.

Symbols

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

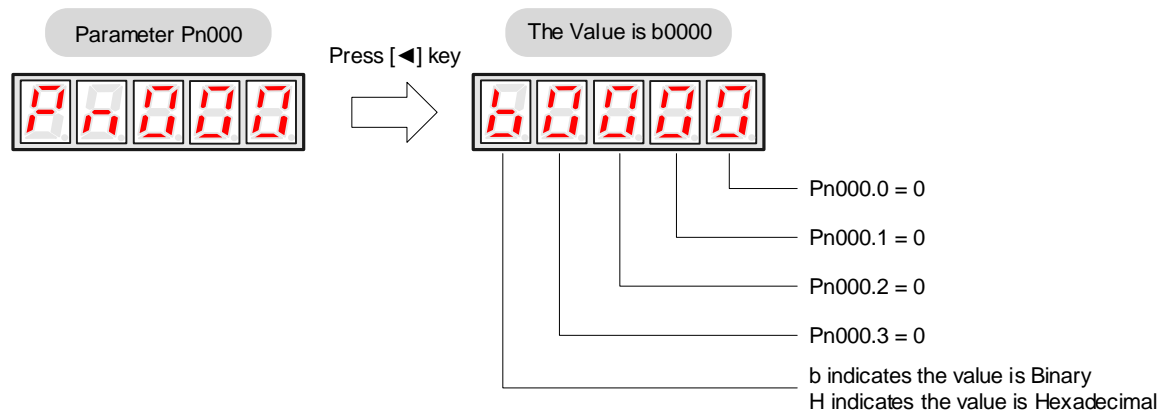
Symbol	Description
 DANGER	Indicates a hazard with a high level of risk that, if not avoided, will result in death or serious injury.
 WARNING	Indicates a hazard with a medium or low level of risk which, if not avoided, could result in minor or moderate injury.
 CAUTION	Indicates a potentially hazardous 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

The names of sub-parameters are written as the format of Pnxxx.x. The following takes the parameter Pn000 as an example, whose sub-parameters Pn000.0, Pn000.1, Pn000.2 and Pn000.3 corresponding to one bit of its value respectively.



Safety Precautions

General Precautions



- Never remove covers, cables, connectors, or optional devices while power is being supplied to the Drive.
 - Wait for 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 remain in the Drive.
-



- Use a power supply with specifications (number of phases, voltage, frequency, and AC/DC type) that are appropriate for the product.
 - 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 the inside of the Drive.
-



- 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.
 - 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



- 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 that exceed product specifications.
 - Locations that are subject to relative humidity that 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 that exceeds product specifications.
 - Locations that are subject to radiation.

Installation Precautions



- Install the drive in a control cabinet that provides fire and electrical protection.
- Install the drive and motor in a location that is sufficiently heavy.
- 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 that exceed product specifications.
 - Locations that are subject to relative humidity that 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 that 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, and never cover the outlet from the Motor's cooling fan.
- 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



- Never pass the electromagnetic contactor in the wiring between the driver and the motor.
- Firmly connect the power terminal to the Motor terminal.
- Provide at least 10 millimeters space between the Drives and the control cabinet or with other devices. In addition, the longitudinal space between them are above 30 millimeters.
- 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 command input line is up to 3 meters, and the wiring length of the encoder is up to 20 meters.
- Never frequently turn the power supply ON and OFF. After you have started actual operation, allow at least one hour between turning the power supply ON and OFF (as a guideline).

Operation Precautions



- In order to prevent accidents, please test the servo 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 and homing operation.
- When overtravel occurs, the power supply to the Motor is turned OFF and the brake is released. If you use the Motor 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.
- Make sure set a correct moment of inertia ratio to avoid vibration if not use the auto-tuning.
- When an alarm occurs, reset it after troubleshooting the cause and ensuring safety.
- Never use the brake of the Motor for normal braking.

Maintenance Precautions



- 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



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 a final product as required.

Contents

About this Manual	i
Purpose.....	i
Terms	i
Symbols	ii
Safety Precautions.....	iii
General Precautions	iii
Storage Precautions.....	iv
Installation Precautions	iv
Wiring Precautions.....	v
Operation Precautions.....	v
Maintenance Precautions	v
Disposal Precautions.....	vi
Contents	i
Chapter 1 Summa Series AC Drive	1-1
1.1 Product Features.....	1-1
1.2 Interpreting the Nameplate.....	1-2
1.3 Model Designations	1-2
1.4 Part Names	1-3
1.5 Ratings and Specifications	1-4
1.6 External Dimensions	1-7
1.7 System Configuration	1-8
Chapter 2 Installation.....	2-1
2.1 Installation Precautions.....	2-1
2.2 Mounting Types and Orientation	2-1
2.3 Mounting Hole Dimensions.....	2-2
2.4 Mounting Interval	2-2
2.5 EMC Installation Conditions	2-4
2.5.1 EMC Directives.....	2-4
2.5.2 Ferrite Coil Mounting.....	2-5
Chapter 3 Wiring and Connecting	3-1
3.1 Precautions for Wiring	3-1
3.1.1 General Precautions.....	3-1
3.1.2 Countermeasures against Noise.....	3-2
3.1.3 Grounding	3-5
3.2 Basic Wiring Diagrams	3-6
3.3 Wiring the Power Supply to Drive	3-7
3.3.1 Terminals Arrangement	3-7
3.3.2 Wiring Procedure.....	3-8
3.4 Wiring the Motor.....	3-10
3.5 Wiring the Encoder	3-11
3.6 I/O Signal Connections.....	3-14
3.7 Communication Connections.....	3-15
3.7.1 EtherCAT Communication Cable	3-15
3.7.2 USB Communication Cable	3-17
3.8 Wiring the 2nd Encoder	3-17
3.9 Connecting STO Function Signals.....	3-17

Chapter 4 Basic Settings.....	4-1
4.1 Panel Operator	4-1
4.1.1 Key Names and Functions.....	4-1
4.1.2 Basic Mode Selection.....	4-2
4.1.3 Status Display Mode	4-2
4.1.4 Parameter Setting Mode	4-4
4.1.5 Monitor Mode	4-6
4.1.6 Utility Function Mode	4-8
4.2 ESView V4.....	4-14
4.2.1 Installation.....	4-14
4.2.2 Starting ESView V4	4-20
4.2.3 Edit Parameters	4-23
4.2.4 Monitor.....	4-29
Chapter 5 EtherCAT Communications	5-1
5.1 Introduction.....	5-1
5.1.1 Protocol Overview.....	5-1
5.1.2 Specification.....	5-1
5.2 Relevant Settings	5-2
5.3 EtherCAT Basis.....	5-3
5.3.1 CANopen over EtherCAT Reference Model	5-3
5.3.2 EtherCAT Slave Information	5-3
5.3.3 EtherCAT State Machine.....	5-4
5.3.4 Process Data Object (PDO).....	5-5
5.3.5 Service Data Object (SDO)	5-7
5.3.6 Emergency Message	5-7
5.3.7 Distributed Clock (DC)	5-7
5.4 Communication Indication.....	5-8
5.4.1 Indicator Lamps on Panel Operator.....	5-8
5.4.2 Indicator Lamps on RJ45	5-9
Chapter 6 CiA402 Drive Profile.....	6-1
6.1 Conversion Factor Setting.....	6-1
6.2 Device Control	6-3
6.2.1 CiA402 State Machine	6-3
6.2.2 Stop Modes.....	6-5
6.3 Control Modes	6-7
6.3.1 Modes of Operation.....	6-7
6.3.2 Modes of Operation Display	6-8
6.3.3 Mode Change	6-8
6.3.4 Communication Cycle.....	6-8
6.4 Position Control	6-9
6.4.1 Profile Position (PP) Mode.....	6-9
6.4.2 Interpolated Position (IP) Mode	6-13
6.4.3 Cyclic Synchronous Position (CSP) Mode.....	6-17
6.5 Homing	6-20
6.5.1 Homing (HM) Mode	6-20
6.5.2 Homing Methods.....	6-23
6.6 Velocity Control	6-26
6.6.1 Profile Velocity (PV) Mode.....	6-26
6.6.2 Cyclic Synchronous Velocity (CSV) Mode.....	6-29
6.7 Torque Control	6-32
6.7.1 Profile Torque (PT) Mode	6-32
6.7.2 Cyclic Synchronous Torque (CST) Mode	6-34
6.8 Torque Limits.....	6-36
6.9 Digital and Remote I/O Signals	6-37
6.10 Touch Probe	6-38
6.11 Soft Limit Function	6-43

Chapter 7 Application Functions	7-1
7.1 Power Supply	7-1
7.2 Motor Rotation Direction.....	7-2
7.3 Overtravel Limit.....	7-3
7.3.1 Function Description	7-3
7.3.2 Connecting the Overtravel Signal	7-3
7.3.3 Enabling/Disabling the Overtravel Signal.....	7-3
7.4 Motor Stop Methods	7-4
7.4.1 Motor Stop Methods for Gr.1 Alarms, Safet State and Servo OFF	7-4
7.4.2 Motor Stop Methods for Overtravel	7-5
7.4.3 Motor Stop Methods for Gr.2 Alarms.....	7-5
7.4.4 Reverse Brake Torque Limit Setting	7-5
7.5 Holding Brake.....	7-6
7.5.1 Function Description	7-6
7.5.2 Brake Operating Sequence	7-6
7.5.3 /BK (Brake) Signal.....	7-7
7.5.4 Output Timing of /BK Signal when Motor is Stopped	7-8
7.5.5 Output Timing of /BK Signal when Motor is operating.....	7-8
7.6 Overload Enhancement.....	7-9
7.7 Encoder Setting.....	7-9
7.7.1 Absolute Encoder Selection.....	7-9
7.7.2 Encoder Alarm Resetting.....	7-10
7.7.3 Encoder Divided Pulse Output	7-10
7.8 I/O Signal Allocations.....	7-12
7.8.1 Input Signal Allocations	7-12
7.8.2 Output Signal Allocations	7-13
7.9 Torque Limit	7-15
7.9.1 Internal Torque Limits	7-15
7.9.2 External Torque Limits.....	7-15
7.9.3 Limiting torque with /CLT output signal	7-17
7.10 Soft Start	7-17
7.11 SEMI F47 Function.....	7-18
Chapter 8 Trial Operation	8-1
8.1 Preparations for Trail Operation	8-1
8.2 Inspections and Confirmations.....	8-1
8.3 Motor Operation without a Load	8-2
8.3.1 Preparations.....	8-2
8.3.2 Applicable Tools.....	8-2
8.3.3 JOG Operation.....	8-2
8.4 Motor Operation with a Load.....	8-5
8.4.1 Precautions	8-5
8.4.2 Preparations.....	8-5
8.4.3 Operation Procedure.....	8-6
8.5 Program Jogging	8-6
8.5.1 Preparations.....	8-7
8.5.2 Operation Description	8-7
8.5.3 Relevant Parameters	8-8
8.5.4 Applicable Tools.....	8-8
8.5.5 Operation Procedure.....	8-8
Chapter 9 Tuning	9-1
9.1 Overview.....	9-1
9.1.1 Basic Conception.....	9-1
9.1.2 Control Block Diagram	9-2
9.1.3 Tuning Process	9-3
9.1.4 Precautions Before Tuning	9-4
9.2 Tuning Modes	9-4

9.2.1 Tuning-Less	9-4
9.2.2 One-Parameter Auto-Tuning	9-5
9.2.3 Manual Tuning	9-7
9.3 Tuning Tools	9-10
9.3.1 Auto-Tuning Tool	9-10
9.3.2 Manual-Tuning Tool.....	9-19
9.4 Feedback Speed Selection.....	9-27
9.5 Additional Adjustment Functions.....	9-28
9.5.1 Gain Switching.....	9-28
9.5.2 P / PI Switching	9-30
9.5.3 Feedforward	9-31
9.5.4 Friction Compensation	9-33
9.5.5 Load Torque Compensation	9-34
9.5.6 Model Following Control	9-35
9.6 Vibration Suppression.....	9-37
9.6.1 Notch Filter	9-37
9.6.2 IF (Intermediate Frequency) Vibration Suppression	9-38
9.6.3 Load Oscillation Suppression.....	9-39
9.6.4 Automatic Vibration Suppression	9-40
9.7 Diagnostic Tools	9-41
9.7.1 Load Inertia Identification.....	9-41
9.7.2 Mechanical Analysis	9-44
9.7.3 FFT	9-46
9.7.4 Friction Analysis	9-48
Chapter 10 Fully-Closed Loop Control	10-1
10.1 Overview	10-1
10.2 Commissioning Procedure	10-1
10.3 Parameter Settings	10-2
10.3.1 Control Block Diagram	10-3
10.3.2 Motor Direction and Machine Movement Direction Setting.....	10-3
10.3.3 External Encoder Enabled	10-3
10.3.4 Encoder Divided Pulse Output for External Encoder	10-4
10.3.5 Alarm Detection Settings.....	10-4
Chapter 11 STO.....	11-1
11.1 Introduction.....	11-1
11.2 Environmental Conditions	11-4
11.3 Terminals Arrangement.....	11-5
11.4 Function Description.....	11-6
11.4.1 EDM (External Device Monitor).....	11-6
11.4.2 Safe State.....	11-6
11.4.3 S-RDY (Servo Ready Output) Signal.....	11-7
11.4.4 /BK (Brake Output) Signal	11-7
11.4.5 Stopping Methods.....	11-7
11.4.6 Reset Method for Deviation Counter.....	11-8
11.5 Safety Function Device Connection.....	11-8
11.5.1 Disconnecting a Safety Function Device	11-8
11.5.2 Connecting a Safety Function Device	11-9
11.6 Procedure	11-11
Chapter 12 Appendix.....	12-12
12.1 Parameters List.....	12-12
12.1.1 Interpreting the Parameter Lists	12-12
12.1.2 Parameters Detailed.....	12-13
12.2 Alarms Displays.....	12-40
12.3 Object Dictionary.....	12-46
12.3.1 General Objects.....	12-46
12.3.2 PDO Mapping Objects	12-49

12.3.3 Parameters Table	12-54
12.3.4 Device Control	12-54
12.3.5 Profile Position Mode.....	12-63
12.3.6 Homing Mode	12-66
12.3.7 Position Control Function	12-67
12.3.8 Interpolated Position Mode	12-69
12.3.9 Cyclic Synchronous Position Mode	12-70
12.3.10 Profile Velocity/Cyclic Synchronous Velocity Mode.....	12-71
12.3.11 Profile Torque / Cyclic Synchronous Torque Mode	12-72
12.3.12 Torque Limit Function.....	12-73
12.3.13 Digital Inputs/Outputs	12-74
12.3.14 Object Dictionary List	12-75

Chapter 1 Summa Series AC Drive

1.1 Product Features

ED3S is ESTUN's newly developed single-axis AC Servo Drive, which is designed in an array, supports close installation and flexible common DC bus structure, suitable for large machinery applications. Its excellent performance, with EtherCAT protocol, can achieve the motion control of High-Speed, High-Precision, High-Safety, and maximize the performance of the machine in the shortest possible time.

Compared with previous servo products, ED3S has the following outstanding features.

- Intelligent tuning function and vibration suppression in the full frequency range.
- Compact size for mounting closely *NEW*
- Fully-Closed Loop Control *NEW*
- Safe Torque Off (STO) *NEW*
- Multiple power supply methods
- New protection system
- Coverable Motor capacity from 50W to 5KW

1.2 Interpreting the Nameplate

ESTUN SERVODRIVE

MODEL ED3S-02AHA IP20

	AC-INPUT	AC-OUTPUT
Phase	1PH/3PH	3PH
Voltage	200-240V	0-240V
Freq	50/60Hz	0-500Hz
F.L.C	1.1A	1.5A
Power		0.2KW

OPERATING TEMPERATURE: -5-55 °C

7600001J001

Estun Automation Technology 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 attendez 5 min. 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 causer 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

ED3S - 02 A E A - □ □ Customized

Summa Series Servodrive

1st+2nd digits Output Power

Output Power	
A5	50 W
01	100 W
02	200 W
04	400 W
08	750 W
10	1 kW
15	1.5 kW
20*	2 kW
30*	3 kW

3rd digit Voltage

Voltage	
A	200 V
D*	400 V

4th digit Interface and Options

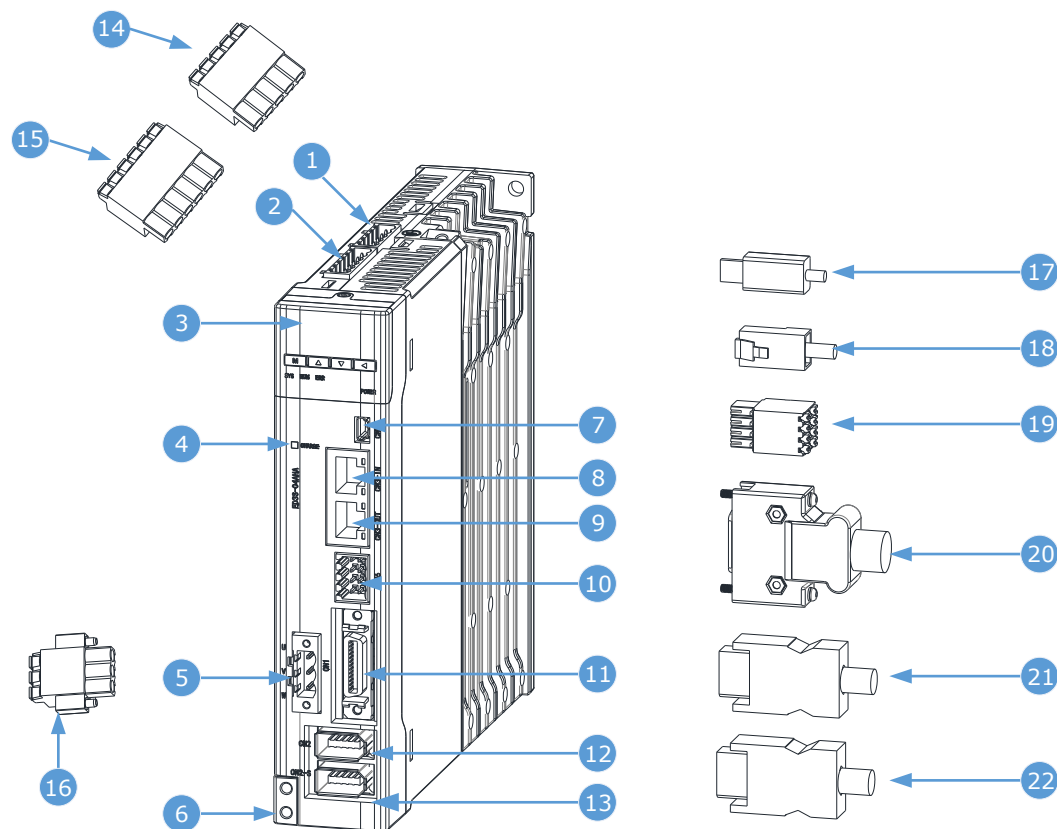
Interface and Options	
E	EtherCAT
H	EtherCAT, STO, Fully-closed

5th digit Design Sequence

Design Sequence	
A	—
...	...

NOTE: Specifications marked with an asterisk (*) have not been released yet.

1.4 Part Names



No.	Name	Description
1	Control Circuit Connector	Connects to a control power supply (5 pins)
2	Main Circuit Connector	Connects to a main circuit power supply (6 pins)
3	Panel Operator	A module for Servo status displays and parameter settings
4	CHARGE Indicator Lamp	Lit while the main circuit power is being supplied ⁽¹⁾
5	Motor Connector	Connects to a Motor main circuit cable
6	Grounding Terminal	Connects to the ground terminal of the Motor main circuit cable
7	USB Connector	Connects a computer for ESView V4
8	EtherCAT Input Connector	Connect to an EtherCAT device
9	EtherCAT Output Connector	Connects to an EtherCAT device or be vacant
10	Safety Connector	Connects to a Safety Function Device
11	IO Signal Connector	Connects to sequence I/O signals
12	Encoder Connector	Connects to the encoder in the Motor
13	2nd Encoder Connector	Connects to the encoder in the machine for fully-closed loop control
14	Control Circuit Terminals	The connection terminals for the control power supply
15	Main Circuit Terminals	The connection terminals for the main circuit power supply
16	Motor Terminals	The connection terminals for the Motor main circuit cable

No.	Name	Description
17	USB Terminals	Standard Mini USB Type-B
18	EtherCAT Terminals	Standard RJ-45 terminal
19	Safety Terminals	The connection terminals for the Safety Function Device
20	IO Signal Terminals	The connection terminals for sequence IO signals
21	Encoder Terminals	The connection terminals for the encoder cable in the Motor
22	2nd Encoder Terminals	The connection terminals for the encoder cable in the machine

(1): 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.

1.5 Ratings and Specifications

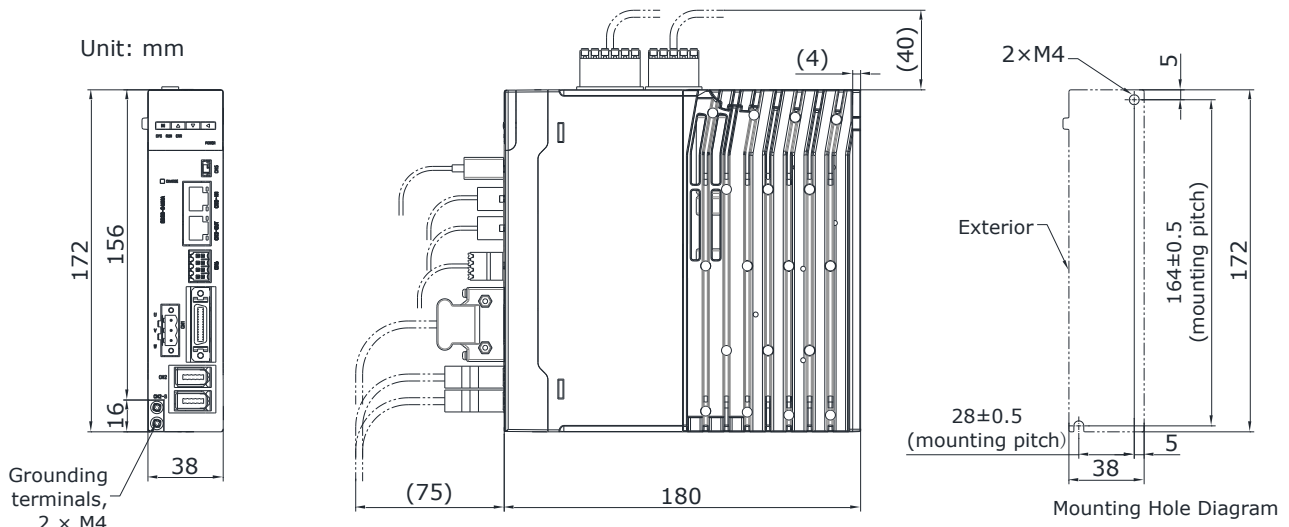
Drive Model: ED3S-		A5A*	01A*	02A*	04A*	08A*	10A*	15A*	20A*	30A*
Continuous Output Current [Arms]		0.66	0.91	1.6	2.8	5.5	7.6	11.6	18.5	19.6
Instantaneous Maximum Output Current [Arms]		2.1	3.2	5.9	9.3	16.9	17.0	28.0	42.0	56.0
Power Supply Capacity [kVA]	Single-phase	0.2	0.3	0.6	1.2	1.9	—	—	—	—
	Three-phase	0.2	0.3	0.5	1.0	1.6	2.3	3.2	4.0	5.9
Power Supply	Main Circuit	<ul style="list-style-type: none"> Single-phase (not applied for ED3S-20A* and ED3S-30A*) or Three-phase, 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz 270 VDC to 324 VDC, -15% to +10% 								
	Control Circuit	<ul style="list-style-type: none"> Single-phase 200 VAC to 240 VAC, -15% to +10%, 50Hz or 60Hz 270 VDC to 324 VDC, -15% to +10% 								
Control Method		SVPWM								
Feedback		Serial encoder: <ul style="list-style-type: none"> 20bits incremental encoder 23bits absolute encoder 								
Environmental Conditions	Temperature	Ambient temperature: -5°C to 55°C Storage temperature: -20°C to +85°C								
	Humidity	Both operating and storage: 5% to 95% (with no condensation)								
	Protection Class	IP20								
	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								

Drive Model: ED3S-		A5A*	01A*	02A*	04A*	08A*	10A*	15A*	20A*	30A*
	Coefficient of Speed Fluctuation	$\pm 0.01\%$ of rated speed max. (For a load fluctuation of 0% to 100%)								
		0% of rated speed max. (For a load fluctuation of $\pm 10\%$)								
		$\pm 0.1\%$ of rated speed max. (For a temperature fluctuation of $25\text{ }^{\circ}\text{C} \pm 25\text{ }^{\circ}\text{C}$)								
	Soft Start Time Setting	0 s to 10 s (Can be set separately for acceleration and deceleration.)								
I/O Signals	Encoder Divided Pulse Output	Phase A, phase B, phase C: Line-driver output. Number of divided output pulses: Any setting is allowed.								
	Input Signals	Allowable voltage range: 24 VDC $\pm 20\%$ Number of input points: 7 (2 of them are high-speed optocoupler inputs, fixed as Touch Probe)								
		Input Signals are EXT1 (Touch Probe 1), EXT2 (Touch Probe 2), ALM-RST (Alarm Reset), N-OT (Reverse Drive Prohibit), P-OT (Forward Drive Prohibit), P-CON (Proportional Control), S-ON (Servo ON). Except EXT1 and EXT2, a signal can be allocated and the positive and negative logic can be changed								
		Allowable voltage range: 5 VDC to 30 VDC Number of output points: 4 (1 of them fixed for Servo Alarm)								
EtherCAT Communications	Output Signals	Output Signals are TGON (Rotation Detection), ALM (Servo Alarm), SRDY (Servo Ready), COIN (Positioning Completion), PAO (Encoder Divided Pulse, Phase A), PBO (Encoder Divided Pulse, Phase B), PCO (Encoder Divided Pulse, Phase C). Except ALM, a signal can be allocated and the positive and negative logic can be changed.								
	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 (APRW, FPRW, BRW, and LRW commands are not supported.)								
	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.)								

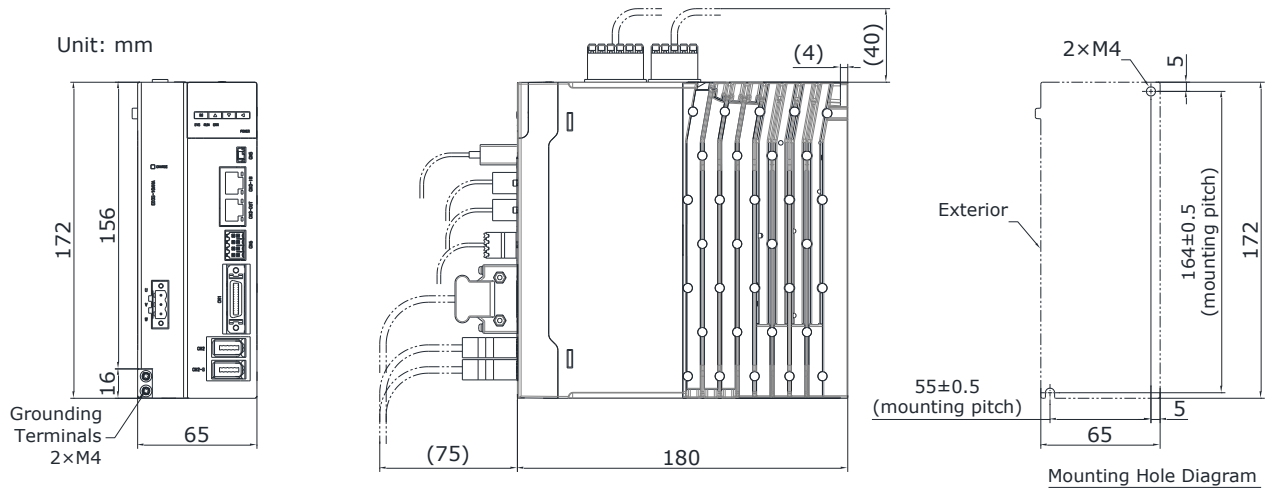
Drive Model: ED3S-		A5A*	01A*	02A*	04A*	08A*	10A*	15A*	20A*	30A*
	Distributed Clocks	Free-Run Mode and DC Mode (Can be switched), SM2 (SM2 event sync) Applicable DC cycles: 125 μ s to 8 ms in 125- μ s increments								
	Slave Information Interface	256 bytes (read-only)								
CiA402 Drive Profile		<ul style="list-style-type: none"> • Homing Mode • Profile Position Mode • Profile Velocity Mode • Profile Torque Mode • Interpolated Position Mode • Cyclic Synchronous Position Mode • Cyclic Synchronous Velocity Mode • Cyclic Synchronous Torque Mode • Touch Probe Function • Torque Limit Function 								
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		ED3S-A5*, ED3S-01*, ED3S-02* and ED3S-04* must connect an external regenerative resistor. Other models 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.								
Optional Functions	STO	According to IEC 61800-5-2. Cat.4, PLe according to ISO 13849-1, SIL3 according to IEC 61508, IEC 62061.								
	Fully-Closed	Supports A, B, and Z TTL differential type sensor signal								

1.6 External Dimensions

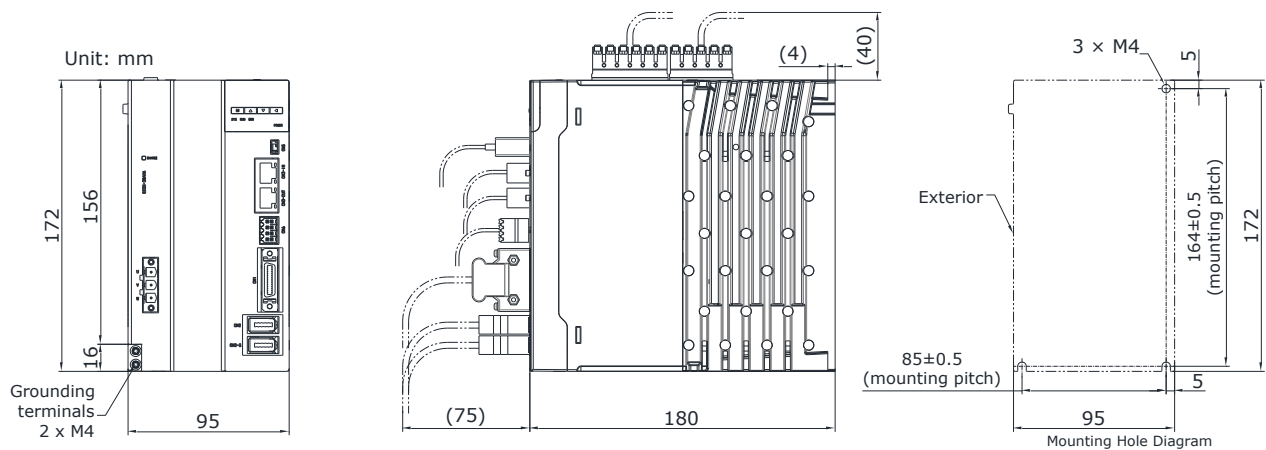
ED3S-A5* to ED3S-04*



ED3S-08* to ED3S-15*

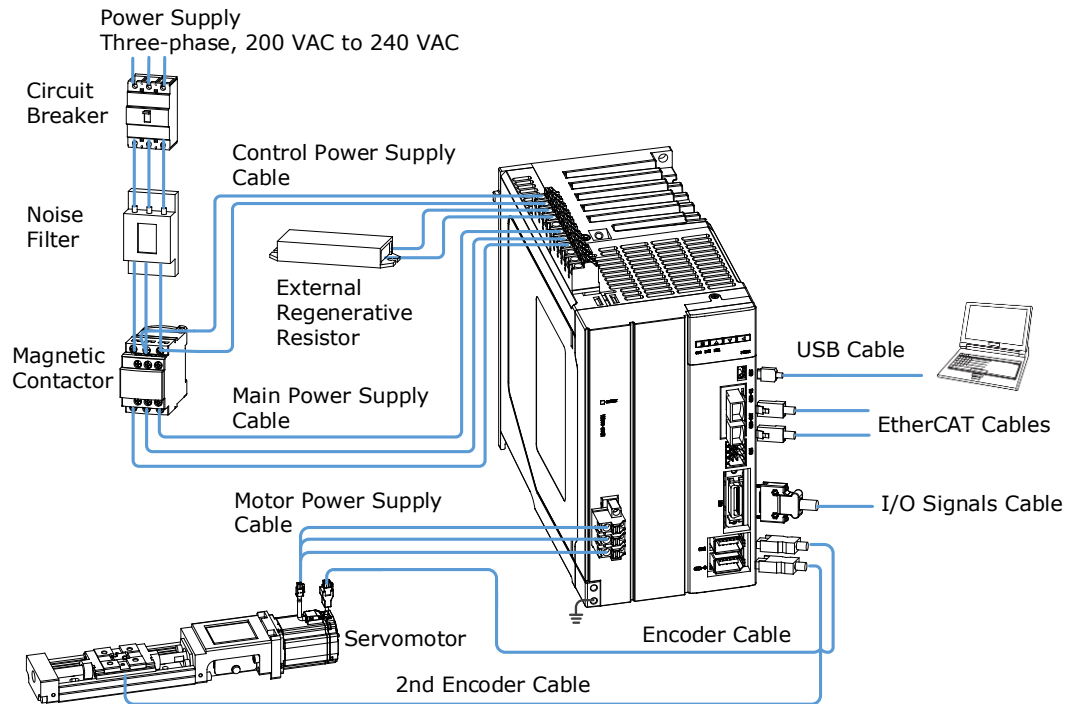


ED3S-20* to ED3S-30*



1.7 System Configuration

Example Diagram



Peripheral Devices Specification

Device Name	Description	Specification
Circuit Breaker	Uses to protect the power supply line and cut off the circuit when an overcurrent occurs.	<p>The minimum rated current of the circuit breaker depends on the Drive model.</p> <ul style="list-style-type: none"> • ED3S-A5A*, 01A*, -02A*, -04A*: 10A • ED3S-08A*, -10A*: 25A • ED3S-15A*: 35A • ED3S-20A*: 55A • ED3S-30A*: 70A
Noise Filter	Used to prevent external noise interference from the power supply.	The rated current is 10A or 20A.
External Regenerative Resistor	When the busbar capacitance is insufficient, remove the short wiring between B2 and B3, and connect an external regenerative resistor between B1 and B2. ⁽¹⁾	<p>The minimum value of the regenerative resistor depends on the Drive model.</p> <ul style="list-style-type: none"> • ED3S-A5A*, 01A*, -02A*, -04A*: 50Ω • ED3S-08A*, -10A*: 25Ω • ED3S-15A*, -20A*, -30A*: 10Ω

(1): ED3S-A5*, ED3S-01*, ED3S-02* and ED3S-04* must connect an external regenerative resistor.

Chapter 2 Installation

2.1 Installation Precautions

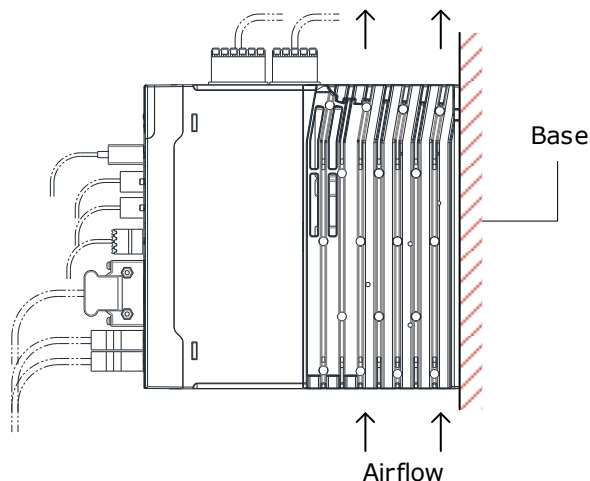
- **Installation Near Sources of Heat**
Implement measures to prevent temperature increases caused by radiant or convection heat from heat sources so that the ambient temperature of the Drive meets the ambient conditions.
- **Installation Near Sources of Vibration**
Install a vibration absorber on the 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. Mount the Drive vertically, as is shown in Figure 2-1.

Mount the Drives so that the Panel Operator is facing toward the operator. And, 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 capacity of the Drive).

Figure 2-1 Base-mounted diagram

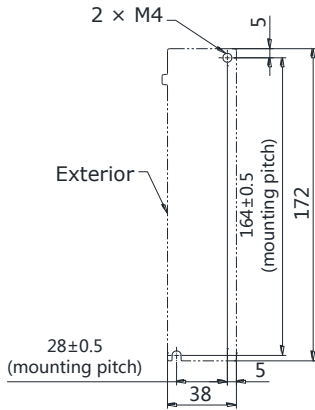


2.3 Mounting Hole Dimensions

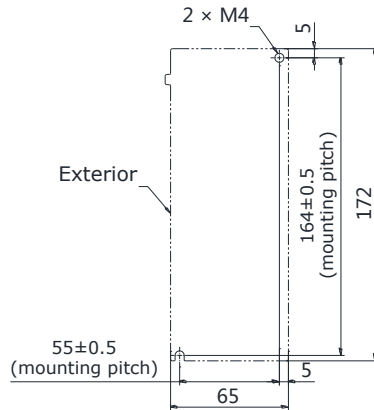
Use two or three mounting holes to securely mount the Drive to the mounting surface.

To mount the Drive, you will need to prepare a screwdriver that is longer than the depth of the Drive.

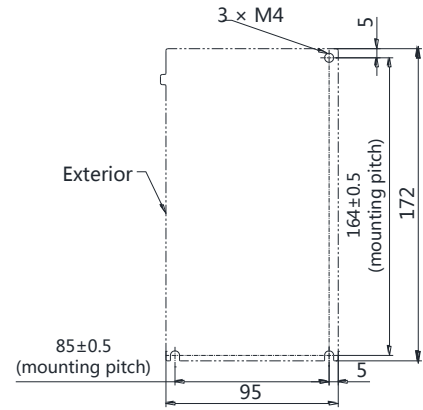
ED3S-A5*~ED3S-04*



ED3S-08*~ED3S-15*



ED3S-20*~ED3S-30*

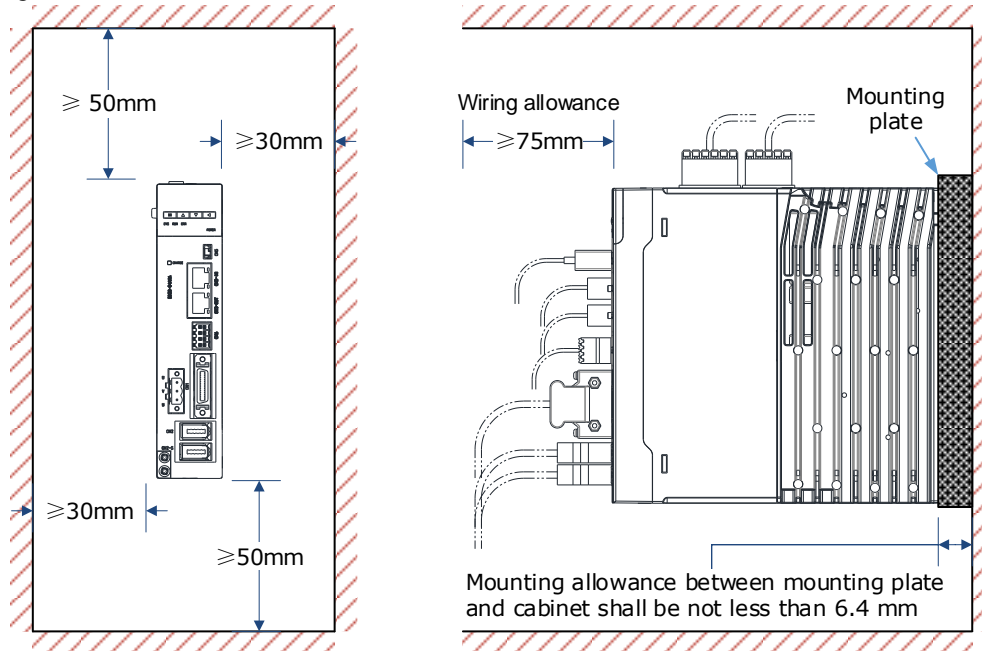


2.4 Mounting Interval

Installing One Drive in a Control Cabinet

Provide enough space around the Drive when installing one Drive in a control cabinet, as is shown in Figure 2-2.

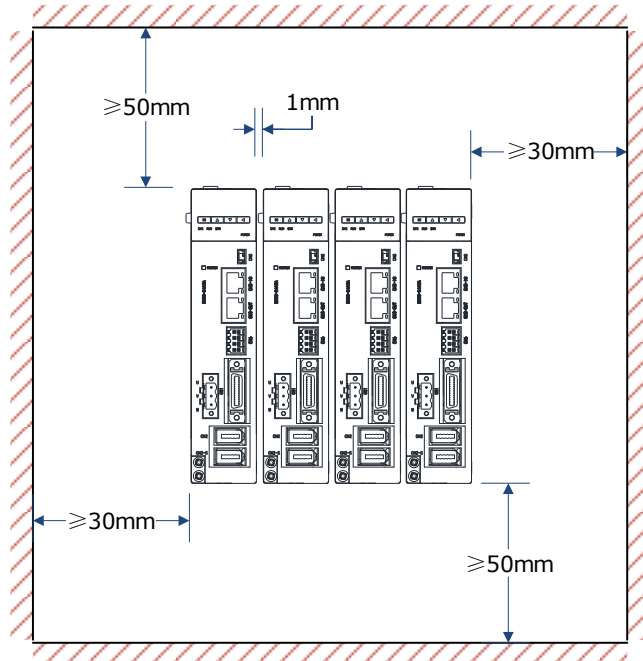
Figure 2-2 Install one Drive in a control cabinet



Installing More than One Drive in a Control Cabinet

Provide enough space around the Drive when installing more than one Drive in a control cabinet, as is shown in Figure 2-3.

Figure 2-3 Install more than one Drive in a control cabinet



NOTE

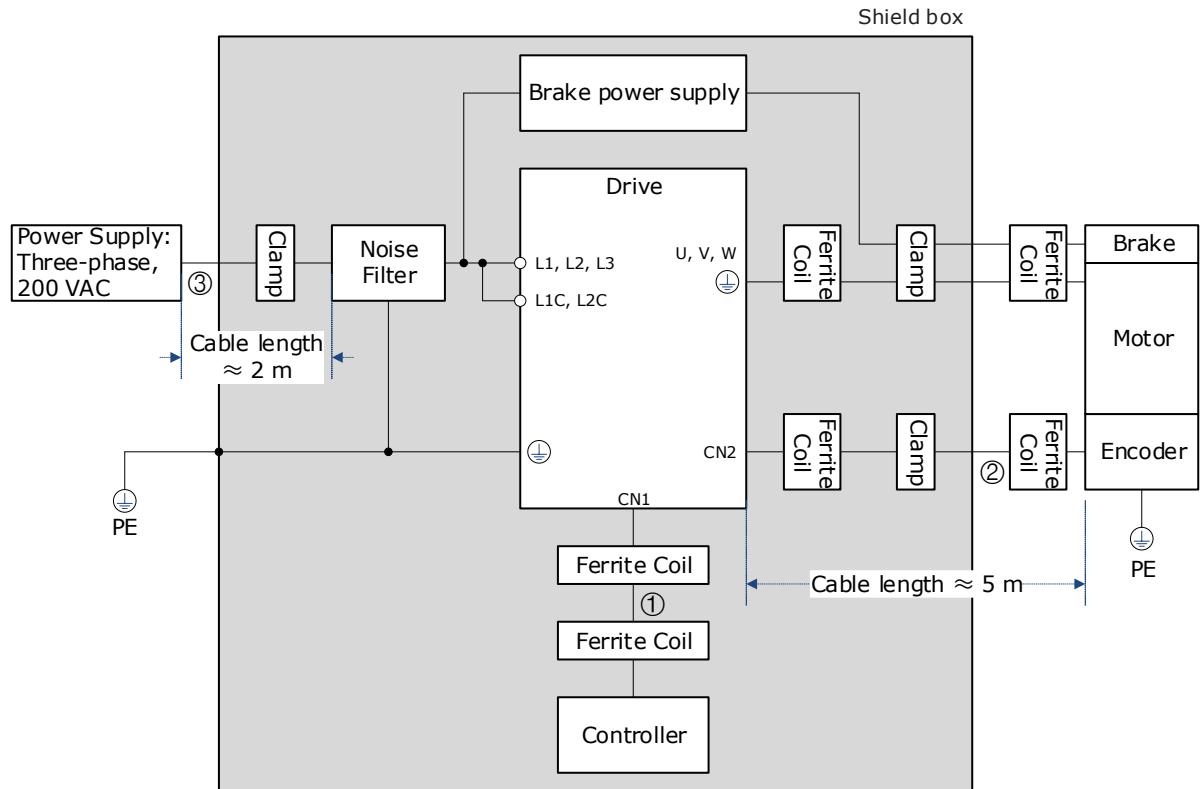
The ED3S Drivers can be mounted closely and the distance between adjacent drives is 1mm.

2.5 EMC Installation Conditions

This section gives the installation conditions that were used for EMC certification testing.

2.5.1 EMC Directives

The EMC installation conditions that are given here are the conditions that were used to pass testing criteria at ESTUN. The EMC level may change under other conditions, such as the actual installation structure and wiring conditions. These ESTUN products are designed to be built into equipment. Therefore, you must implement EMC measures and confirm compliance for the final equipment.

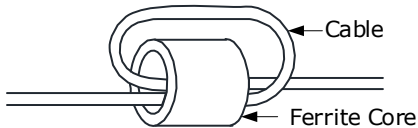


No	Cable Name	Specification
①	I/O Signal Cable	Shielded cable
②	Encoder Cable	Shielded cable
③	Motor Main Circuit Cable	Shielded cable

2.5.2 Ferrite Coil Mounting

Ferrite Coil Attached

Wrap the cable around the ferrite coil for 2 turns. The Ferrite Coil mounting positions of each cable is shown in the following table.

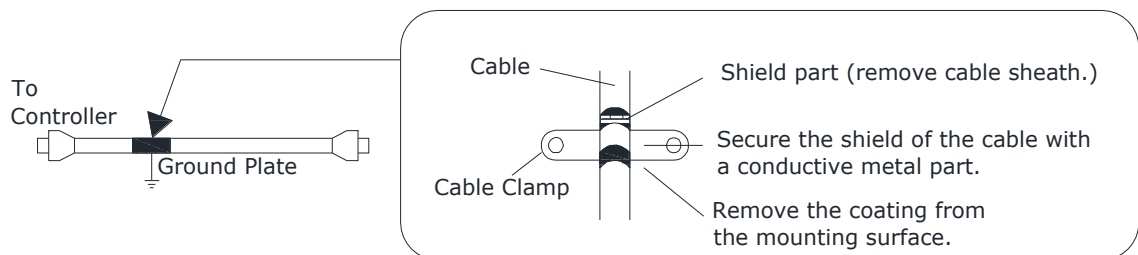
Wrapping Diagram	Cable Name	Mounting Position
	I/O Signal Cable	Near the terminals of the Controller and Drive
	Motor Main Circuit Cable	Near the terminals of Motor and Drive
	Encoder Cable	Near the terminals of Motor and Drive

Recommended Model of Ferrite Core

Cable Name	Model	Manufacturer
I/O Signal Cable	ESD-SR-25	TOKIN
Encoder Cable		
Motor Main Circuit Cable (400 W or less)		
Motor Main Circuit Cable (750 W or more)	PC40T96 × 20 × 70	TDK

Cable Fixed

Secure the shield of the cable with a conductive metal part, and fix it to the ground plate.



Shield Box

Use a shield box with the closed metal housing to shield electromagnetic interference from the Drive. The shield box must have a structure that allows the body, door, cooling device, etc. to be grounded, and the opening of the shielding box shall be as small as possible.



It is recommended that you deploy your system as described above. ESTUN is not responsible for the risk of electromagnetic interference caused by the above-mentioned setups not being used on your application.

Chapter 3 Wiring and Connecting

3.1 Precautions for Wiring

3.1.1 General Precautions



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



- 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.



- 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.

**NOTE**

- Whenever possible, use the Cables specified by ESTUN.
- Securely tighten cable connector screws and lock mechanisms, in case cable connectors falling off during operation.
- Never bundle power lines (e.g. the Main Circuit Cable) and low-current lines (e.g. the I/O Signal Cables or Encoder Cables) together or run them through the same duct. If you do not place power lines and low-current lines in separate ducts, separate them by at least 30 cm.

**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.

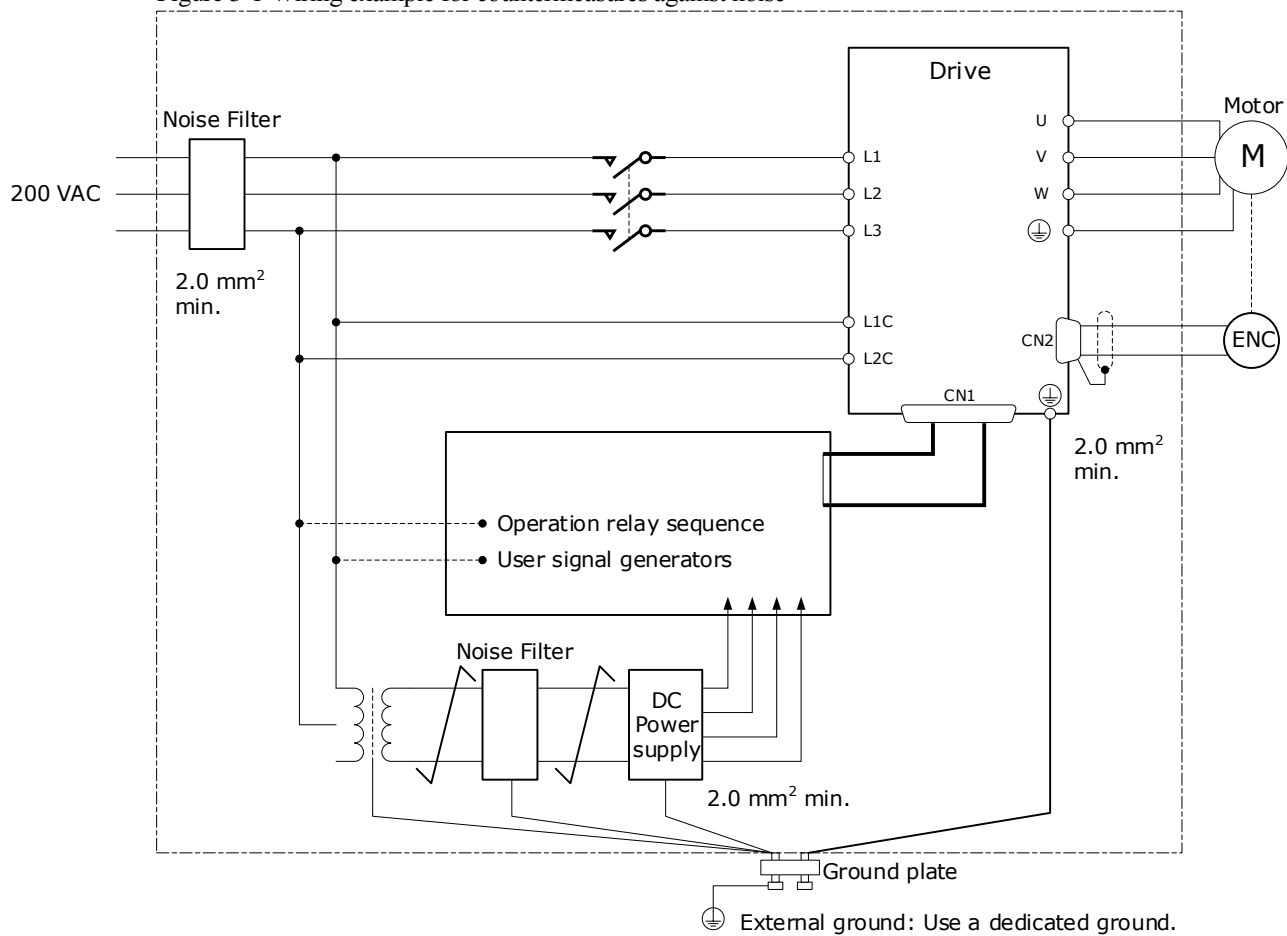
To prevent the noise from the Drive or the peripheral devices from causing malfunctions of any devices, take the following countermeasures against noise as required.

- 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 **3.1.3 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

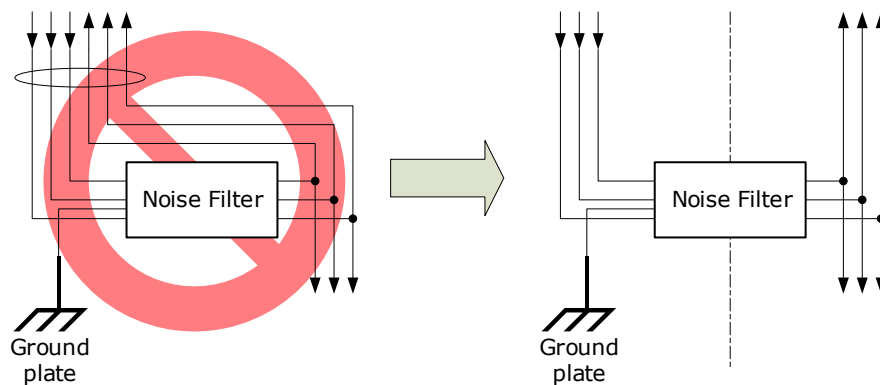


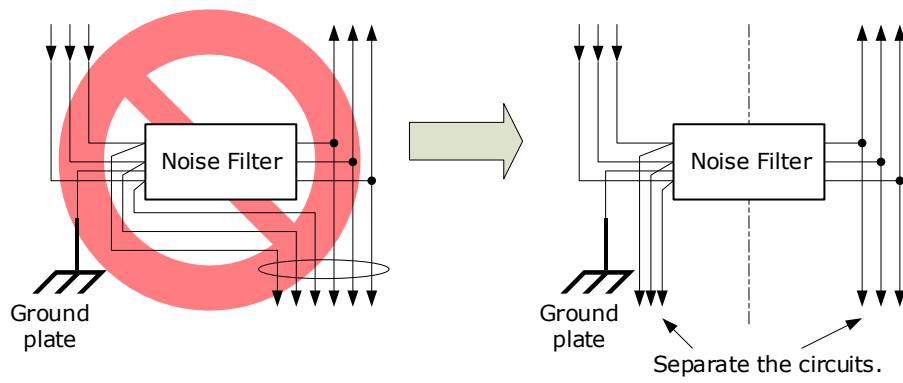
- For the ground wire, use a wire with a thickness of at least 2.0 mm² (preferably, flat braided copper wire).
- Whenever possible, use twisted-pair wires to wire all connections marked with ∇

Noise Filter Wiring and Connection Precautions

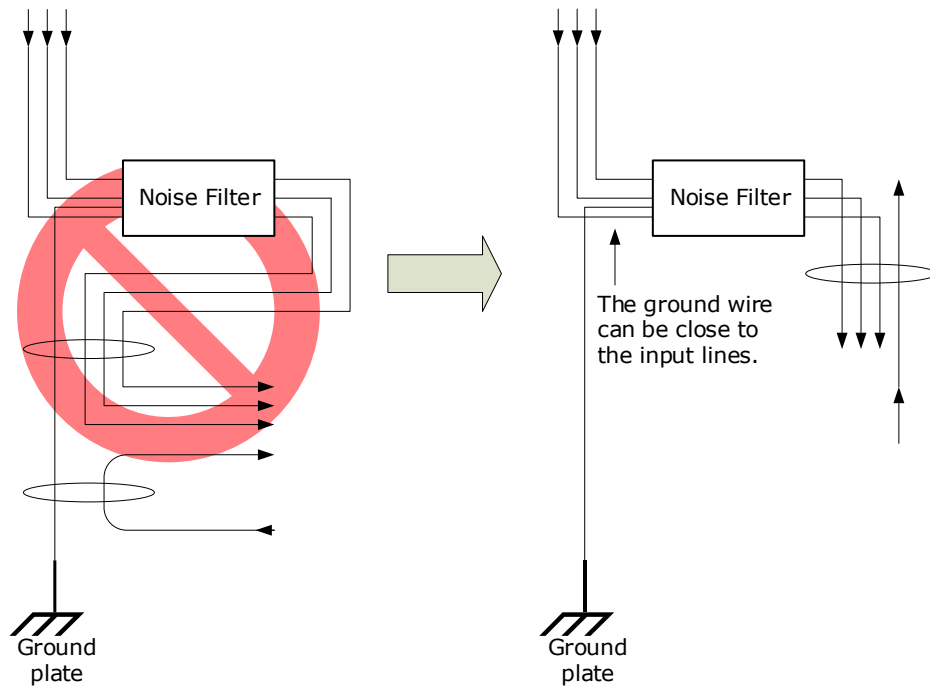
Always observe the following precautions when wiring or connecting Noise Filters.

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

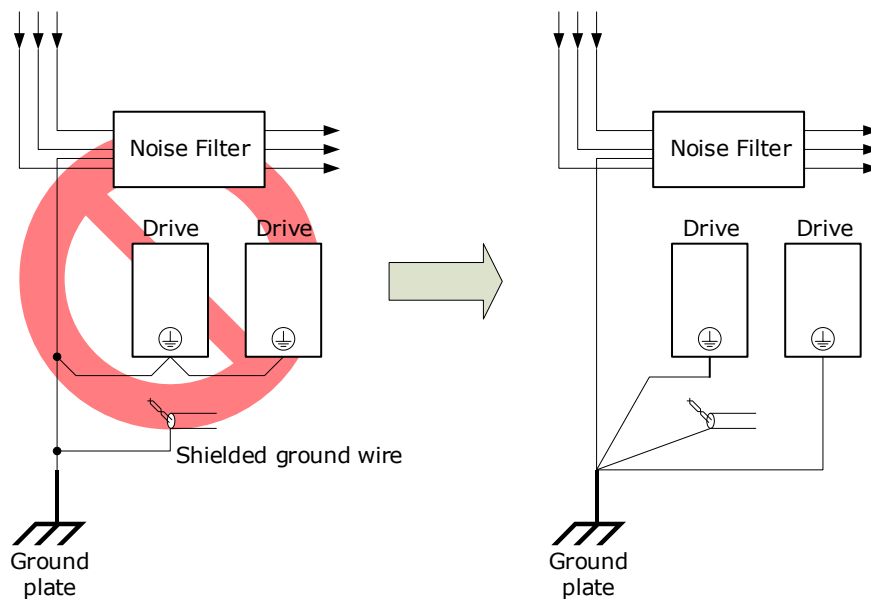




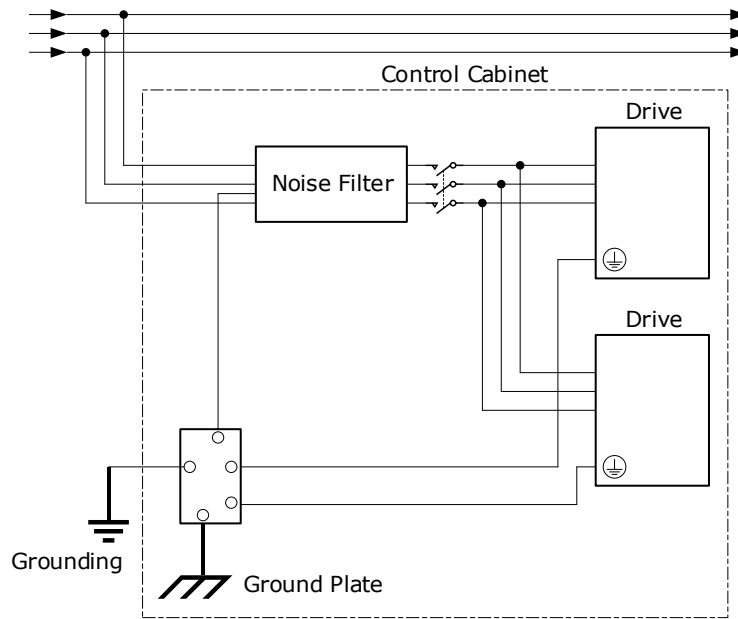
- Separate the Noise Filter ground wire from the output lines. Do not place the Noise Filter ground wire, output lines, and other signal lines in the same duct or bundle them together.



- 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 Grounding

Implement grounding measures as described in this section. Implementing suitable grounding measures will also help prevent malfunctions, which can be caused by noise.

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.

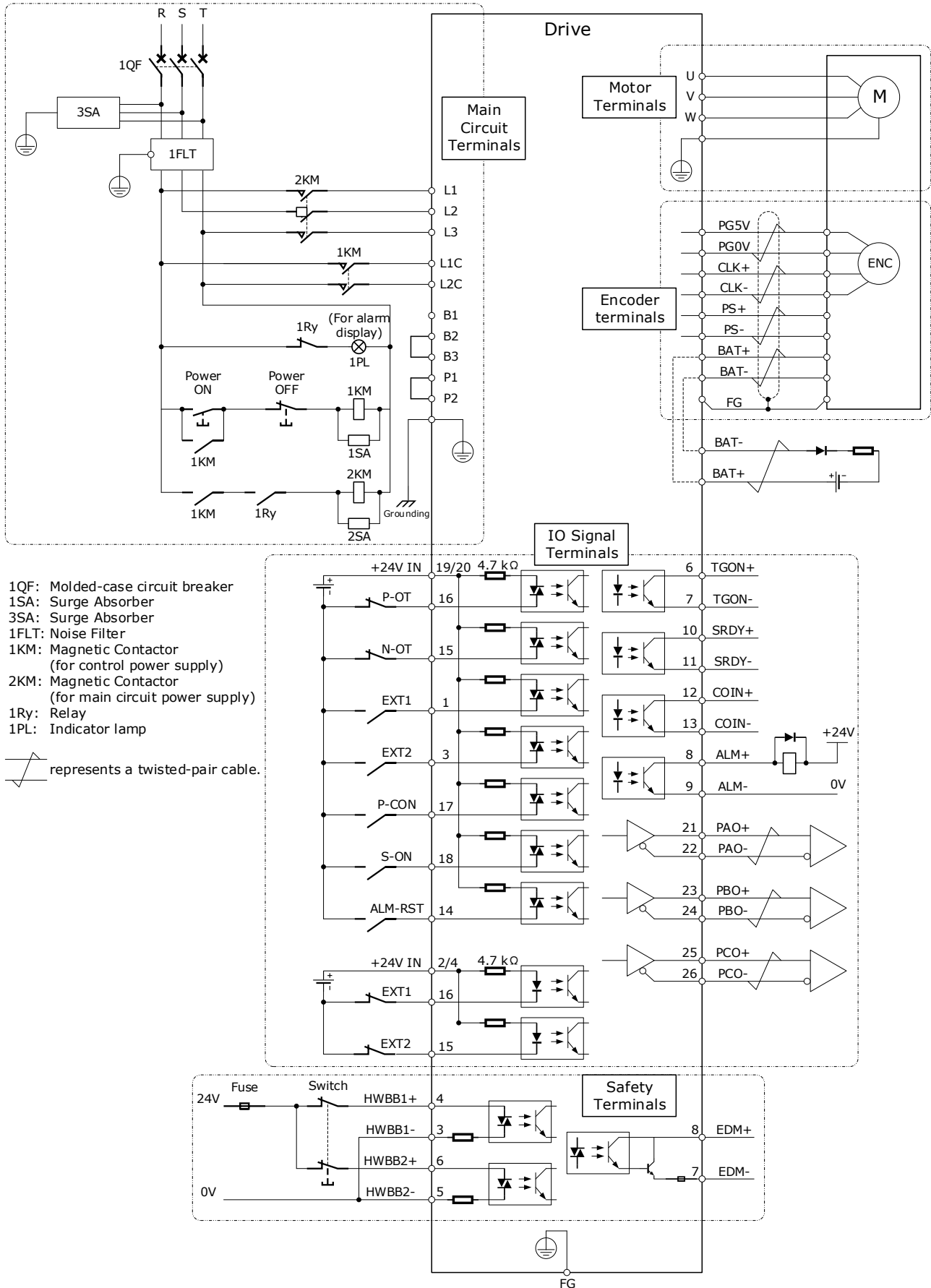
Motor Frame Ground or Motor Ground

If you ground the Motor through the machine, 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 \oplus on the Drive. Also be sure to ground the ground terminal \oplus .

Noise on I/O Signal Cables

If noise enters the I/O Signal Cable, connect the shield of the I/O Signal Cable to the connector shell to ground it. If the Motor Main Circuit Cable is placed in a metal conduit, ground the conduit and its junction box. For all grounding, ground at one point only.

3.2 Basic Wiring Diagrams

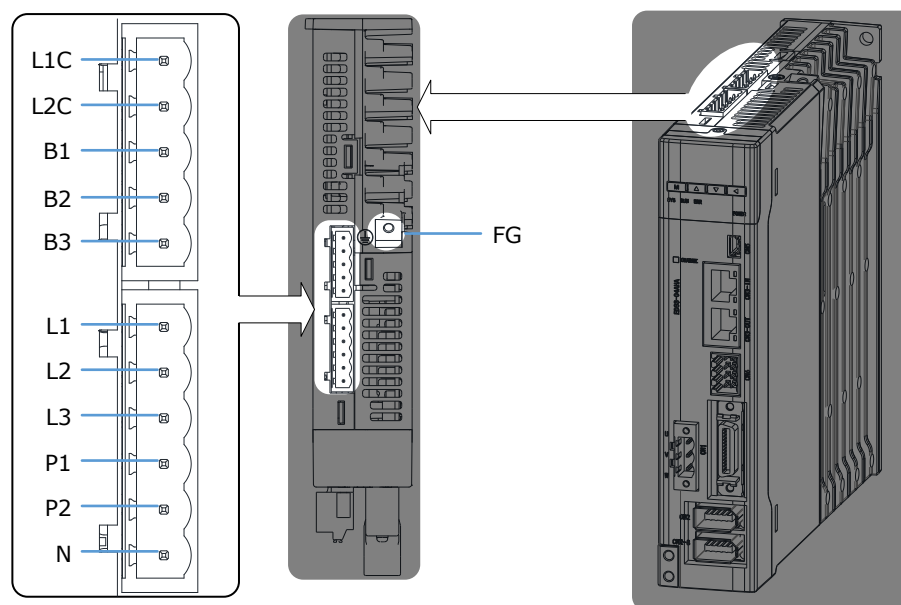


3.3 Wiring the Power Supply to Drive


3.3.1 Terminals Arrangement

The power supply to Drive includes main circuit terminals and control circuit terminals.

Signal Diagram



Pin Layout

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
L1C, L2C	Control power supply 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.
P1, P2, N	DC terminals	There is a short wiring between P1 and P2 at the factory. <ul style="list-style-type: none"> For using a DC reactor, remove the short wiring, and connect a DC reactor between P1 and P2. For using a DC power supply, connects P2 to the positive pole, and connects N to negative pole. For the common DC bus, connect all P2 of Drive to the positive pole, and N to the negative pole.
	Ground terminal	Always connect this terminal to prevent electric shock.

3.3.2 Wiring Procedure

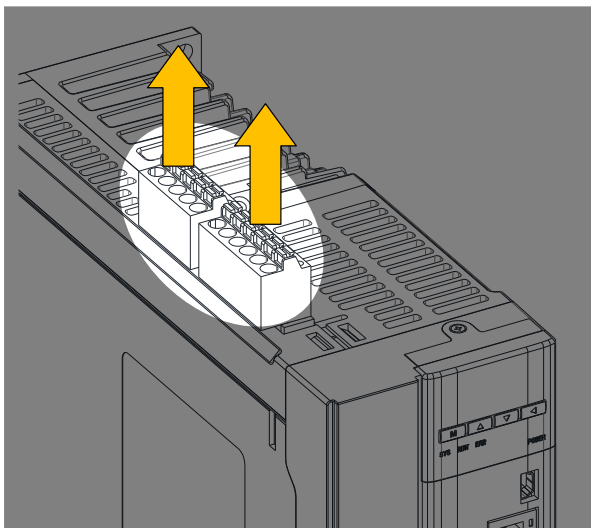
Prepare the following items before preparing the wiring for the Main Circuit Terminals and Control Circuit Terminals.

Required Item	Description
Flat-blade screwdriver	Commercially available screwdriver with tip width of 3.0 mm to 3.5 mm
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.

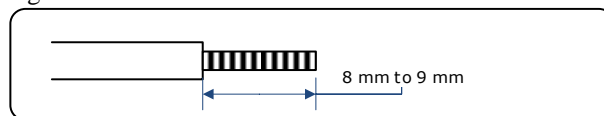
Step 1 Remove the Main Circuit Terminals and Control Circuit Terminals from the Drive.

Figure 3-2 Remove the terminals



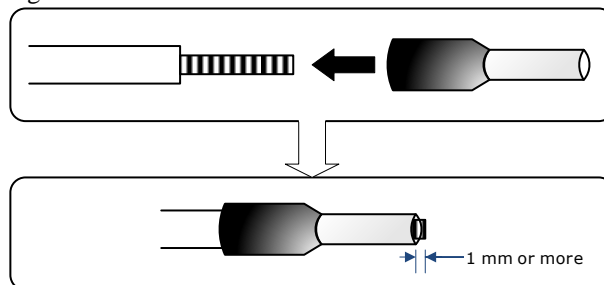
Step 2 Peel off the sheath so that the conductor portion of the cable will protrude from the tip of the ferrule.

Figure 3-3 Remove the sheath



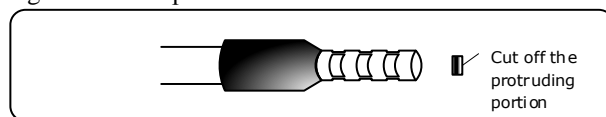
Step 3 Insert the cable into the ferrule (It should protrude 1 mm or more from the ferrule).

Figure 3-4 Insert the cable into 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).

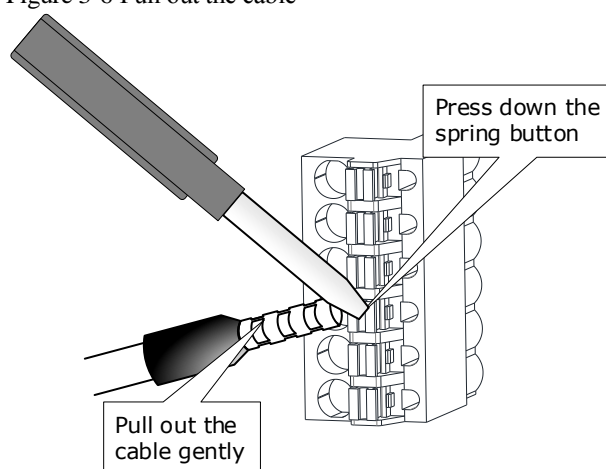
Figure 3-5 Crimp the cable



- Step 5 Insert the crimped cable into the connection terminals directly until the cable is not easily pulled out (A slight pull is allowed).
- Step 6 Make all other connections in the same way.
- Step 7 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.

Figure 3-6 Pull out the cable



- Step 8 When you have completed wiring, attach connection terminals to the Drive.

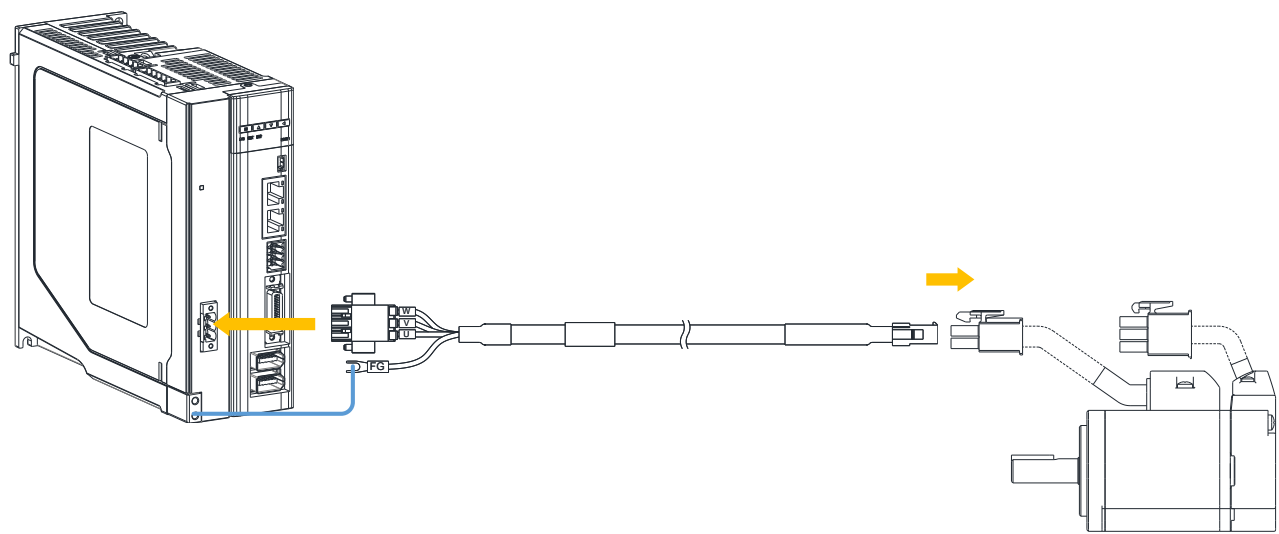


NOTE

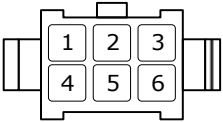
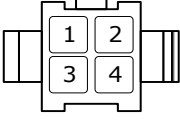
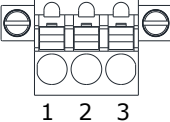
The above wiring procedure is also applicable to the Motor Terminals.

3.4 Wiring the Motor

Connection Diagram

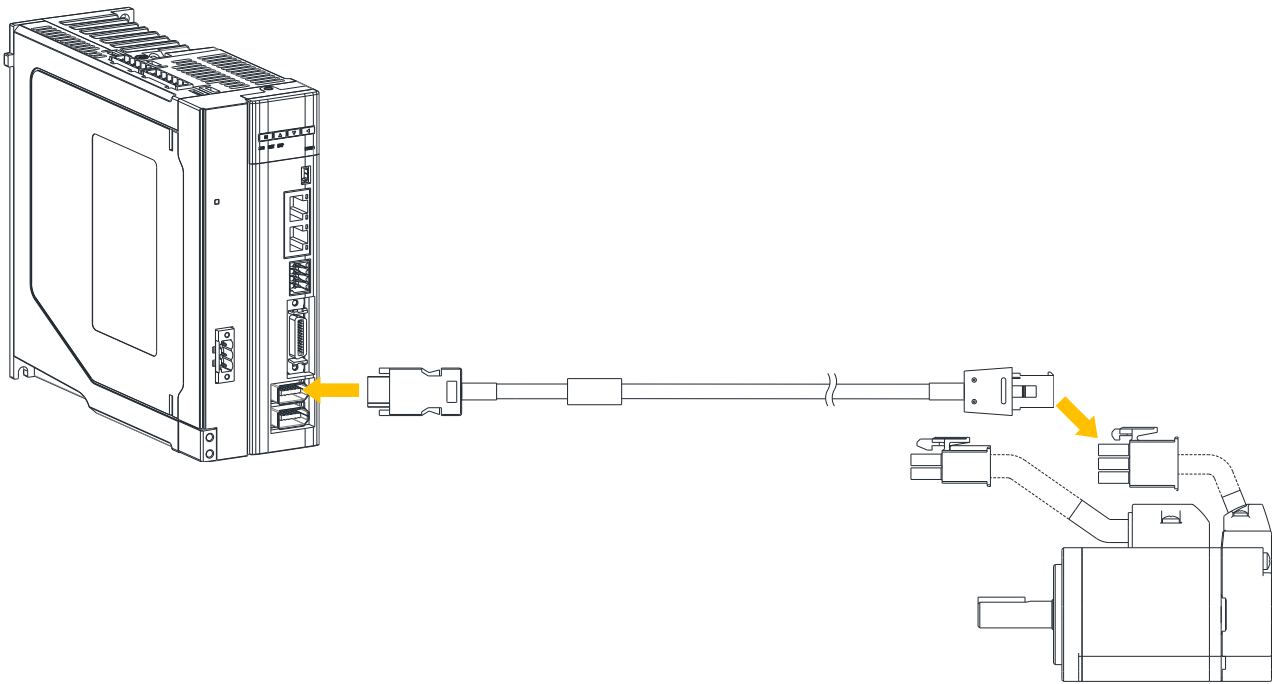


Terminals Arrangement

Terminals		Pin Layout		
Motor connection side	Terminal with brake 	Pin	Symbols	Color
		1	U	Brown
		2	V	Gray
		3	W	Black
		4	FG	Yellow-Green
		5	B1	White
		6	B2	Green
Motor connection side	Terminal without brake 	Pin	Symbols	Color
		1	U	Brown
		2	V	Gray
		3	W	Black
		4	FG	Yellow-Green
Drive connection side		Pin	Symbols	Color
		1	U	Brown
		2	V	Gray
		3	W	Black

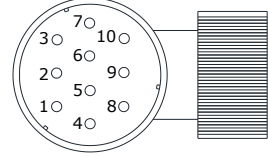
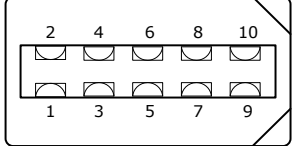
3.5 Wiring the Encoder

Connection Diagram



Terminals Arrangement

Terminals		Pin Layout		
Motor connection side	<div>Ordinary Plug</div> <div><div><div>1</div><div>2</div><div>3</div><div>4</div><div>5</div><div>6</div><div>7</div><div>8</div><div>9</div></div></div>	Pin	Symbols	Color
		1	S+	Blue
		2	S-	Blue-Black
		3	BAT+	Yellow
		4	MA+	Green
		5	MA-	Green-Black
		6	PG5V	Red
		7	PG0V	Black
		8	BAT-	Yellow-Black
		9	FG	Frame ground

Terminals		Pin Layout		
	 <p>Waterproof Plug</p>	Pin	Symbols	Color
		1	S+	Blue
		2	S-	Blue-Black
		3	BAT+	Yellow
		4	BAT-	Green
		5	MA+	Green-Black
		6	MA-	Red
		7	PG0V	Black
		8	PG5V	Yellow-Black
		9	–	–
		10	FG	Frame ground
Drive connection side		Pin	Symbols	Color
		1	PG5V	Red
		2	PG0V	Black
		3	–	–
		4	–	–
		5	MA+	Green
		6	MA-	Green-Black
		7	S+	Blue
		8	S-	Blue-Black
		9	BAT+	Yellow
		10	BAT-	Yellow-Black
		Shell	FG	Frame ground

Battery Case Connection

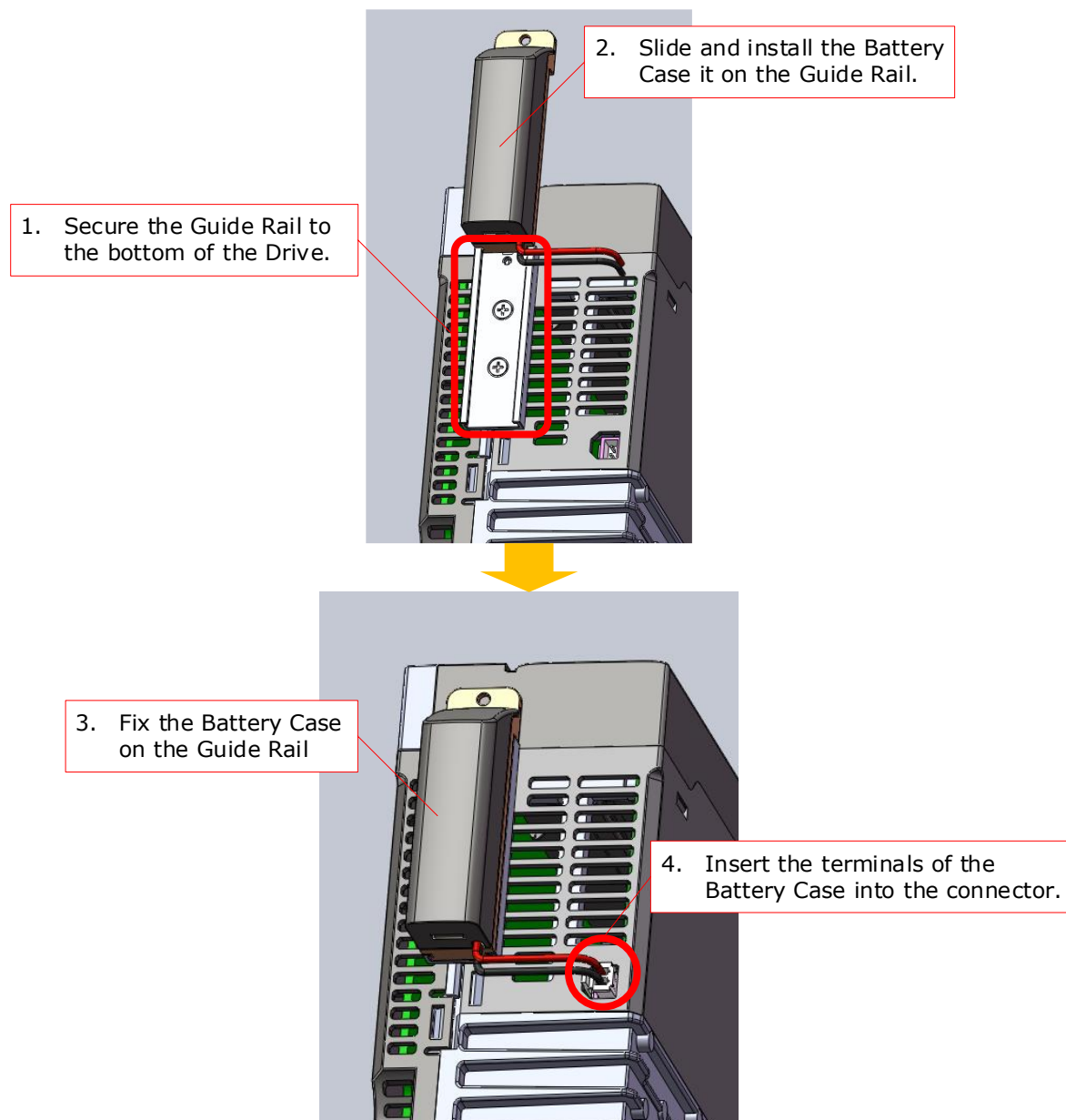


It is necessary to connect the battery case for using an absolute encode. Keep the Control power supply to the Drive is ON when you remove the battery case or disconnect the Encoder Cable, in case losing the absolute encoder data.

Prepare the following items before connecting a Battery Case.

Required Item	Description
Battery Case	Accessories for the Summa Series Product.
Guide Rail	Please contact ESTUN to purchase.
Wiring plier	Commercially available plier with crimping and stripping functions

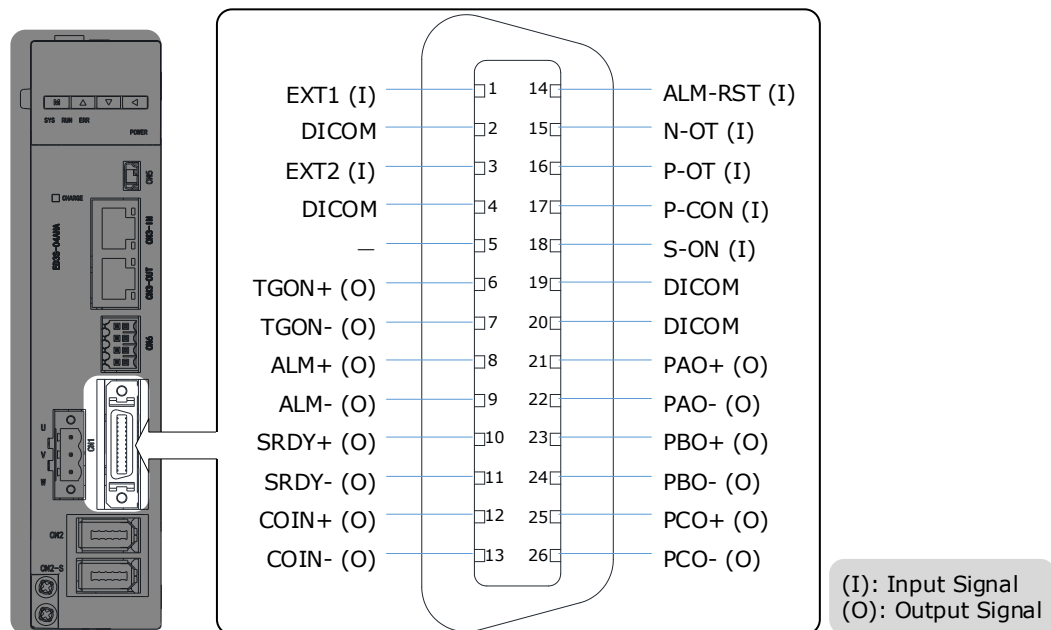
The installation diagram of the battery case is as follows.

**NOTE**

The reverse installation procedure is the disassembling procedure of the battery case.

3.6 I/O Signal Connections

Signal Diagram



Pin Layout

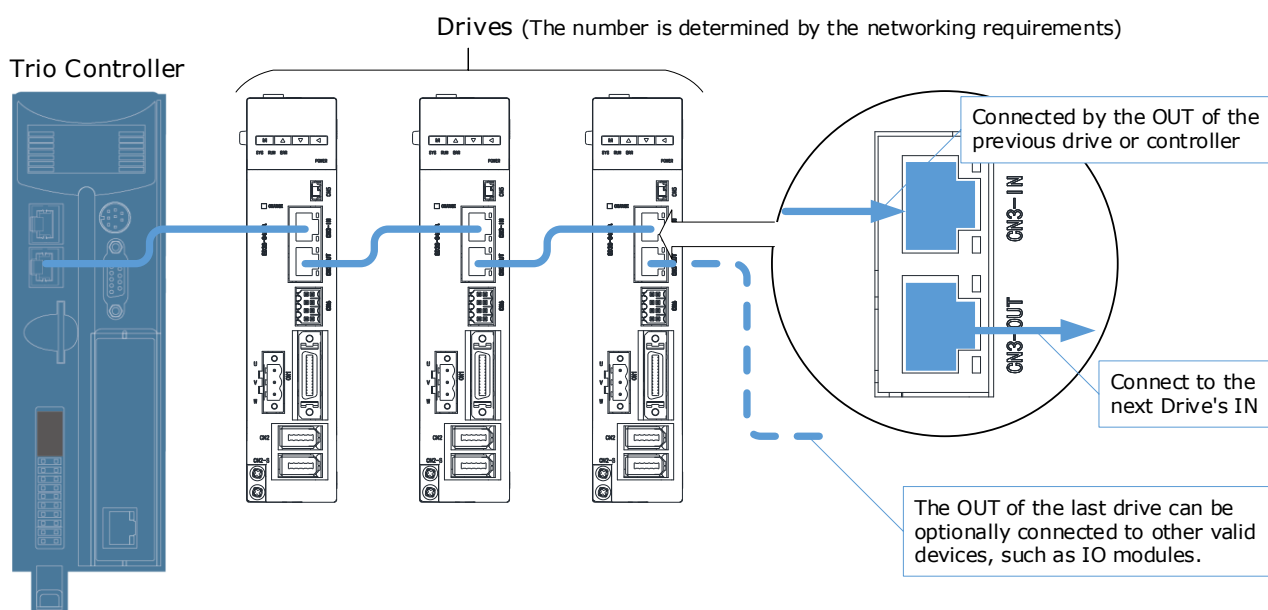
Pin	Name	Type	Function
1	EXT1	Input	Touch Probe Input 1
2	DICOM	Common	Power supply to Touch Probe Input signal, connect to a 24 VDC power supply together with Pin-4.
3	EXT2	Input	Touch Probe Input 2
4	DICOM	Common	Power supply to Touch Probe Input signal, connect to a 24 VDC power supply together with Pin-2.
5	—	—	—
6	TGON+	Output	Rotation Detection signal indicates that the Motor is operating.
7	TGON-	Output	
8	ALM+	Output	Servo Alarm signal is output when the Drive detects an error.
9	ALM-	Output	
10	SRDY+	Output	Servo Ready signal turns ON when the Drive is ready to accept the Servo ON command.
11	SRDY-	Output	
12	COIN+	Output	Positioning Completion signal indicates that Motor positioning has been completed during position control.
13	COIN-	Output	
14	ALM-RST	Input	Alarm Reset Input signal can reset the servo alarm and continue operation.

Pin	Name	Type	Function
15	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.
16	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.
17	P-CON	Input	Proportional control input signal. You can allocate it to use with a parameter.
18	S-ON	Input	Servo On signal can supply power to Motor.
19	DICOM	Common	Power supply to IO signals, connect to a 24 VDC power supply together with Pin-19 and Pin-20.
20	DICOM	Common	
21	PAO+	Output	Encoder Divided Pulse Output, Phase A. Output the encoder divided pulse output signals with a 90 °phase differential.
22	PAO-	Output	
23	PBO+	Output	Encoder Divided Pulse Output, Phase B. Output the encoder divided pulse output signals with a 90 °phase differential.
24	PBO-	Output	
25	PCO+	Output	Encoder Divided Pulse Output, Phase C. Outputs the origin signal once every encoder rotation.
26	PCO-	Output	

3.7 Communication Connections

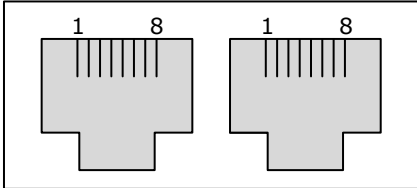
3.7.1 EtherCAT Communication Cable

Connection Diagram



Pin Layout

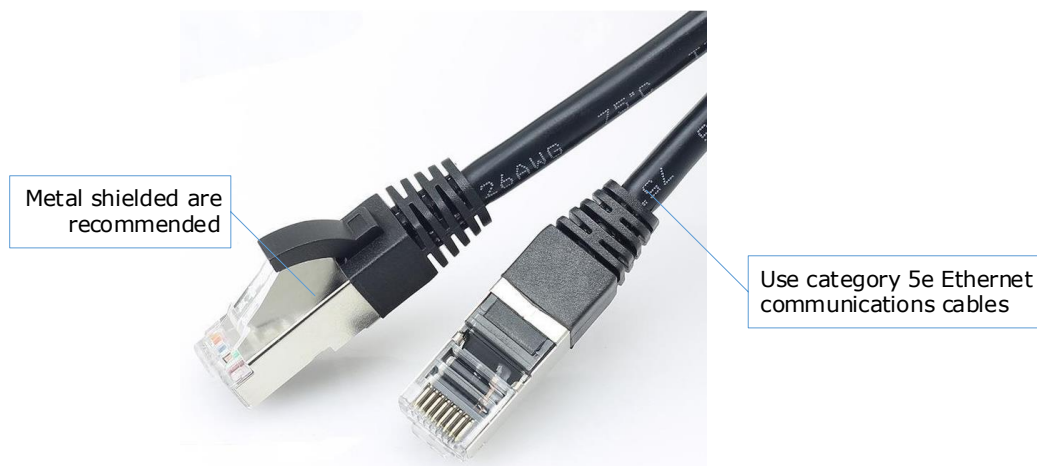
EtherCAT communication (CN3-ON and CN3-OUT) are RJ45 terminals. The communication cable as the master station or controller should be connected from CN3-IN, and CN3-OUT should be connected to the CN3-IN terminal of the next driver (slave station).

Connectors	Pin	Name	Function
 CN3-OUT CN3-IN	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

You shall purchase or make your own EtherCAT communication cable.

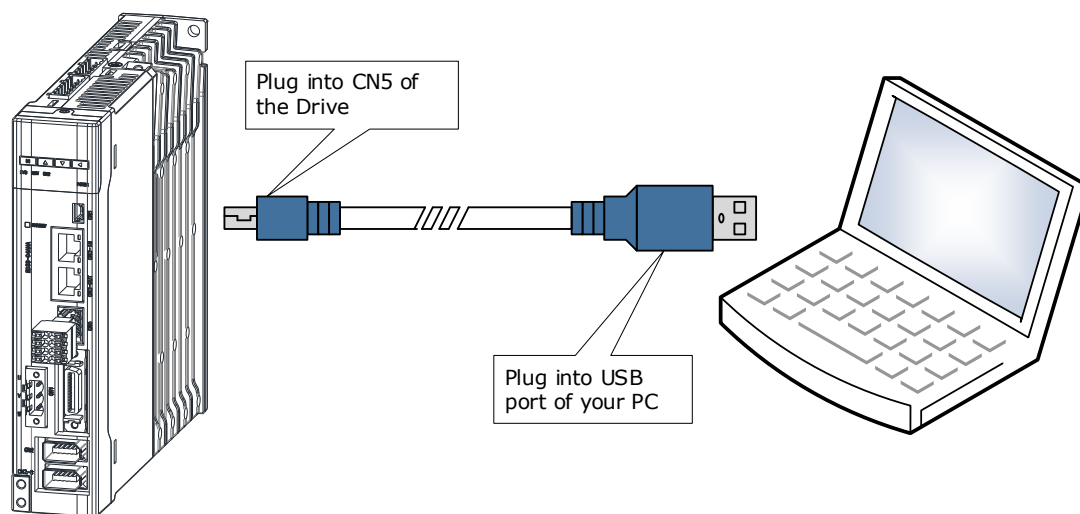
Use category 5e Ethernet communications cables to make the connections, and metal shielded terminals are recommended to prevent signal interference.



3.7.2 USB Communication Cable

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

Connection Diagram



Cable Description

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

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



3.8 Wiring the 2nd Encoder

The 2nd encoder will be used only with a fully-closed system. For the connection and usage, please refers to **Chapter 10 Fully-Closed Loop Control**.

3.9 Connecting STO Function Signals

A Safety Function Device shall be connected for using the STO function. For the connection and usage, please refers to **Chapter 11 STO**.

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.

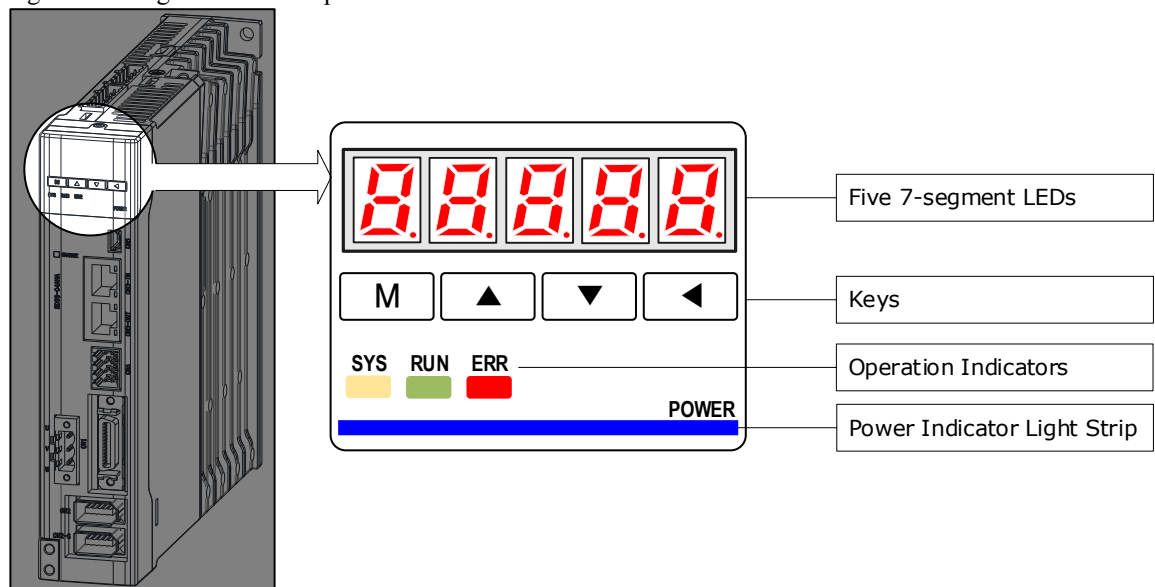
- Use the Panel Operator of the Drive
- Use the ESView V4 (**Recommended**)

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



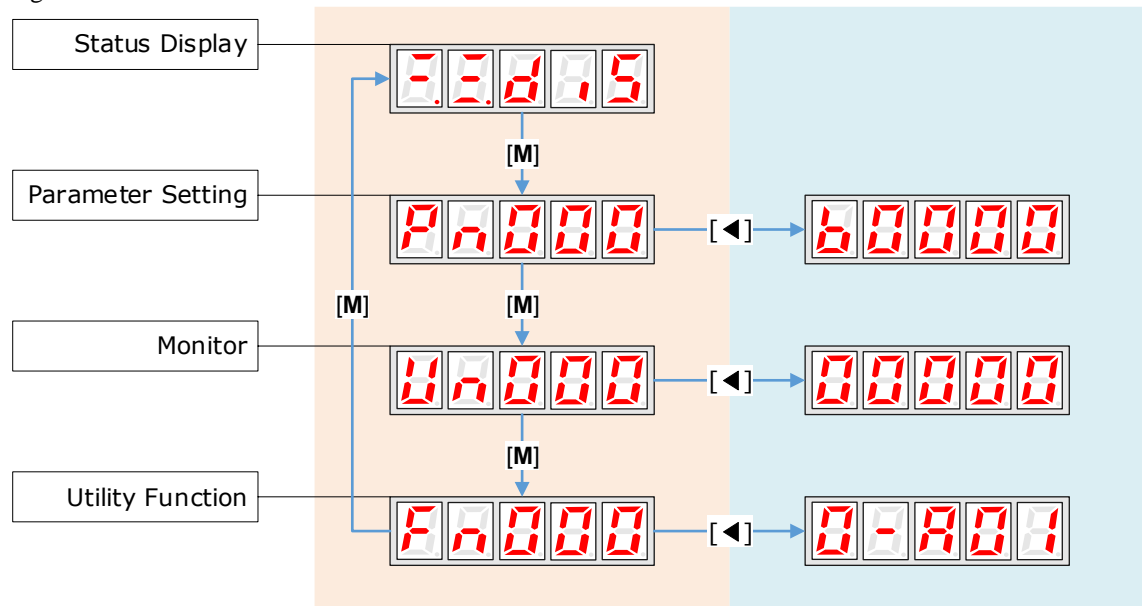
The names and functions of the keys on the Panel Operator are as follows.

Keys	Function
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.
◀	<ul style="list-style-type: none"> • 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

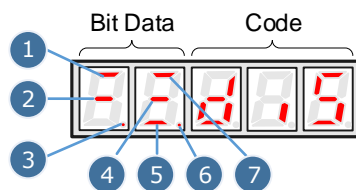


4.1.3 Status Display Mode

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.

No.	Speed or Torque Control Mode		Position Control Mode	
	Meaning	Description	Meaning	Description
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

Code	Meaning
	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.

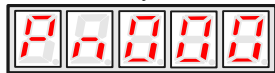
For a description of the parameter settings, please refer to **Chapter 12: Appendix**

Parameters List.

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.



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

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.

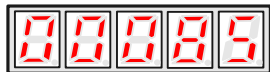


Step 3 Press [◀] key to display the current value of Pn102.



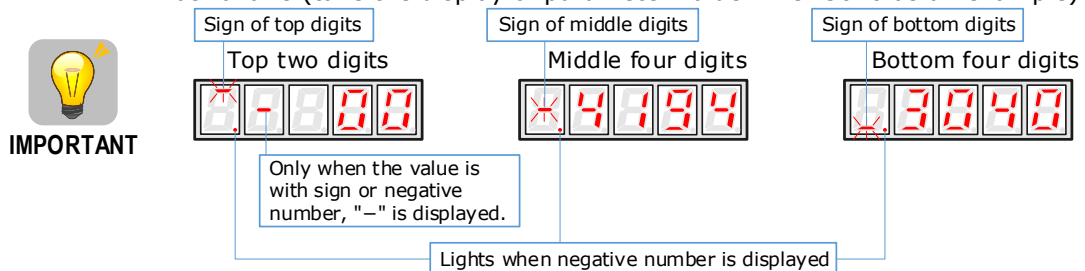
Step 4 Press [▼] key or [▼] key to change the value to 00085.

Press and hold [▼] key or [▼] key to jump the setting value quickly.



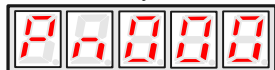
Step 5 Press [◀] key or [M] key to return to the display of Pn102.

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.



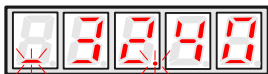
Step 4 Press and hold [◀] key for 1 second or more, and then a flashing decimal point will appear at the bottom right of the 5th digit.



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.

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 Un000 (when the Motor rotates at 1500 rpm).

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



Step 2 Press [▲] key or [▼] key to select the monitor number Un000.



Step 3 Press [◀] key to display the data of Un000.

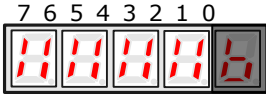


Step 4 Press [◀] key to return to the display of Un000.

Contents of Monitor Mode Display

Monitor Number	Content of Display	Unit
Un000	Motor speed	rpm
Un001	Reserved	—
Un002	Reserved	—
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, 2nd Encoder input signals (A, B, C) monitor, STO input signal monitor	—
Un007	Output signal monitor	—
Un008	Reserved	—
Un009	Input reference pulse counter	1 pulse
Un010	Reserved	—
Un011	Deviation pulse counter	1 pulse
Un012	Reserved	—
Un013	Reference pulse	1 pulse
Un014	Reserved	—
Un015	Load Inertia Percentage	%
Un016	Motor Overload Ratio	%
Un017	Reserved	—
Un018	Reserved	—
Un019	Busbar Voltage	V
Un020	Reserved	—
Un021	Encoder temperature	°C
Un022	Main board temperature	°C
Un023	Fully-closed feedback pulse counter	1 pulse

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

Monitor Diagram	Monitor Number	Meaning
	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	0: HWBB1 1: HWBB2 3: 2nd Encoder input signal C 4: 2nd Encoder input signal B 5: 2nd Encoder input signal A 6: EXT1 (Touch Probe Input 1) 7: EXT2 (Touch Probe Input 2)
	Un007	0: CN1-06, -07 1: CN1-08, -09 2: CN1-10, -11 3: CN1-12, -13

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.

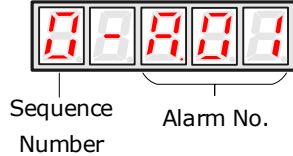
- Step 1 Press [M] key several times to select the Utility Function Mode.



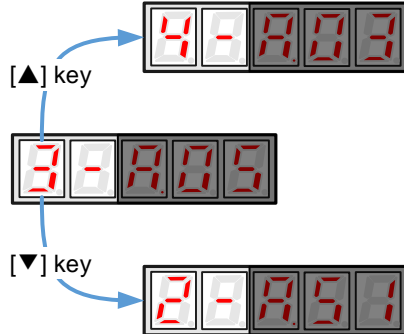
- Step 2 Press [▲] key or [▼] key to select the function number Fn000.



- 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.

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.



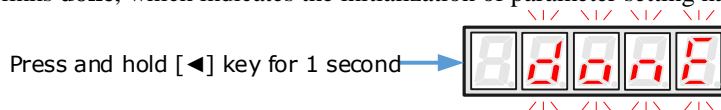
- Step 2 Press [▲] key or [▼] key to select the function number Fn001.



- 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.

Fn002 (JOG operation)

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

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

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



IMPORTANT

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

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

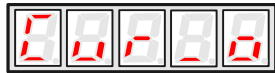
Step 1 Press [M] key several times to select the Utility Function Mode.



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

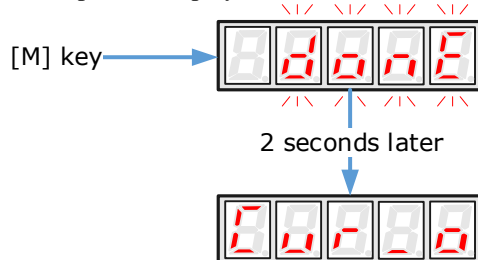


Step 3 Press [◀] key, and Panel Operator displays as below.



Step 4 Press [M] key to execute the automatic offset adjustment.

Panel Operator displays and blinks **done**, and 2 seconds later, it will return to previous display.



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

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.

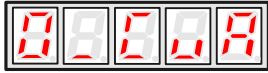
Step 1 Press [M] key several times to select the Utility Function Mode.



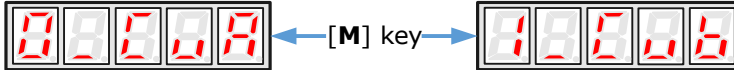
Step 2 Press [▲] key or [▼] key to select the function number Fn006.



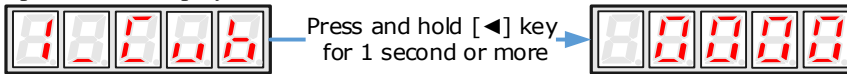
Step 3 Press [◀] key, and Panel Operator displays as below.



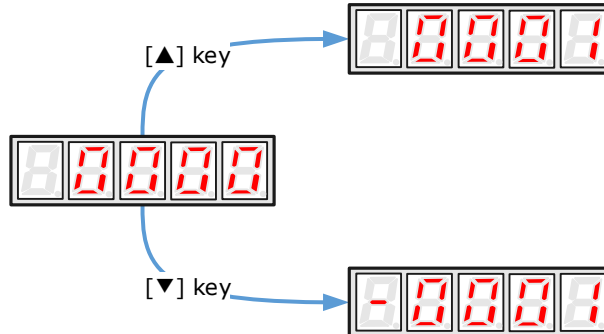
Step 4 Press [M] key for switching the display between 0_CuA (phase-U) and 1_Cub (phase-V).



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.



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.

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.

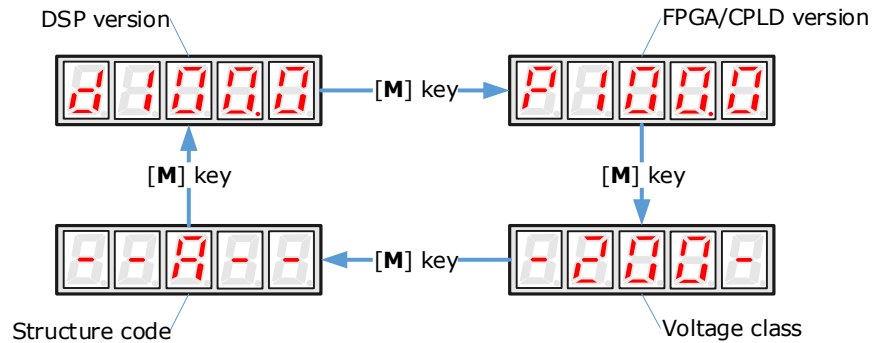


Step 2 Press [▲] key or [▼] key to select the function number Fn007.



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

Step 4 Press [M] key several times 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.

Fn009 (Load inertia identification)

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

Fn010 (Absolute encoder multi-turn reset)

The following are the steps to reset the absolute encoder multi-turn data.

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



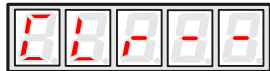
Step 2 Press [▲] key or [▼] key to select the function number Fn010.



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.

Fn011 (Absolute encoder alarm reset)

The following are the steps to reset the absolute encoder alarm.

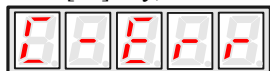
Step 1 Press [M] key several times to select the Utility Function Mode.



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.

Fn017 (Auto-tuning tool)

This utility function often use used for tuning, refers to the section **9.3.1 Auto-Tuning Tool**.

Fn018 (P)OG operation)

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

4.2 ESView V4

4.2.1 Installation

System Requirements

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

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

Preparation

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

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

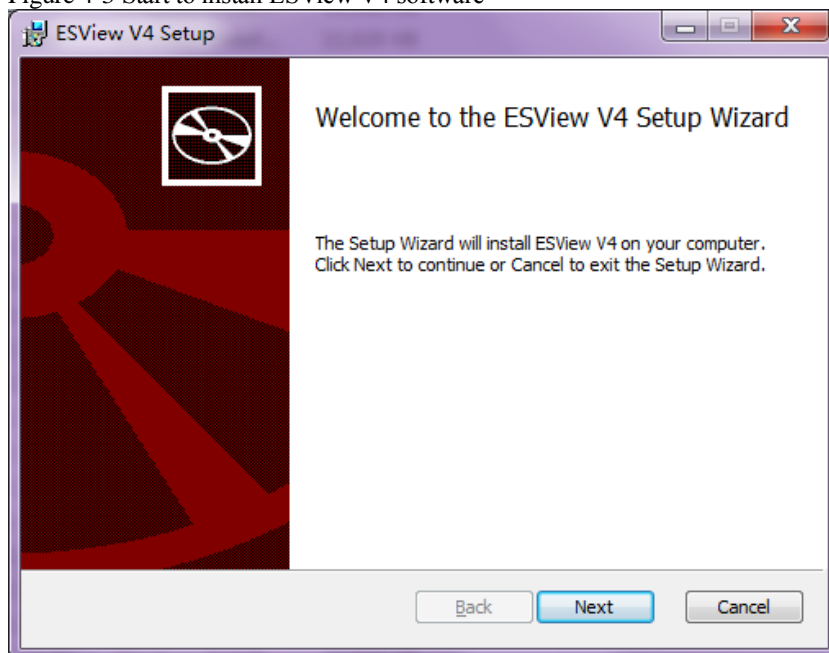
- Turn on the power supply of PC and start Windows. (Close down other software running.)
- Copy *ESView V4* compressed file into an appropriate folder.
- Disconnect if the servo drive is connected to the PC with the cable.

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.
The files compressed include *ESView V4* installation program and USB driver.
- 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 software



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

Install USB Driver

If you have successfully installed a USB drive, you can skip what is described in this section, or follow the steps below to install the USB driver.

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

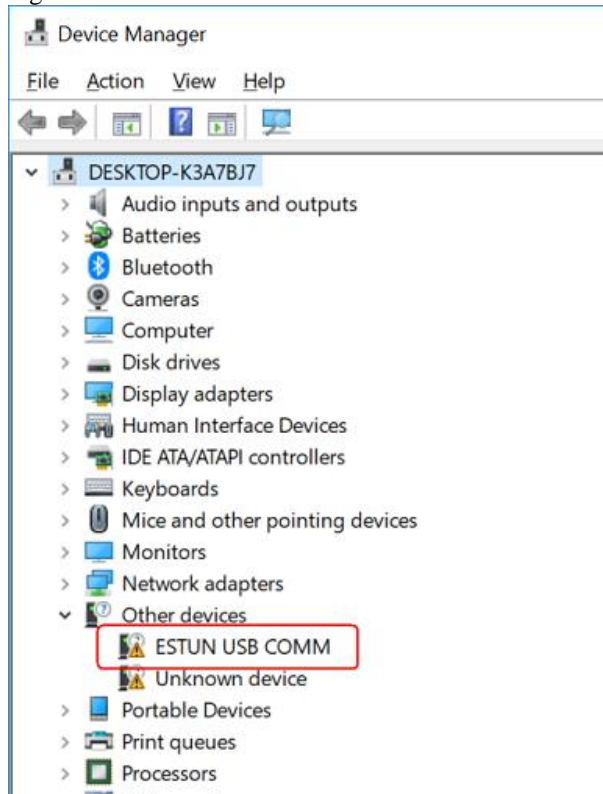
Step 2 Extract the ESView V4 compressed file in an appropriate directory of your PC.
The files compressed include ESView V4 installation program and USB driver.

Step 3 Open **Device Manager**.

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

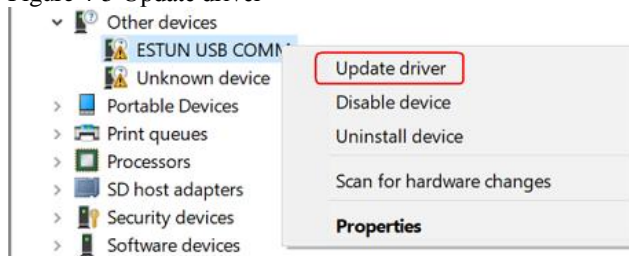
Step 4 An exclamatory mark attaches to the option **Other devices > ESTUN USB COMM** in **Device Manager** window, which indicates an error occurs in the driver and needs to update, as shown in Figure 4-4.

Figure 4-4 An error occurs in the driver



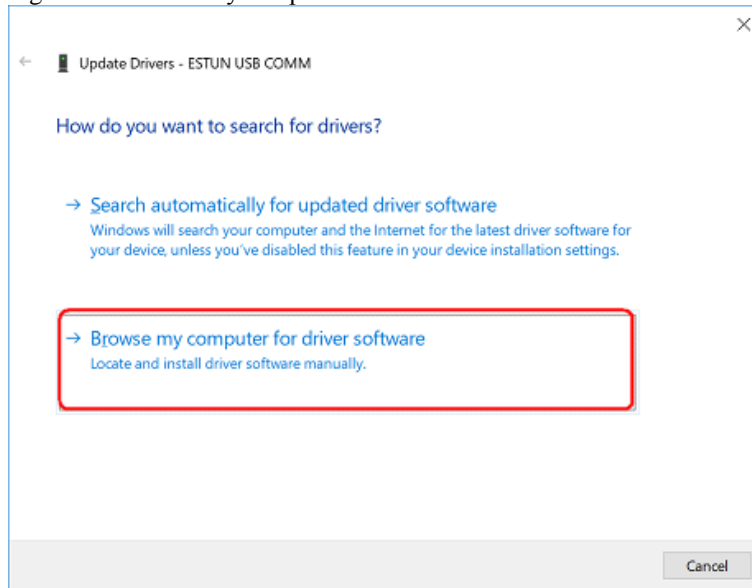
Step 5 Right-click **ESTUN USB COMM**, and select **Update driver** on the pop-up menu.

Figure 4-5 Update driver



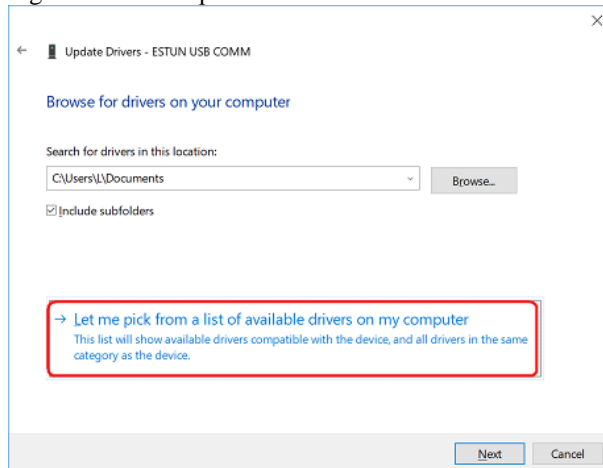
Step 6 Click **Browse my computer for driver software** on the **Update Drivers** dialog box.

Figure 4-6 Browse my computer for driver software



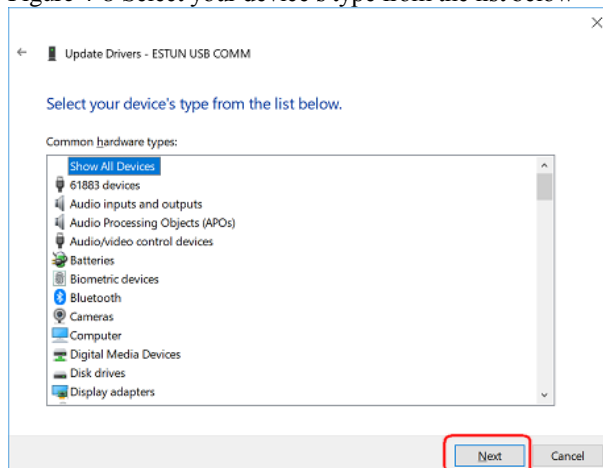
Step 7 Click **Let me pick from a list of available drivers on my computer.**

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



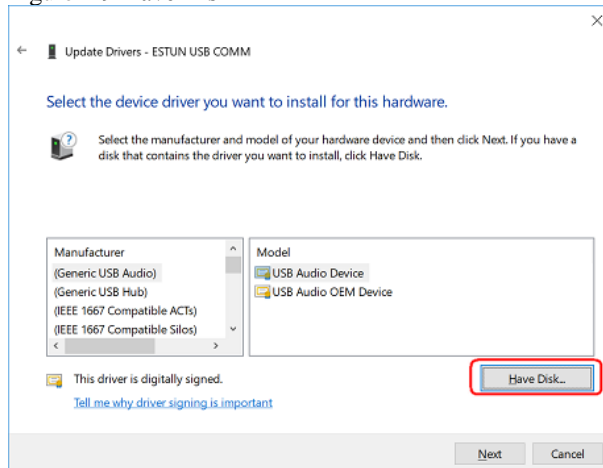
Step 8 Click Next.

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



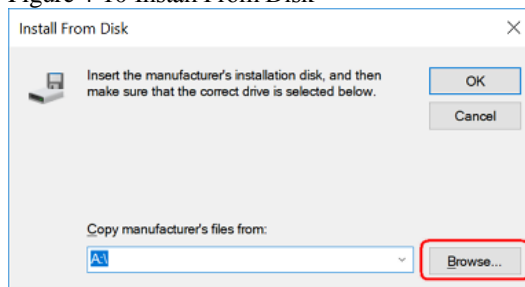
Step 9 Click **Have Disk**.

Figure 4-9 Have Disk



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

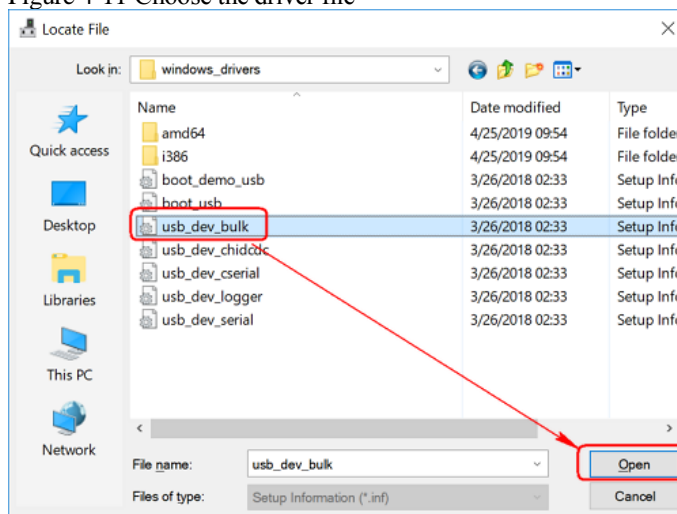
Figure 4-10 Install From Disk



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

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

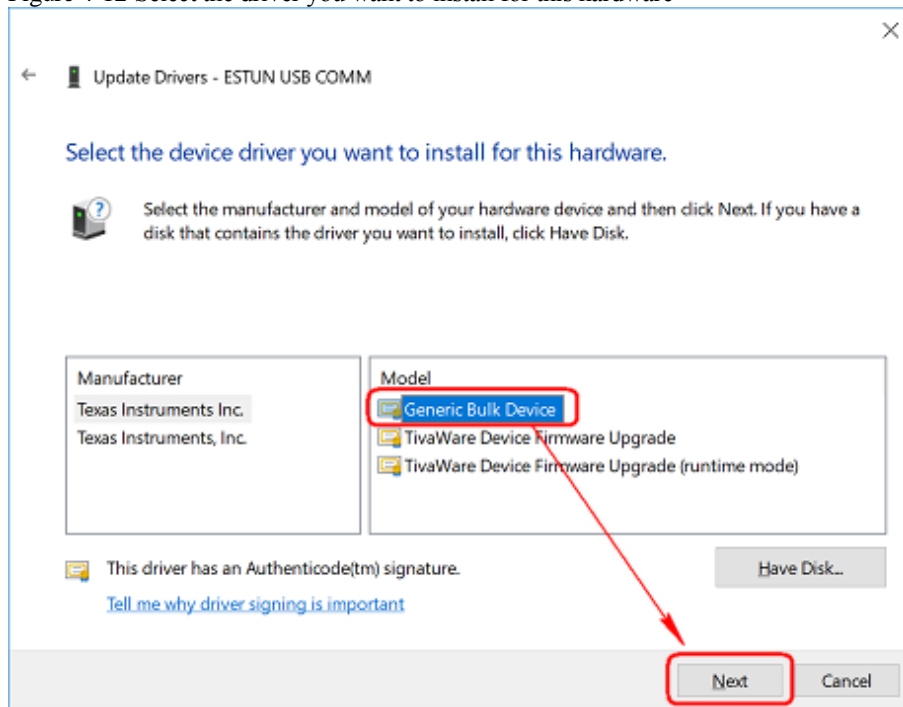
Figure 4-11 Choose the driver file



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

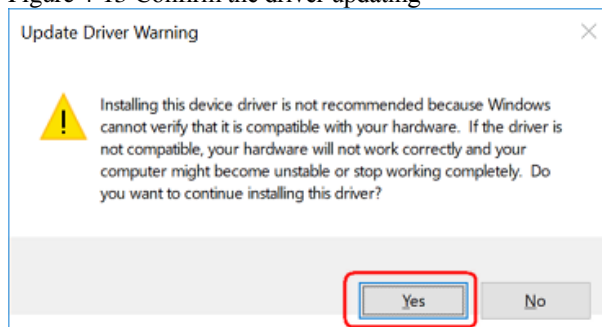
Step 14 Choose **Generic Bulk Device**, and then click **Next**.

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



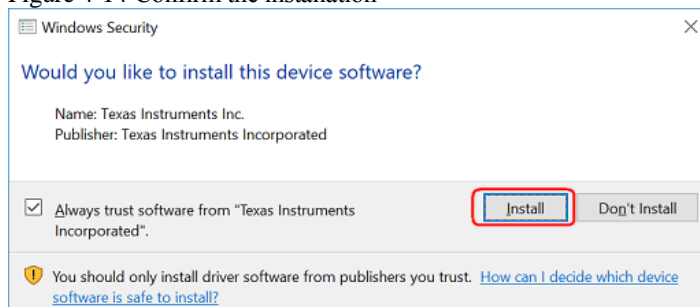
Step 15 Click **Yes** on the **Update Driver Warning** dialog box.

Figure 4-13 Confirm the driver updating



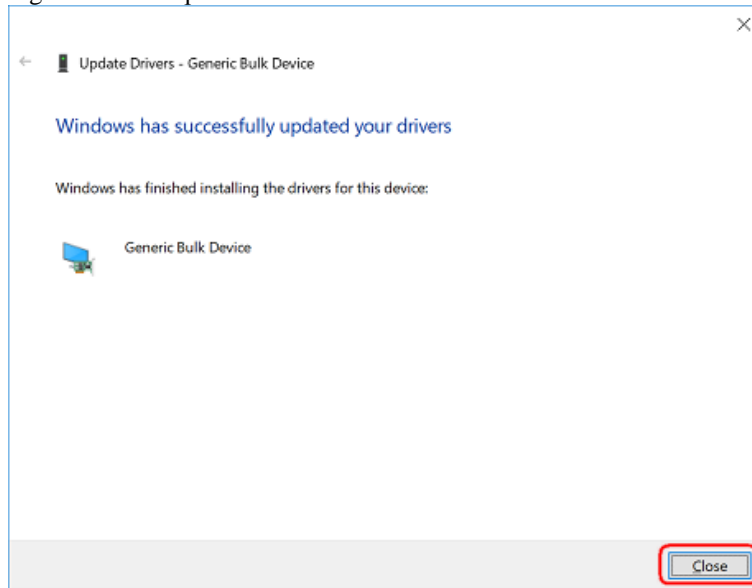
Step 16 Wait for a while, and then click **Install** on the **Windows Security** dialog box.

Figure 4-14 Confirm the installation



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

Figure 4-15 Complete the USB driver installation



4.2.2 Starting ESView V4

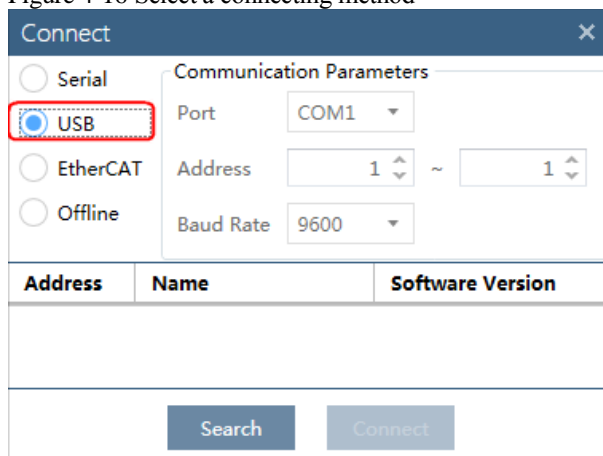
Online Operation

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**.

Figure 4-16 Select a connecting method



- Step 5 Click **Search**.

Figure 4-17 Search the connected device

连接

☐ Serial
☒ USB
☐ EtherCAT
☐ Offline

通信参数

端口: COM1

地址: 1 ~ 1

波特率: 9600

地址	名称	设备软件版本号
----	----	---------

搜索 连接

Step 6 Select the found device.

Figure 4-18 Select the device

Connect

☐ Serial
☒ USB
☐ EtherCAT
☐ Offline

Communication Parameters

Port: COM1

Address: 1 ~ 1

Baud Rate: 9600

Address	Name	Software Version
0	ED3S-04AHA	V101B4

Search Connect

Step 7 Click **Connect**.

Figure 4-19 Connect the device

Connect

☐ Serial
☒ USB
☐ EtherCAT
☐ Offline

Communication Parameters

Port: COM1

Address: 1 ~ 1

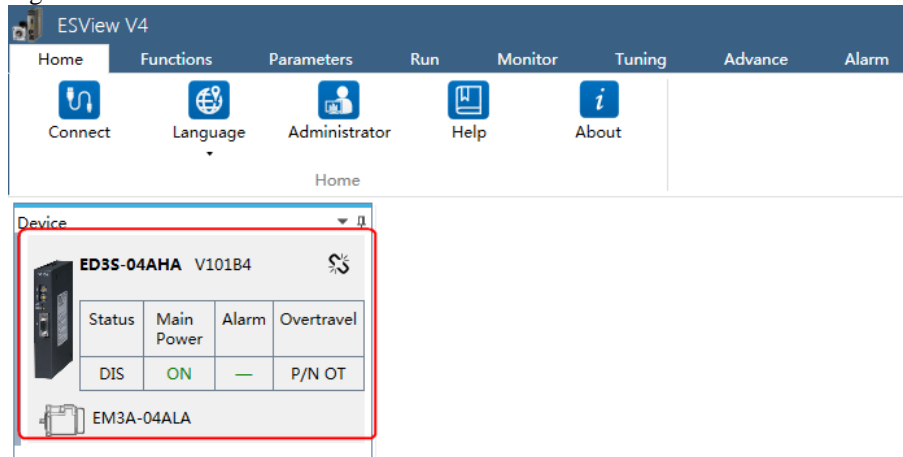
Baud Rate: 9600

Address	Name	Software Version
0	ED3S-04AHA	V101B4

Search Connect

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


Figure 4-20 Connected device in the list



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.

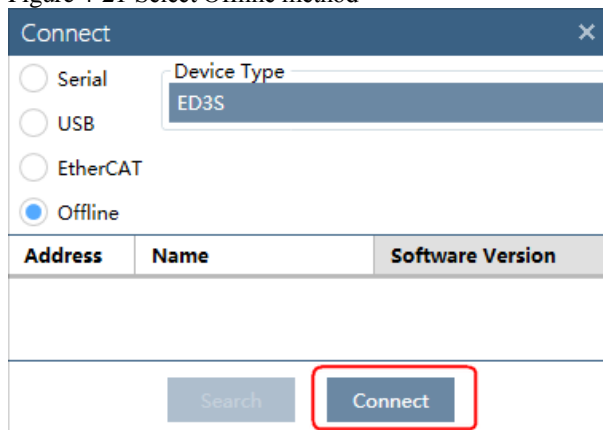
Offline Operation

You shall choose a Drive to manipulate on the computer under the offline operation.

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

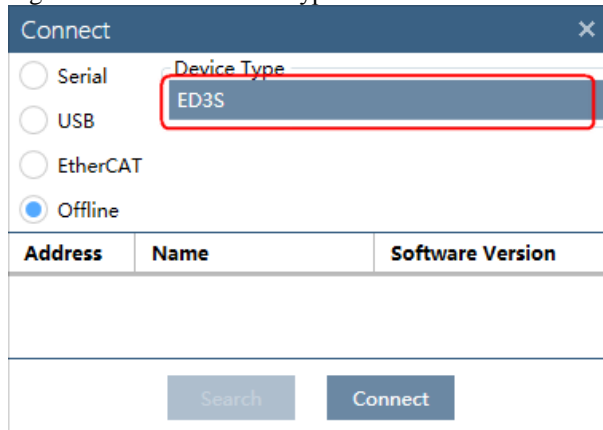
- Step 1 Select **Programs** > **ESView V4** > **ESView V4** from the Windows **Start** Menu.
Also, you can find and click *ESView V4* shortcut on the desktop of Windows.
- Step 2 The **Connect** dialog box will be displayed.
If you had started *ESView V4*, select **Home** > **Connect** in the **Menu Bar**.
- Step 3 Select **USB**.

Figure 4-21 Select Offline method



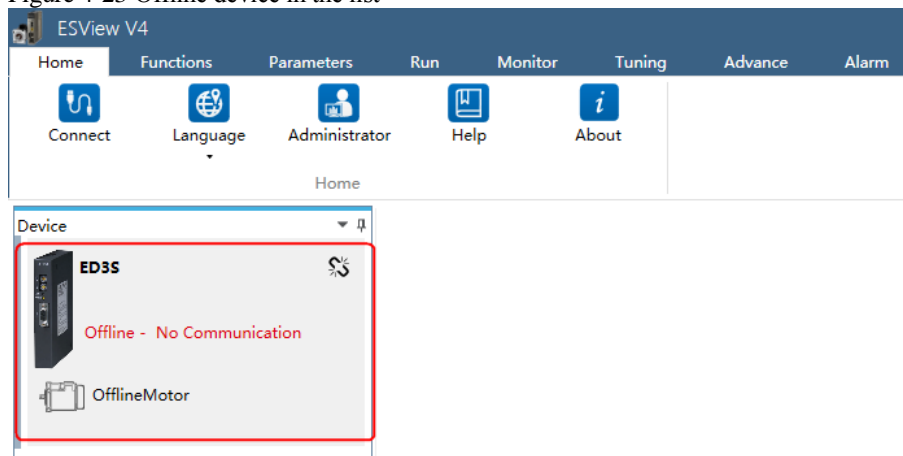
- Step 4 Select the desired **Device Type**, e.g. ED3S.


Figure 4-22 Select a device type



Step 5 The created device will be displayed in the **Device** list on the left of the *ESView V4* main windows.

Figure 4-23 Offline device in the list

**NOTE**

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

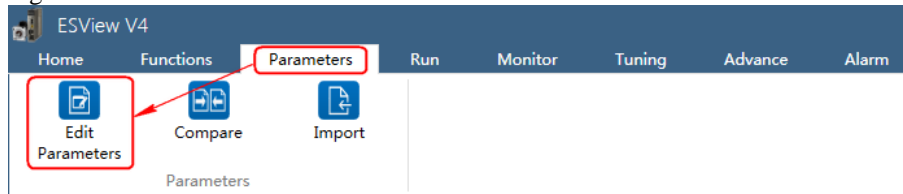
4.2.3 Edit Parameters

You can fulfill the following functions in **Edit Parameters** window.

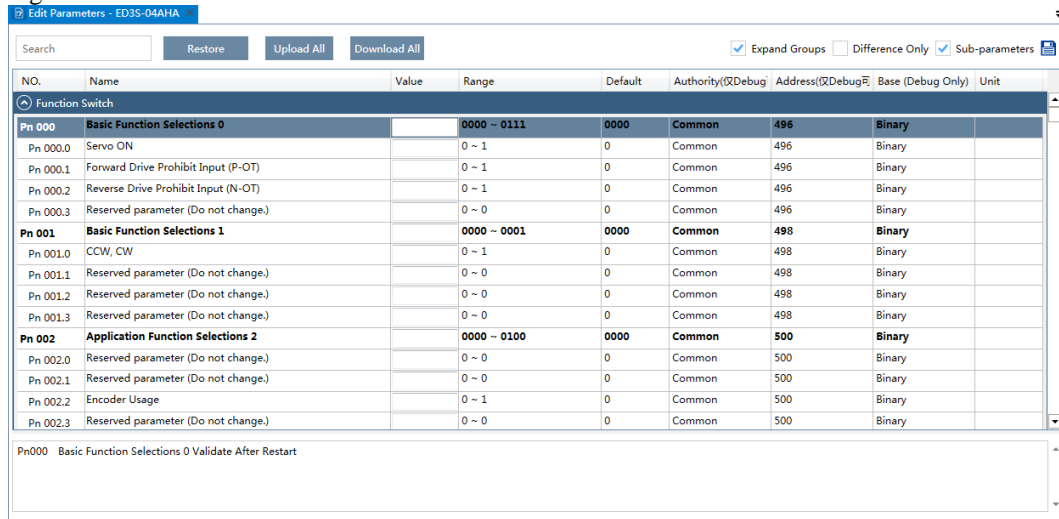
- Upload Parameters
- Modify Parameters
- Search Parameters
- Download Parameters
- Restore Parameters
- Save Parameters

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 4-24 Select **Edit Parameters**

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

Figure 4-25 **Edit Parameters** window

Upload Parameters

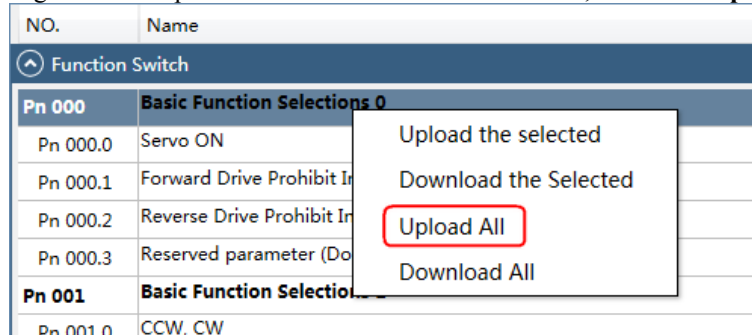
- Upload All

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

Upload the selected
Download the Selected
Upload All
Download All



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 4-26.

Figure 4-26 Display after editing parameters

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

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

Figure 4-27 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.

Search Parameters

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.

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

Figure 4-28 Search a desired parameter

Edit Parameters - ED3S-04AHA			
Encoder Pn001	Restore	Upload All	Download All
NO.	Name	Value	Range
Function Switch			
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 002.2	Encoder Usage	1	0 ~ 1
Gain			
Pn 162	Speed Feedback Selection	0	0 ~ 1
Position Loop			
Pn 200	Pulse Numbers for PG Frequency Division	16384	16 ~ 16384
Pn 210	2nd Encoder Functions 1	0000	0000 ~ 1111
Pn 210.0	2nd Encoder Selection	0	0 ~ 1
Pn 210.1	2nd Encoder Output Pulse Setting	0	0 ~ 1

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.

Search [] Restore Upload All **Download All** Range Check (Debug On)

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

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

Search [] Restore Upload All **Download All** Range Check (Debug On)

NO.	Name	Value
Function Switch		
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

Upload the selected
 Download the Selected
 Upload All
Download All

- 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.

Search [] Restore Upload All **Download All** Range Check (Debug On)

NO.	Name	Value
Function Switch		
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

Upload the selected
Download the Selected
 Upload All
 Download All



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.

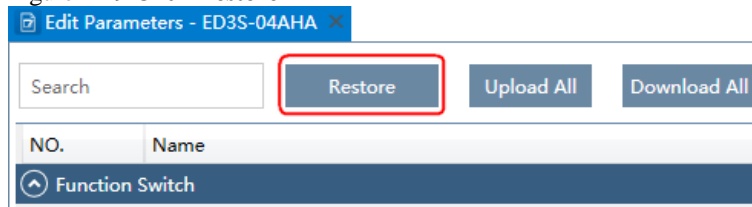
Restore Parameters



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

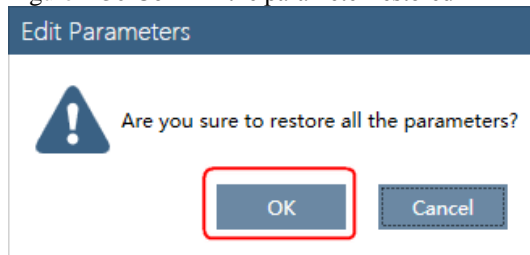
Step 1 Click **Restore** in the **Edit Parameters** window.

Figure 4-29 Click **Restore**



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

Figure 4-30 Confirm the parameter restored



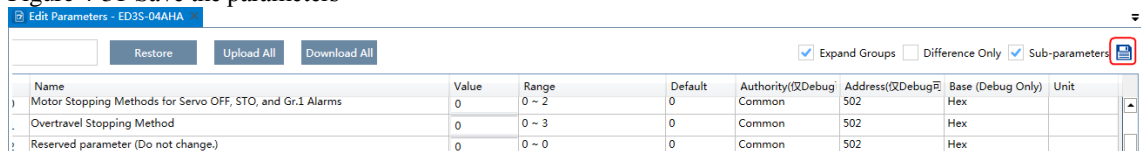
Step 3 *ESView V4* will send the **Restore Parameters** command to the Drive, and then the Drive will execute the **Restore Parameters**.

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 4-31 Save the parameters



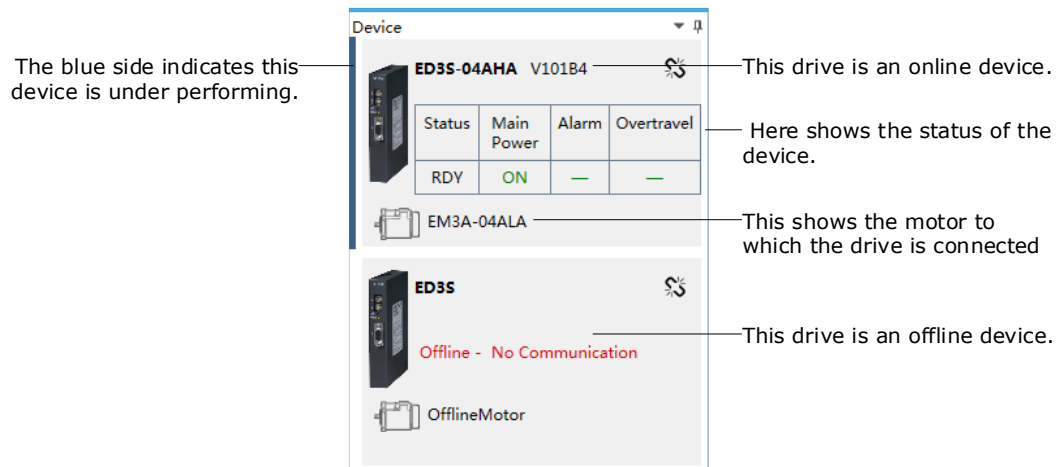
Step 2 Choose the desired files in the **Save As** dialog box.

Step 3 Click **Save**.

4.2.4 Monitor

Device Status

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

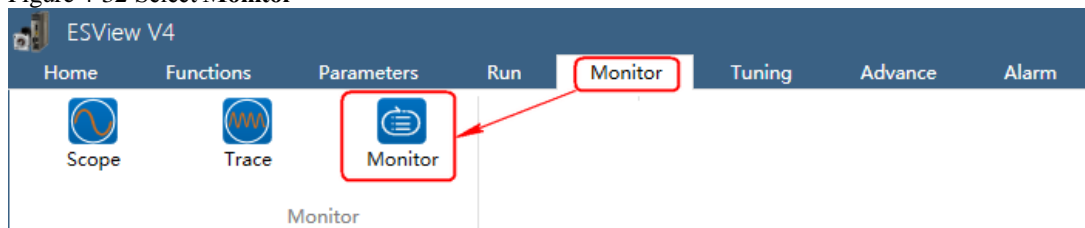


IO Monitor

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

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

Figure 4-32 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 4-33 Monitor List

Monitor - ED3S-04AHA

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	°C
Power Plate Temperature	33	°C
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

Chapter 5 EtherCAT Communications

5.1 Introduction

5.1.1 Protocol Overview

EtherCAT is an open network based on Ethernet to achieve real time control. It could support high speed and synchronized control. By using efficient network topology, the network structure with too many concentrator and complicated connections are avoided. It is very suitable to use this protocol in motion control and other factory automation applications.

EtherCAT is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

EtherCAT technology breaks the limits of normal internet solution. Through this technology, we don't need to receive Ethernet data, decode the data, and then copy the process data to different devices. EtherCAT slave device could read the data marked with this device's address information when the frame passes this device. As the same, some data will be written into the frame when it passes the device. In this way, data reading and data writing could be done within several nanoseconds.

EtherCAT uses standard Ethernet technology and support almost kinds of topologies, including the line type, tree type, star type and so on. Its physical layer could be 100 BASE-TXI twisted-pair wire, 100BASE-FX fiber or LVDS (low voltage differential signaling). It could also be done through switch or media converters or in order to achieve the combination of different Ethernet structure.

Relying on the ASICs for EtherCAT in the slave and DMA technology that reads network interface data, the processing of the protocol is done in the hardware. EtherCAT system could update the information for 1000 I/O within 30 μ s. It could exchange a frame as big as 1486 bytes within 300 μ s. This is almost like 12000 digital output or input. Controlling one servo with 100 8-byte I/O data only takes 100 μ s. Within this period, the system could update the actual positions and status presented by command value and control data. Distributed clock technology could make the cyclic synchronous error lower than 1 μ s.

5.1.2 Specification

The specifications for EtherCAT communication are as follows.

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, 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 (APRW, FPRW, BRW, and LRW commands are not supported.)

Item	Specifications
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.)
Distributed Clocks	Free-Run Mode and DC Mode (Can be switched), SM2 (SM2 event sync) Applicable DC cycles: 125 μ s to 8 ms in 125- μ s increments
Slave Information Interface	256 bytes (read-only)
CiA402 Drive Profile	<ul style="list-style-type: none"> • Homing Mode • Profile Position Mode • Profile Velocity Mode • Profile Torque Mode • Interpolated Position Mode • Cyclic Synchronous Position Mode • Cyclic Synchronous Velocity Mode • Cyclic Synchronous Torque Mode • Touch Probe Function • Torque Limit Function

5.2 Relevant Settings

If the EtherCAT network cannot communicate, check the settings of the parameters Pn006 and Pn704.

Parameter	Name	Setting	Meaning	When Enabled
Pn006.0	Bus Selection	0	Do not use the Bus. Select the control method by the setting of Pn005.1.	After restart
		1	Use EtherCAT. [Default]	

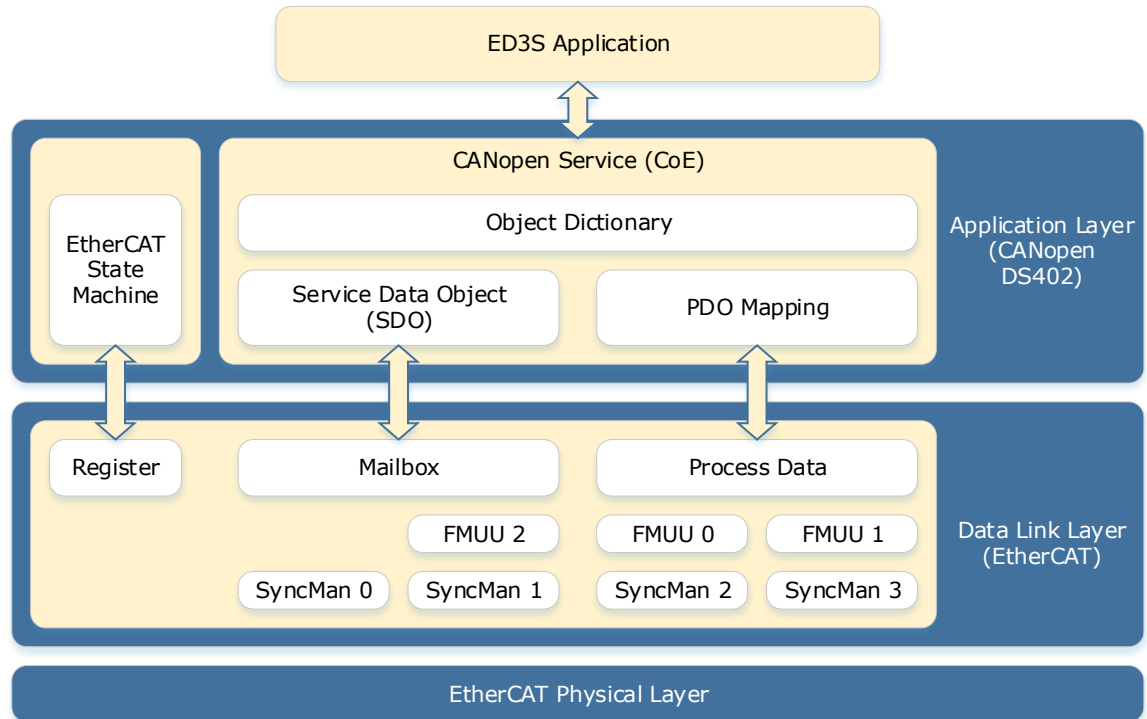
Parameter	Name	Range	Unit	Default	When Enabled
Pn704	Device Node Number	0 to 127	–	1	After restart

5.3 EtherCAT Basis

5.3.1 CANopen over EtherCAT Reference Model

CANopen over EtherCAT (CoE) reference model is as shown in Figure 5-1.

Figure 5-1 CoE Reference Model



The coe reference model mainly includes two parts: the Data Link Layer and the Application Layer. The Data Link Layer is mainly responsible for the EtherCAT communication protocol, and the Application Layer embeds the CANopen drive profile (DS402) communication protocol. The Object Dictionary in the Application Layer contains parameters, application data, and PDO mapping information.

The Process Data Object (PDO) consists of objects in the object dictionary that can be mapped to the PDO. The contents of the process data are defined by the PDO mapping. Process data communication cyclically reads/writes the PDO.

Mailbox communication (SDO) uses asynchronous message communications where all objects in the object dictionary can be read and written.

5.3.2 EtherCAT Slave Information

You can use EtherCAT slave information files (XML format) to configure the EtherCAT master.

The XML file contains the standard EtherCAT communications settings for the Drive. The following file is provided for the Drive:

*ESTUN_ED31_V***.xml*

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

5.3.3 EtherCAT State Machine

The EtherCAT state machine is used to manage the communications states between the master and slave applications when EtherCAT communications are started and during operation, as shown in Figure 5-2. Normally, the state changes for requests from the master.

Figure 5-2 EtherCAT state machine

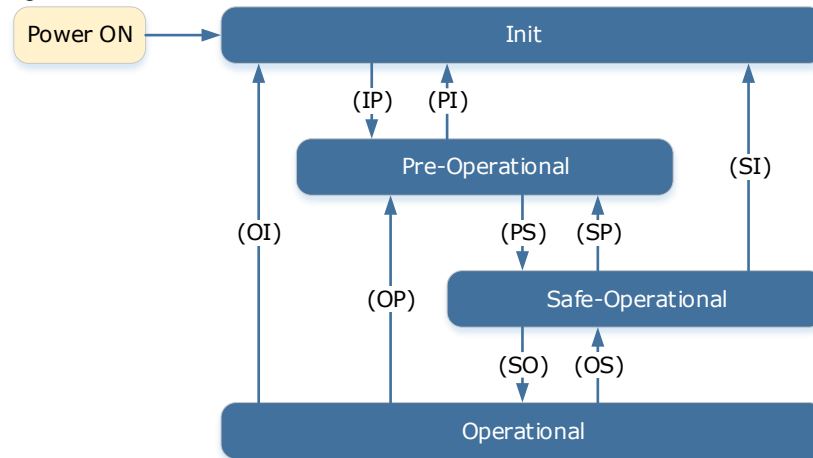


Table 5-1 lists the state transition and initialization process.

Table 5-1 Description of state or transition

State or Transition	Operation
Init (I)	<ul style="list-style-type: none"> Mailbox communications are not available. Process data communications are not available.
Init to Pre-Operational (IP)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> Mailbox communications are available. Process data communications are not available.
Pre-Operational to Safe-Operational (PS)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> The master sends available output data. The master requests the Operational state.
Operational (O)	Process data communications are available.

5.3.4 Process Data Object (PDO)

The ED3S provides 4 RxPDOs and 4 TxPDOs, all of which support dynamic mapping. The mapping objects are shown in Table 5-2.

Table 5-2 Process data mapping

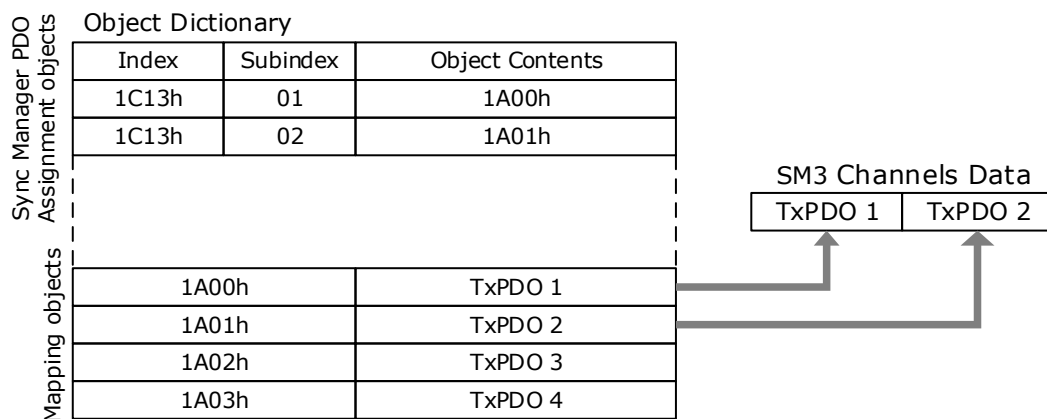
PDOs	Mapping Objects
RxPDO 1 to RxPDO 4	1600h to 1603h
TxPDO 1 to TxPDO 4	1A00h to 1A03h

NOTE: Each PDO Mapping can be assigned up to 8 objects, and the total assignment is not more than 32 bytes.

PDO Assignment

The Sync Manager Channels SM2 is responsible for receiving the data from RxPDO, and Sync Manager Channels SM3 is responsible for transmitting the data in TxPDO.

The Sync Manager PDO assignment objects (1C12h and 1C13h) establish the relationship between these PDOs and the Sync Managers. The following figure shows an example that how to set the relationship between SM3 and TxPDO through object 1C13h.

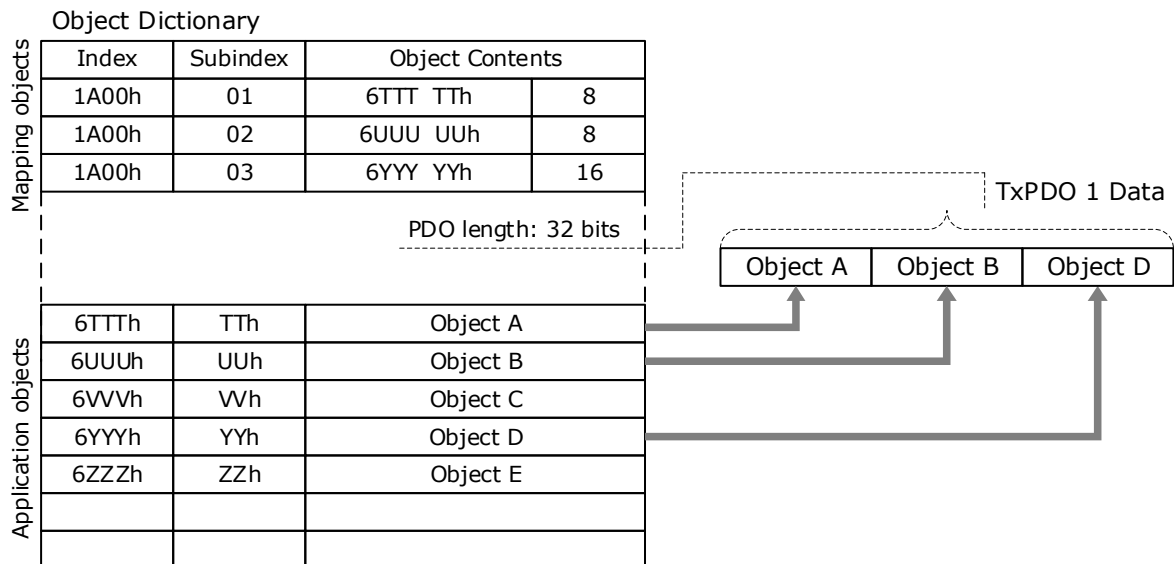


PDO Mapping

POD mappings are definitions of the applications objects that are sent with PDOs (RxPDOs and TxPDOs).

The PDO mapping tables are in indexes 1600h to 1603h and 1610h to 1613h for the RxPDOs (RxPDO 1 to RxPDO 4) and indexes 1A00h to 1A03h and 1A10h to 1A13h for the TxPDOs (TxPDO 1 to TxPDO 4) in the object dictionary.

Each PDO mapping object can be added up to 10 objects, and the total assignment is not more than 32 bytes. The following figure shows a mapping example of TxPDO 1. The mapping object is 1A00h.



Taking SM2 channel and RxPDO 1 as an example, the steps of PDO mapping are as follows:

1. Disable the assignment between the SM2 and RxPDO 1:
Set subindex 00h in object 1C12h to 0.
2. Disable the assignments of RxPDO 1:
Set subindex 00h in object 1600h to 0.
3. Set all of the mapping entries (index and subindex) for the RxPDO 1 mapping objects:
Write the mapping entity index and subindex values into the corresponding subindex of 1600h.
4. Set number of mapping entries for the RxPDO 1 mapping objects:
Write the number of mapping entries into the subindex 00h of 1600h.
5. Set the assignments between the SM2 and RxPDO 1:
Set subindex 01h in object 1C12h to 0x1600.
6. Enable the assignments between the Sync Manager and RxPDO 1:
Set subindex 00h in object 1C12h to 1.



NOTE

The PDO mapping objects (indexes 1600h to 1603h, 1A00h to 1A03h) and the Sync Manager PDO Assignment objects (index 1C12h and 1C13h) can be written only in Pre-Operation state.

Default PDO Mappings

The following table shows the default PDO mappings for the Drive. These initial settings are also defined in the EtherCAT slave information file (XML format).

Mode	PDO	Default
PV	RxPDO (1600h)	Controlword (6040h) Target Velocity (60FFh)
	TxPDO (1A00h)	Statusword (6041h) Velocity Actual Value (606Ch) Torque Actual Value (6077h)
PP	RxPDO (1601h)	Controlword (6040h) Target Position (607Ah)

Mode	PDO	Default
	TxPDO (1A01h)	Statusword (6041h) Position Actual Value (6064h) Torque Actual Value (6077h)
CSP	RxPDO (1602h)	Controlword (6040h) Target Position (607Ah) Touch Probe Function (60B8h)
	TxPDO (1A02h)	Statusword (6041h) Position Actual Value (6064h) Torque Actual Value (6077h) Following Error Actual Value (60F4h) Touch probe status (60B9h) Touch probe pos1 pos value (60BAh) Touch probe pos2 pos value (60BCh) Physical Inputs (60FDh)
HOME	RxPDO (1603h)	Controlword (6040h)
	TxPDO (1A03h)	Statusword (6041h)

5.3.5 Service Data Object (SDO)

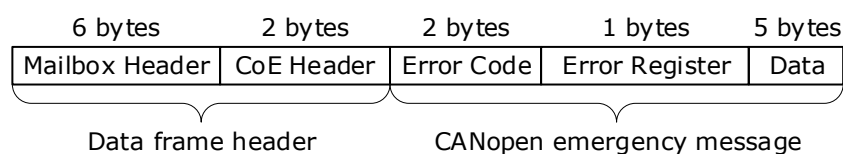
SDO is used to transfer non-cyclic data, such as communication parameter configuration, and Servo running parameter configuration. The CoE service type includes Emergency Message, SDO request and SDO response.

5.3.6 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.

An emergency message consists of eight bytes of data as shown in the following description.

Emergency Message Structure



Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Emergency error code		Error register (1001h)	Reserved	Alarm Number		Reserved	

NOTE: Byte4 and Byte5 are the alarm numbers of the Drive, and the alarm number is a hexadecimal value.

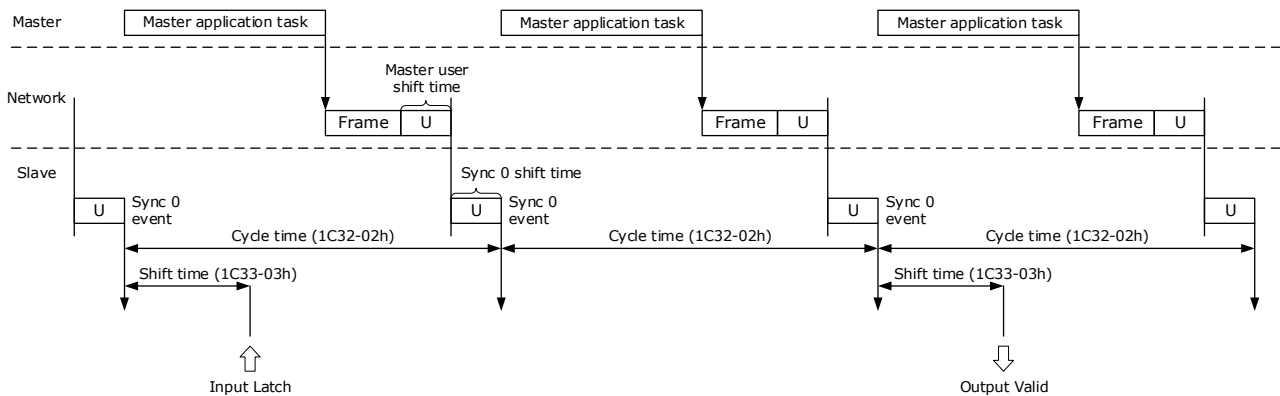
5.3.7 Distributed Clock (DC)

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.

You can use the following synchronization modes with EtherCAT (CoE). You can change the synchronization mode in the Sync Control registers (ESC registers 0x980 and 0x981).

- Free-Run (ESC register 0x981: 0x980 = 0x0000)
In Free-Run mode, the local cycle is independent from the communications cycle and master cycle.
- DC Mode (ESC register 0x981: 0x980 = 0x0300)
In this mode, the Drive is synchronized with the host controller (master) on the Sync0 event.

The following figure gives a timing chart for DC synchronization.

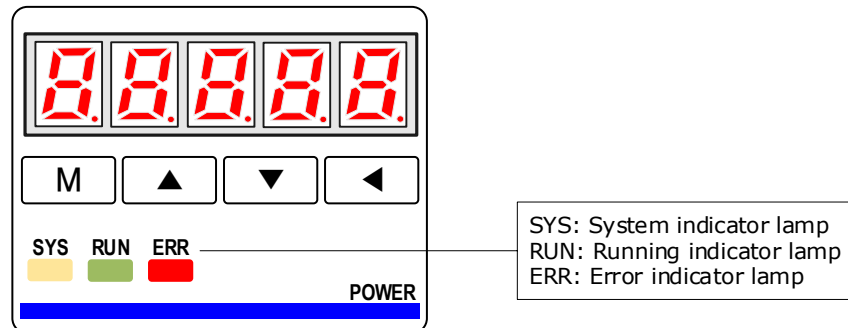


NOTE: Only the object 1C33-03h can be set.

5.4 Communication Indication

5.4.1 Indicator Lamps on Panel Operator

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



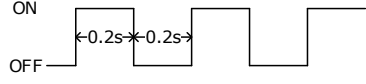
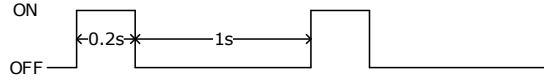
SYS Indicator

The SYS indicator shows the system status of EtherCAT communications.

Indicator		Description
Status	Pattern	
Off	Never lit	No power supplied or EtherCAT is resetting
Blinking		EtherCAT is booting
On	Always lit	Initialization is complete and EtherCAT is operating normally

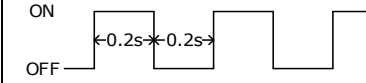
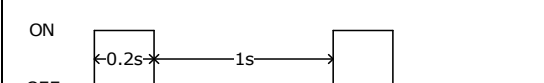
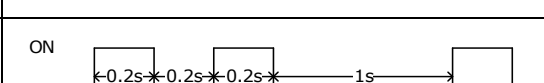
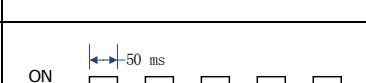
RUN Indicator

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

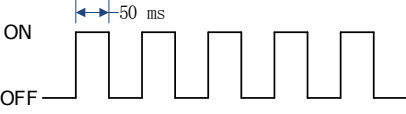
ERR Indicator

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.
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

5.4.2 Indicator Lamps on RJ45

The Link/Activity indicators show whether Communications Cables are connected to the CN3-IN and CN3-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

Chapter 6 CiA402 Drive Profile

6.1 Conversion Factor Setting

Gear Ratio (6093h)

The gear ratio indicates the Motor displacement (in encoder unit) corresponding to the driving shaft displacement of one reference unit.

The gear ratio is defined by the numerator (6091-01h) and denominator (6091-02h). It determines the relationship between the driving shaft displacement (in reference unit) and the Motor displacement (in encoder unit):

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

The Motor is connected with the load through the reduction wheel and other mechanical transmission mechanism. The gear ratio is calculated based on parameters such as the mechanical reduction ratio, mechanical size and Motor resolutions:

$$\text{Gear Ratio} = \frac{\text{Motor resolution}}{\text{Driving shaft resolution}}$$



IMPORTANT

This section uses the Motor encoder as an example.

The setting of 2nd encoder is the same as that of the Motor encoder.

Index	Name	Data Type	Access	PDO Mapping	Related Mode
6093	Gear Ratio	UINT32	RW	No	PP, HM, IP, CSP
<p>It sets the relationship between number of Motor shaft revolutions and number of driving shaft revolutions.</p> <p>For Motor encoders with different bit, the setting ranges of the gear ratio are as following:</p> <ul style="list-style-type: none"> • 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 <p>If the setting exceeds the above range, A07 (Electronic Gear Error) alarm will occur.</p> <p>The Motor position feedback (encoder unit) and driving shaft position feedback (reference unit) is in the following relationship:</p> <p style="text-align: center;">Motor position feedback = Driving shaft position feedback × Gear ratio</p>					

Subindex	Name	Data Type	Access	PDO Mapping	Related Mode
00	Highest subindex supported	UINT32	RW	No	PP, HM, IP, CSP

Subindex	Name	Data Type	Access	PDO Mapping	Related Mode
01	Numerator	UINT32	RW	No	
02	Denominator	UINT32	RW	No	

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

Setting Example

Take the load ball screw as an example: Minimum reference unit $f_c = 1 \text{ mm}$, Lead $p_B = 10 \text{ mm/r}$, Reduction ratio $n = 5:1$, 20-bit incremental encoder resolution $P = 1048576$;

The gear ratio is calculated as follows:

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

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



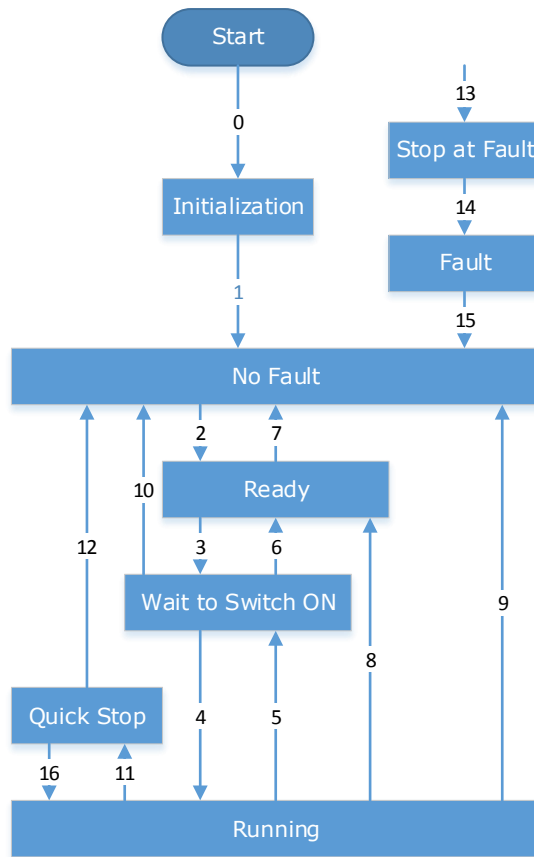
IMPORTANT

The ratio of 6093-01h and 6093-02h must be reduced to without common divisor.

6.2 Device Control

6.2.1 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 <i>Fault</i> , 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

6.2.2 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 <i>Profile Deceleration</i> (6084h) for decelerating to a stop and moves to the No Fault state
2	Decelerates according to <i>Quick Stop Deceleration</i> (6085h) for decelerating to a stop and moves to the No Fault state
5	Decelerates according to <i>Profile Deceleration</i> (6084h) for decelerating to a stop and stays at the QuickStop state
6	Decelerates according to <i>Quick Stop Deceleration</i> (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 <i>Profile Deceleration</i> (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 <i>Profile Deceleration</i> (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 <i>Profile Deceleration</i> (6084h) for decelerating to a stop
2	Decelerates according to <i>Quick Stop Deceleration</i> (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)

6.3 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	V1 (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

6.3.1 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	–
6	Homing Mode

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

6.3.2 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

6.3.3 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.

6.3.4 Communication Cycle

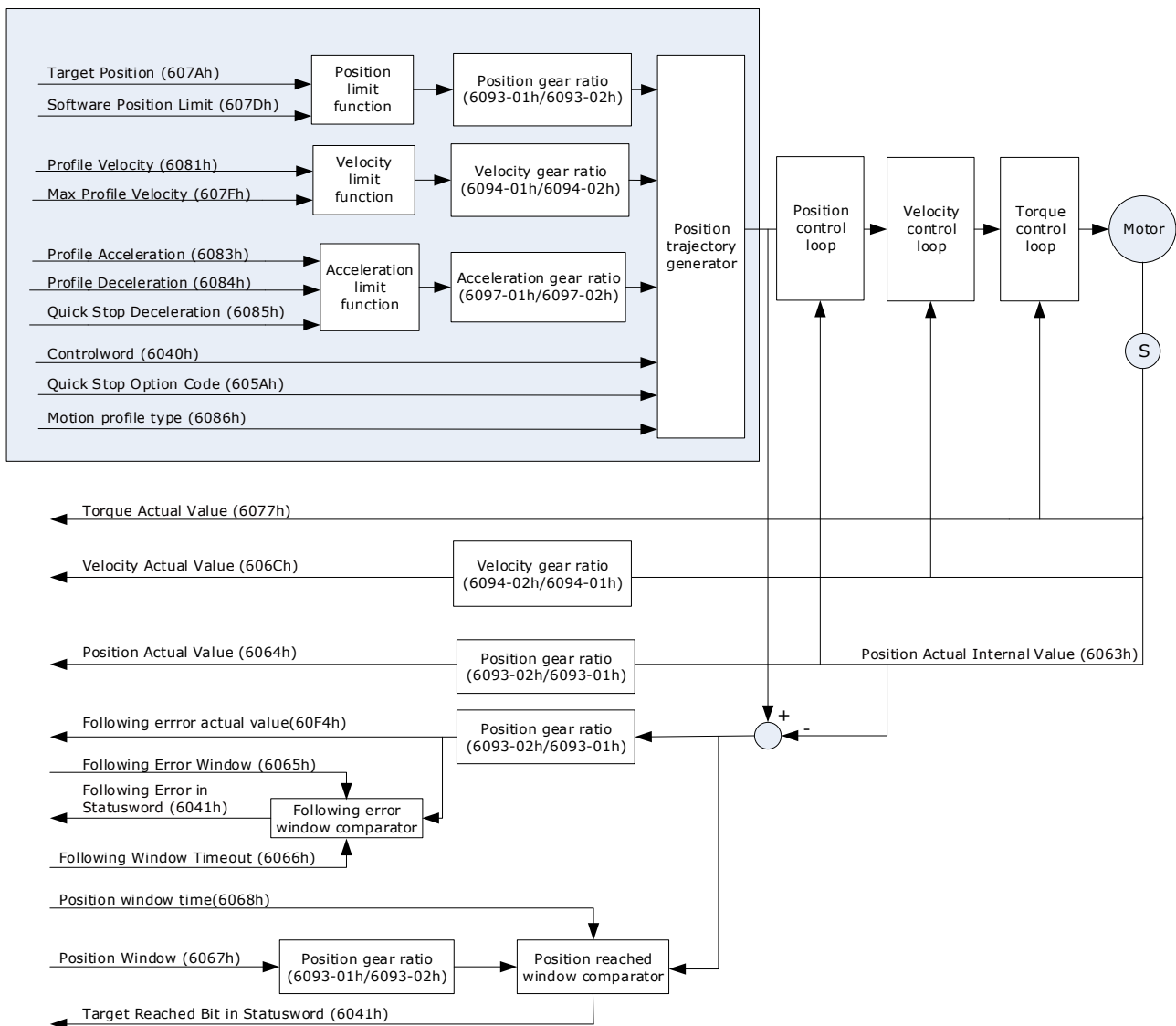
The communication Cycle Time of all Control Modes (PP, PV, PT, HM, IP, CSP, CSV, and CST) supports an integer multiple of 125μs (e.g. 125μs, 250μs, 500μs, 1ms, and so on).

6.4 Position Control

6.4.1 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

Object	Bit	Name	Value	Description
Controlword 6040h	0	Switch on	0	Disabled
			1	Enabled
	1	Enable voltage	0	Disabled
			1	Enabled
	2	Quick stop	0	Disabled
			1	Enabled
	3	Enable operation	0	Disabled
			1	Enabled
	4	New set-point	0 → 1	Starts positioning at the rising edge from 0 to 1 of the signals. In this timing, the values of 607Ah, 6081h, 6083h, and 6084h are obtained.
	5	Change set immediately	0	Starts the next positioning after the current positioning completes (target reached)
			1	Starts the next positioning immediately
Statusword 6041h	10	Target reached	0	<ul style="list-style-type: none"> • Halt (Bit 8 in Controlword) = 0: Target position not reached • Halt (Bit 8 in Controlword) = 1: Axis decelerates
			1	<ul style="list-style-type: none"> • 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
	13	Following error	0	No following error
			1	Following error
	15	Homeflag	0	Homing not completed
			1	Homing completed

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

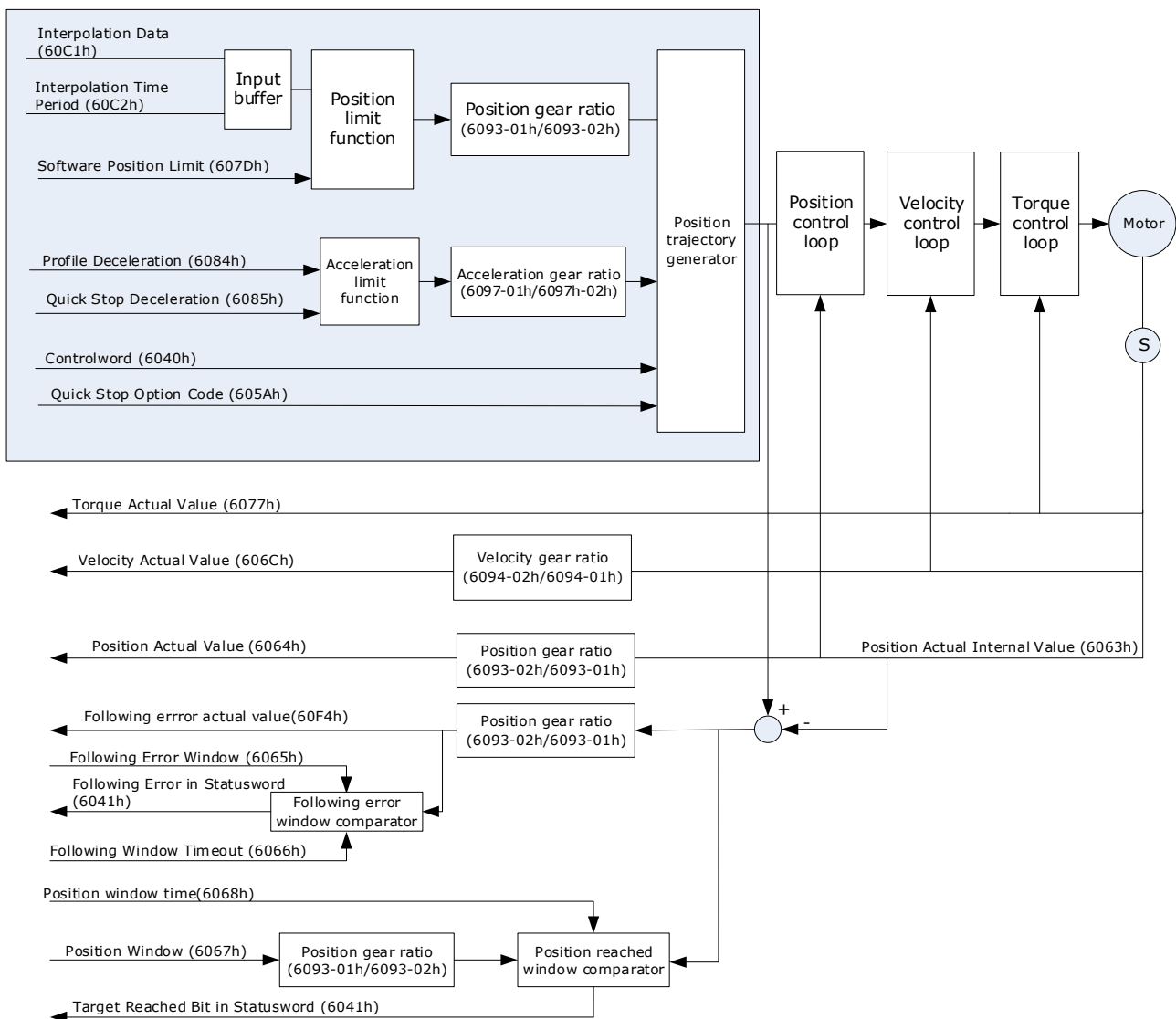
RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
607Ah: Target position	6064h: Position Actual Value	Mandatory
6081h: profile velocity	–	Mandatory
6083h: profile acceleration	–	Optional (cannot be 0)
6084h: profile deceleration	–	Optional (cannot be 0)
6060h: mode of operation	6061h: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

6.4.2 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	

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	Enable interpolation	0	Disables interpolation.
			1	Enables interpolation.
	8	Halt	0	Enables Bit4
			1	Stops the axis according to <i>Halt Option Code</i> (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	–

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
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
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

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
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

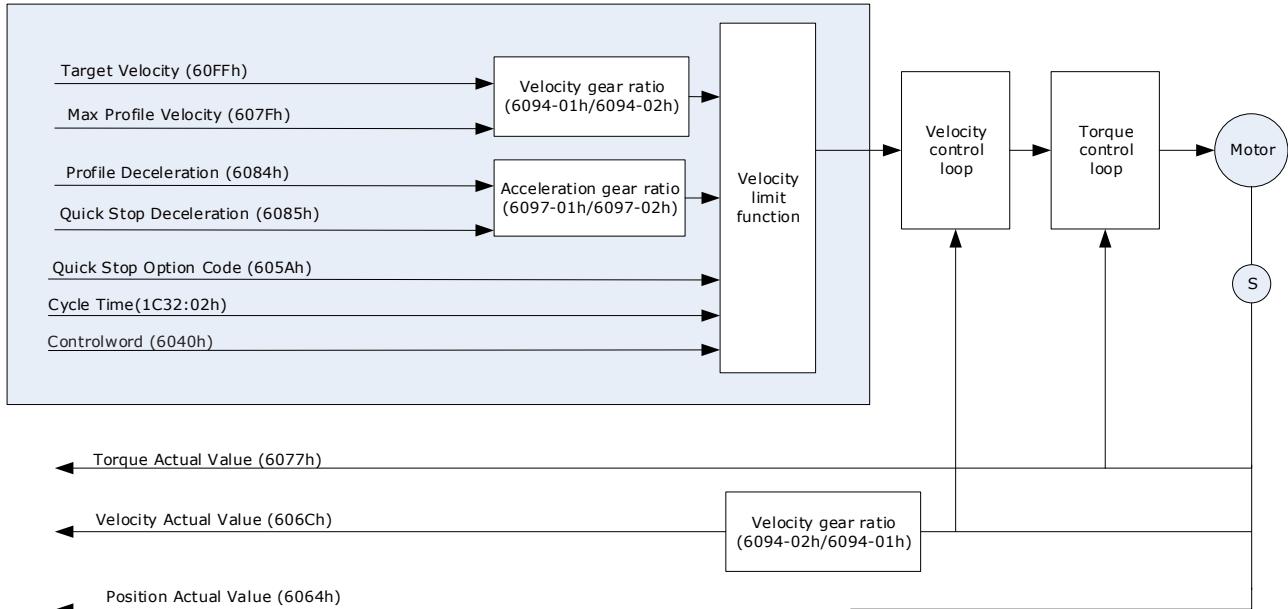
Recommended Configuration

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

6.4.3 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
			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 <i>Halt Option Code</i> (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)

Object	Bit	Name	Value	Description
	13	Following error	1	Drive follows the target value (position, velocity or torque)
			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
6093	01	numerator	RW	UINT32	–	0 to 4294967295	1

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
	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
	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

6.5 Homing

6.5.1 Homing (HM) Mode

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

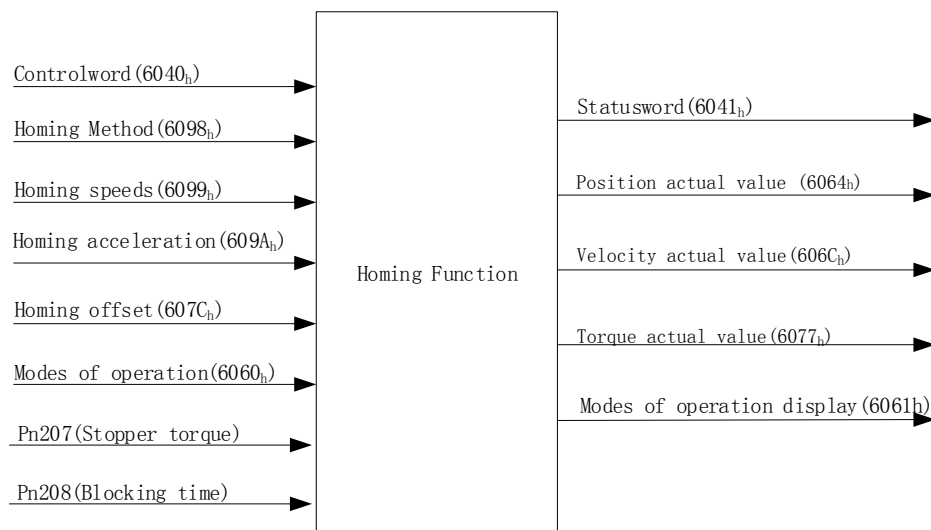
- Home: mechanical home reference point, that is, the Motor C-pulse.
- Zero: absolute zero point in the machine.

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 <i>Halt Option Code</i> (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	–

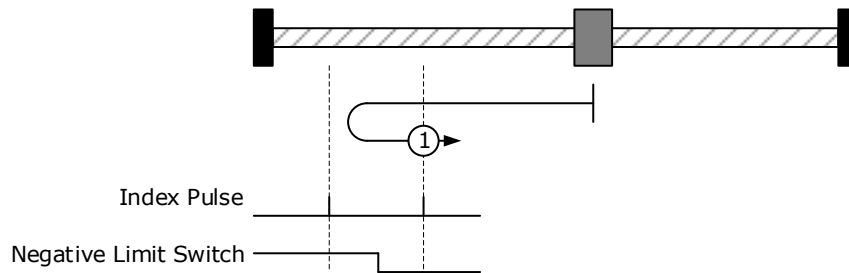
Recommended Configuration

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

6.5.2 Homing Methods

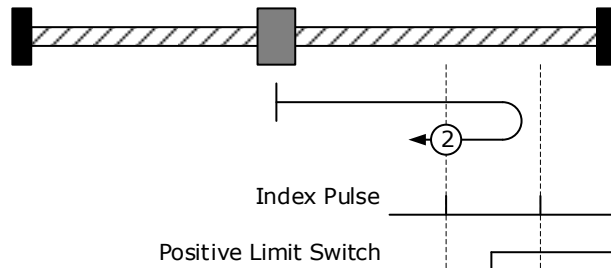
Method 1: Homing with the negative limit switch and index pulse

With this method, homing starts in the negative direction if the negative limit switch is inactive. The home position is the first index pulse that is detected after the negative limit switch becomes inactive.



Method 2: Homing with the positive limit switch and index pulse

With this method, homing starts in the positive direction if the positive limit switch is inactive. The home position is the first index pulse that is detected after the positive limit switch becomes inactive.

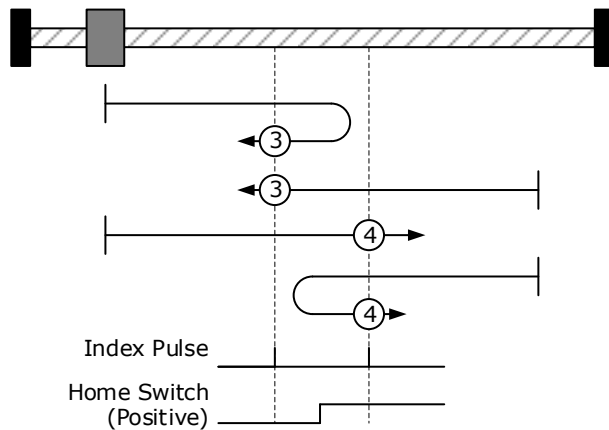


Methods 3 and 4: Homing with the home switch input signal (positive) and index pulse

With methods 3 and 4, homing starts in the positive direction. However, if the home switch input signal is already active when homing is started, the initial homing direction depends on the required edge.

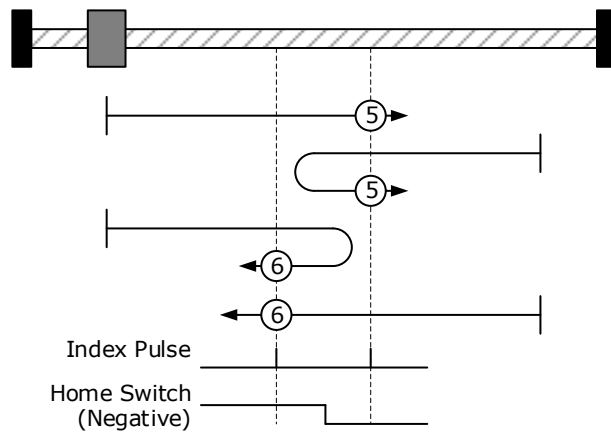
The home position will be the index pulse on either the rising or falling edge side of the home switch input signal.

If the initial movement direction is away from the home switch input signal, the motor will reverse direction when the home switch in the movement direction is input.



Methods 5 and 6: Homing with the home switch input signal (negative) and index pulse

These methods are similar to methods 3 and 4 except that homing starts in the negative direction.

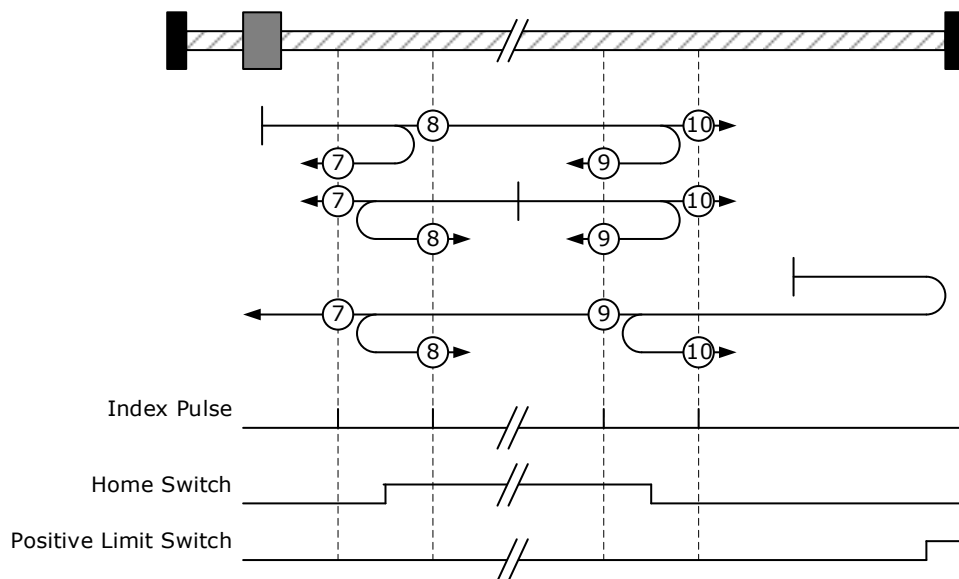


Methods 7 to 10: Homing with the home switch input signal and index pulse and starting in the positive direction

With methods 7 to 10, homing starts in the positive direction. However, if the home switch input signal is already active when homing is started, the initial homing direction depends on the required edge.

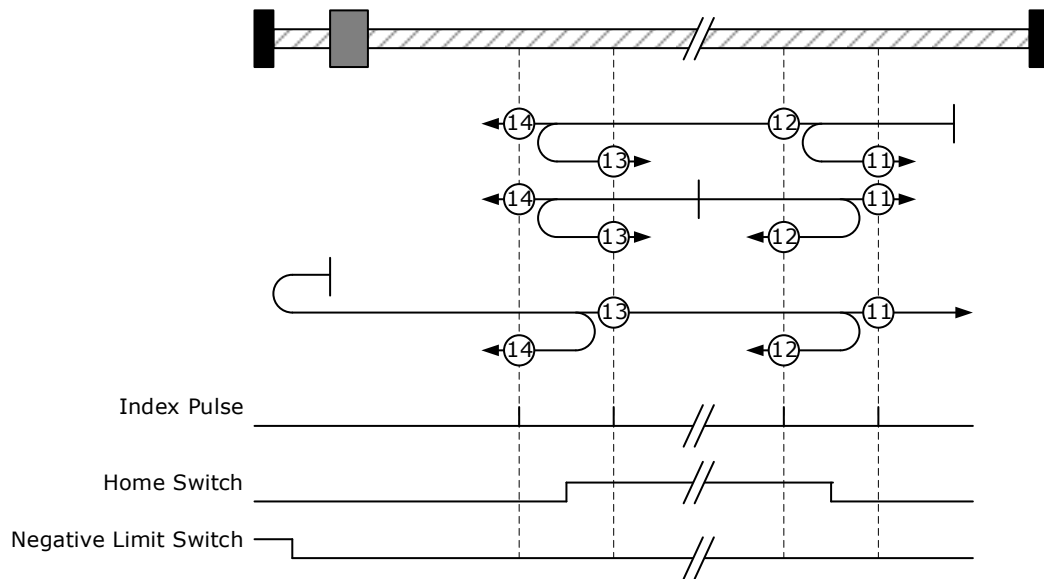
The home position will be the index pulse on either the rising or falling edge side of the home switch input signal.

If the initial movement direction is away from the home switch input signal, the motor will reverse direction when the limit switch in the movement direction is input.



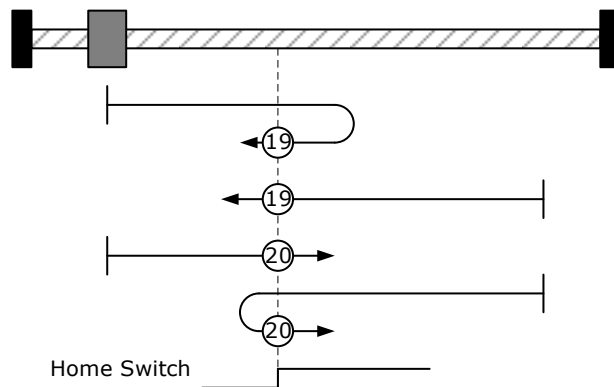
Methods 11 to 14: Homing with the home switch input signal and index pulse and starting in the negative direction

These methods are similar to methods 7 to 10 except that homing starts in the negative direction.



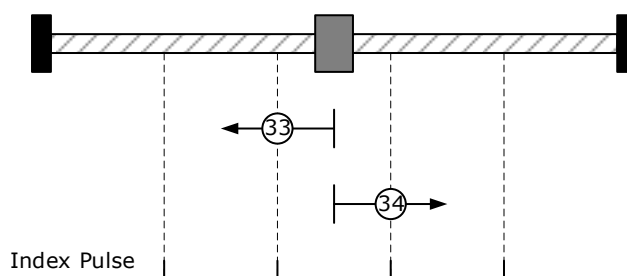
Methods 17 to 30: Homing without the index pulse

These methods are similar to methods 1 to 14, however, without the index pulse, the home position will be the home switch or limit switch on either the rising or falling edge side of input signal. As an example, the following shows the methods 19 and 20, which is similar to methods 3 and 4, but without index pulse.



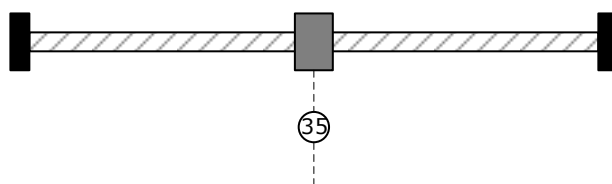
Methods 33 and 34: Homing with the index pulse

With the method 33, homing starts in the negative direction, and the home position is the first index pulse that is detected. With the method 34, homing starts in the positive direction, and the home position is the first index pulse that is detected.



Method 35: Homing with the current position

With this method, the current position is defined as the home position.

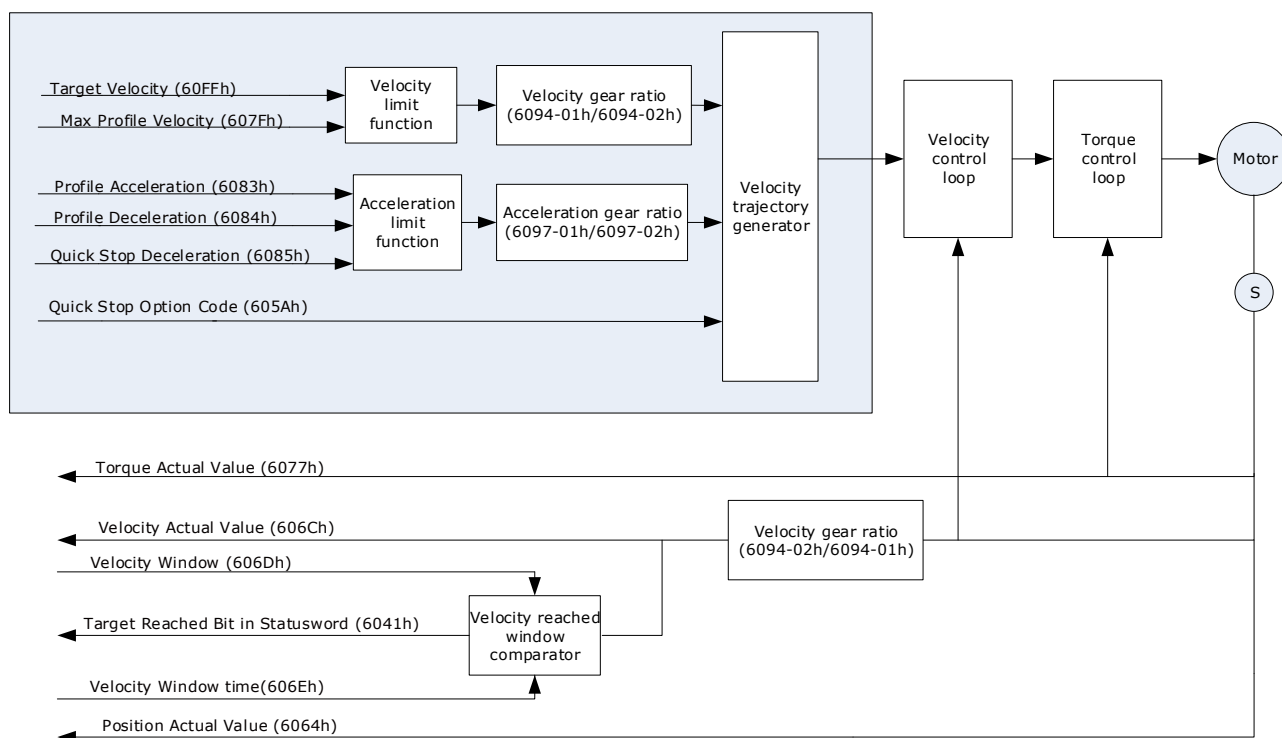


6.6 Velocity Control

6.6.1 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	

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
	8	Halt	0	Executes or continues operation.
			1	Stops the axis according to <i>Halt Option Code</i> (605Dh)
Statusword 6041h	10	Target reached	0	<ul style="list-style-type: none"> • Halt (Bit 8 in Controlword) = 0: Target position not reached • Halt (Bit 8 in Controlword) = 1: Axis decelerates
			1	<ul style="list-style-type: none"> • 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

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
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
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

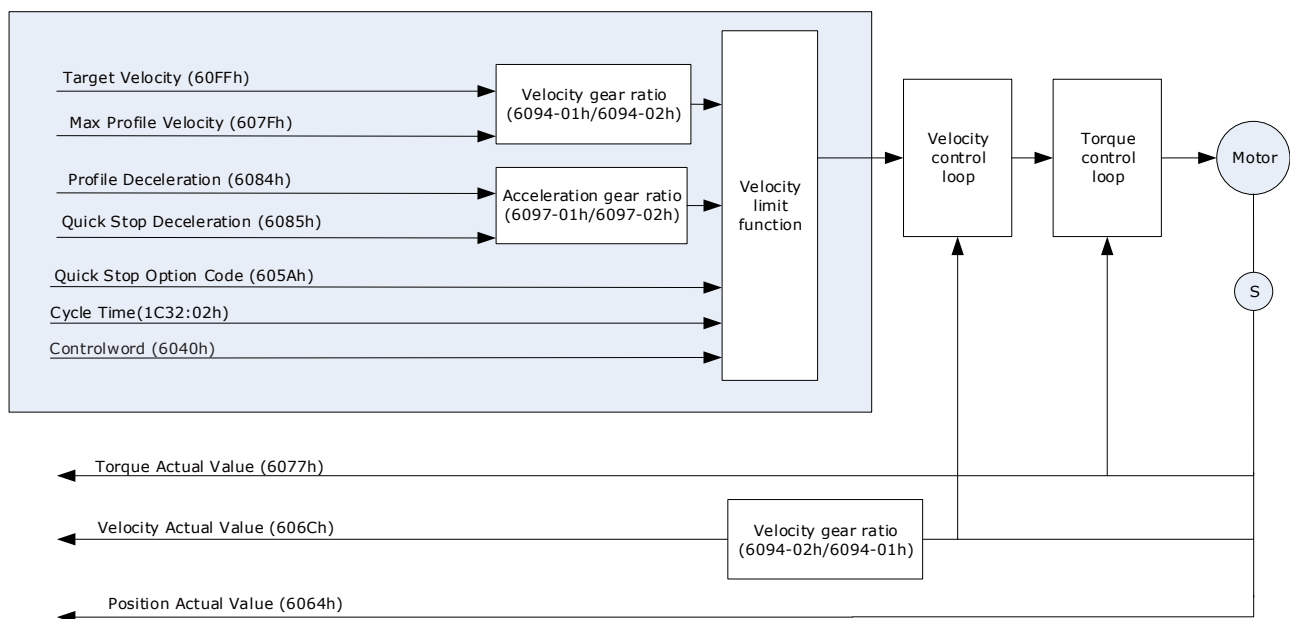
RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
60FF: Target Velocity	–	Mandatory
–	6064h: Position Actual Value	Optional
–	606Ch: Velocity Actual value	Optional
6083h: Profile Acceleration	–	Optional

RPDO	TPDO	Remarks
6084h: Profile Deceleration	–	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

6.6.2 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
			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.

If Bit0 to Bit3 are all 1, the Drive starts running.

Object	Bit	Name	Value	Description
			1	Stops the axis according to <i>Halt Option Code</i> (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	Homing flag	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

Index	Subindex	Name	Access	Data Type	Unit	Range	Default
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
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

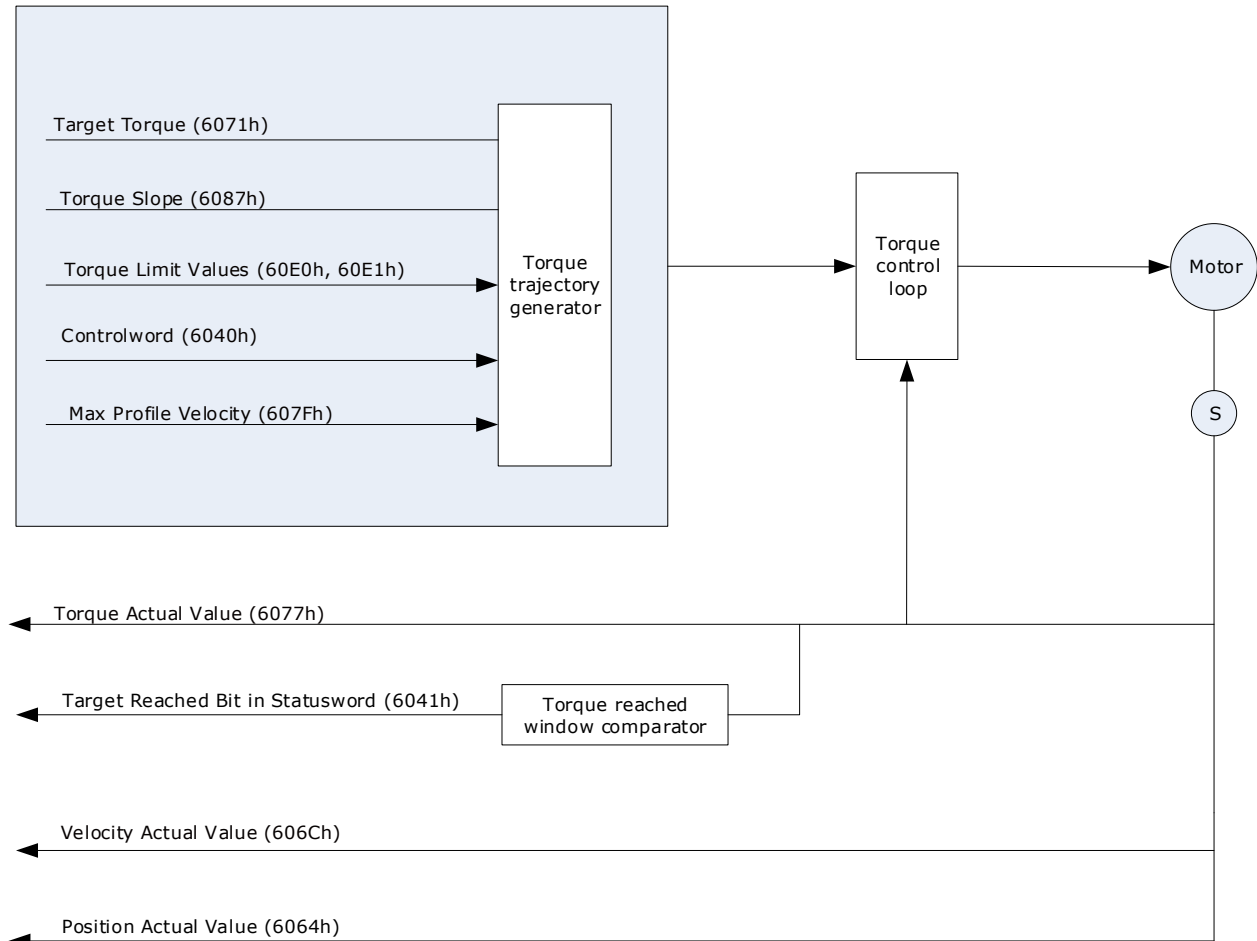
RPDO	TPDO	Remarks
6040h: Controlword	6041h: Statusword	Mandatory
60FFh: Target Velocity	–	Mandatory
–	6064h: Position Actual Value	Optional
–	606Ch: Velocity Actual value	Optional
6060h: Modes of operation	6061h: Modes of Operation display	Optional

6.7 Torque Control

6.7.1 Profile Torque (PT) Mode

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
			1	Enabled
	1	Enable voltage	0	Disabled
			1	Enabled
	2	Quick	0	Disabled

If Bit0 to Bit3 are all 1, the Drive starts running.

Object	Bit	Name	Value	Description
	3	stop	1	Enabled
		Enable operation	0	Disabled
			1	Enabled
	8	Halt	0	Executes or continues operation.
			1	Stops the axis according to <i>Halt Option Code</i> (605Dh)
Statusword 6041h	10	Target reached	0	<ul style="list-style-type: none"> • Halt (Bit 8 in Controlword) = 0: Target position not reached • Halt (Bit 8 in Controlword) = 1: Axis decelerates
			1	<ul style="list-style-type: none"> • 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

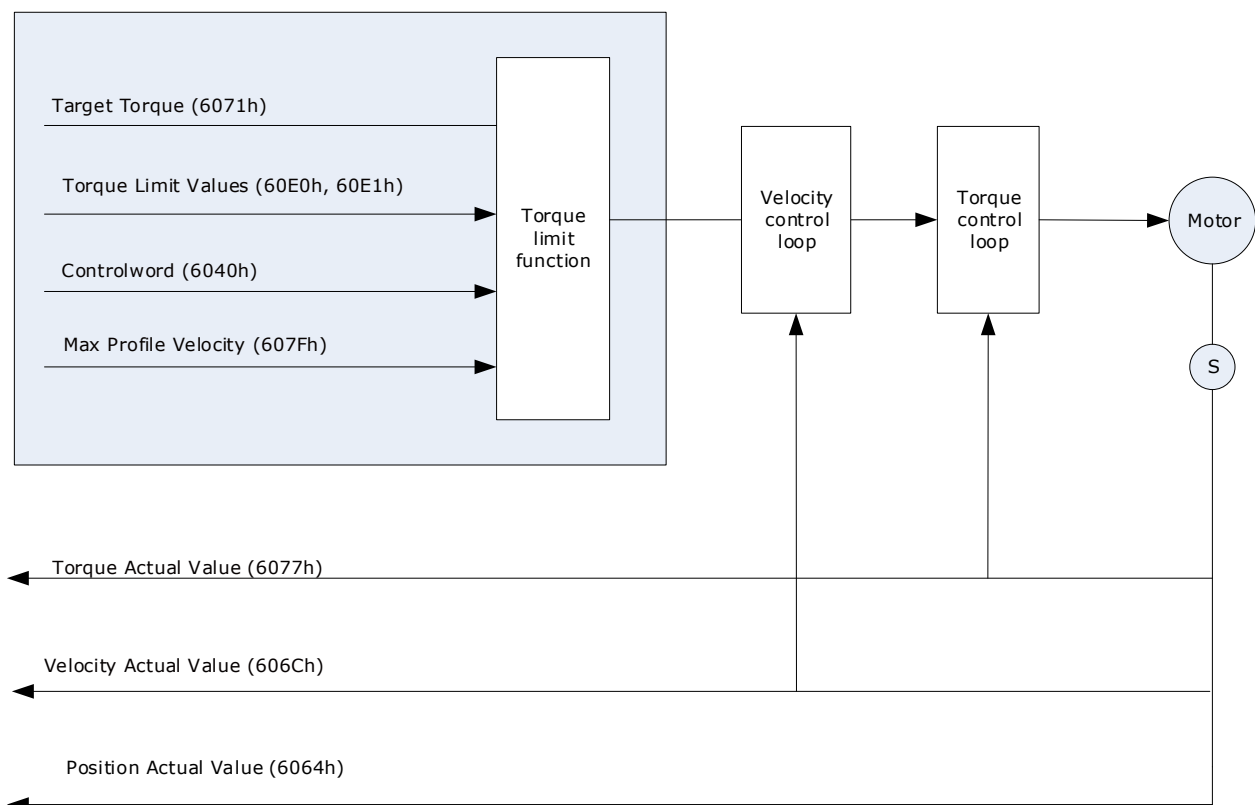
Recommended Configuration

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

6.7.2 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
			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 <i>Halt Option Code</i> (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

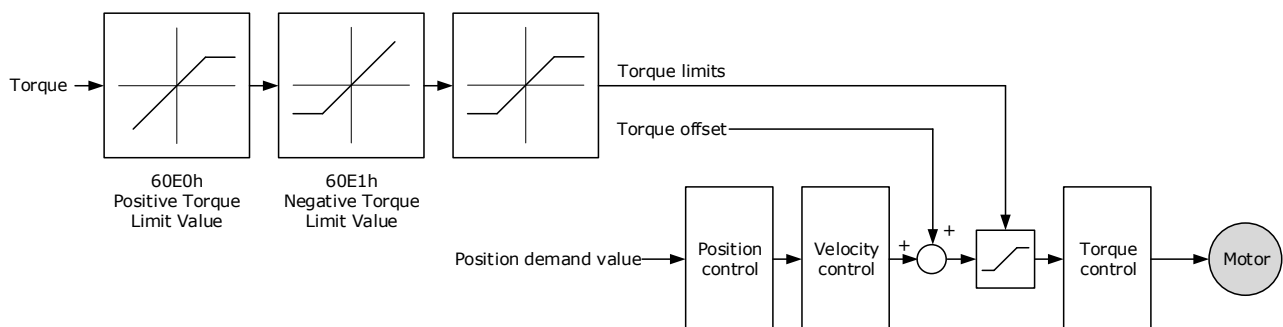
Index	Subindex	Name	Access	Data Type	Unit	Range	Default
60E0	00	Positive Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
60E1	00	Negative Torque Limit Value	RW	UINT16	0.1%	0 to 65535	–
31CD	00	Torque Command Filter Time	RW	INT32	0.01ms	0 to 2500	50
31CA	00	Speed Loop Gain	RW	INT32	rad/s	1 to 10000	500
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

6.8 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

6.9 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
	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	CN1-6, -7	Remote0
25	CN1-8, -9	Remote1
26	CN1-10, -11	Remote2
27	CN1-12, -13	Remote3
28 to 31	–	Reserved

6.10 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.

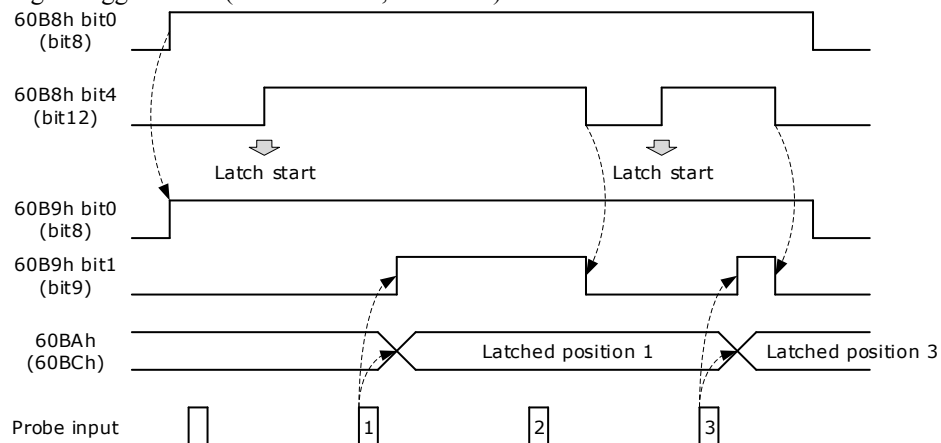
- Touch Probe Input 1
 - Latch control object: 60B8h (bits 0 to 7)
 - Latch status object: 60B9h (bits 0 to 7)
 - The latched position is always stored in touch probe 1 position value (60BAh and 60BBh).
 - Trigger signal: Encoder zero signal or EXT1 signal
- Touch Probe Input 2
 - Latch control object: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

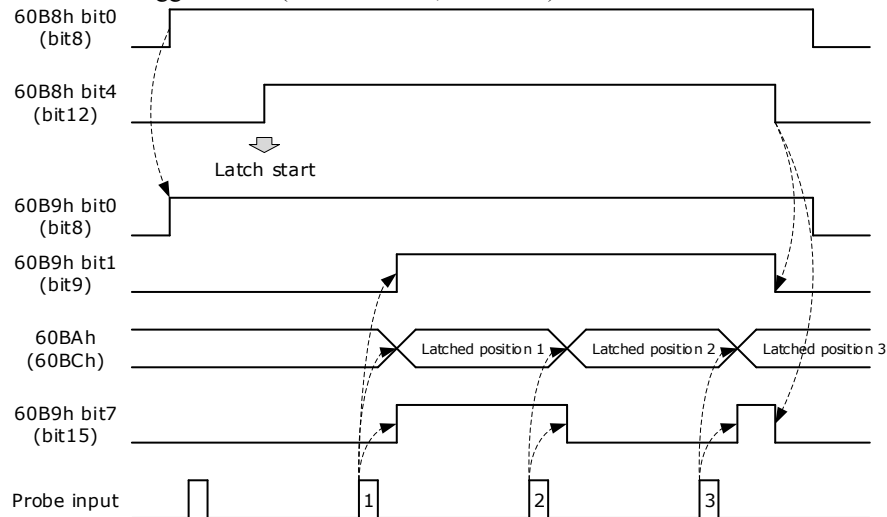
Index	Subindex	Name	Access	Data Type	PDO Mapping	Default
60B8	00	Touch Probe Function	RW	UINT16	Yes	–
60B9	00	Touch Probe Status	RO	UINT16	Yes	–
60BA	00	Touch Probe Pos 1 Pos Value	RO	INT32	Yes	–
60BB	00	Touch Probe Neg 1 Pos Value	RO	INT32	Yes	–
60BC	00	Touch Probe Pos 2 Pos Value	RO	INT32	Yes	–
60BD	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).

Bit	Value	Definition
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	–	–	–

Pn331, Pn332

You can allocate the touch probe functions by Pn331, and set Touch Probe Digital Input Filtering Time by Pn332. The relevant parameters are as following:

NO.	Name	Range	Unit	Default	When Enabled
Pn331.0	Touch Probe 1 signal Allocated Pin Number	0 to 2	–	0	After restart
Pn331.1	Touch probe 2 Signal Allocated Pin Number	0 to 2	–	1	
Pn332	Touch Probe Digital Input Filtering Time	0 to 1000	10 ns	0	Immediately

6.11 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	–

Chapter 7 Application Functions

7.1 Power Supply

The main circuit and control circuit of the Drive can be operated with AC or DC 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. NOTE: for the Drives of ED3S-15A* and ED3S-30A*, this setting is unavailable.	After restart
	1 [Default]	Use a three-phase AC power supply.	
	2	Use a DC power supply.	
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.



- Connect to the specified terminal for power supply:
In the case of an AC power supply, connects it to the L1, L2, L3 terminals and L1C, L2C terminals.
In the case of a DC power supply, connects P2 terminal to the positive pole, and connects N terminal to negative pole.
- Be sure to set Pn007.1=2 before using a DC power supply, in case damaging the internal components of the Drive.
- Set the fuse on the power supply wiring when using a DC power supply.
- Since the Drive does not perform regenerative processing when using the DC power input, perform regenerative energy processing on the power supply side.

7.2 Motor Rotation Direction

Only the rotation direction of the Motor can be switched without changing the reference pulse to the
The standard setting for Forward Rotation is counterclockwise (CCW) as viewed from the drive end.

Parameter	Setting	Reference	Diagram
Pn001.0	0: CCW=Forward	Forward Reference	
		Reverse Reference	
	1: CW=Reverse	Forward Reference	
		Reverse Reference	

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

7.3 Overtravel Limit

7.3.1 Function Description

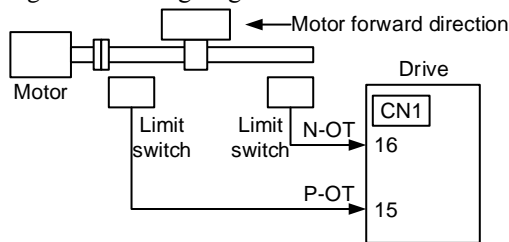
Overtravel is a safety function of the DRIVE that forces the Motor to stop in response to a signal input from a limit switch that is activated when a moving part of the machine exceeds the safe range of movement.

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 7-1.

Figure 7-1 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.



- 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.

7.3.2 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.

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

7.4 Motor Stop Methods

There are four methods to stop the Motor when an alarm (Gr.1 or Gr.2) occurs, in Safe state, or Servo OFF.

Stop method	Meaning
Stop by dynamic brake	The electric circuits are internally connected to stop the Motor quickly.
Coast 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, regard as a warning	Regards Alarms as the Warnings, and the motor will not be stopped.

There are four ways of states after the Motor is stopped:

Motor after Stopping	Meaning
Coast	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.

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

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

Parameter	Setting	Stop Method	After Stopping	When Enabled
Pn003.0	0 [Default]	Stop by dynamic brake	Coast	After restart

Parameter	Setting	Stop Method	After Stopping	When Enabled
	1	Stop by dynamic brake	Dynamic Brake	
	2	Coast to a stop	Coast	

7.4.2 Motor Stop Methods for Overtravel

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

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

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).

7.4.3 Motor Stop Methods for Gr.2 Alarms

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

Parameter	Setting	Stop Method	After Stopping	When Enabled
Pn004.0	0 [Default]	Stop by dynamic brake	Coast	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.

7.4.4 Reverse Brake Torque Limit Setting

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

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

**NOTE**

- This setting is a percentage of the rated torque (i.e., the rated torque is 100%).
- The default setting is 800%. This setting is large enough to allow you to operate the Motor at the maximum torque. However, the maximum emergency stop torque that you can actually use is the maximum torque of the Motor.

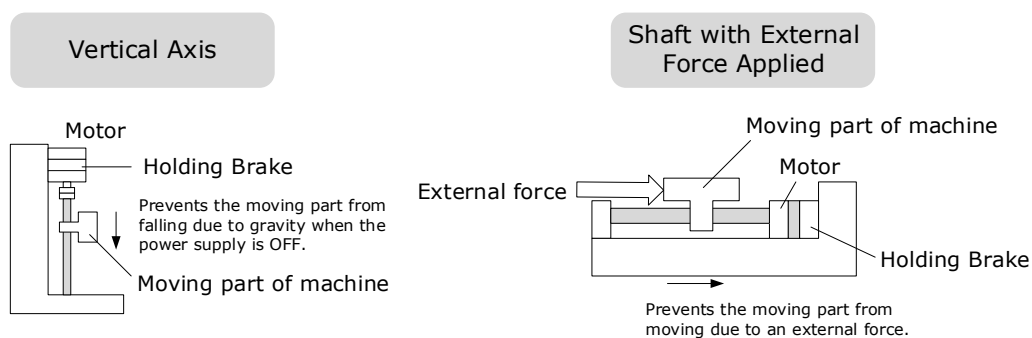
7.5 Holding Brake

7.5.1 Function Description

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

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

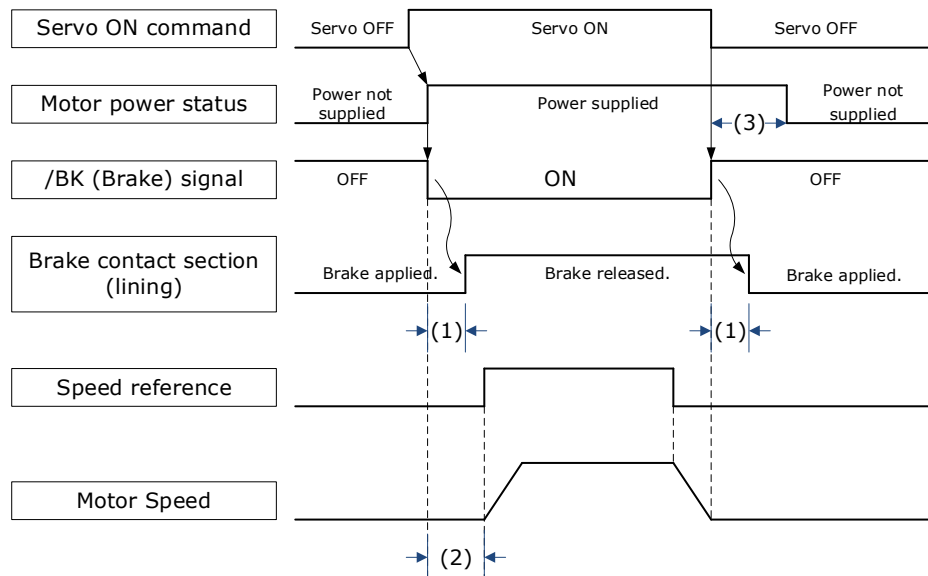
The holding brake is used in the following cases.

**IMPORTANT**

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

7.5.2 Brake Operating Sequence

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



(1): The brake delay times for Motors with Holding Brakes.

(2): Before you output a reference from the host controller to the DRIVE, wait for at least 50 ms plus the time required to release the brake after you send the S-ON command.

(3): Use Pn506 (Servo OFF Waiting Time), Pn507 (Brake Enable Speed Threshold), and Pn508 (Brake Enable Waiting Time) to set the timing of when the brake will operate and when the servo will be turned OFF.



- 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.

7.5.3 /BK (Brake) Signal

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

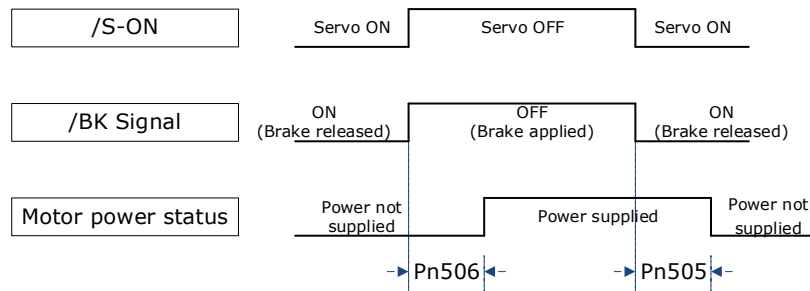
Type	Signal	Pin	Signal Status	Meaning
Output	/BK	Allocated by Pn511	ON	Releases the brake.
			OFF	Activates the brake.

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

Parameter	Setting	+ Pin	- Pin	Meaning
Pn511.0	4	CN1-11	CN1-12	The /BK signal is output from CN1-11 and CN1-12.
Pn511.1	4	CN1-5	CN1-6	The /BK signal is output from CN1-5 and CN1-6.
Pn511.2	4	CN1-9	CN1-10	The /BK signal is output from CN1-9 and CN1-10.

7.5.4 Output Timing of /BK Signal when Motor is Stopped

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



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

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.

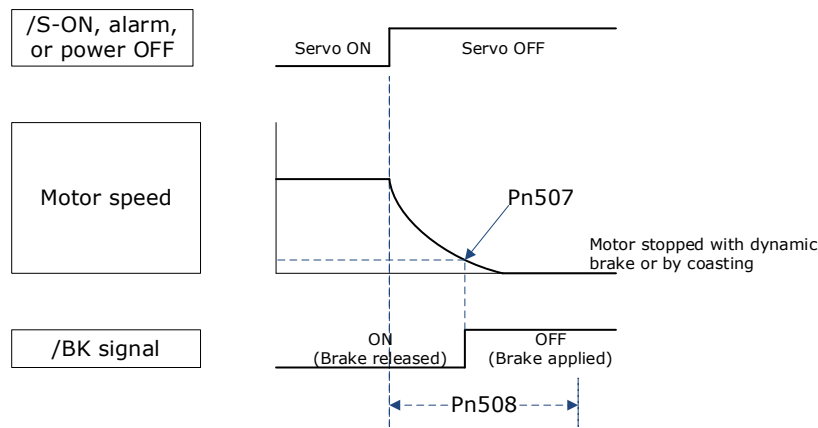


IMPORTANT

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.

7.5.5 Output Timing of /BK Signal when Motor is operating

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



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

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

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

7.6 Overload Enhancement

Overload Enhancement 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.

Set Pn003.3=1 for enabling this function, and it takes effect when the Motor speed is over 30 rpm.

Parameter	Setting	Meaning	When Enabled
Pn003.3	0	The overload enhancement function is disabled.	After restart
	1	The overload enhancement function is enabled.	

NOTE: This function is not applicable to EM3A series Motors.

7.7 Encoder Setting

7.7.1 Absolute Encoder Selection

The absolute encoder records the current position of the stop position even when the power supply is OFF.

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.

7.7.2 Encoder Alarm Resetting

It is necessary to connect a battery case for the absolute encoder, refers to the section **Battery Case Connection** in **3.5 Wiring the Encoder**.

A48 Alarm Occurred

When the voltage of the encoder battery is lower than 3V, an alarm A48 will occur. In this case, follow the below methods to troubleshooting.

- Turn ON only the control power supply to the Drive, and then, replace the battery case. Please contact ESTUN or the Authorized Distributor to purchase a new battery box if necessary.
- Perform the Fn011 on Panel Operator, refers to the section **Fn011 (Absolute encoder alarm reset)**.
- Repower up the Drive, and the alarm A48 no longer occurs indicating the fault has been solved.

A47 Alarm Occurred

When the voltage of the encoder battery is lower than 2.45V, an alarm A47 will occur. In this case, the multi-turn data in the encoder has been lost, and you shall follow the below methods to troubleshooting.

- Turn ON only the control power supply to the Drive, and then, replace the battery case. Please contact ESTUN or the Authorized Distributor to purchase a new battery box if necessary.
- Perform the Fn011 on Panel Operator, refers to the section **Fn011 (Absolute encoder alarm reset)**.
- Perform the Fn010 on Panel Operator, refers to the section **Fn010 (Absolute encoder multi-turn reset)**.
- Repower up the Drive, and the alarm A48 or A47 no longer occurs indicating the fault has been solved.

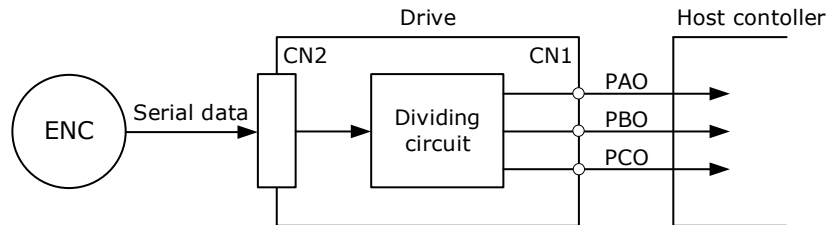
7.7.3 Encoder Divided Pulse Output

Encoder Divided Pulse Output Signals

The encoder divided pulse output is a signal that is output from the encoder and processed inside the DRIVE. It is then output externally in the form of two phase pulse signals (phases A and B) with a 90° phase differential. At the host controller, it is used as the position feedback.

Signal	Pin	Name	Remarks
PAO+	CN1-21	Encoder Divided Pulse Output, Phase A	These encoder divided pulse output pins output the number of pulses per motor resolution that is set in Pn200 (Pulse Numbers for PG Frequency Division). The phase difference between phase A and phase B is an electric angle of 90 °.
PAO-	CN1-22		
PBO+	CN1-23	Encoder Divided Pulse Output, Phase B	
PBO-	CN1-24		

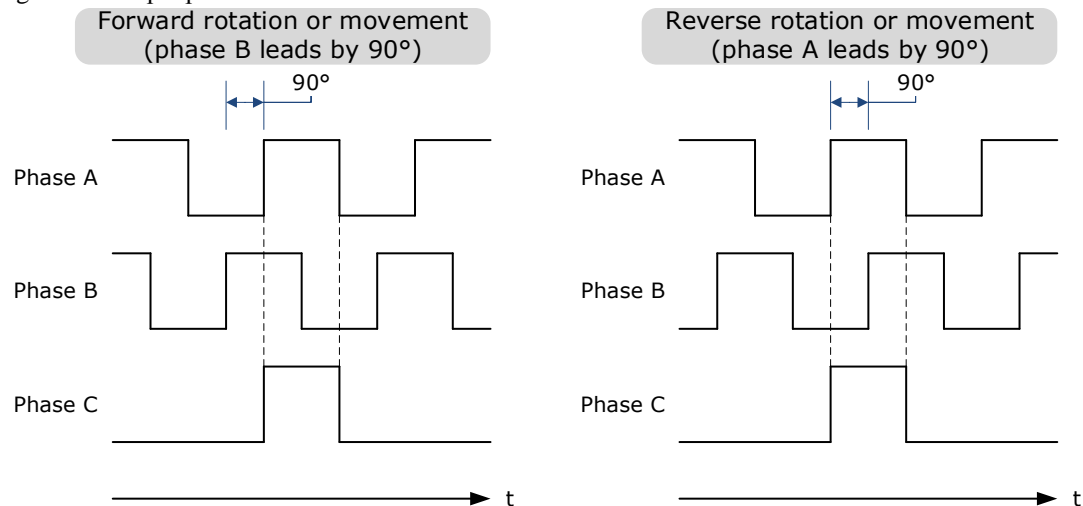
Signal	Pin	Name	Remarks
PCO+	CN1-25	Encoder Divided Pulse Output, Phase C	These pins output one pulse every motor rotation.
PCO-	CN1-26		



NOTE: Even for reverse operation (Pn001.0=1), the output phase form is the same as shown above.

The output phase form is as shown in Figure 7-2.

Figure 7-2 Output phase form



IMPORTANT

- If you use the Drive's phase-C pulse output for an origin return, rotate the Motor two or more rotations before you start an origin return.
- If an external encoder is used for the divided pulse output, the setting is the same as above.

Divide Pulse Setting

The pulse density set by the parameter Pn200 is converted and output based on the pulse data of the Motor encoder or an external encoder. The unit is "pulses per 1 revolution".

Parameter	Name	Range	Unit	Default	When Enabled
Pn200	Pulse Numbers for PG Frequency Division	16 to 16384	1 pulse	16384	After restart
Pn210.1	External Encoder Output Pulse Setting ⁽¹⁾	0 to 1	—	0	After restart

(1): The external encoder is only used for the Fully-Closed Loop Control.

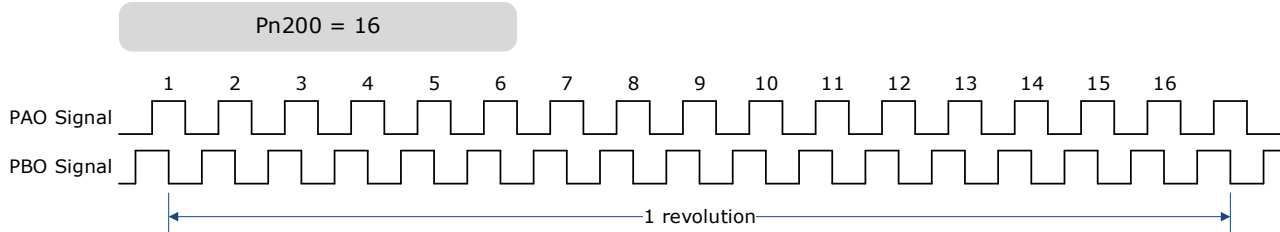
Enables the external encoder (Pn210.0=1) and then using the external encoder for the divided pulse output.

The number of pulses from the encoder per rotation are processed inside the Drive, divided by the setting of Pn200, and then output.

Set the number of encoder divided output pulses according to the system specifications of the machine or host controller.

The setting of the number of encoder output pulses is limited by the resolution of the encoder.

An output example is given below for the PAO (Encoder Pulse Output Phase A) signal and the PBO (Encoder Pulse Output Phase B) signal when Pn200 is set to 16 (16 pulses output per revolution).



7.8 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.

7.8.1 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 Table 7-1.

Table 7-1 Input signals allocated

Parameter	Pin	Meaning
Pn509.0	CN1-14	Allocated the input signal to CN1-14.
Pn509.1	CN1-15	Allocated the input signal to CN1-15.
Pn509.2	CN1-16	Allocated the input signal to CN1-16.
Pn509.3	CN1-17	Allocated the input signal to CN1-17.
Pn510.0	CN1-18	Allocated the input signal to CN1-18.



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

Input Signals

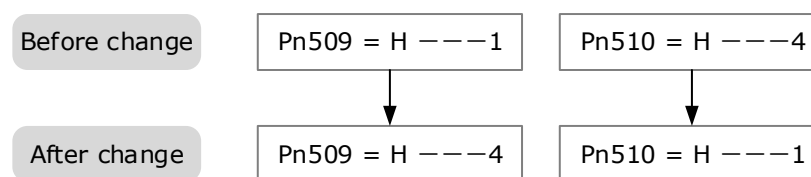
Table 7-2 lists the input signals that can be allocated and their corresponding values. Set the sub-parameters of Pn509 and Pn510 to use the following values, which means that they are allocated to the corresponding pins.

Table 7-2 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

Allocation Example

The following example shows reversing the P-OT (Forward Drive Prohibit) signal allocated to CN1-14 and the N-CL (Reverse External Torque Limit) signal allocated to CN1-18.



7.8.2 Output Signal Allocations

Allocation Description

The I/O signal connector (CN1) on the Drive provides three pins (points) for allocating the output signals, corresponding to the parameter Pn511, as is shown in Table 7-3.

Table 7-3 Output signals allocated

Parameter	Pin	Meaning
Pn511.0	CN1-6, -7	Allocated the output signal to CN1-6, -7.
Pn511.1	CN1-10, -11	Allocated the output signal to CN1-10, -11.
Pn511.2	CN1-12, -13	Allocated the output signal to CN1-12, -13.

**IMPORTANT**

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

Output Signals

Table 7-4 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 7-4 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	Encoder 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	9
Remote1	Remoted IO Output Signal 1	A
Remote2	Remoted IO Output Signal 2	B

Allocation Example

The following example shows reversing the S-RDY (Servo Ready) signal allocated to CN1-12, -13 and the TGON (Rotation Detection) signal allocated to CN1-10, -11.

Before change

Pn511 = H — 2 1 —



After change

Pn509 = H — 1 2 —

7.9 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.	7.9.1
External Torque Limits	The torque is limited with an input signal from the host station.	7.9.2
Limiting torque with EtherCAT command	The torque is limited with the settings of objects 60E0h (PosTorLimit) and 60E1h (NegTorLimit) in EtherCAT command.	6.8
Limiting torque with /CLT output signal	The torque is limited by the output signal /CLT (Allocated by Pn511).	7.9.3

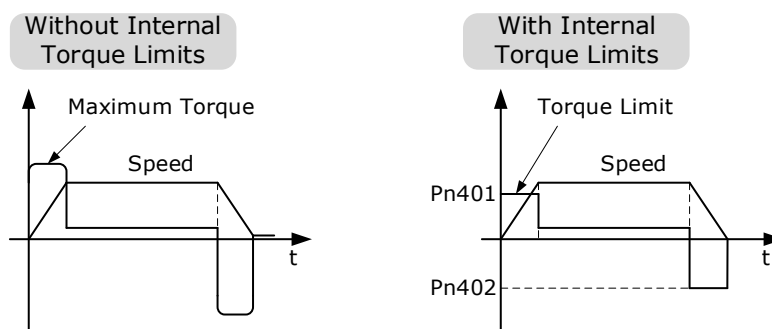
NOTE: If you set a value that exceeds the maximum torque of the Motor, the torque will be limited to the maximum torque of the Motor.

7.9.1 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.



7.9.2 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.
	/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

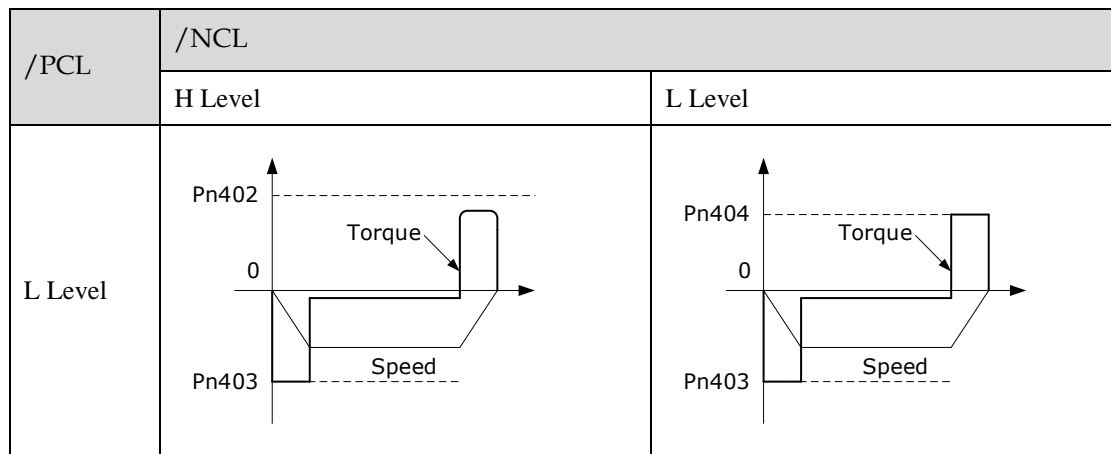
If the setting of Pn401 (Forward Torque Limit), Pn402 (Reverse Torque Limit), Pn403 (Forward External Torque Limit), or Pn404 (Reverse External Torque Limit) is too low, the torque may be insufficient for acceleration or deceleration of the Motor.

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		



7.9.3 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.

7.10 Soft Start

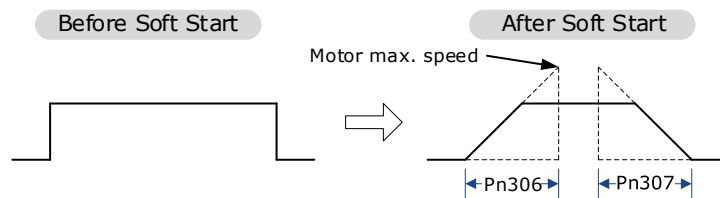
The soft start function converts the stepwise speed reference inside the DRIVE to a consistent rate of acceleration and deceleration.

The soft start form can be selected by parameter Pn310:

[0] Ramp; [1] S-Curve; [2] Primary filtering; [3] Secondary filtering

The soft start function enables smooth speed control when inputting a stepwise speed reference or when selecting internally set speeds. Set both Pn306 and Pn307 to “0” for normal speed control. Set these parameters as follows:

- Pn305: The time interval from the time the motor starts until the motor maximum speed is reached.
- Pn306: The time interval from the time the motor is operating at the motor maximum speed until it stops.



Parameter	Name	Range	Unit	Default	When Enabled
Pn306	Soft Start Acceleration Time	0 to 10000	ms	0	Immediately
Pn307	Soft Start Deceleration Time	0 to 10000	ms	0	Immediately

7.11 SEMI F47 Function

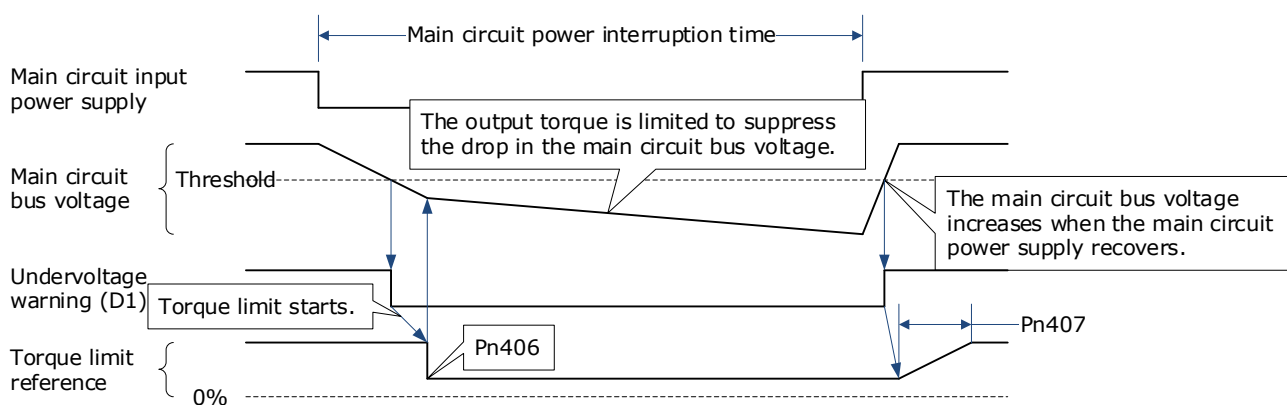
The SEMI F47 function detects an A.D1 warning (Undervoltage Warning) and limits the output current if the DC main circuit power supply voltage to the Drive drops to a specified value or lower because the power was momentarily interrupted or the main circuit power supply voltage was temporarily reduced.

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
Pn406	Torque Limit at Main Circuit Voltage Drop	0 to 100	%	50	Immediately
Pn407	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 8 Trial Operation

8.1 Preparations for Trial Operation

The procedure for trial operation is given below.

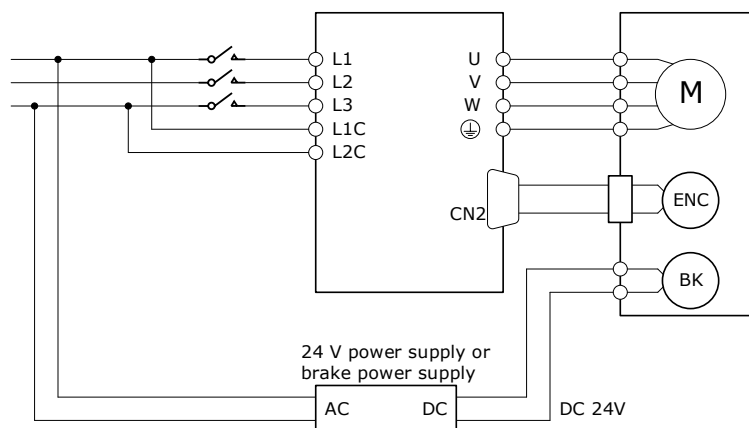
- Step 1 Install the Motor and DRIVE according to the installation conditions. First, operation is checked with no load. Do not connect the Motor to the machine.
Refers to **Chapter 2 Installation**.
- Step 2 Wire and connect the DRIVE. First, Motor operation is checked without a load. Do not connect the CN1 connector on the DRIVE.
Refers to **Chapter 3 Wiring and Connecting**.
- Step 3 Confirmations before Trial Operation.
- Step 4 Power ON the system.
- Step 5 If an absolute encoder is used, it is necessary to reset the absolute encoder.
Refers to **7.7 Encoder Setting**.

8.2 Inspections and Confirmations

To ensure safe and correct trial operation, check the following items before you start trial operation.

- Make sure that the DRIVE and Motor are installed, wired, and connected correctly.
- Make sure that the correct power supply voltage is supplied to the DRIVE.
- Make sure that there are no loose parts in the Motor mounting.
- If you are using a Motor with an Oil Seal, make sure that the oil seal is not damaged. Also make sure that oil has been applied.
- If you are performing trial operation on a Motor that has been stored for a long period of time, make sure that all Motor inspection and maintenance procedures have been completed.
- If you are using a Motor with a Holding Brake, make sure that the brake is released in advance. To release the brake, you must apply the specified voltage of 24 VDC to the brake.

A circuit example for trial operation is provided below.



8.3 Motor Operation without a Load

You use jogging for trial operation of the Motor without a load.

Jogging is used to check the operation of the Motor without connecting the DRIVE to the host controller. The Motor is moved at the preset jogging speed.



- During jogging, the overtravel function is disabled.
- Consider the range of motion of your machine when you jog the Motor.

8.3.1 Preparations

Always check the following before you execute jogging.

- The main circuit power supply must be ON.
- There must be no alarms.
- The Servo must not be in Safe State.
- The servo must be OFF.
- The jogging speed must be set considering the operating range of the machine.

The jogging speed is set with the following parameters.

Parameter	Name	Range	Unit	Default	When Enabled
Pn305	Jogging Speed	0 to 6000	rpm	500	Immediately
Pn306	Soft Start Acceleration Time	0 to 10000	ms	0	Immediately
Pn307	Soft Start Deceleration Time	0 to 10000	ms	0	Immediately

NOTE: for details on soft start setting, refers to the section **7.10 Soft Start**.

8.3.2 Applicable Tools

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

8.3.3 JOG Operation

Use the Panel Operator of the Drive

Before performing the JOG operation by using the Panel Operator, you shall check and set the relevant parameters properly.

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

Following the below steps to jog the Motor.

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



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



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

Lit for Servo OFF
Not lit for Servo ON

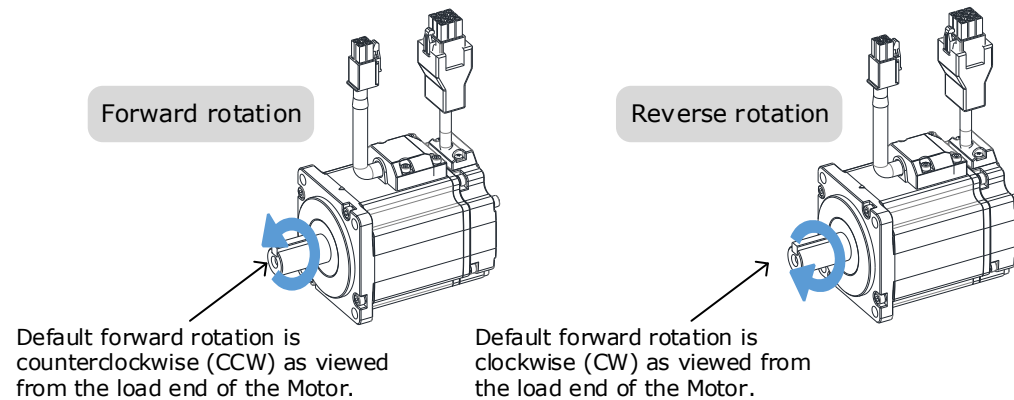


Step 4 Press [M] key to Servo ON (supply power to Motor).

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.

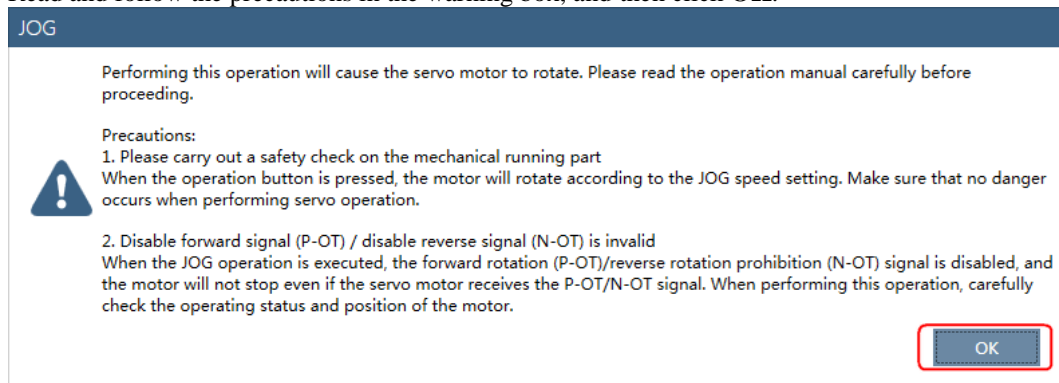
Use the ESView V4

The Motor will operate only while a button is clicked on the *ESView V4*.

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



Step 2 Read and follow the precautions in the warning box, and then click **OK**.



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

JOG_ED3S-04AHA

AXIS

EM3A-04ALA

SETTINGS

Pn305 JOG Speed: 500 rpm Range: 0 ~ 6000

Pn306 Soft Start Acceleration Time: 0 ms Range: 0 ~ 10000

Pn307 Soft Start Deceleration Time: 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.

JOG_ED3S-04AHA

AXIS

EM3A-04ALA

SETTINGS

Pn305 JOG Speed: 50 rpm Range: 0 ~ 6000



Pn306 Soft Start Acceleration Time: 1000 ms Range: 0 ~ 10000

Pn307 Soft Start Deceleration Time: 1000 ms Range: 0 ~ 10000

Current speed: 0 rpm

RUN

Servo Off

Step 5 Click the button  or  for running the motor.

JOG_ED3S-04AHA

AXIS

EM3A-04ALA

SETTINGS

Pn305 JOG Speed: 50 rpm Range: 0 ~ 6000



Pn306 Soft Start Acceleration Time: 1000 ms Range: 0 ~ 10000

Pn307 Soft Start Deceleration Time: 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.

8.4 Motor Operation with a Load

8.4.1 Precautions



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.



IMPORTANT

Failures caused by incorrect wiring or incorrect voltage application in the brake circuit may cause the DRIVE to fail, damage the DRIVE, damage the equipment, or cause an accident resulting in death or injury.

Observe the precautions and instructions for wiring and trial operation precisely as described in this manual.

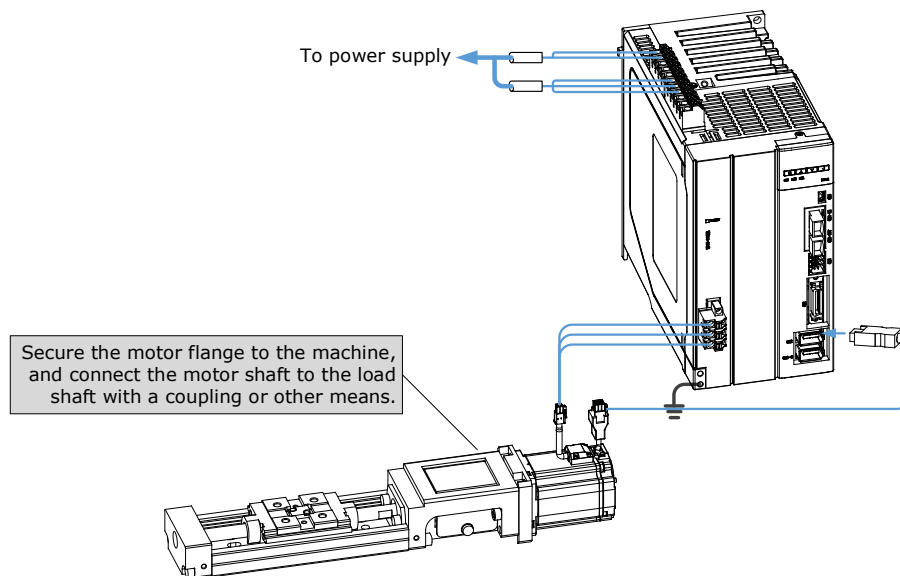
8.4.2 Preparations

Always confirm the following before you perform the trial operation procedure for both the machine and Motor.

- Make sure that the DRIVE is connected correctly to both the host controller and the peripheral devices.
- Safety Function Wiring
 - If you do not connect a safety function device, keep the Safety Connector plugged into the CN6 port, and the shorting pins on the connector remain in the default state.
 - If you are using the safety function, remove the shorting pins on the Safety Connector, and connect the safety function device.
- Overtravel wiring
- Brake wiring
- Allocation of the /BK (Brake) signal to a pin on the I/O signal connector (CN1)
- Emergency stop circuit wiring
- Host controller wiring

8.4.3 Operation Procedure

- Step 1 Enable the overtravel signals
Refers to the section **7.3.3 Enabling/Disabling the Overtravel Signal**.
- Step 2 Make the settings for the protective functions, such as the safety function, overtravel, and the brake.
- For details on connecting safety function signals, refers to **Chapter 11 STO**.
 - For details on overtravel settings, refers to the section **7.3 Overtravel Limit**.
 - For details on holding brake settings, refers to the section **7.5 Holding Brake**.
- Step 3 Turn OFF the power supplies to the DRIVE.
The control power supply and main circuit power supply will turn OFF.
- Step 4 Couple the Motor to the machine.



- Step 5 Turn ON the power supplies to the machine and host controller and turn ON the control power supply and main circuit power supply to the DRIVE.
- Step 6 Check the protective functions, such overtravel and the brake, to confirm that they operate correctly.
NOTE: Enable activating an emergency stop so that the Motor can be stopped safely should an error occur during the remainder of the procedure.
- 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.

8.5 Program Jogging

You can use program jogging to perform continuous operation with a preset operation pattern, travel distance, movement speed, acceleration/deceleration time, waiting time, and number of movements.

You can use this operation when you set up the system in the same way as for normal jogging to move the Motor without connecting it to the host controller in order to check Motor operation and execute simple positioning operations.

8.5.1 Preparations

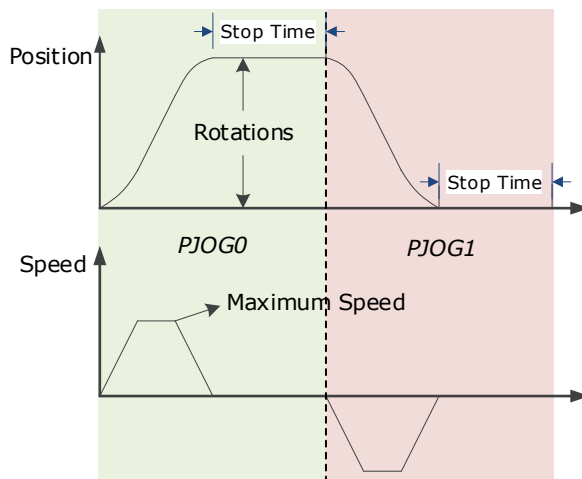
Always check the following before you execute program jogging.

- The parameters must not be written prohibited.
- The main circuit power supply must be ON.
- There must be no alarms.
- The Servo must not be in Safe State.
- The servo must be OFF.
- The range of machine motion and the safe movement speed of your machine must be considered when you set the travel distance and movement speed.
- There must be no overtravel.

8.5.2 Operation Description

Program jogging operation consists of two operation patterns (PJOG0 and PJOG1), you can set their relevant parameters respectively. Figure 8-1 shows an example of position-speed timing diagram in PJOG operation.

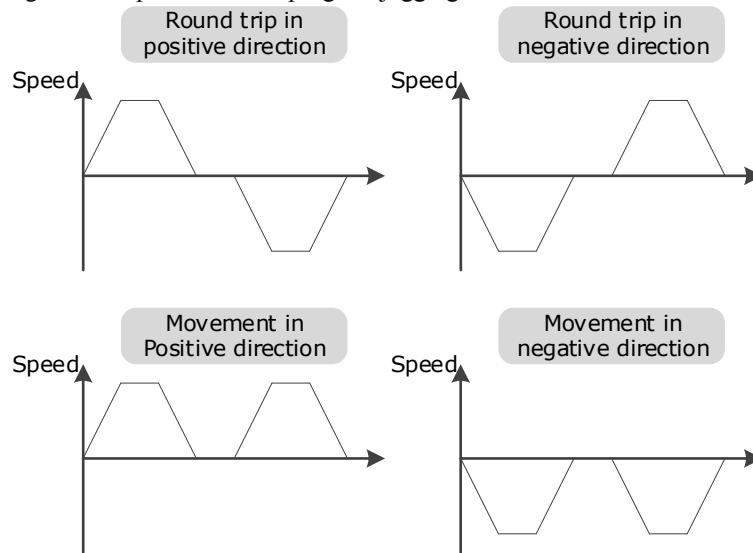
Figure 8-1 Position-speed timing diagram



The Drive will operator the Motor repeatedly according to the parameter settings of the two operation patterns until you stop the program jogging operation manually.

You can set the parameters Pn164 and Pn168 to a negative value for reversing the motor, so that there are four ways of the operation in the program jogging, as is shown in Figure 9-9.

Figure 8-2 Operation in the program jogging



You shall set the Rotations (Pn164 and Pn168) and Max Speed (Pn165 and Pn169) to a proper value. If the Rotations is set too small or the Max Speed is set too large, it is possible that the maximum speed set cannot be reached. In this case, it is necessary to increase the Rotations or decrease the Max Speed.

8.5.3 Relevant Parameters

Parameter	Name	Range	Unit	Default	When Enabled
Pn164	Turns for PJOG0	-50 to 50	rotation	5	Immediately
Pn165	Max Speed for PJOG0	100 to 3000	rpm	1000	Immediately
Pn166	Acc./Dec. Time for PJOG0	50 to 2000	ms	500	Immediately
Pn167	Stop Time for PJOG0	100 to 10000	ms	1000	Immediately
Pn168	Turns for PJOG1	-50 to 50	rotation	5	Immediately
Pn169	Max Speed for PJOG1	100 to 3000	rpm	1000	Immediately
Pn170	Acc./Dec. Time for PJOG1	50 to 2000	ms	500	Immediately
Pn171	Stop Time for PJOG1	100 to 10000	ms	1000	Immediately

8.5.4 Applicable Tools

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

8.5.5 Operation Procedure

Use the Panel Operator of the Drive

Before performing the Program Jogging (PJOG) operation by using the Panel Operator, you shall check and set the following parameters properly.



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.



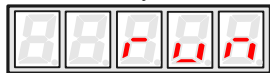
Step 2 Press [▲] key or [▼] key to select the function number Fn018.



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.

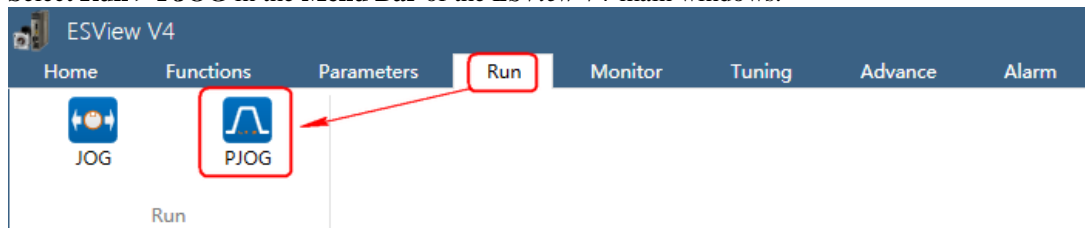


Step 5 Press [◀] key to return to the display of the Fn018.

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**.

PJOG

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.

OK

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

PJOG - ED3S-04AHA

PJOG0 Curve

SETTINGS

PJOG0

Pn164 PJOG0 Rotation N... rev Range: -50 ~ 50

Pn165 PJOG0 Rotation S... rpm Range: 100 ~ 3000

Pn166 PJOG0 Acceleratio... ms Range: 50 ~ 2000

Pn167 PJOG0 Stop Time ms Range: 100 ~ 10000

PJOG1

Pn168 PJOG1 Rotation N... rev Range: -50 ~ 50

Pn169 PJOG1 Rotation S... rpm Range: 100 ~ 3000

Pn170 PJOG1 Acceleratio... ms Range: 50 ~ 2000

Pn171 PJOG1 Stop Time ms Range: 100 ~ 10000

Apply

OPERATIONS

Servo Off

Run

PJOG1 Curve

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	
<input type="button" value="Apply"/>				

- **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.

OPERATIONS	
Servo Off	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="button" value="Run"/>

Step 7 Click **Run**.

OPERATIONS	
Servo On	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="button" value="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.

Chapter 9 Tuning

9.1 Overview

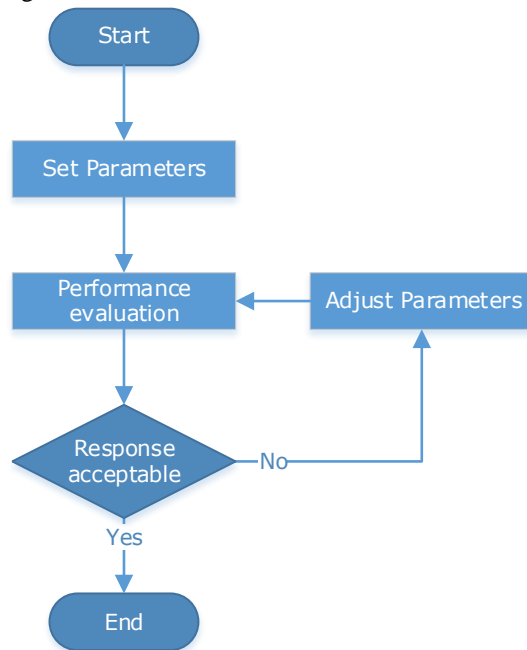
9.1.1 Basic Conception

Tuning is a process of satisfying the Servo performance by adjusting the Servo parameters. The key is to grasp the adjustment method of the Servo parameters and correctly evaluate the Servo performance.

Tuning Flow

Tuning is usually an iterative process, and Figure 9-1 shows the general flow.

Figure 9-1 General flow



Parameter Classification

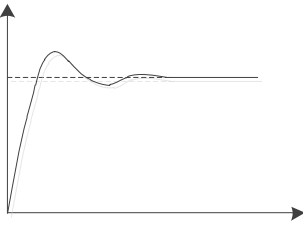
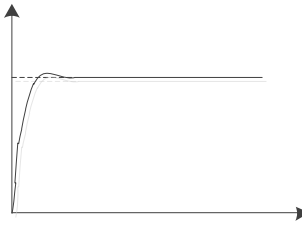
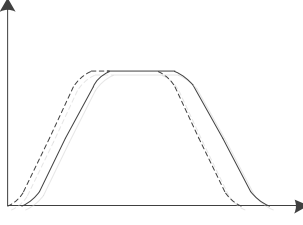
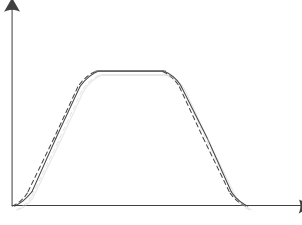
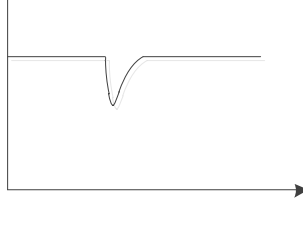
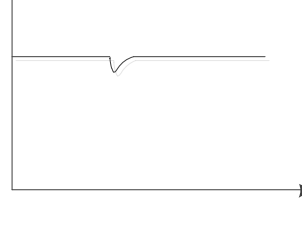
There are two types of parameters in the tuning.

- Function Parameters: refers to some application function selections or switches that may improve Servo performance.
- Adjustment Parameters: increasing or decreasing these parameters may improve Servo performance.

Servo Performance

In general, the indicators used to evaluate Servo performance are bandwidth, response time, overshoot, steady state error, anti-load disturbance, speed ripple fluctuation, torque ripple, and so on. Table 9-1 shows the comparison of the graphics before and after tuning in the example indicators.

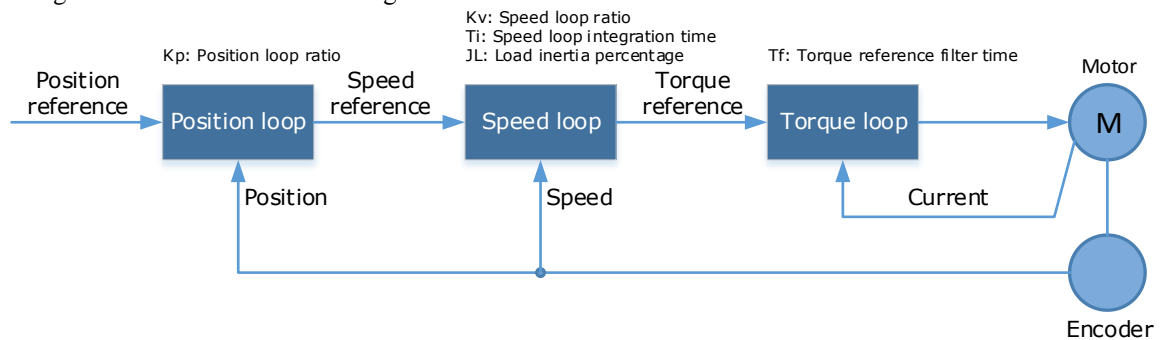
Table 9-1 Comparison of the graphics before and after tuning

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

9.1.2 Control Block Diagram

It is necessary to learn the Servo control principle and Figure 9-2 shows the Servo control block diagram. The position loop, the speed loop and the torque loop are cascade structures, corresponding to the position control mode, the speed control mode and the torque control mode respectively.

Figure 9-2 Servo control block diagram

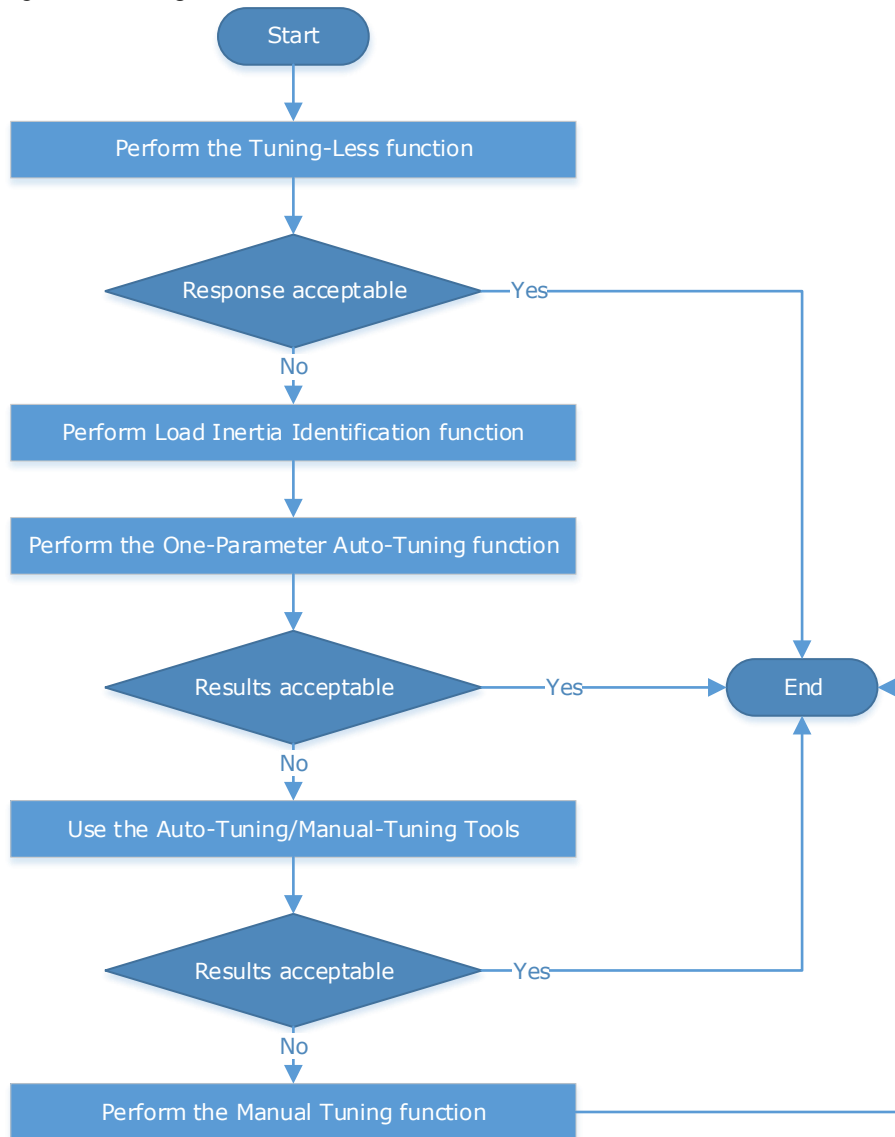


NOTE: only the basic tuning parameters during the tuning are shown in the figure.

9.1.3 Tuning Process

The Drive provides a variety of tuning methods, you can adjust the device according to the process shown in Figure 9-3, in order to obtain the desired Servo performance.

Figure 9-3 Tuning Process



IMPORTANT

It is necessary to perform the tuning operation again if the motor had been disassembled or the load device had been replaced.

9.1.4 Precautions Before Tuning



- Before performing the tuning operation, make sure the limit function is available.
- Before performing the tuning operation, make sure that an emergency stop can be performed at any time.
- Before performing the tuning operation, you shall set the torque limit according to actual condition.
- Never touch the moving parts during the tuning operation.

9.2 Tuning Modes

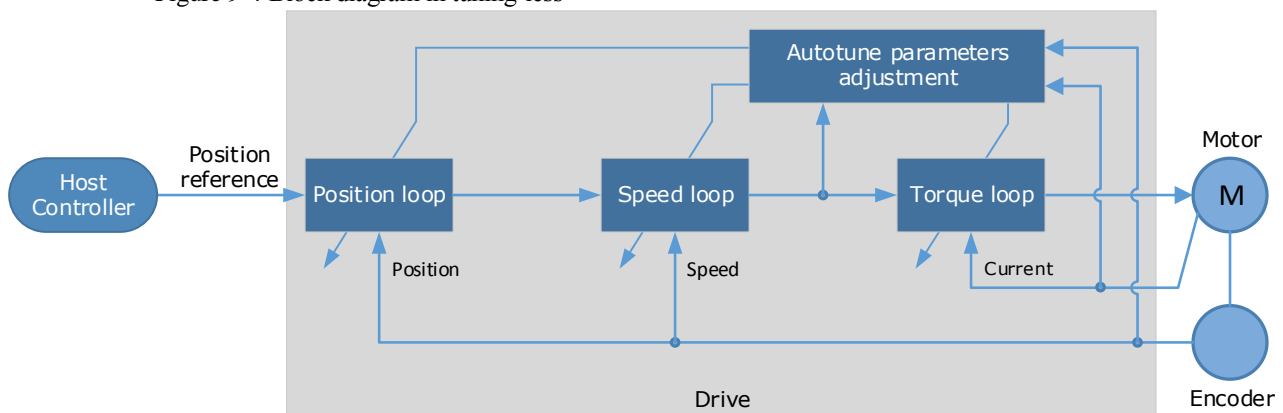
9.2.1 Tuning-Less

Function Description

The tuning-less performs auto-tuning to obtain a stable response regardless of the type of machine or changes in the load. Autotuning is started when the Servo is turned ON.

The tuning-less function uses an Autotune parameters adjustment module that updates the position loop and speed loop parameters in real time based on the servo operating state (position, speed, current). Figure 9-4 shows the block diagram in tuning-less.

Figure 9-4 Block diagram in tuning-less



When using the tuning-less function, the following parameters are automatically adjusted.

Parameter	Adjustment method
Speed Loop Gain	Auto-tuning
Speed Loop Integral Time	Auto-tuning
Position Loop Gain	Auto-tuning
Torque Command Filter Time	Auto-tuning
Load Inertia Percentage	Auto-tuning

NOTE: The parameters will not change automatically in tuning-less function.

Applicated Case

- Applied for that no more than 30 times the load moment of inertia.
- Applied for any rotation speed.

Relevant Parameters

Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	1 [Default]	Set the Tuning Mode as Tuning-less .	After restart	Function

Application Restrictions

The following functions or applications are not available in the Tuning-less function:

- Gain switch is disabled.
- P/PI Switch is disabled.
- Speed feedback by using observed speed is disabled.
- Load Torque Compensation is disabled.
- Model Following Control Function is disabled.

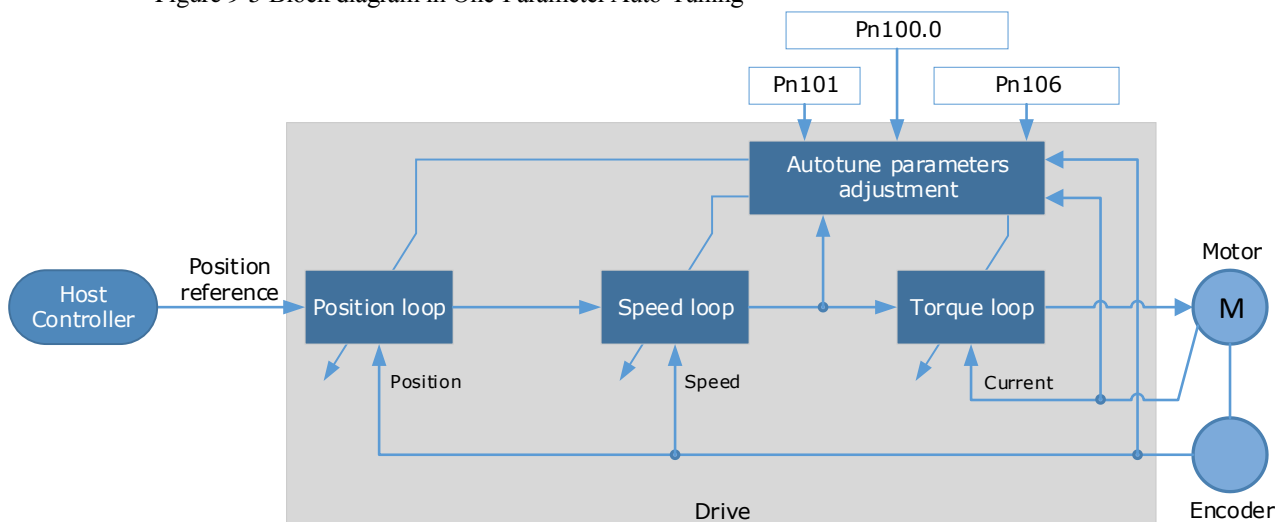
9.2.2 One-Parameter Auto-Tuning

Function Description

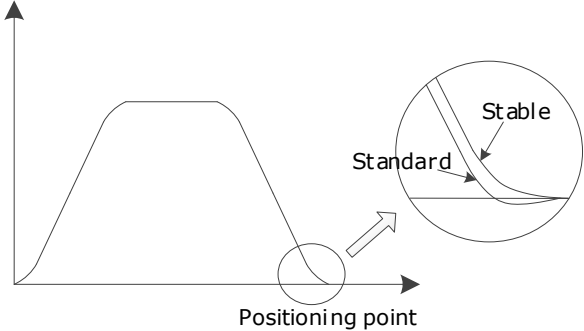
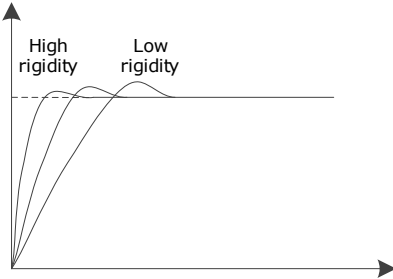
This tuning function is similar to the tuning-less function, using an Autotune parameters adjustment module that updates the position loop and speed loop parameters in real time based on the servo operating state (position, speed, current).

Only the parameter Pn101 (Servo Rigidity) needs to set in One-Parameter Auto-Tuning function, and Figure 9-5 shows the block diagram in One-Parameter Auto-Tuning.

Figure 9-5 Block diagram in One-Parameter Auto-Tuning



Before performing One-Parameter Auto-Tuning, you need to manually set the following parameters:

Parameter	Name	Description
Pn106	Load Inertia Percentage	<p>Properly setting the Load Inertia Percentage is a prerequisite for the One-Parameter Auto-Tuning to obtain a better Servo performance.</p> <p>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.</p>
Pn100.3	Damping Selection	<p>Select a damping method according to your requirement and application.</p> <ul style="list-style-type: none"> • [0] Standard: Short positioning time, but prone to overshoot. • [1] Stable: Stable positioning, but long positioning time. 
Pn101	Servo Rigidity	<p>The Servo Rigidity determines the response characteristic of the position loop or speed loop.</p> <p>The performance can be improved by increasing the Servo Rigidity, and decrease it if a vibration occurs.</p> <p>The figure below shows the speed step response for different Servo Rigidities:</p> 

When using the One-Parameter Auto-Tuning function, the following parameters are automatically adjusted.

Parameter	Adjustment method
Speed Loop Gain	Auto-tuning
Speed Loop Integral Time	Auto-tuning
Position Loop Gain	Auto-tuning
Torque Command Filter Time	Auto-tuning

NOTE: The parameters will not change automatically in tuning-less function.

Compared to Tuning-less, there are some features below in One-Parameter Auto-Tuning:

- Tuning based on a proper load inertia percentage can get a better servo performance.
- The setting of Servo Rigidity can be applied to more operating conditions.

Applicated Case

- Applied for that more than 50 times the load moment of inertia.
- Applied for any rotation speed.

Relevant Parameters

Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	3	Set the Tuning Mode as One-Parameter Auto-Tuning .	After restart	Function
Pn100.3	0	Set the damping method in One-Parameter Auto-Tuning as Standard .		
	1	Set the damping method in One-Parameter Auto-Tuning as Stable .		
Pn101	–	Servo Rigidity	Immediately	Adjustment
Pn106	–	Load Inertia Percentage	Immediately	Adjustment

Application Restrictions

The following functions or applications are not available in One-Parameter Auto-Tuning function:

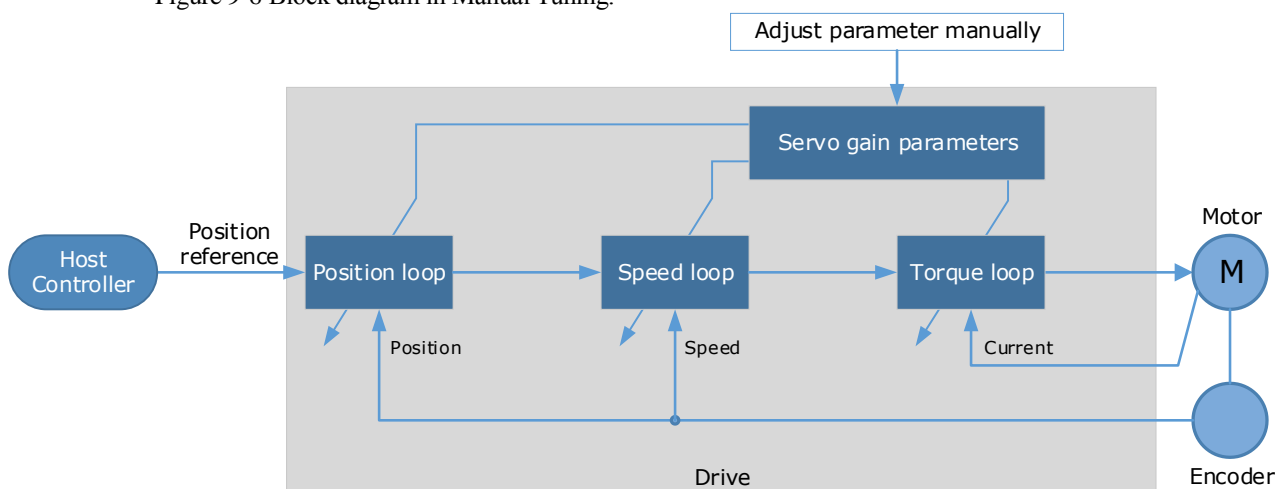
- Gain switch is disabled.
- Model Following Control Function is disabled.

9.2.3 Manual Tuning

Function Description

In the Manual Tuning, you need to manually adjust the gain parameters without using the autotune parameter adjustment module, until the Servo get the desired performance. Figure 9-6 shows the block diagram in Manual Tuning.

Figure 9-6 Block diagram in Manual Tuning.



It is necessary to adjust the three-loop control parameters of the Servo from the inside out, that is, the adjustment sequence is **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.

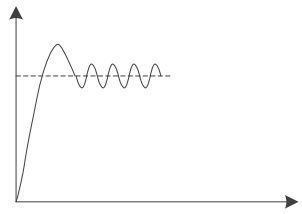
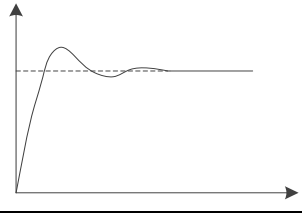
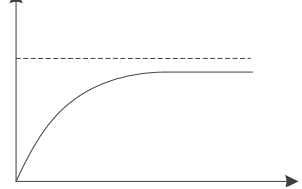
- Speed Loop Gain (Kv), Speed Loop Integral Time (Ti)

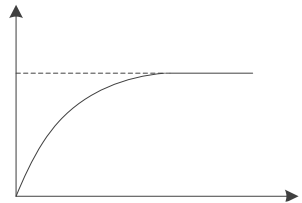
The speed loop is controlled using a Proportional-Integral Controller that contains Speed Loop Gain and Speed Loop Integral Time. Both of them determine the speed loop bandwidth and anti-disturbance performance of the Servo.

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 9-2 lists several commonly used adjustment methods based on the characteristics of the speed step response.

Table 9-2 Adjustment example in speed loop

Response Curve	Description	Adjustment method
	Speed loop bandwidth is high	Properly decrease the Speed Loop Gain or increase the Speed Loop Integral Time.
	Speed loop damping ratio is low	Properly increase the Speed Loop Integral Time.
	Steady-state error is existed	Properly decrease the Speed Loop Integral Time.

Response Curve	Description	Adjustment method
	Speed loop bandwidth is low	Properly increase the Speed Loop Gain or decrease the Speed Loop Integral Time.

It is recommended to increase the Speed Loop Gain and decrease the Speed Loop Integral Time to obtain a larger speed loop bandwidth.

- Position loop (Position Control Mode)

- Relevant parameters in speed loop (K_v , T_i , T_f , and J_L)
- Position Loop Gain (K_p)

The position loop is controlled using a Proportional Controller that only contains the Position Loop Gain. This parameter determines the position loop bandwidth. If you increase the Position Loop Gain, the position loop bandwidth will be increased and the anti-load disturbance performance will be better. However, overshooting and vibration in the position reference may be occurred.

It is recommended to set the Position Loop Gain to a quarter of the Speed Loop Gain, and make appropriate adjustments based on this.

Applicated Case

- Applied for that more than 50 times the load moment of inertia.
- Applied for any rotation speed.

Relevant Parameters

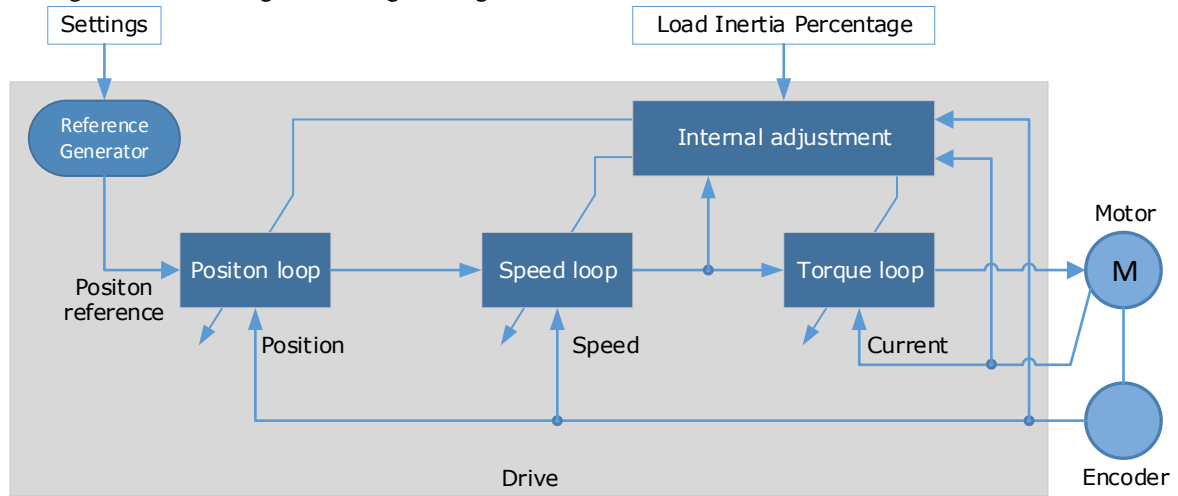
Parameter	Setting	Meaning	When Enabled	Classification
Pn100.0	5 [Default]	Set the Tuning Mode as Manual tuning .	After restart	Function
Pn102/Pn107	–	Speed Loop Gain	Immediately	Adjustment
Pn103/Pn108	–	Speed Loop Integral Time	Immediately	Adjustment
Pn104/Pn109	–	Position Loop Gain	Immediately	Adjustment
Pn105/Pn110	–	Torque Command Filter Time	Immediately	Adjustment
Pn106	–	Load Inertia Percentage	Immediately	Adjustment

NOTE: the settings of Pn107 to Pn110 are taken effect after the gain is switched.

9.3 Tuning Tools

There is an Auto-Tuning Tool and a Manual Tuning Tool in Tuning tools. When using a tuning tool, the Drive will execute the position references generated internally, Figure 9-5 shows the block diagram in using a tuning tool.

Figure 9-7 Block diagram in using a tuning tool



The reference generator plans an appropriate position reference according to the settings of relevant parameter.



Since the limit function is unavailable when using the tuning tools, please make sure that the movable parts have sufficient travel in the planned motion track.

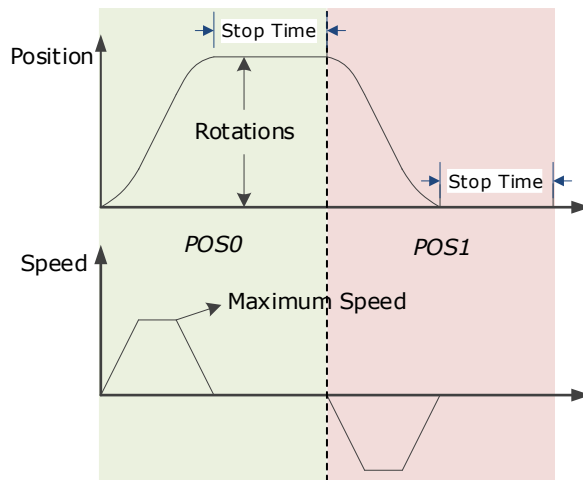
9.3.1 Auto-Tuning Tool

Function Description

With the Auto-Tuning Tool, the reference generator can plan the position curve and generate a position reference as inputs to the position loop.

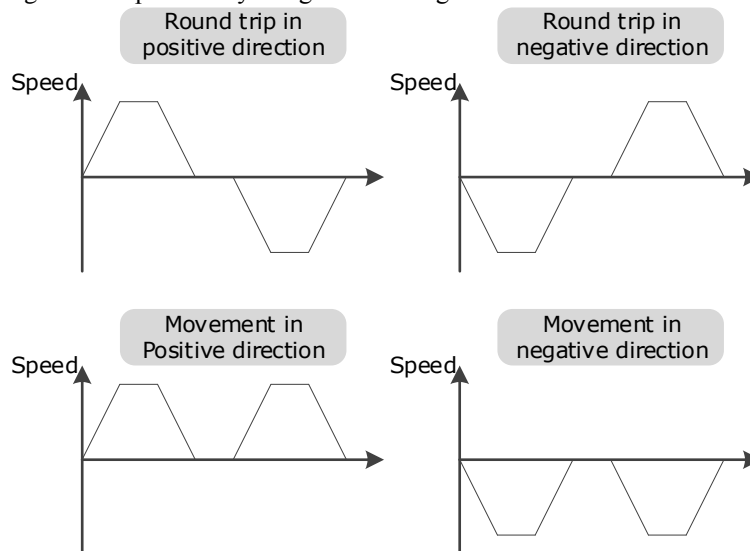
There are two operation patterns (POS0 and POS1), you can set their relevant parameters respectively. Figure 9-8 shows an example of position-speed timing diagram in PJOG operation.

Figure 9-8 Position-speed timing diagram



The Drive will operator the Motor repeatedly according to the parameter settings of the two operation patterns until the tuning is completed. You can set the parameters Pn164 and Pn168 to a negative value for reversing the motor, so that there are four ways of the operation in the program jogging, as is shown in Figure 9-9.

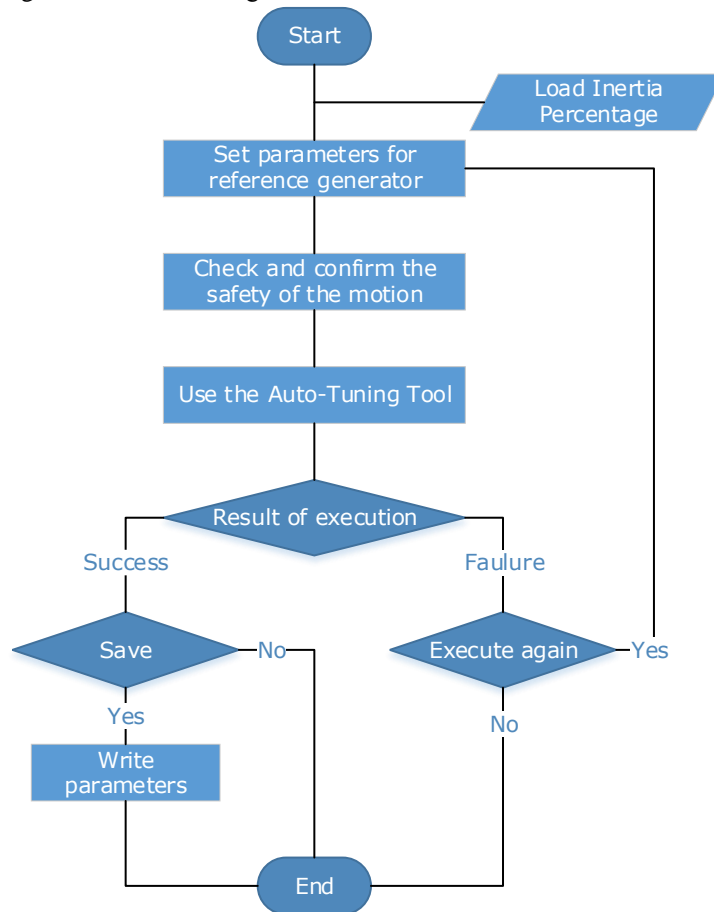
Figure 9-9 Operation by using Auto-Tuning Tool



You shall set the Rotations (Pn164 and Pn168) and Max Speed (Pn165 and Pn169) to a proper value. If the Rotations is set too small or the Max Speed is set too large, it is possible that the maximum speed set cannot be reached. In this case, it is necessary to increase the Rotations or decrease the Max Speed.

Use the Auto-Tuning Tool as shown in Figure 9-10.

Figure 9-10 Auto-Tuning Tool flowchart



The following parameters are automatically adjusted when using the auto-tuning tool.

Parameter	Adjustment method	Write into
Speed Loop Gain	Auto-tuning	Pn102
Speed Loop Integral Time	Auto-tuning	Pn103
Position Loop Gain	Auto-tuning	Pn104
Torque Command Filter Time	Auto-tuning	Pn105



CAUTION

- The parameters cannot be changed automatically when using the Auto-Tuning Tool.
- You have to choose whether to save (write) the parameters into the Drive. If you choose to save, parameters will be changed, but they are only available for **Manual Tuning** function.

Applicated Case

- Applied for the high rigidity (up to 20 times load moment of inertia) equipment.
- Applied for the low rigidity (up to 10 times load moment of inertia) equipment.
- The number of revolutions is more than 1 rotation, and the rotation speed is higher than 100 rpm.

Relevant Parameters

Parameter	Setting	Description	When Enabled	Classification
Pn106	–	Load Inertia Percentage	Immediately	Adjustment
Pn164	–	Turns for PJOG0	Immediately	Adjustment
Pn165	–	Max Speed for PJOG0	Immediately	Adjustment
Pn167	–	Stop Time for PJOG0	Immediately	Adjustment
Pn168	–	Turns for PJOG1	Immediately	Adjustment
Pn169	–	Max Speed for PJOG1	Immediately	Adjustment
Pn171	–	Stop Time for PJOG1	Immediately	Adjustment

Application Restrictions

You can use the automatic vibration suppression function when using the auto-tuning tool. For details, refers to the section **9.6.4 Automatic Vibration Suppression**.

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.

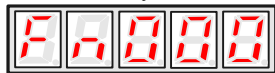


The Auto-Tuning Tool is unavailable in fully-closed loop control.

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.

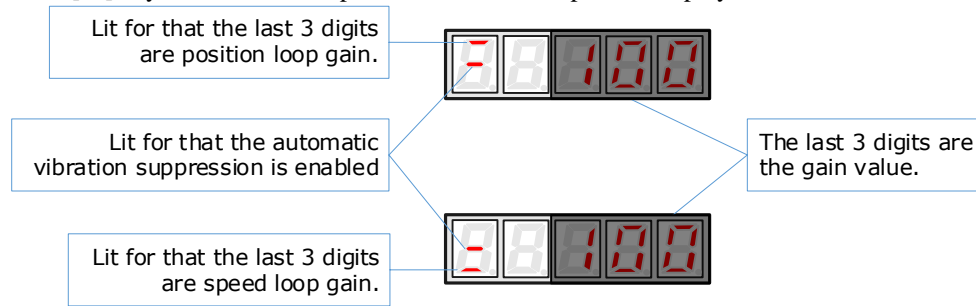


Step 3 Press [◀] key, and Panel Operator displays as below.



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.

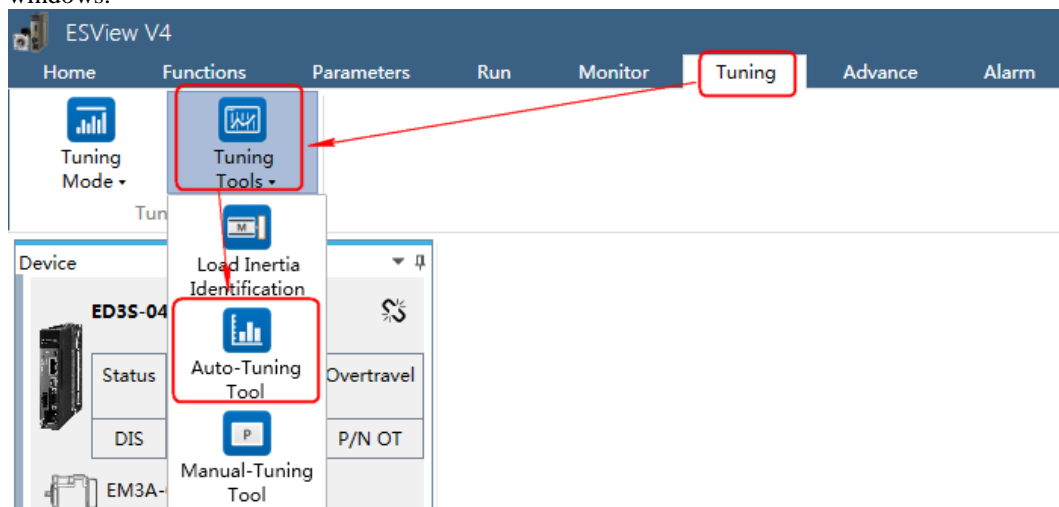


Step 6 Press [◀] key to return to the display of the Fn017.

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.

For details, refers to the section **9.7.1 Load Inertia Identification**.

Parameter Auto-Tuning Tool - ED3S-04AHA

Parameter Settings

Running Tuning

Save Parameter

LOAD INERTIA

SETTINGS

POS0

Pn164 PJOG0 Rotation N... rev Range: -50 ~ 50

Pn165 PJOG0 Rotation S... rpm Range: 100 ~ 3000

Pn167 PJOG0 Stop Time ms Range: 100 ~ 10000

POS1

Pn168 PJOG1 Rotation N... rev Range: -50 ~ 50

Pn169 PJOG1 Rotation S... rpm Range: 100 ~ 3000

Pn171 PJOG1 Stop Time ms Range: 100 ~ 10000

PJOG0 Curve

PJOG1 Curve

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

Apply

- **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**.

Parameter Auto-Tuning Tool - ED3S-04AHA

Parameter Settings

LOAD INERTIA

Detect

Running Tuning

Save Parameter

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

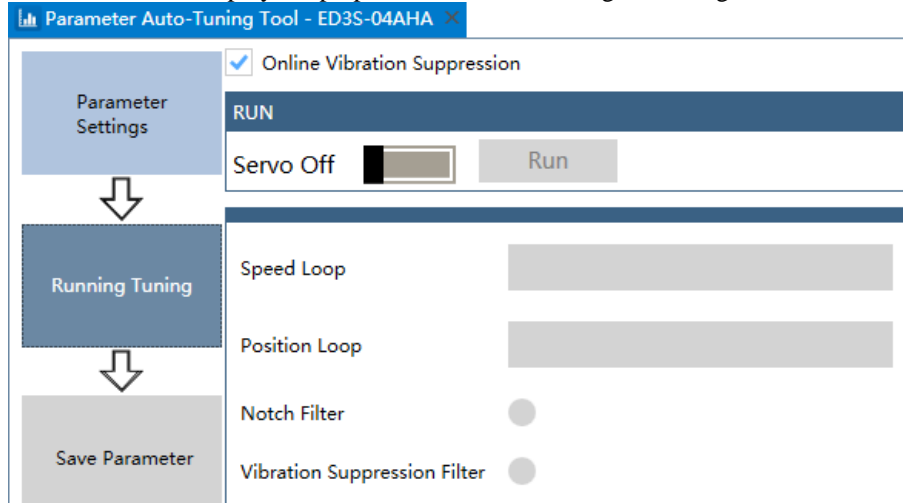
Pn168 PJOG1 Rotation N... -5 rev Range : -50 ~ 50

Pn169 PJOG1 Rotation S... 1000 rpm Range : 100 ~ 3000

Pn171 PJOG1 Stop Time 1000 ms Range : 100 ~ 10000

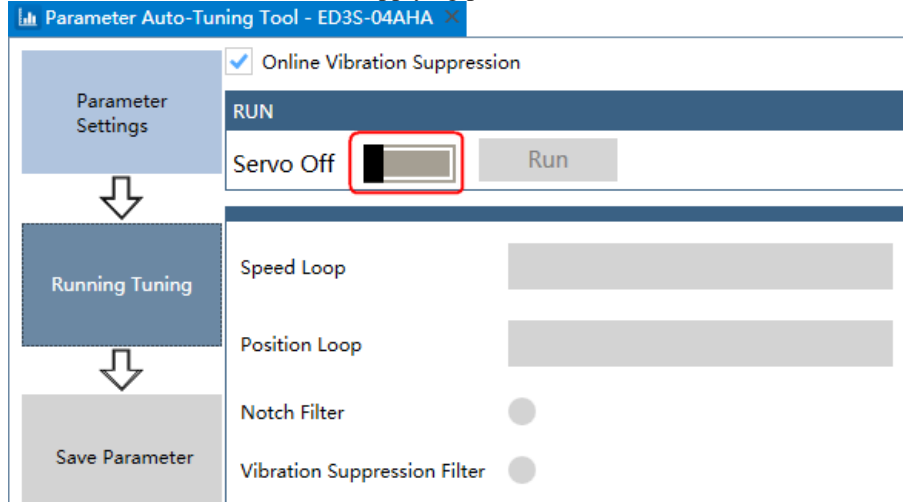
Apply

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

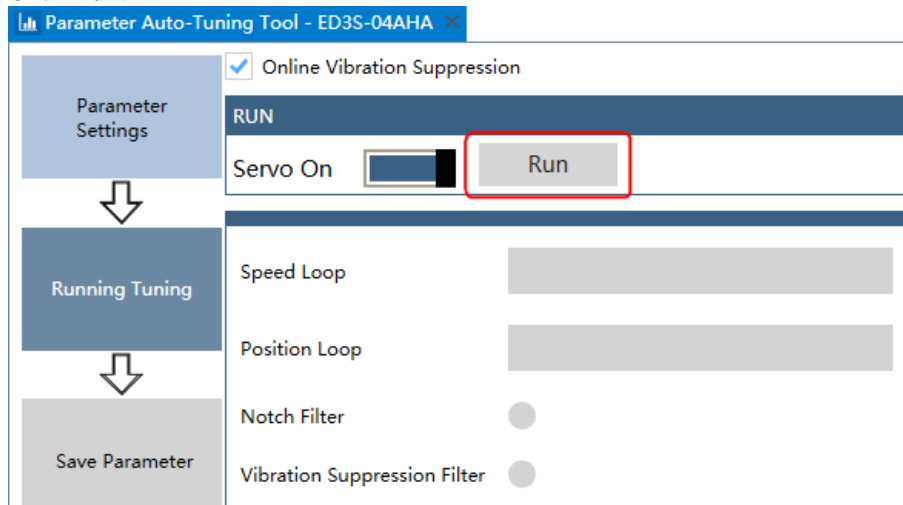


The setting will be written into the Drive automatically after you check or uncheck **Online Vibration Suppression** option.

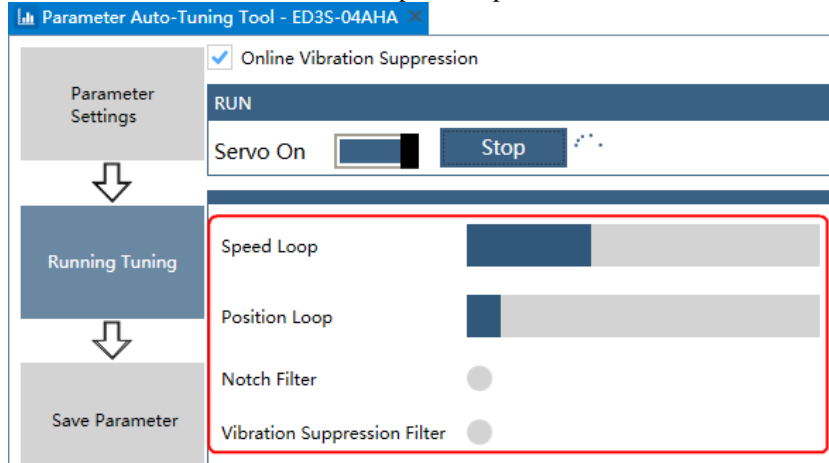
Step 9 Click **Servo Off** / **Servo On** for supplying power to the Motor.



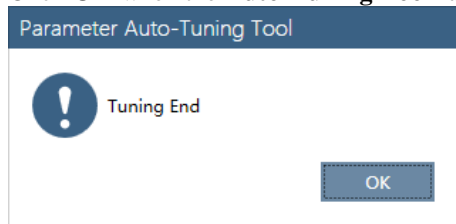
Step 10 Click **Run**.



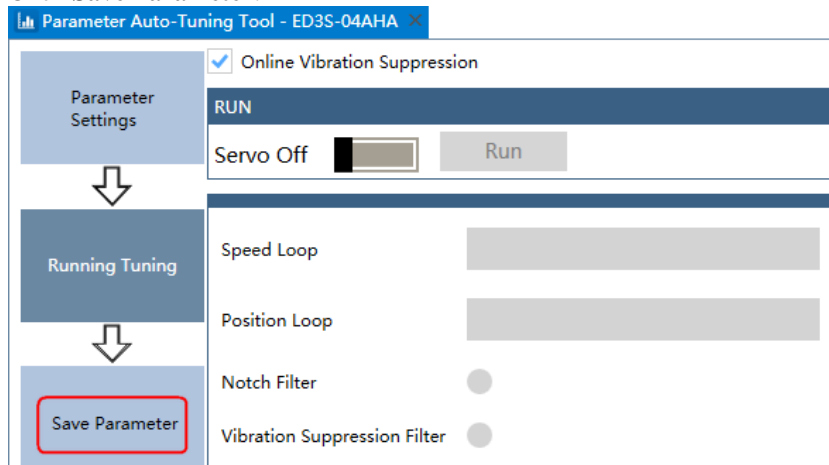
Step 11 The Motor will be run between the operation patterns POS0 and POS1.



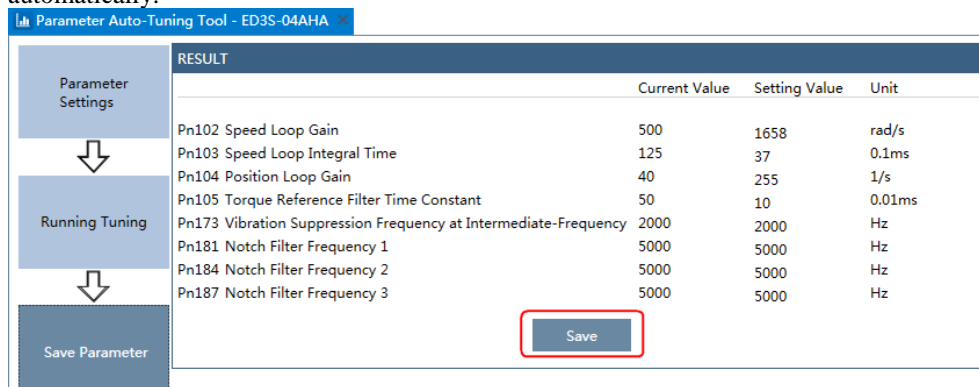
Step 12 Click **OK** when the **Auto-Tuning Tool** function has been completed.



Step 13 Click **Save Parameter**.



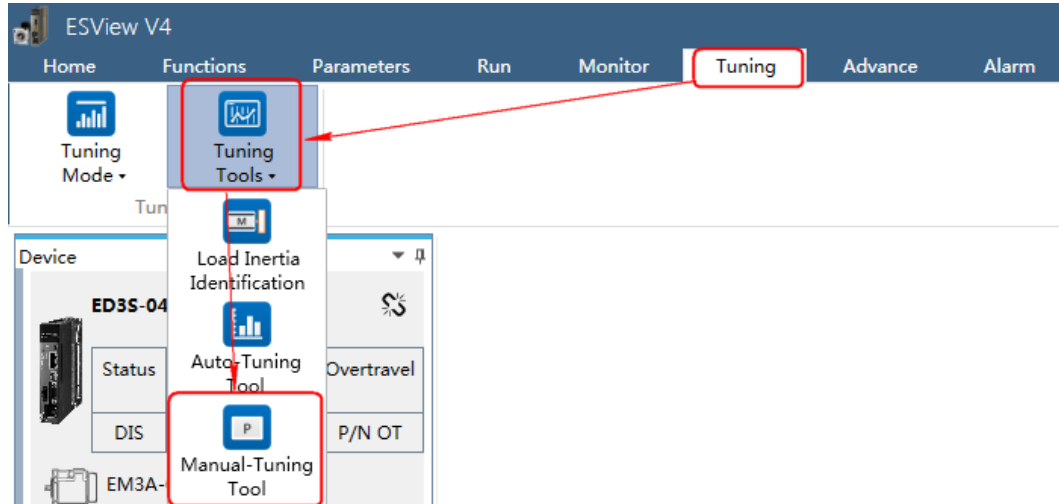
Step 14 Check the **RESULT**, and click **Save**, the settings of parameters will be written into the Drive automatically.



9.3.2 Manual-Tuning Tool

By using the Manual-Tuning Tool, you will set the Servo gain parameters again and again according to the waveform graphics of the data (Speed Feedback, Speed Setting, Position Feedback and Position Setting), as far as the performance of the servo meets the requirements.

Step 1 Select **Tuning** → **Tuning Tools** → **Manual-Tuning Tool** in the **Menu Bar** of the *ESView V4* main windows.



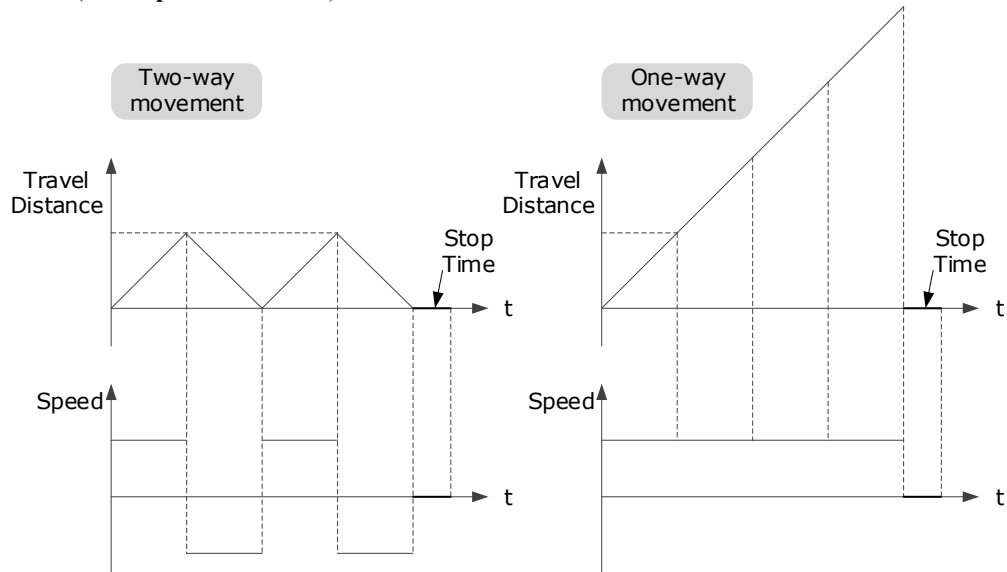
Step 2 The **Manual-Tuning Tool** window will be displayed in **Function Display Area**.



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

- Choose **Test Command Wave** as **Position Slope**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure

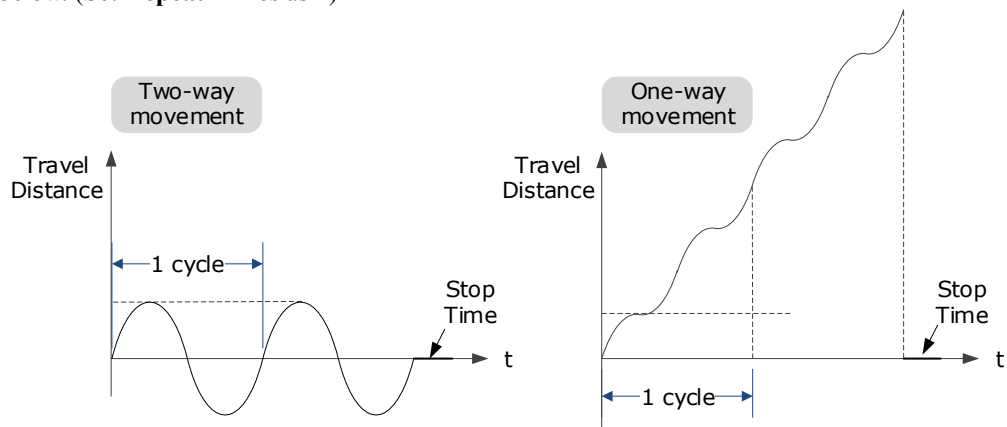
below. (Set **Repeat Times** as 2)



The relevant parameters in the **Position Slope** are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel distance the motor moves in one command. The positive and negative values indicate the direction of rotation.
Repeat Times	1 to 10	The number of times the command was executed.
Stop Time	0 to 32767	Set the hold time when the motor stops running.
Speed	0 to 3000	The speed of the motor when the command is executed.
One-Way Move	—	Check this option indicates that the motor is running in One-way movement.

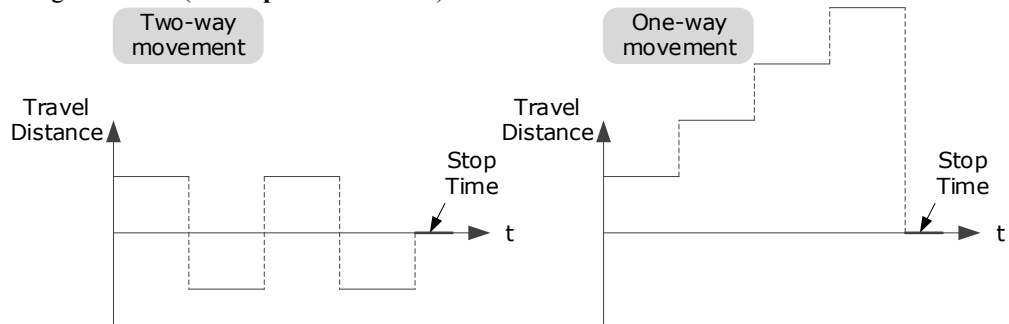
- Choose **Test Command Wave** as **Position Sine**, the Drive will operate in position control method, and the trajectory of the Motor in Two-way movement and One-way movement is shown in the figure below. (Set **Repeat Times** as 2)



The relevant parameters in the **Position Sine** are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel 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.
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)

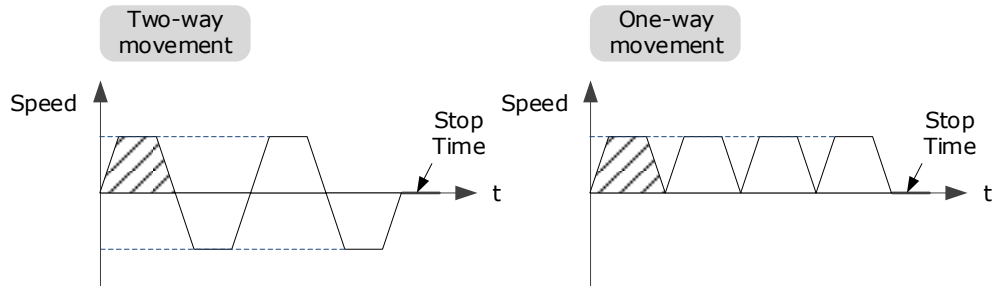


The relevant parameters in the **Position Stepwise** are shown in the table below.

Parameter	Range	Description
Travel Distance	-9 999 999 to 9 999 999	The travel 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.
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

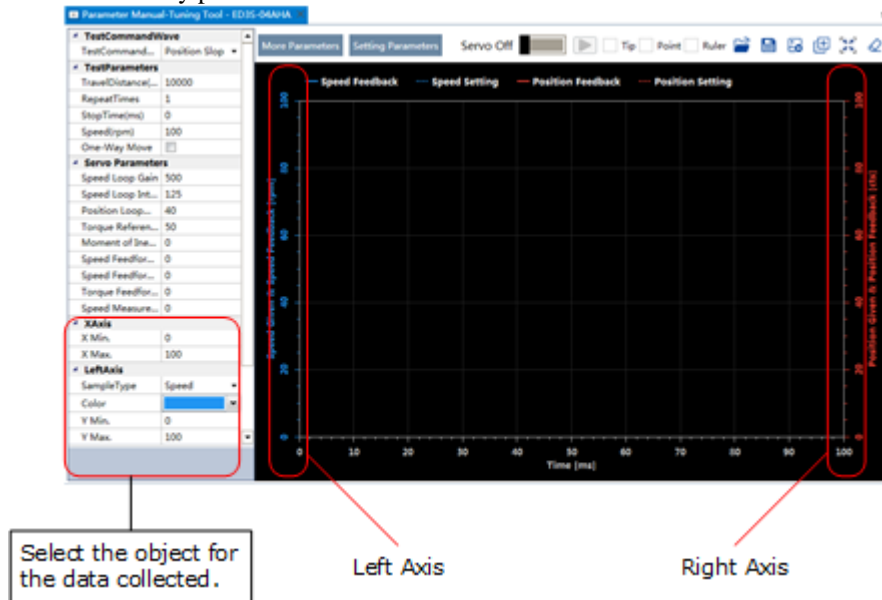
the figure below. (Set **Repeat Times** as 2)



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 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.
Acceleration	1 to 65535	The Acceleration of the motor when the command is executed.
One-Way Move	—	Check this option indicates that the motor is running in One-way movement.

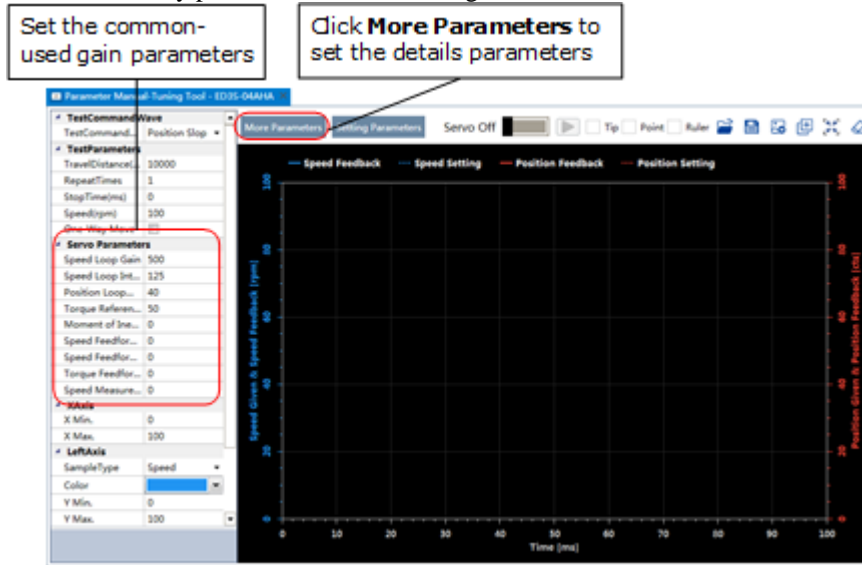
Step 4 Set the necessary parameters for the data collected.



- X Axis: Indicates Times.
- Left Axis: Select **Sample Type** as **Speed** or **Position**.
This selection will affect the **Sample Type** of the Right Axis.
- Right Axis: Select **Sample Type** as **None**, **Speed**, **Position**, or **Offset**.

The setting **Offset** indicates the deviation of the sample type (speed or position) selected by the left axis.

Step 5 Set the necessary parameters for the Servo gain.



The parameters that may be used are shown in Table 9-3.

Table 9-3 The parameters that may be used

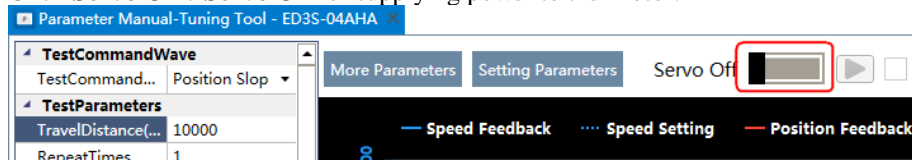
Type	Parameter	Name	Range	Unit	Default	When Enabled
Gain	Pn102	Speed Loop Gain	1 to 10000	rad/s	500	Immediately
	Pn103	Speed Loop Integral Time	1 to 5000	0.1ms	125	Immediately
	Pn104	Position Loop Gain	0 to 1000	1/s	40	Immediately
	Pn105	Torque Command Filter Time	0 to 2500	0.01ms	50	Immediately
	Pn106	Load Inertia Percentage	0 to 9999	%	0	Immediately
	Pn107	Second Speed Loop Gain	1 to 10000	rad/s	250	Immediately
	Pn108	Second Speed Loop Integral Time	1 to 5000	0.1ms	200	Immediately
	Pn109	Second Position Loop Gain	0 to 1000	1/s	40	Immediately
	Pn110	Second Torque Reference Filter Time	0 to 2500	0.01ms	100	Immediately
	Pn116	P/PI Switch Mode	0 to 4	—	0	After restart
	Pn117	Torque Reference Threshold for P/PI Switch	0 to 300	200	%	Immediately


Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn118	Deviation Counter Threshold for P/PI Switch	0 to 10000	0	1 pulse	Immediately
	Pn119	Acceleration Reference Threshold for P/PI Switch	0 to 3000	0	10 rpm/s	Immediately
	Pn120	Speed Reference Threshold for P/PI Switch	0 to 10000	rpm	0	Immediately
	Pn121	Gain Switch Mode	0 to 10	–	0	After restart
	Pn122	Delay Time for Gain Switch	0 to 20000	0.1 ms	0	Immediately
	Pn123	Threshold for Gain Switch	0 to 20000	–	0	Immediately
	Pn124	Speed Threshold for Gain Switch	0 to 2000	rpm	0	Immediately
	Pn125	Ramp Time for Position Loop Gain Switch	0 to 20000	0.1ms	0	Immediately
	Pn126	Hysteresis for Gain Switch	0 to 20000	–	0	Immediately
Feedforward and Vibration Suppression	Pn005	Application Function Selections 5	00d0 to 33d3	–	00d0	After restart
	Pn005.0	Internal Torque Feedforward Method	0 to 3	–	0	
	Pn005.1	Local Control Method	d to d	–	d	
	Pn005.2	Torque Feedforward Method	0 to 3	–	0	
	Pn005.3	Speed Feedforward Method	0 to 3	–	0	
	Pn112	Speed Feedforward	0 to 100	%	0	Immediately
	Pn113	Speed Feedforward Filter Time	0 to 640	0.1ms	0	Immediately
	Pn114	Torque Feedforward	0 to 100	%	0	Immediately
	Pn115	Torque Feedforward Filter Time	0 to 640	0.1ms	0	Immediately

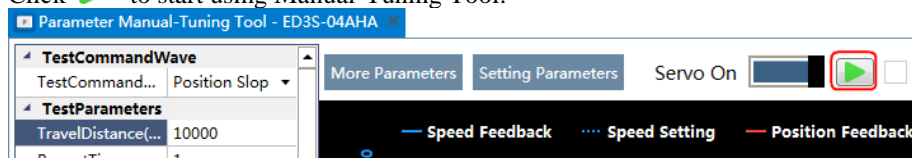
Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn150	Model Following Control Function	0000 to 0002	—	0000	After restart
	Pn150.0	Model Following Control Selection	0 to 2	—	0	
	Pn151	Model Following Control Gain	10 to 1000	1/s	50	Immediately
	Pn152	Model Following Control Gain Correction	20 to 500	%	100	Immediately
	Pn153	Model Following Control Speed Feedforward	0 to 200	%	100	Immediately
	Pn154	Model Following Control Torque Feedforward	0 to 200	%	100	Immediately
	Pn155	Load Oscillation Frequency	50 to 500	0.1Hz	100	Immediately
	Pn156	Filter Time for Load Oscillation Suppression	2 to 500	0.1ms	10	Immediately
	Pn157	Limit for Load Oscillation Suppression	0 to 1000	rpm	100	Immediately
	Pn173	Frequency of Vibration Suppression Filter	100 to 2000	Hz	2000	Immediately
	Pn174	Adjust Bandwidth of Vibration Suppression Filter	1 to 100	—	30	Immediately
	Pn175	Vibration Suppression	0 to 500	—	100	Immediately
	Pn176	Lowpass Filter Time for Vibration Suppression	0 to 50	0.1ms	0	Immediately
	Pn177	Highpass Filter Time for Vibration Suppression	0 to 1000	0.1ms	1000	Immediately
	Pn178	Damping of Vibration Suppression Filter	0 to 500	—	100	Immediately
	Pn181	Frequency of Notch Filter 1	50 to 5000	Hz	5000	Immediately
	Pn182	Depth of Notch Filter 1	0 to 23	—	0	Immediately

Type	Parameter	Name	Range	Unit	Default	When Enabled
	Pn183	Width of Notch Filter 1	0 to 15	–	2	Immediately
	Pn184	Frequency of Notch Filter 2	50 to 5000	Hz	5000	Immediately
	Pn185	Depth of Notch Filter 2	0 to 23	–	0	Immediately
	Pn186	Width of Notch Filter 2	0 to 15	–	2	Immediately
	Pn187	Frequency of Notch Filter 3	50 to 5000	Hz	5000	Immediately
	Pn188	Depth of Notch Filter 3	0 to 23	–	0	Immediately
	Pn189	Width of Notch Filter 3	0 to 15	–	2	Immediately
Others	Pn127	Low Speed Filter	0 to 100	1cycle	0	Immediately
	Pn130	Coulomb Friction Compensation	0 to 3000	0.1%Tn	0	Immediately
	Pn131	Speed Dead Band for Coulomb Friction Compensation	0 to 100	rpm	0	Immediately
	Pn132	Viscous Friction Compensation	0 to 1000	0.1%Tn/1000rpm	0	Immediately
	Pn135	Encoder Speed Filter Time	0 to 30000	0.01ms	4	Immediately
	Pn160	Load Torque Compensation	0 to 100	%	0	Immediately
	Pn161	Load Torque Observer Gain	0 to 1000	Hz	200	Immediately
	Pn162	Feedback Speed Selection	0 to 1	–	0	After restart

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



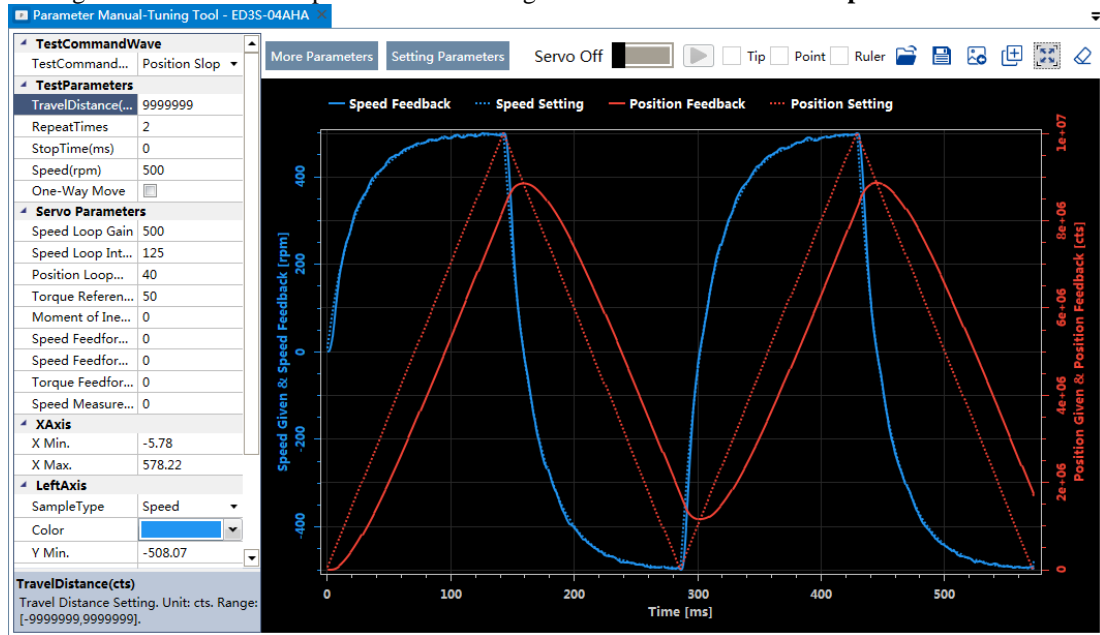
Step 7 Click  to start using Manual-Tuning Tool.



The Motor will run according to the set parameters and perform the data collecting.

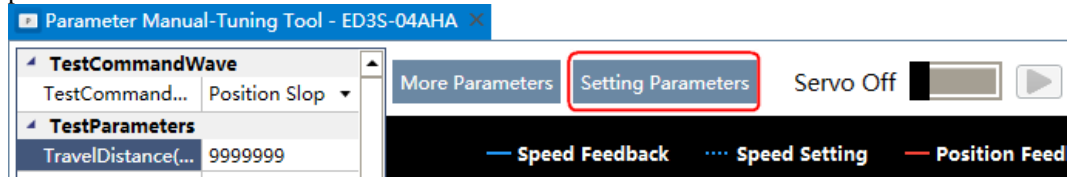
Step 8 When the **Manual-Tuning Tool** function has been completed, the waveform graphics of the data result is displayed in the window.

The figure below is an example of data collecting results with the **Position Slope** command.



Step 9 Repeat setting the parameters and perform the data collecting until result meets the requirements.

Step 10 Click **Setting Parameters** after confirming that the results have reached the desired performance, and the parameters will be written into the Drive.



9.4 Feedback Speed Selection

The speed feedback from the encoder is the calculate result that the Drive read the position value from the encoder and differentiate time.

There is a speed observer inside the Drive for detecting the speed of the motor in real time. The detected speed can be used for host controller monitoring or as a speed feedback for the speed loop.

In the case of low speed or low encoder resolution, the method of position-to-time differentiation introduces large noise. You can set Pn162=1 to use observed speed as the feedback speed.

In addition, you can increase the setting of Pn161 for making the observed speed closer to the actual speed, but overshooting will be likely to occur.

Parameter	Setting	Meaning	When Enabled	Classification
Pn161	—	Load Torque Observer Gain	Immediately	Adjustment
Pn162	0 [Default]	Use encoder speed as the feedback speed.	After restart	Function
	1	Use observed speed as the feedback speed.		

If you keep the default setting of Pn162, you can use a low-pass filter to eliminate the noise and high-frequency band, in this case, you shall set Encoder Speed Filter Time (Pn135) as a proper value.

Increase the setting of Pn135, the filtering effect will be better, and the encoder feedback speed will be smooth, but the phase lag of the speed feedback is also larger, which can reduce the servo performance.

Parameter	Setting	Meaning	When Enabled	Classification
Pn135	—	Encoder Speed Filter Time	Immediately	Adjustment

9.5 Additional Adjustment Functions

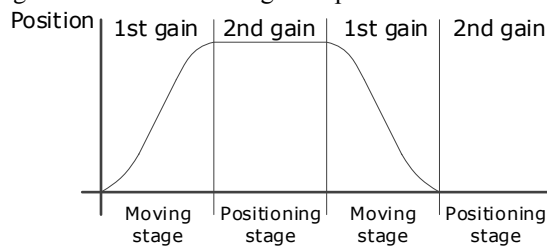
9.5.1 Gain Switching

Function Description

The gain switching function can be used for the manual tuning. It is required to switch from 1st gain parameters to 2nd gain parameters for the Servo operation in a specific stage, so that the overall performance of the Servo system can reach the desired performance.

Take Figure 9-11 as an example, the position stage focuses on the performances such as position ripples and positional rigidity, while the moving stage focuses on the performance such as following error. In this case, two switchable groups of gain parameters are required to meet the Servo performance.

Figure 9-11 Gain switching example

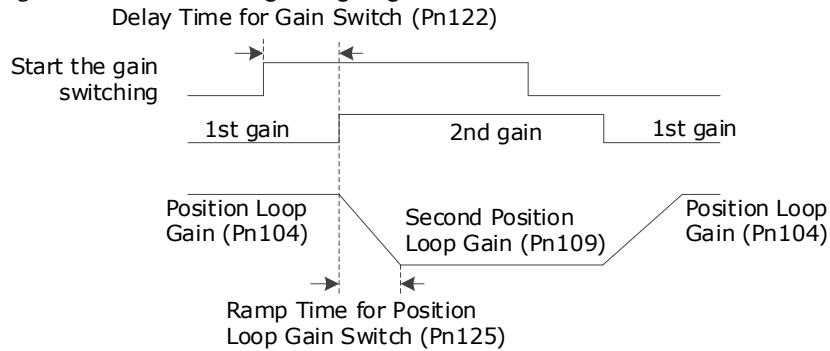


The parameters of the first gain and the second gain are as follows.

Parameter	First Gain	Second Gain
Speed Loop Gain	Pn102	Pn107
Speed Loop Integral Time	Pn103	Pn108
Position Loop Gain	Pn104	Pn109
Torque Command Filter Time	Pn105	Pn110

The gain switching function includes two settings: one is the conditions for starting the gain switching and the other is which process to start the gain switching. Figure 9-12 shows a timing diagram for the gain switching.

Figure 9-12 Gain switching timing diagram



Conditions for the Gain Switching

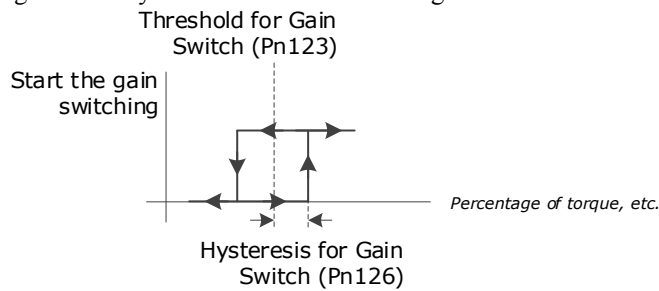
The Drive uses the first group of gain parameters by default. You can set the parameter Pn121 (Gain Switch Mode) as a desired value, so that the second group of gain parameters are used when the condition set in Pn121 are met.

Parameter	Setting	Meaning	When Enabled	Classification
Pn121	0 [Default]	Fixed to first group gains.	After restart	Function
	1	Use external signal (G-SEL) as the condition.		
	2	Use torque reference as the condition (threshold setting: Pn117).		
	3	Use position deviation counter as the condition (threshold setting: Pn118).		
	4	Use acceleration as the condition (threshold setting: Pn119).		
	5	Use speed reference as the condition (threshold setting: Pn120).		
	6	Use position reference as the condition (threshold setting: Pn123).		
	7	Use actual speed as the condition (threshold setting: Pn124).		
	8	Use position reference (Pn123) and actual speed (Pn124) as the condition.		
	9	Fixed to second group gains.		
	10	Use positioning completed flag as the condition.		

- Set Pn121 to 0 (Fixed to first group gains), indicating that the first group of gain parameters is always used.
- Set Pn121 to 1 (Use external signal (G-SEL) as the condition) or 10 (Use positioning completed flag as the condition), indicating that switch to second group of gain parameters when the G-SEL signal is active or positioning completed, otherwise the first group of gain parameters is used.
- Set Pn121 as 2 to 7, indicating that switch to second group of gain parameters when the switching condition exceeds the set threshold value, otherwise the first group of gain parameters is used.

In this case, you can set a proper Hysteresis for Gain Switch (Pn126) to avoid the error between input and output, and Figure 9-13 shows the diagram for this setting.

Figure 9-13 Hysteresis for Gain Switch diagram



- Set Pn121 to 8 (Use position reference and actual speed as the condition), indicating that there are two conditions to be met when switching to the second gain:
 - Condition 1: Hysteresis switching based on position reference, you shall set a proper Threshold value for Gain Switch (Pn123) and Hysteresis for Gain Switch (Pn126). This condition is met when the output exceeds the sum of Pn123 and Pn126.
 - Condition 2: Switch based on actual speed judgment, and you shall set a proper Speed Threshold for Gain Switch (Pn124). This condition is met when the actual speed exceeds the threshold value.

Both condition 1 and condition 2 are met, switching to second group of gain parameters, otherwise the first group of gain parameters is used.

- Set Pn121 to 9 (Fixed to second group gains), indicating that the second group of gain parameters is always used.

Relevant Parameters

Parameter	Setting	Meaning	When Enabled	Classification
Pn122	–	Delay Time for Gain Switch	Immediately	Adjustment
Pn123	–	Threshold for Gain Switch	Immediately	Adjustment
Pn124	–	Speed Threshold for Gain Switch	Immediately	Adjustment
Pn125	–	Ramp Time for Position Loop Gain Switch	Immediately	Adjustment
Pn126	–	Hysteresis for Gain Switch	Immediately	Adjustment

9.5.2 P / PI Switching

The Drive uses the Proportional-Integral Controller by default to adjust the speed loop. You can set Pn116 (P/PI Switch Mode) for switching to the Proportional Controller when the set condition is met.

Parameter	Setting	Meaning	When Enabled	Classification
Pn116	0 [Default]	Use torque reference as the condition (threshold setting: Pn117).	After restart	Function
	1	Use position deviation counter as the condition (threshold setting: Pn118).		
	2	Use acceleration reference as the condition (threshold setting: Pn119)		

Parameter	Setting	Meaning	When Enabled	Classification
	3	Use the speed reference as the condition (threshold setting: Pn120).		
	4	Fixed to PI Control.		

- Set Pn116 to 4 (Fixed to PI Control), indicating that the Proportional-Integral Controller is always used.
- Set Pn116 as 0 to 3, indicating that switch to Proportional Controller when the switching condition exceeds the set threshold value, otherwise the Proportional-Integral Controller is used.

The relevant threshold parameters are shown in the table below.

Parameter	Setting	Meaning	When Enabled	Classification
Pn117	–	Torque Reference Threshold for P/PI Switch	Immediately	Adjustment
Pn118	–	Deviation Counter Threshold for P/PI Switch	Immediately	Adjustment
Pn119	–	Acceleration Reference Threshold for P/PI Switch	Immediately	Adjustment
Pn120	–	Speed Reference Threshold for P/PI Switch	Immediately	Adjustment

Take the default settings as an example, the default setting of Pn116 is **0** (Use torque reference as the condition), and the default Torque Reference Threshold for P/PI Switch (Pn117) is 200, in this case, when the torque reference percentage exceeds 200, the speed loop adjustment will be switched from PI control to P control, and then if the torque reference percentage is not more than 200, the speed loop adjustment is switched to PI control.

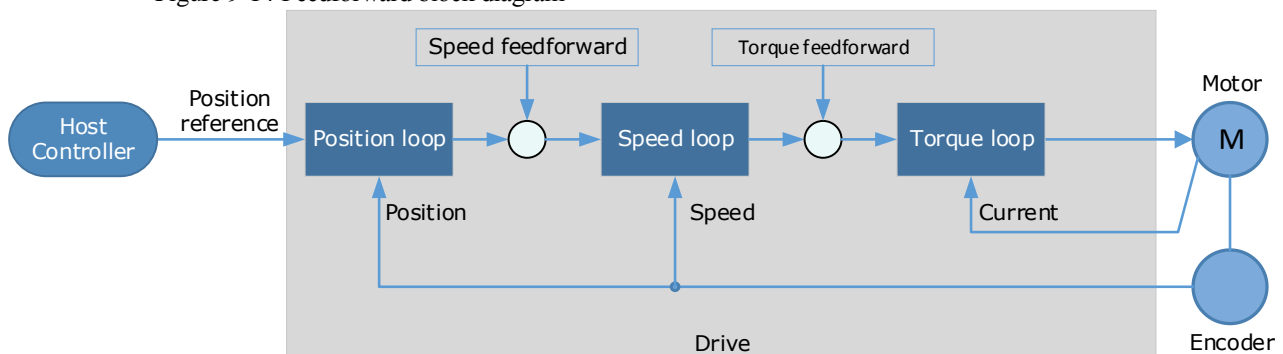
9.5.3 Feedforward

Feedforward includes speed feedforward and torque feedforward.

- Speed feedforward can improve position response and reduce position following error
- Torque feedforward can improve the speed response and reduce the speed following error

Figure 9-14 shows the block diagram in the feedforward function.

Figure 9-14 Feedforward block diagram



In general, the differential of the position reference is used as the feedforward, you can also set the feed forward by the controller or other application functions.

You can set Pn005 to select the method for the feedforward.

Parameter	Setting	Meaning	When Enabled	Classification
Pn005.3	0 [Default]	Use the internal speed feedforward.	After restart	Function
	1	Use the model following control speed feedforward, which is available when Model Following Control Selection (Pn150.0) is enabled.		
	2	Use the speed feedforward set by the controller, which is available in the bus control and set by the object 60B1h.		
	3	Use the speed feedforward generated by Cubic interpolation algorithm, which is available when the object 60C0h is set to Cubic interpolation algorithm in bus control.		
Pn005.2	0 [Default]	Use the internal torque feedforward.		
	1	Use the model following control torque feedforward, which is available when Model Following Control Selection (Pn150.0) is enabled.		
	2	Use the torque feedforward set by the controller, which is available in the bus control and set by the object 60B2h.		
	3	Use the torque feedforward generated by Cubic interpolation algorithm, which is available when the object 60C0h is set to Cubic interpolation algorithm in bus control.		

Internal Feedforward

In order to reduce the overshoot caused by the feedforward when the setting of Pn005.3 or Pn005.2 is 0, it is necessary to set Speed Feedforward (Pn112) or Torque Feedforward (Pn114) to adjust the feedforward compensation value.

- Internal Speed Feedforward = Differential of position reference × Speed Feedforward
- Internal Torque Feedforward = Differential of speed reference × Load Inertia Percentage × Torque Feedforward

In addition, it is required to filter the noise caused by the differential for the feedforward. You can increase the Filter Time for the feedforward, the noise can be filtered better, but overshooting may be occurred.

In the case of high rotation speed, you shall set Pn005.0 to 2 and Pn005.2=0.

Parameter	Setting	Meaning	When Enabled	Classification
Pn005.0	0	Use the general internal torque feedforward.	After restart	Function
	2	Use the high-speed internal torque feedforward.		
Pn112	–	Speed Feedforward	Immediately	Adjustment
Pn113	–	Speed Feedforward Filter Time	Immediately	Adjustment
Pn114	–	Torque Feedforward	Immediately	Adjustment
Pn115	–	Torque Feedforward Filter Time	Immediately	Adjustment

Model Following Control Feedforward

You shall confirm and set that the Model Following Control function has been enabled (Pn150.0=1 or 2), and then set Pn005.3=1(Use the model following control speed) or Pn005.2=1 (Use the model following control torque feedforward).

For details on this method, refers to the section **9.5.6 Model Following Control**.

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

9.5.4 Friction Compensation

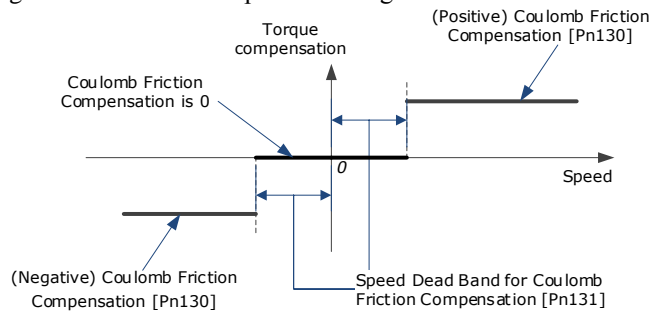
The load friction must exist in the transmission system. However, severe load friction may cause low-speed crawling, waveform distortion at speed zero-crossing, positioning lag, etc., which can affect the dynamic and static performance of the Servo system.

The friction compensation function is that the Drive compensates the load friction by using the relevant parameter settings, which can be used for applications with frequently forward and reverse motion, and high speed-stability requirements.

Friction compensation is used to compensate for viscous friction fluctuations and coulomb friction fluctuations.

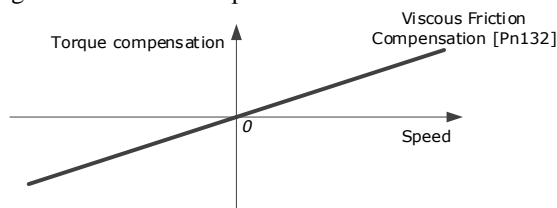
You can set Coulomb Friction Compensation (Pn130) manually, and its direction is consistent with the direction of rotation speed. In addition, it is necessary to set Speed Dead Band for Coulomb Friction Compensation (Pn131) to avoid the Motor changing the compensation direction frequently near zero speed, in this case, the Friction Compensation in the Dead Band is 0, as is shown in Figure 9-15.

Figure 9-15 Friction compensation diagram



The viscous friction compensation is a linear relationship with the Motor speed, as is shown in Figure 9-16. You can set the Viscous Friction Compensation by Pn132.

Figure 9-16 Relationship between viscous friction and speed



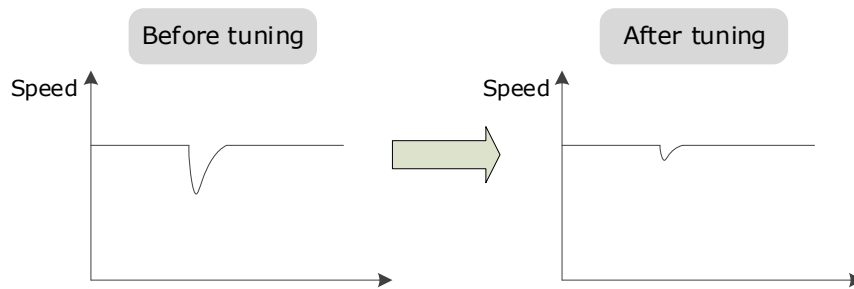
Parameter	Setting	Meaning	When Enabled	Classification
Pn130	—	Coulomb Friction Compensation	Immediately	Adjustment
Pn131	—	Speed Dead Band for Coulomb Friction Compensation	Immediately	Adjustment
Pn132	—	Viscous Friction Compensation	Immediately	Adjustment

9.5.5 Load Torque Compensation

If there is a sudden load torque during the operation of the Motor, the speed will decrease or the position will move. The continuously changing load torque will also cause the speed fluctuation or position jitter. In this case, it is generally necessary to improve the anti-load disturbance performance of the servo by tuning.

In the tuning process, the load torque compensation function can be used to improve the anti-load disturbance performance, considering that the reference response performance and the load disturbance resistance cannot be balanced.

As shown in the figure below, the speed drop is caused by a sudden load torque, and the load torque compensation function can be used to reduce the drop of the speed.



The load torque compensation function is to compensate the load torque compensation to the torque reference through the load torque observer.

To reduce the overshoot caused by load torque compensation, use the load disturbance compensation percentage to adjust the compensation value:

$$\text{Load Torque Compensation} = \text{Load Torque Observer} \times \text{Load Inertia Percentage (Pn160)}$$

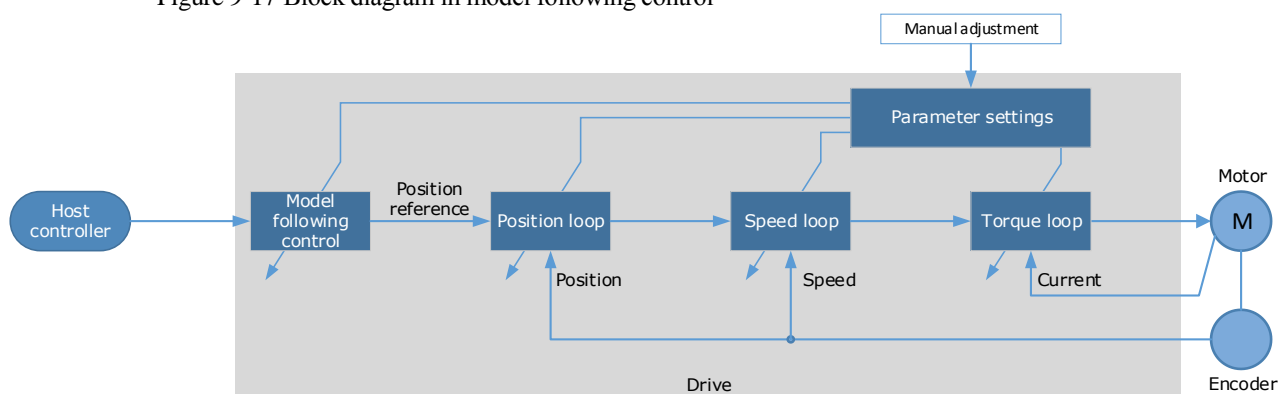
In addition, you can adjust the bandwidth of the load torque observer via Load Torque Observer Gain (Pn161). Increase the setting of Pn161 for making the observed torque closer to the actual torque, but overshooting will be likely to occur.

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

9.5.6 Model Following Control

The Model Following Control is outside of the position loop. In Model Following Control, new position references are generated based on the theoretical motor control model, and relevant speed feedforward and torque feedforward are generated. Applying these controls to the actual control loop can significantly improve the response performance and positioning performance of the position control. Figure 9-17 shows the block diagram in model following control.

Figure 9-17 Block diagram in model following control



To use the Model Following Control function, set the following parameter.

Parameter	Setting	Meaning	When Enabled	Classification
Pn150.0	0 [Default]	Do not use Model Following Control.	After restart	Function
	1	Use the model following control.		

Parameter	Setting	Meaning	When Enabled	Classification
	2	Use the model following control and load oscillation suppression.		

To use the Model Following Control properly, you shall adjust the relevant parameters in the order of **Torque Loop** → **Speed Loop** → **Position Loop** → **Model Following Control**.

For details on the relevant parameter of Torque Loop, Speed Loop and Position Loop, refers to the section 9.2.3 Manual Tuning. The relevant parameters of Model Following Control are as follows.

Parameter	Setting	Meaning	When Enabled	Classification
Pn151	–	Model Following Control Gain	Immediately	Adjustment
Pn152	–	Model Following Control Gain Correction	Immediately	Adjustment

The Model Following Control Gain (Pn151) determines the position response performance, and increase this setting can improve speed of response, but overshooting will be likely to occur.

The Model Following Control Gain Correction (Pn152) determines the damping ratio, and increase this setting can also increase the damping ratio.

The (speed/torque) feedforward in Model Following Control is a percentage factor that is used to adjust the output feedforward.

Parameter	Setting	Meaning	When Enabled	Classification
Pn153	–	Model Following Control Speed Feedforward	Immediately	Adjustment
Pn154	–	Model Following Control Torque Feedforward	Immediately	Adjustment

NOTE: only when Pn005.3=1 or Pn005.2=1, the settings of above parameter are available.

The following application restrictions apply to the Mode Following Control.

- Only applied for the Manual Tuning.
- Only applied for the Position Control Modes.
- It is unavailable in fully-closed loop control.

9.6 Vibration Suppression

9.6.1 Notch Filter

The notch filter is used to eliminate vibration caused by mechanical resonance.

There are three notch filters in the Drive, those who can used independently or in combination, Figure 9-18 shows the block diagram of using the notch filters.

Figure 9-18 Block diagram of using the notch filters

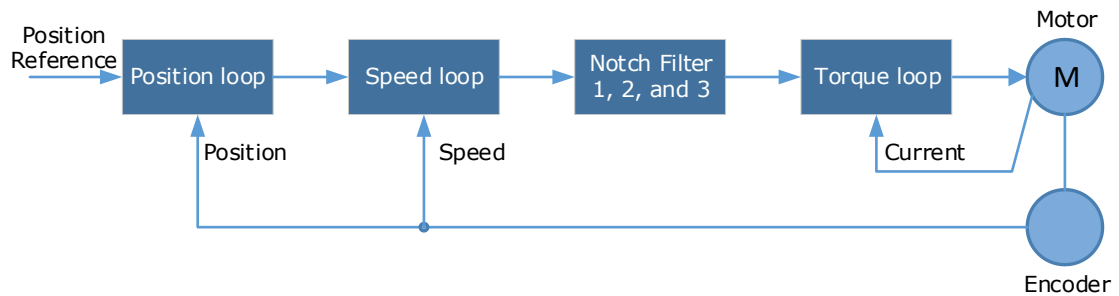
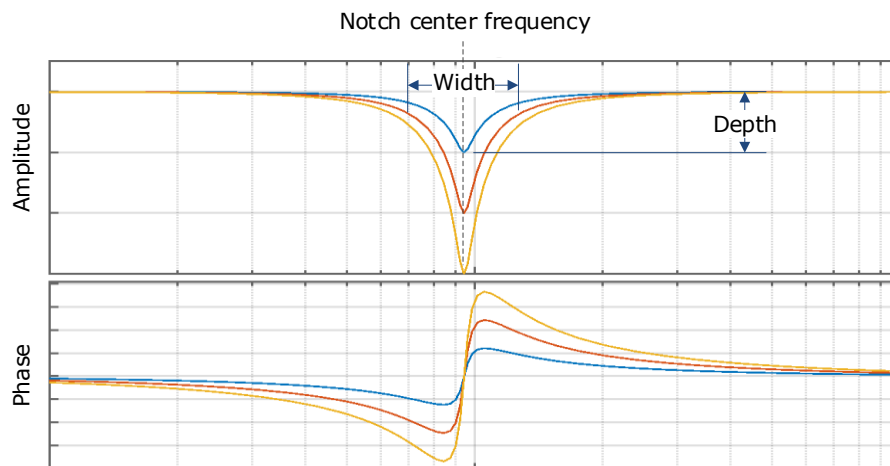


Figure 9-19 shows the relevant parameters for the notch filter. Since the notch filter can attenuate the signal at the notch frequency, if you set a proper frequency (Pn181, Pn184 or Pn187), depth (n182, Pn185 or Pn188) and width (n183, Pn186 or Pn189), the vibration signal in the torque reference can be filtered.

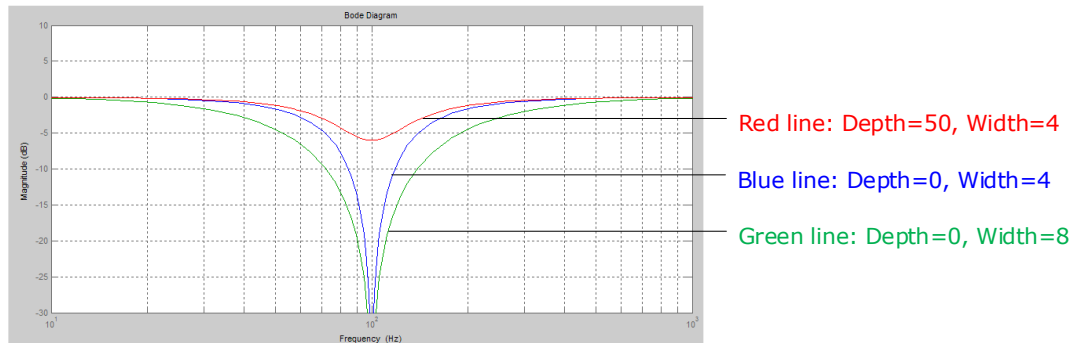
Figure 9-19 Diagram of notch filter parameters



Parameter	Setting	Meaning	When Enabled	Classification
Pn181	—	Frequency of Notch Filter 1	Immediately	Adjustment
Pn182	—	Depth of Notch Filter 1	Immediately	Adjustment
Pn183	—	Width of Notch Filter 1	Immediately	Adjustment
Pn184	—	Frequency of Notch Filter 2	Immediately	Adjustment
Pn185	—	Depth of Notch Filter 2	Immediately	Adjustment
Pn186	—	Width of Notch Filter 2	Immediately	Adjustment
Pn187	—	Frequency of Notch Filter 3	Immediately	Adjustment
Pn188	—	Depth of Notch Filter 3	Immediately	Adjustment

Parameter	Setting	Meaning	When Enabled	Classification
Pn189	—	Width of Notch Filter 3	Immediately	Adjustment

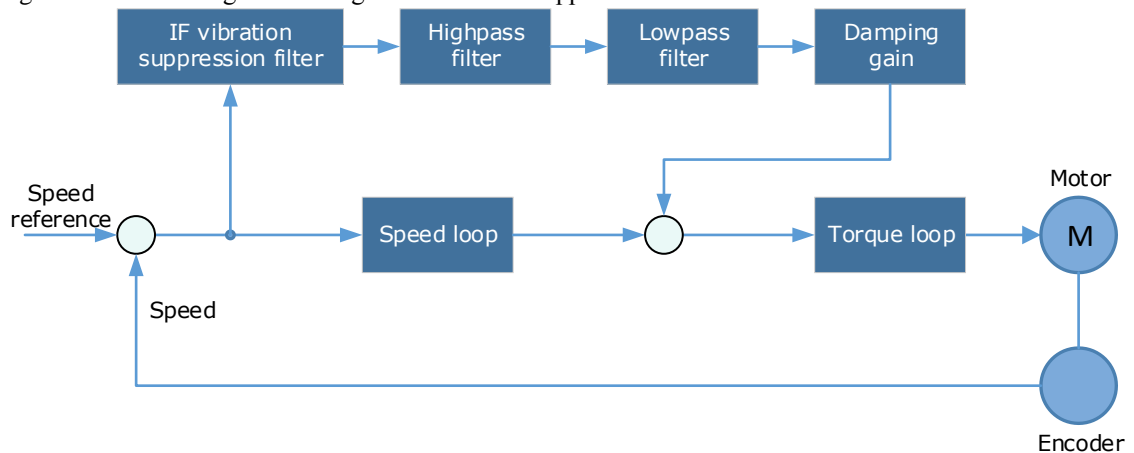
- Set the frequency of notch filter to 5000, indicating the notch filter is unavailable.
- The setting range of the depth is from 0 to 23.
- The setting range of the width is from 0 to 15.



9.6.2 IF (Intermediate Frequency) Vibration Suppression

The IF vibration suppression filter is used to process the speed deviation and compensated to the torque reference. It is applied for the frequency range 100 Hz to 2000 Hz. Figure 9-20 shows the block diagram of using the IF vibration suppression filter.

Figure 9-20 Block diagram of using the IF vibration suppression filter



- Pn173 determines the frequency center at which vibration suppression is to be performed.
- Pn174 determines the vibration suppression bandwidth of the filter, indicating the range of the adjustment filter near the center frequency. Increase this setting can increase the range of vibration suppression, but it will affect the phase of the frequency near the center.
- The highpass filter and the lowpass filter are respectively used to filter high frequency DC signals and low frequency DC signals.
- Pn178 determines the level of the final compensated IF vibration suppression.

Parameter	Setting	Meaning	When Enabled	Classification
Pn173	—	Frequency of Vibration Suppression Filter	Immediately	Adjustment

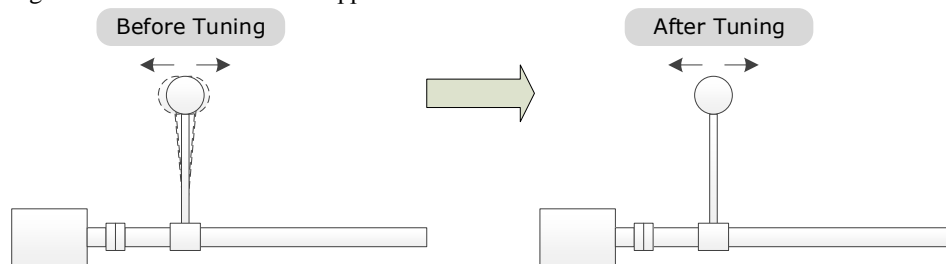
Parameter	Setting	Meaning	When Enabled	Classification
Pn174	–	Adjust Bandwidth of Vibration Suppression Filter	Immediately	Adjustment
Pn175	–	Vibration Suppression	Immediately	Adjustment
Pn176	–	Lowpass Filter Time for Vibration Suppression	Immediately	Adjustment
Pn177	–	Highpass Filter Time for Vibration Suppression	Immediately	Adjustment
Pn178	–	Damping of Vibration Suppression Filter	Immediately	Adjustment

NOTE: Set Pn173 to 2000, indicating the notch filter is unavailable.

9.6.3 Load Oscillation Suppression

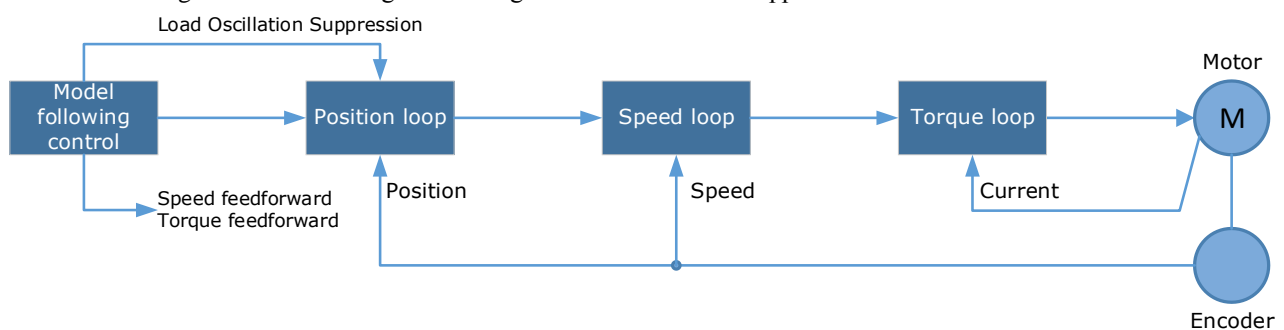
Use the Load Oscillation Suppression function for suppressing low frequency jitter at the end of the load during position control, as is shown in Figure 9-21.

Figure 9-21 Load Oscillation Suppression



This function is based on the Model Following Control. According to the relationship between the load position and the Motor position in the Model Following Control, aiming at controlling the stability of the load position, and correcting the position reference, as well as the feedforward generated by the Model Following Control. Figure 9-22 shows the block diagram of using the Load Oscillation Suppression.

Figure 9-22 Block diagram of using the Load Oscillation Suppression



Parameter	Setting	Meaning	When Enabled	Classification
Pn150.0	2	Use the model following control and load oscillation suppression.	After restart	Function
Pn155	–	Load Oscillation Frequency	Immediately	Adjustment

Parameter	Setting	Meaning	When Enabled	Classification
Pn156	–	Filter Time for Load Oscillation Suppression	Immediately	Adjustment
Pn157	–	Limit for Load Oscillation Suppression	Immediately	Adjustment

- Pn155 determines frequency at which Load Oscillation Suppression is to be performed.
- Pn156 determines the filter time. You can increase this setting, and the filtering effect will be better. However, it may reduce the suppression effect due to the lag.
- You can set Limit for Load Oscillation Suppression (Pn157) as a proper limit value, helping to reduce overshooting during the start and stop.

Frequency Detection for Load Oscillation Suppression

If the frequency for the Load Oscillation Suppression can be detected by a measuring instrument (laser interferometer, etc.), please write the frequency data (in 0.1 Hz) into the Pn155 directly.

You can also use related functions in ESView V4 (FFT, etc.) to measure the frequency for the Load Oscillation Suppression.

Application Restrictions

The following application restrictions apply to the Load Oscillation Suppression.

- Load Oscillation Suppression can only be used when the Model Following Control is in effect.
- Only applied for the Manual Tuning.
- Only applied for the Position Control Modes.
- It is unavailable in fully-closed loop control.

9.6.4 Automatic Vibration Suppression

The automatic vibration suppression function determines the vibration state by the motor during operation and recognizes the vibration frequency, and then selects the notch filter or the intermediate frequency vibration suppression function according to the characteristics of the vibration and automatically sets the vibration frequency.

The automatic vibration suppression function determines and detects the vibration frequency during the operation of the Motor, and then choose the notch filter or the IF suppression function, and set the relevant parameters for the vibration suppression.

Parameter	Setting	Meaning	When Enabled	Classification
Pn100.2	0 [Default]	Automatic Vibration Suppression is disabled.	After restart	Function
	1	Automatic Vibration Suppression is enabled.		
Pn179	–	Amplitude Threshold for Vibration Detection	Immediately	Adjustment

Pn179 determines the threshold of a frequency amplitude. If the detected frequency amplitude exceeds this setting, it will be regarded as a vibration.

Applied in Tuning-less, One-Parameter Auto-Tuning, Manual Tuning, and Manual-Tuning Tool

When the automatic vibration suppression function is applied in the Tuning-less, One-Parameter Auto-Tuning, Manual Tuning, and Manual-Tuning Tool, the following parameters can be set temporarily.

Parameter	Setting	Meaning	When Enabled	Classification
Pn184	–	Frequency of Notch Filter 2	Immediately	Adjustment
Pn173	–	Frequency of Vibration Suppression Filter	Immediately	Adjustment

Applied in Auto-Tuning Tool

When the automatic vibration suppression function is applied in the Auto-tuning Tool, the following parameters can be preset, and you can decide whether to write into the Drive.

Parameter	Setting	Meaning	When Enabled	Classification
Pn181	–	Frequency of Notch Filter 1	Immediately	Adjustment
Pn184	–	Frequency of Notch Filter 2	Immediately	Adjustment
Pn187	–	Frequency of Notch Filter 3	Immediately	Adjustment
Pn173	–	Frequency of Vibration Suppression Filter	Immediately	Adjustment

9.7 Diagnostic Tools

9.7.1 Load Inertia Identification

The Load Inertia Identification function is used to calculate the load inertia relative to the motor rotor inertia (percentage of load inertia).

The motor will rotate back and forth several times (the maximum rotations is 8) when using this function. You can change the number of motor rotations for this function by the parameter Pn172.

Parameter	Setting	Meaning	When Enabled	Classification
Pn172	0 [Default]	8 rotations	Immediately	Function
	1	4 rotations		



- 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 Press [M] key several times to select the Utility Function Mode.



Step 2 Press [▲] key or [▼] key to select the function number Fn009.



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



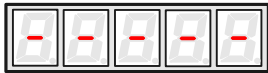
Step 4 Press [M] key to execute the load inertia identification.
At this time, Panel Operator displays the speed of the Motor in real time.

Step 5 When this operation has been completed, Panel Operator will display the detection result (Unit: %).



NOTE: You can press the [M] key several times to execute this operation until the detection result is confirmed.

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

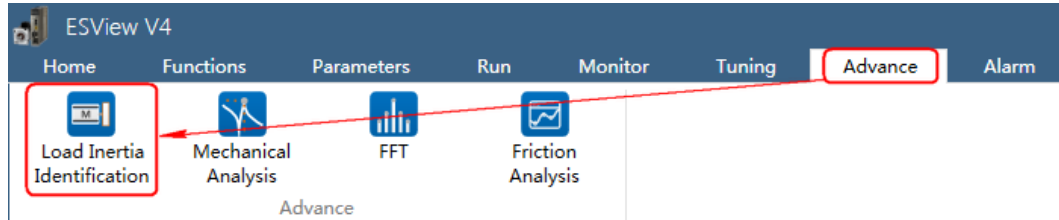


Step 7 Press [◀] key to return to the display of the Fn009.

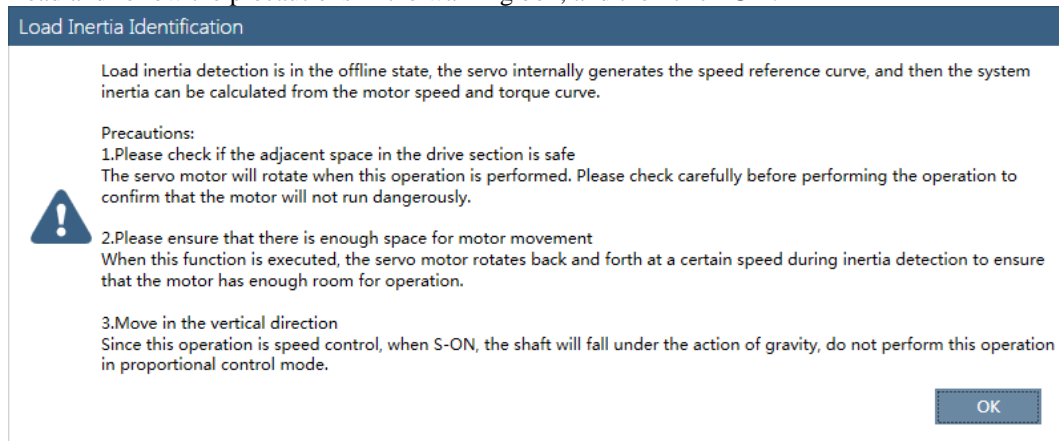
Use the ESView V4

The following are the steps to execute the load inertia identification by using ESView V4.

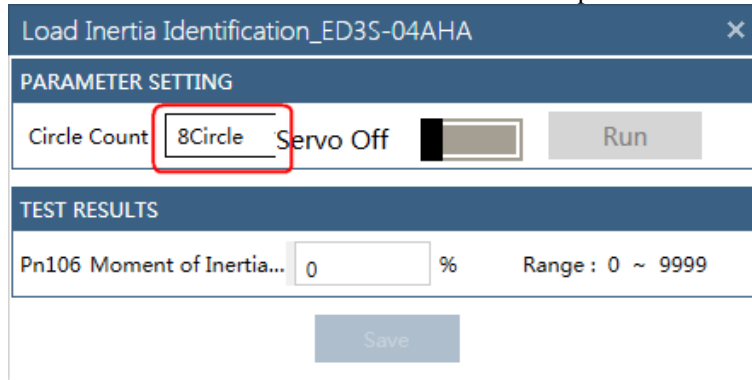
Step 1 Select **Advance** → **Load Inertia Identification** in the **Menu Bar** of the *ESView V4* main windows.



Step 2 Read and follow the precautions in the warning box, and then click **OK**.



- Step 3 Set **Circle Count** on the **Load Inertia Identification** dialog box, indicating the rotation number of the Motor when **Load Inertia Identification** function is performed.



Load Inertia Identification_ED3S-04AHA

PARAMETER SETTING

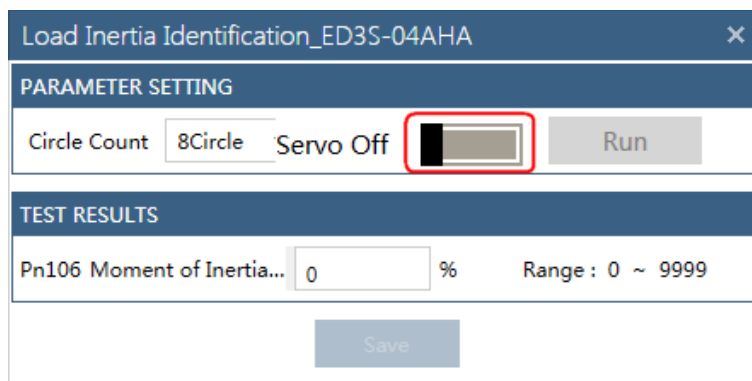
Circle Count **8Circle** Servo Off ☒ Run

TEST RESULTS

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

Save

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



Load Inertia Identification_ED3S-04AHA

PARAMETER SETTING

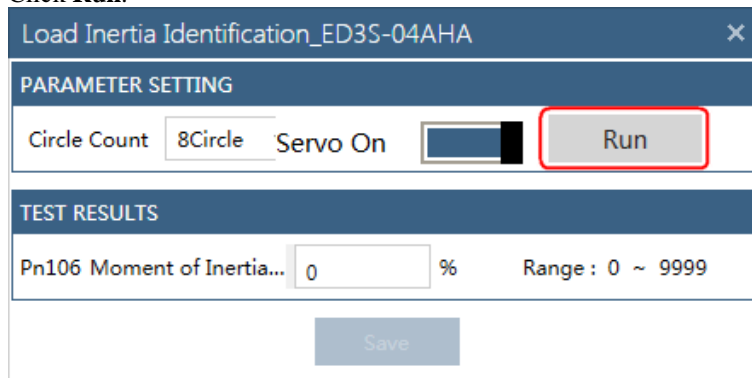
Circle Count 8Circle Servo Off ☒ Run

TEST RESULTS

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

Save

- Step 5 Click **Run**.



Load Inertia Identification_ED3S-04AHA

PARAMETER SETTING

Circle Count 8Circle Servo On ☒ Run

TEST RESULTS

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

Save

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

Load Inertia Identification_ED3S-04AHA

PARAMETER SETTING

Circle Count 8Circle Servo Off ☒ Run

TEST RESULTS

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

Save

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

Load Inertia Identification_ED3S-04AHA

PARAMETER SETTING

Circle Count 8Circle Servo Off ☒ Run

TEST RESULTS

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

Save

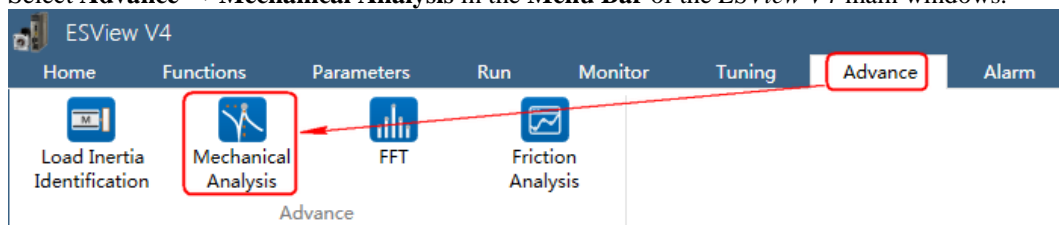
9.7.2 Mechanical Analysis



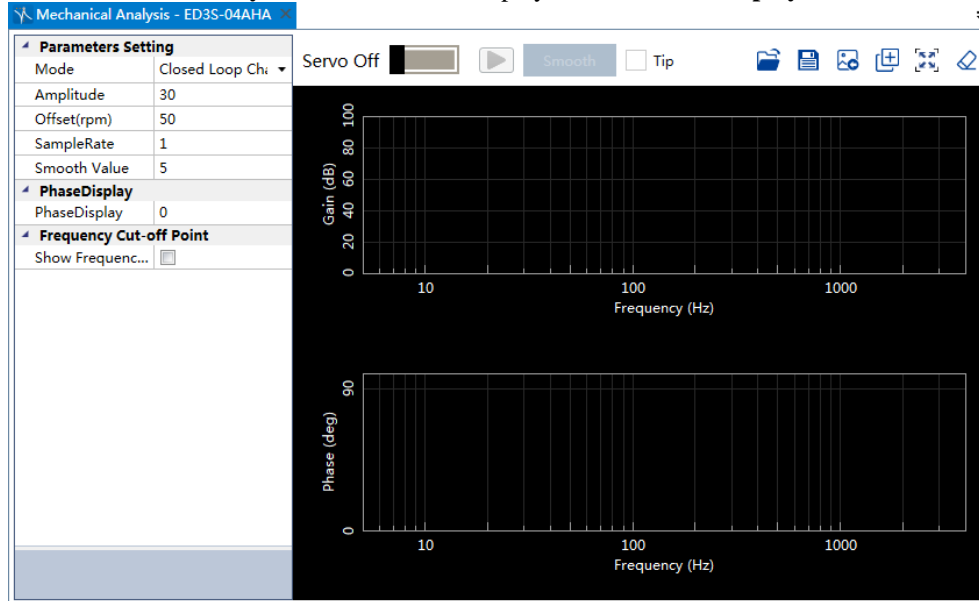
Stop the motor running before performing this function.

This function measures the frequency characteristics of a mechanical system where a servo drive is connected to a PC. It enables the measurement of mechanical frequency characteristics without the use of special equipment.

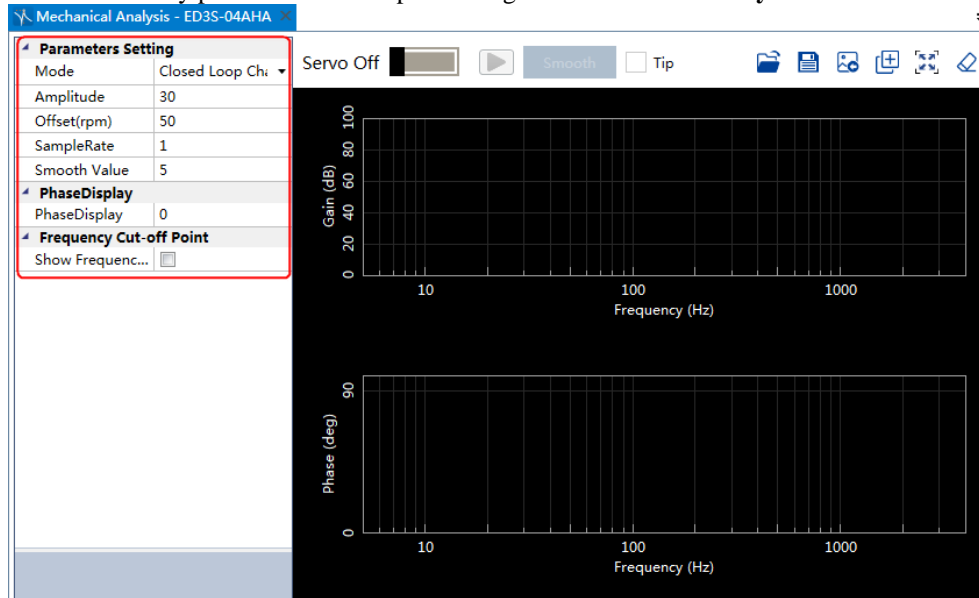
Step 1 Select **Advance** → **Mechanical Analysis** in the **Menu Bar** of the *ESView V4* main windows.



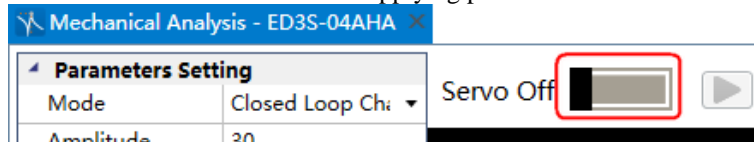
Step 2 The **Mechanical Analysis** window will be displayed in **Function Display Area**.



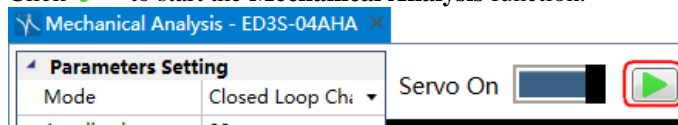
Step 3 Set the necessary parameters before performing the **Mechanical Analysis** function.



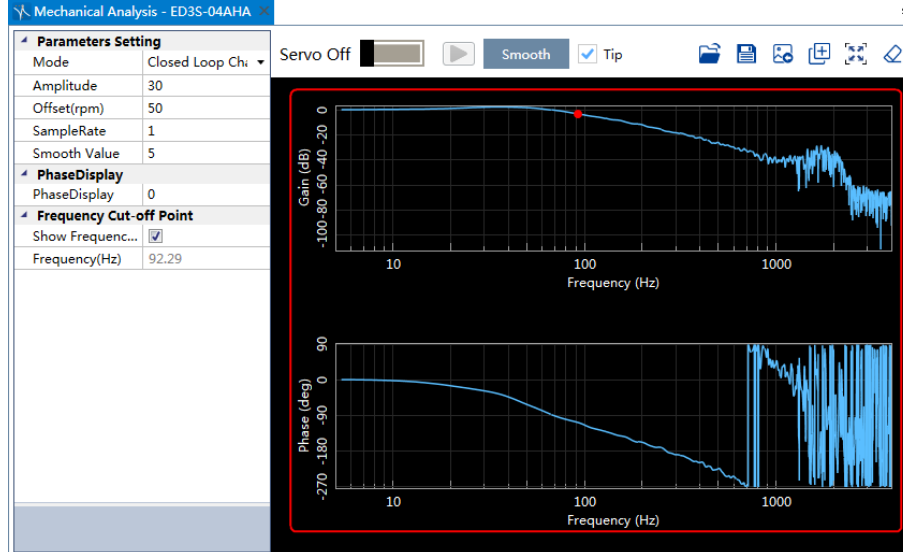
Step 4 Click **Servo Off** / **Servo On** for supplying power to the Motor.



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



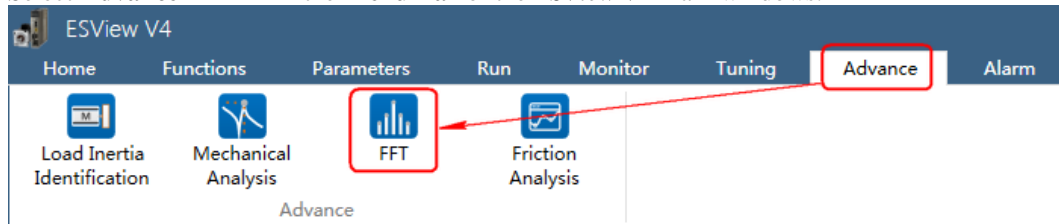
Step 6 When the **Mechanical Analysis** function has been completed, the waveform graphics of the data result is displayed in the window.



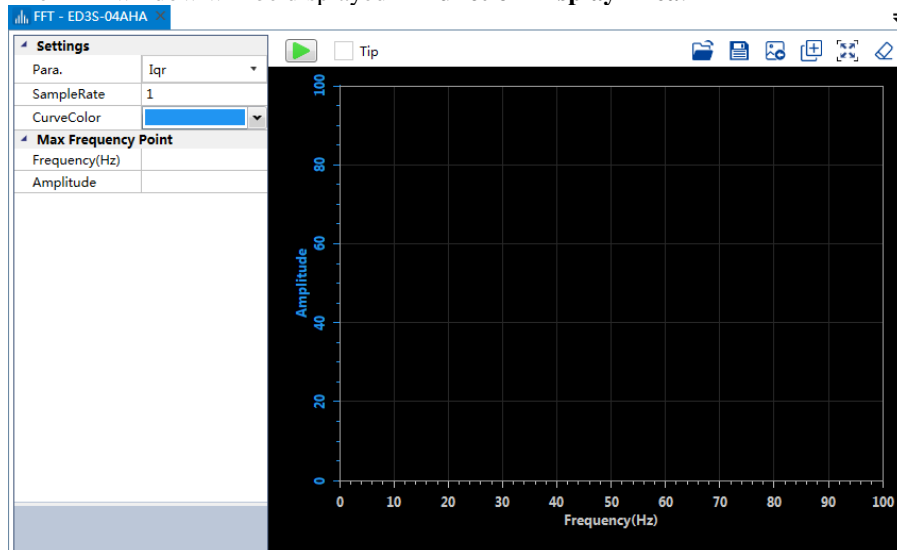
9.7.3 FFT

This function can analyze the vibration frequency of the machine and draw the graphics on the window when the motor is running.

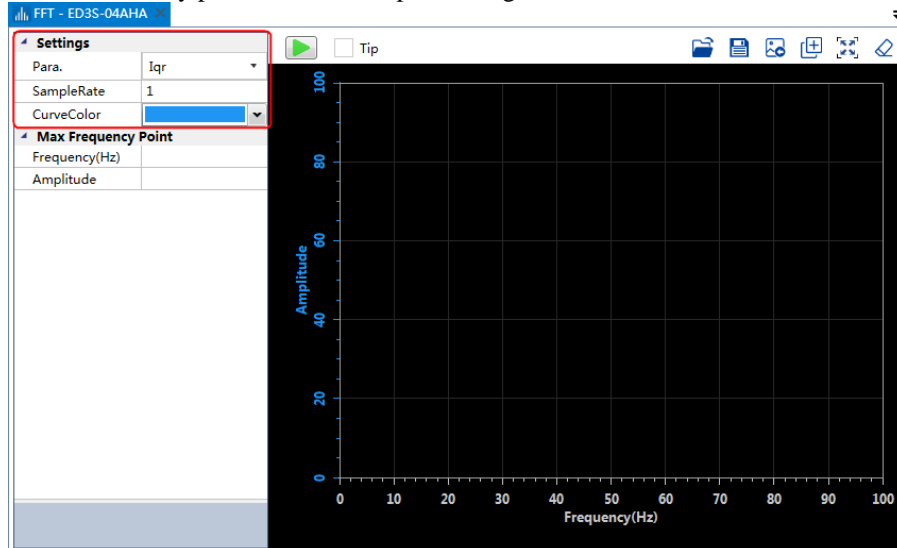
Step 1 Select **Advance** → **FFT** in the **Menu Bar** of the *ESView V4* main windows.




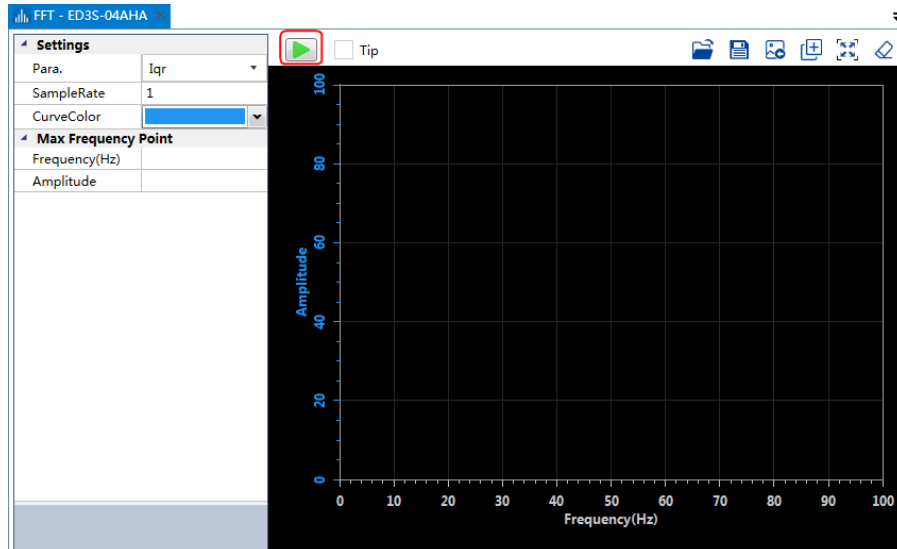
Step 2 The **FFT** window will be displayed in **Function Display Area**.



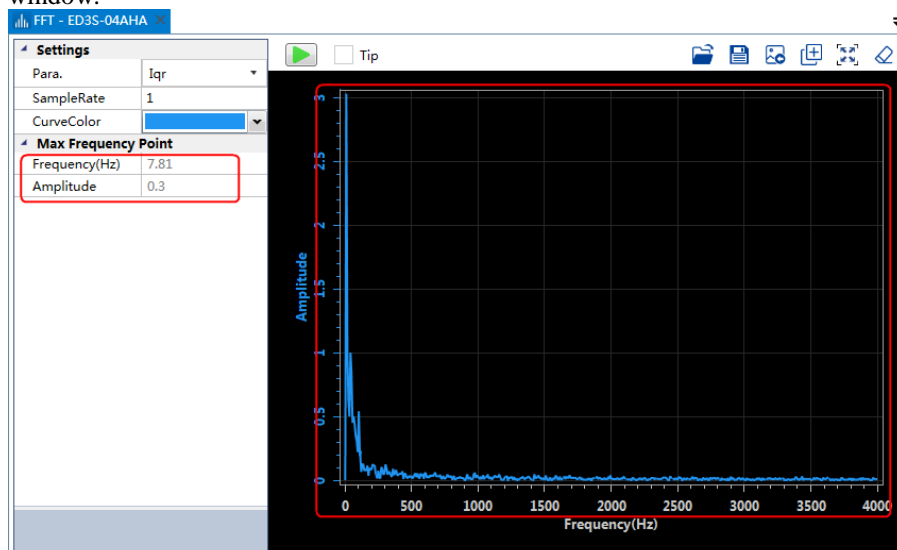
Step 3 Set the necessary parameters before performing the FFT function.



Step 4 Click  to start the FFT function.



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



9.7.4 Friction Analysis

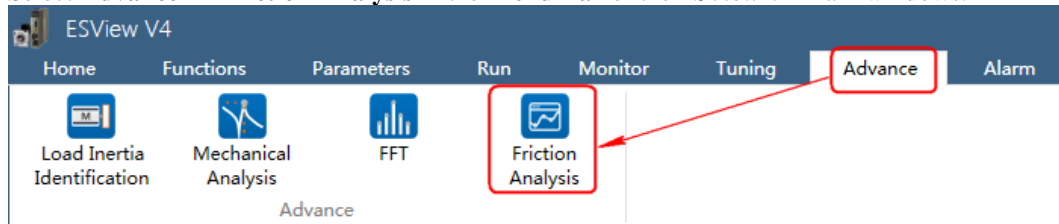


CAUTION

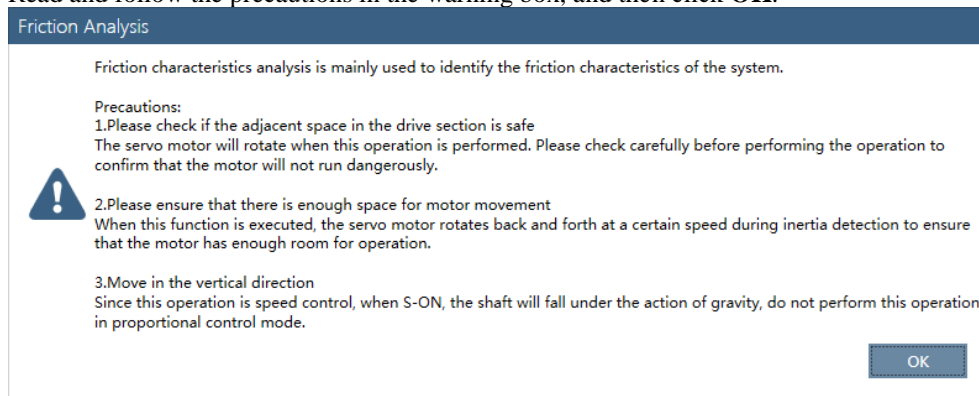
Stop the motor running before performing this function.

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.

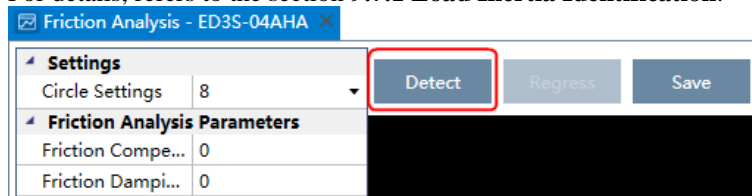


Step 2 Read and follow the precautions in the warning box, and then click **OK**.

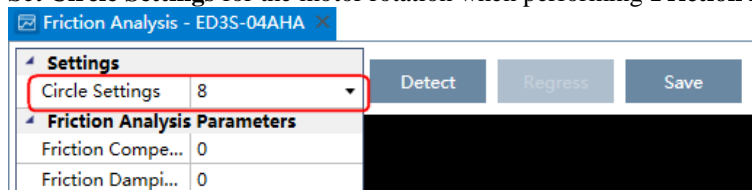


Step 3 The **Friction Analysis** window will be displayed in **Function Display Area**.

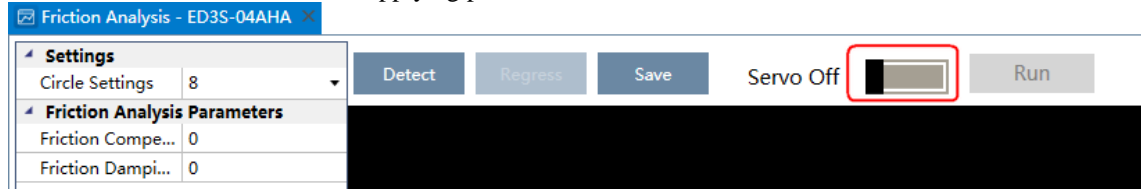
Step 4 Click **Detect** to perform Load Inertia Identification function if necessary.
For details, refers to the section **9.7.1 Load Inertia Identification**.



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



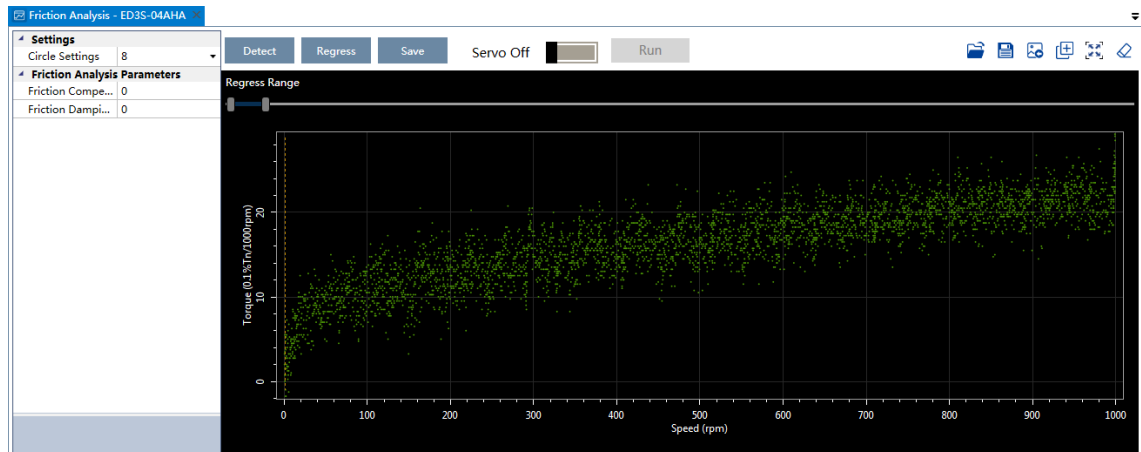
Step 6 Click **Servo Off / Servo On** for supplying power to the Motor.



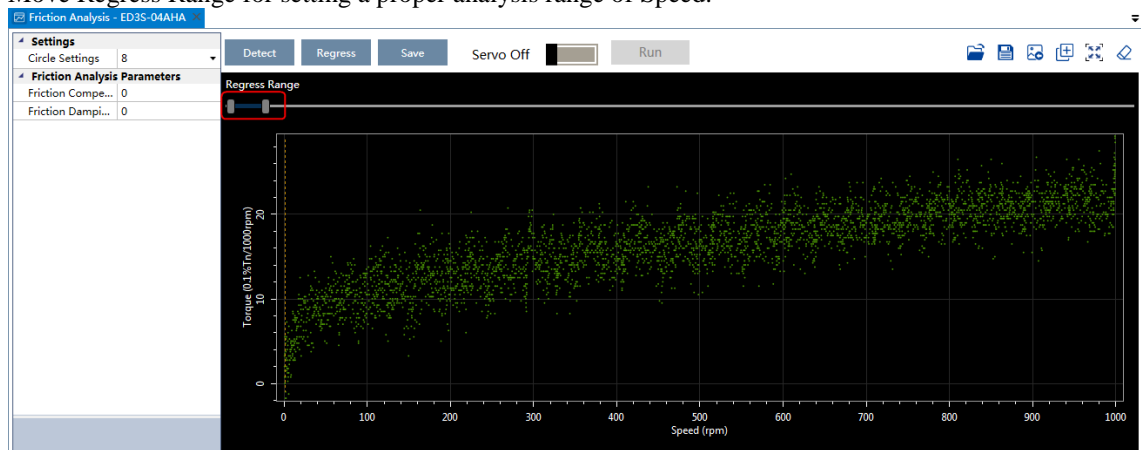
Step 7 Click **Run**.



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

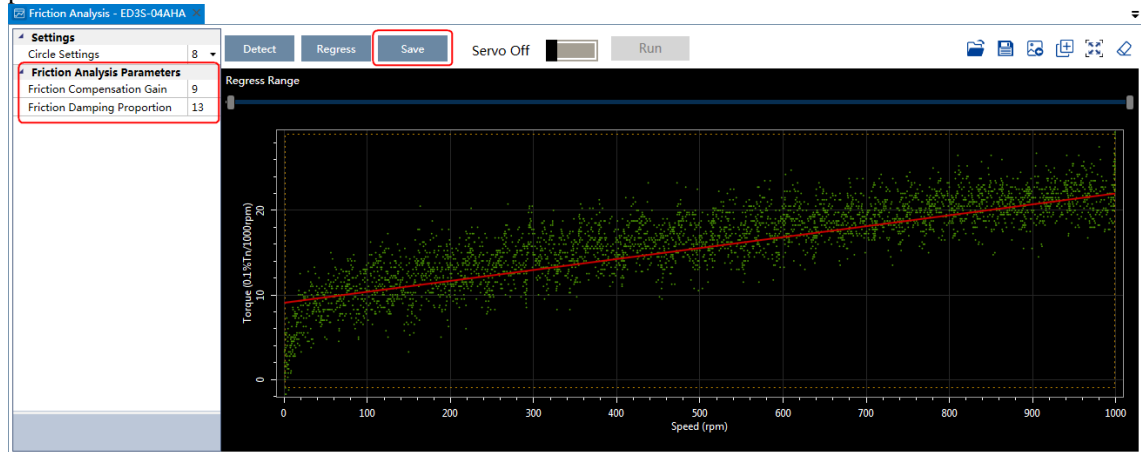


Step 9 Move **Regress Range** for setting a proper analysis range of Speed.



Step 10 Click **Regress** for calculating the **Friction Compensation Gain** and **Friction Damping Proportion**.

Step 11 Click **Save** to write **Friction Compensation Gain** and **Friction Damping Proportion** into the parameters Pn130 and Pn132 of the Drive.

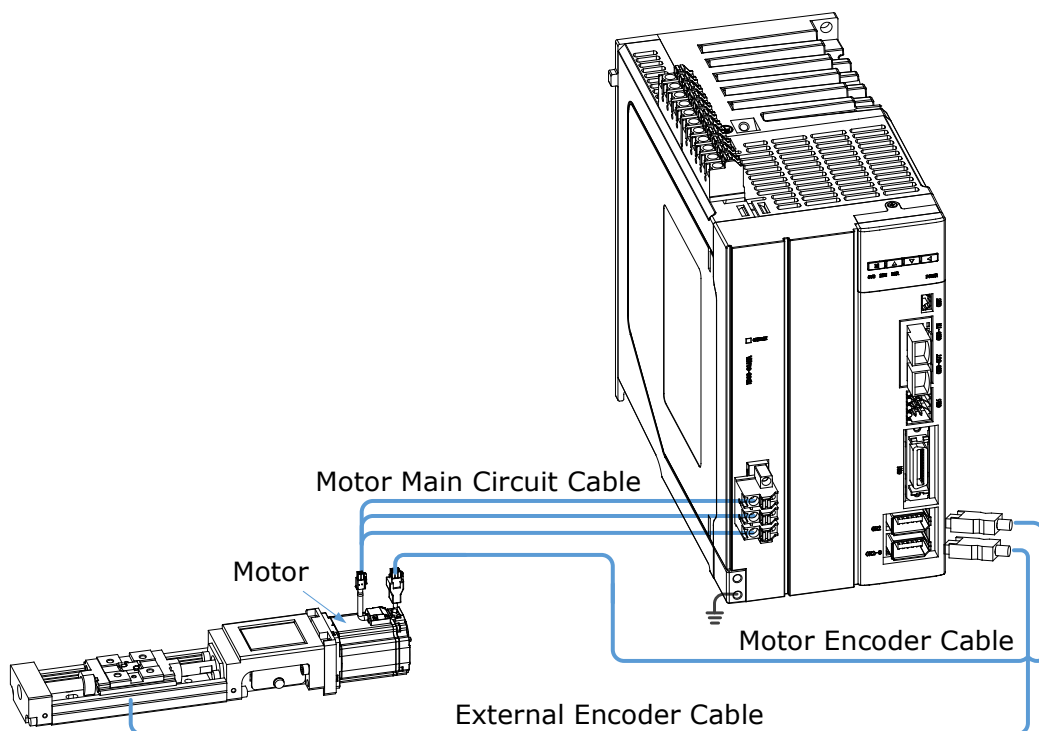


Chapter 10 Fully-Closed Loop Control

10.1 Overview

With a fully-closed system, an externally installed encoder is used to detect the position of the controlled machine and the machine's position information is fed back to the DRIVE. High-precision positioning is possible because the actual machine position is fed back directly. With a fully-closed system, looseness or twisting of mechanical parts may cause vibration or oscillation, resulting in unstable positioning.

The following figure shows an example of the system configuration.



10.2 Commissioning Procedure

First, confirm that the DRIVE operates correctly with semi-closed loop control, and then confirm that it operates correctly with fully-closed loop control.

The commissioning procedure for the DRIVE for fully-closed loop control is given below.

- Step 1 Complete the wiring and connection of the Drive and Motor, and connect to the machine.
Refers to the section **8.4 Motor Operation with a Load**.
- Step 2 Set Pn210.0=0 (Do not use an external encoder) to specify semi-closed loop control.
- Step 3 With the JOG operation, move the movable part on the machine side to an appropriate position, and then confirm the Motor's motion in forward rotation and reverse rotation.
For details on JOG operation, refers to the section **8.3.3 JOG Operation**.
- Step 4 Set Pn210.0=1 (Use an external encoder) to specify fully-closed loop control.

Step 5 Using the JOG operation again to confirm the Motor's motion in forward rotation and reverse rotation.

Step 6 Resolve the following alarms and reset the system.

- If alarms A90 (Phase A Disconnected), A91 (Phase B Disconnected), A92 (Phase C Disconnected) alarms occur, check the wiring of the external encoder.
- If an alarm A93 (Encoder Communications Error) occurs, contact ESTUN or the Authorized Distributor.
- If an alarm A94 (Position Deviation Overflow) occurs, check the settings of Pn210, Pn212, Pn213 and Pn214. Also, you may check the wiring of the external encoder, and check if the mechanical connection structure is loose, slippery or has a large gap.

Step 7 Check the settings of parameters Pn210.3, Pn212, and Pn213.

- You may set Pn210.3 to change the count direction of the external encoder.
- According to your application, set Pn212 to change the size of the external encoder resolution.
- Set Pn213 to change Position Deviation Threshold between Encoder and External Encoder.

Step 8 Try to use the PJOG operation to confirm the Motor's motion.
For details on PJOG operation, refers to the section **8.5 Program Jogging**.

Step 9 Refers to the Step 6, to resolve possible alarms until the alarm no longer occurs.

Step 10 Confirm that the servo can operate normally in PJOG operation, indicating that the Servo can operate in fully-closed loop control.

10.3 Parameter Settings

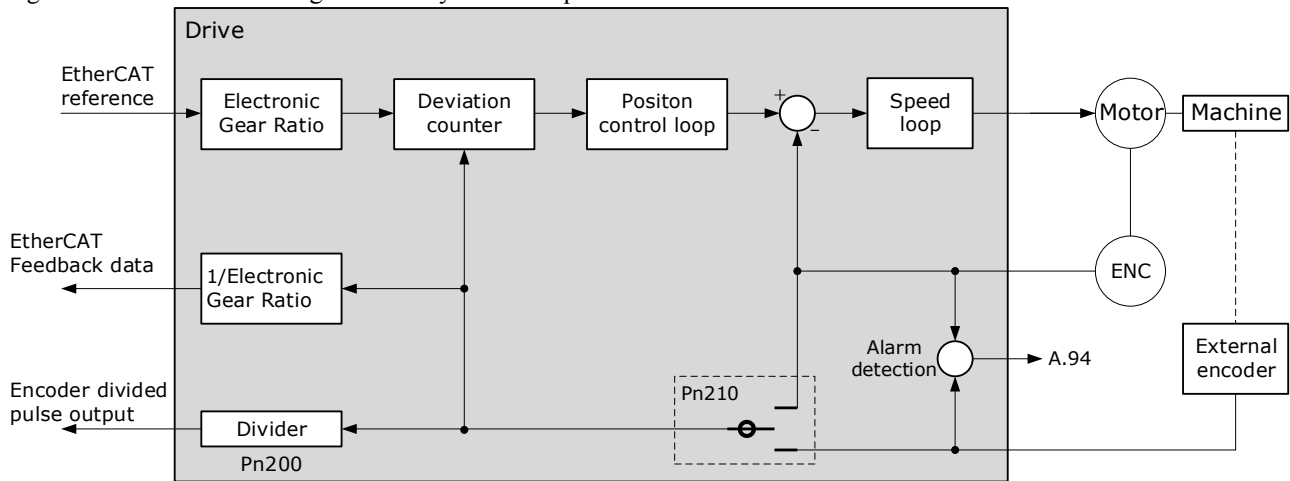
To properly perform fully-closed loop control, you may set the following parameters.

Parameter	Name	Reference
Pn001.0	CCW, CW	7.2 Motor Rotation Direction
Pn200	Pulse Numbers for PG Frequency Division	7.7.3 Encoder Divided Pulse Output
Pn210.0	External Encoder Selection	10.3.3 External Encoder Enabled
Pn210.1	External Encoder Output Pulse Setting	7.7.3 Encoder Divided Pulse Output
Pn210.2	External Encoder Phase Sequence Selection	7.7.3 Encoder Divided Pulse Output
Pn210.3	Direction of External Encoder	10.3.2 Motor Direction and Machine Movement Direction Setting
Pn211.0	C-pulse of External Encoder	—
Pn212	Resolution of External Encoder	10.3.3 External Encoder Enabled
Pn213	Position Deviation Threshold between Encoder and External Encoder	10.3.5 Alarm Detection Settings
Pn214	Position Deviation Clear between Encoder and External Encoder	10.3.5 Alarm Detection Settings

10.3.1 Control Block Diagram

The control block diagram for fully-closed loop control is as shown in Figure 10-1.

Figure 10-1 Control block diagram for fully-closed loop control



10.3.2 Motor Direction and Machine Movement Direction Setting

You must set the motor direction and the machine movement direction. To perform fully-closed loop control, you must set the motor rotation direction with both Pn001.0 (CCW, CW) and Pn210.3 (Direction of External Encoder).

Pn001.0 (CCW, CW) ⁽¹⁾		Pn210.3 (Direction of External Encoder)			
		0 (Not invert)		1 (Invert)	
0 (CCW)	Reference direction	Forward reference	Reverse reference	Forward reference	Reverse reference
	Motor direction	CCW	CW	CCW	CW
	External encoder ⁽²⁾	Forward movement	Reverse movement	Reverse movement	Forward movement
1 (CW)	Reference direction	Forward reference	Reverse reference	Forward reference	Reverse reference
	Motor direction	CW	CCW	CW	CCW
	External encoder	Reverse movement	Forward movement	Forward movement	Reverse movement

(1): Phase B leads in the divided pulses for a forward reference regardless of the setting of Pn001.0.

(2): Forward direction: The direction in which the pulses are counted up. Reverse direction: The direction in which the pulses are counted down.

10.3.3 External Encoder Enabled

Set Pn210.0=1 (Use an external encoder) to specify fully-closed loop control.

In addition, set the parameter Pn212 (Resolution of External Encoder) to specify the resolution of the external encoder, indicating the numbers of AB quadrature pulse edges emitted by the external encoder after one rotation of the Motor (one quadrature pulse has four edges, that is, the pulse numbers $\times 4$).

Parameter	Name	Range	Unit	Default	When Enabled
Pn210.0	External Encoder Selection	0 to 1	–	0	After restart
Pn212	Resolution of External Encoder	1 to 1048576	1 pulse	10000	After restart

10.3.4 Encoder Divided Pulse Output for External Encoder

To use the encoder divided pulse output, you shall set Pn200 (Pulse Numbers for PG Frequency Division) and parameter Pn210.1 (External Encoder Output Pulse Setting).

For details on encoder divided pulse output, refers to the section 7.7.3 Encoder Divided Pulse Output.

If the external encoder is used for the divided pulse output (Pn210.1=1), you can also set Pn210.2 to select whether to invert the output signals.

Parameter	Name	Range	Unit	Default	When Enabled
Pn200	Pulse Numbers for PG Frequency Division	16 to 16384	1 pulse	16384	After restart
Pn210.1	External Encoder Output Pulse Setting	0 to 1	–	0	After restart
Pn210.2	External Encoder Phase Sequence Selection	0 to 1	–	0	After restart

10.3.5 Alarm Detection Settings

This setting is used to detect the difference between the feedback position of the motor encoder and the feedback load position of the external encoder for fully-closed loop control.

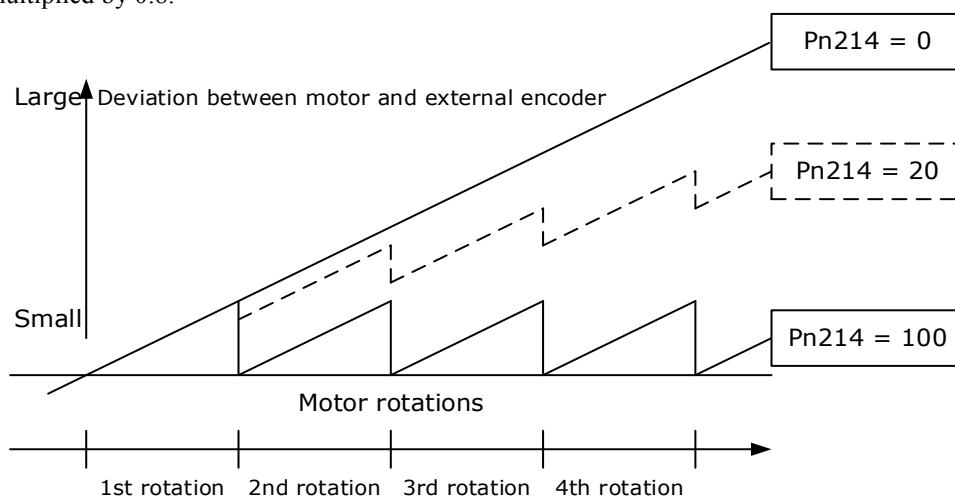
If the detected difference exceeds the setting, an A94 alarm (Position Deviation Overflow) will be output.

In addition, you shall set the coefficient of the deviation between the motor and the external encoder per motor rotation (Pn214). This setting can be used to prevent the motor from running out of control due to damage to the external encoder or to detect belt slippage.

Parameter	Name	Range	Unit	Default	When Enabled
Pn213	Position Deviation Threshold between Encoder and External Encoder	0 to 134217728	1 Pulse	1000	Immediately
Pn214	Position Deviation Clear between Encoder and External Encoder	0 to 100	1%	0	Immediately

- If Pn214 is set to 0, the external encoder value will be read as it is.

- If you set Pn214 to 20, the second rotation will start with the deviation for the first motor rotation multiplied by 0.8.



Chapter 11 STO

11.1 Introduction

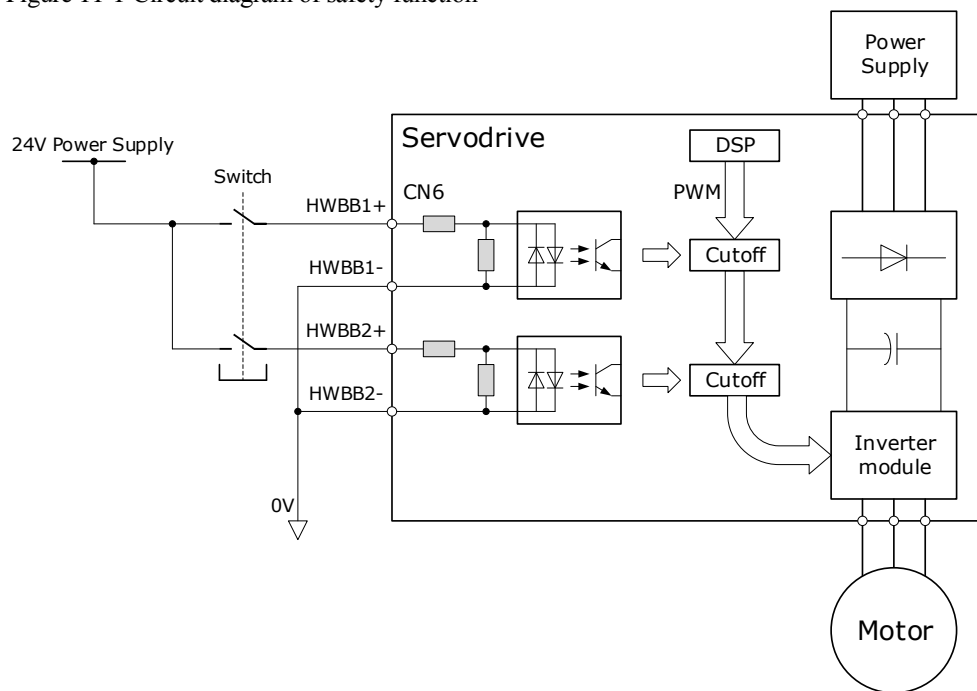
The Drive with Safe Torque OFF (STO) can protect people from dangerous movements of the machine and reduce the risk of operator.

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.

Block Diagram

The circuit diagram of safety function is as shown in Figure 11-1.

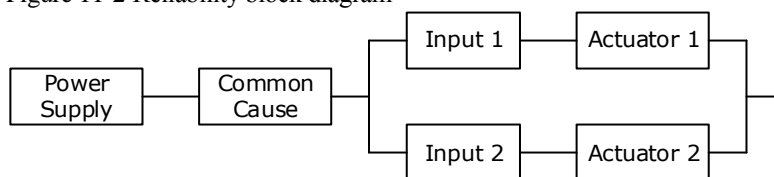
Figure 11-1 Circuit diagram of safety function



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 and 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 11-2.

Figure 11-2 Reliability block diagram



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 PFH may amount to 30% of the complete safety loop. The PFH is less than 0.3×10^{-7} .
- The safety integrity level is SIL3 (IEC 62061: 2015), the performance level is PLe, the category is Cat.4 (ISO 13849-1: 2015).
- According to IEC 61508:2010 and IEC62061:2015, the SFF is no less than 90% for dual channel part (1oo2), and is no less than 99% for signal channel part (1oo1).
- According to ISO 13849-1: 2015, DC is no less than 99%.
- (*) The response time of STO is no more than 5ms.
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 IEC61326-3-1 for the DS definition, the motor will stop within 200ms.
- According to ISO 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.



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 security level, the security confirmation test is performed at least once in 5 years. The inspection items mainly include the items (*) added to the above characteristics.

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. ESTUN is not responsible for any damage or injury caused by residual risks.



- 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 Drive.
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 Drive 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.
- Please use the PELV/SELV switching power supplying to the IO signal of the STO function.

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 ESTUN or the Authorized Distributor.

Applicable Standards

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

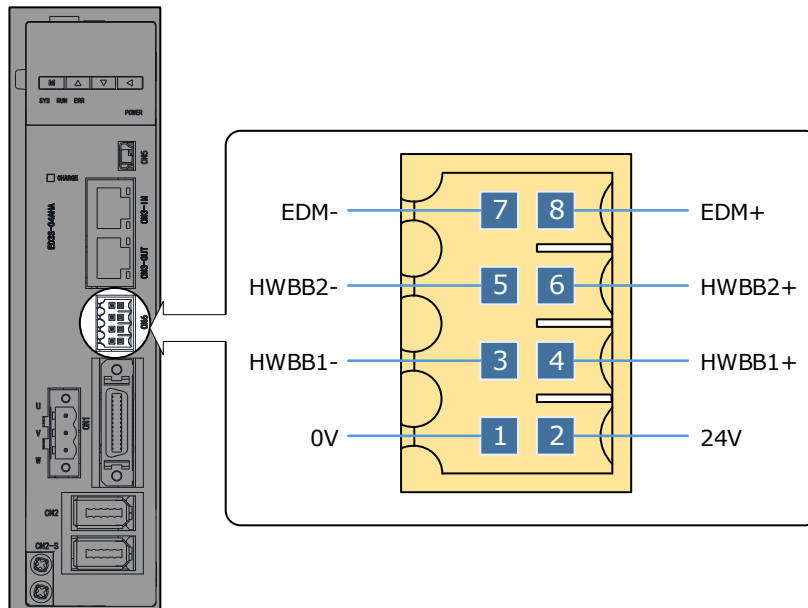
Item	Safety Specification
EMC Directive	<ul style="list-style-type: none"> • IEC 61800-3: 2017 • IEC 61000-4: 2017 • IEC 61326-3-1: 2017 • IEC 61800-5-2: 2016
Low Voltage Directive	<ul style="list-style-type: none"> • EN 61800-5-1: 2007
Functional Safety	<ul style="list-style-type: none"> • IEC 61800-5-2: 2016 • IEC 60204-1: 2016 • IEC 61508: 2010 • IEC 62061: 2015 • ISO 13849-1: 2015
Environmental Requirements	<ul style="list-style-type: none"> • 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 / A1:2017

11.2 Environmental Conditions

Item	Specification
Operation	Temperature: -5°C to 55°C Humidity: 5% to 95% RH (with no condensation)
Storage	Temperature: -20°C to 85°C Humidity: 5% to 95% RH (with no condensation)
Altitude	≤1000m (Rated); ≤2000m (Derated)
IP	IP20
Pollution Index	II
Overvoltage Category	III

11.3 Terminals Arrangement

Signal Diagram



Pin Layout

Pin	Signal	Name	Function
1	0V	24V Power Supply	–
2	24V		
3	HWBB1-	HWBB1 Input	The STO function takes effect when the HWBB1 and the HWBB2 signals are turned OFF.
4	HWBB1+		
5	HWBB2-	HWBB2 Input	
6	HWBB2+		
7	EDM-	External Device Monitor Output	Turns ON when the HWBB1 and HWBB2 signals are turned OFF.
8	EDM+		

11.4 Function Description

11.4.1 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 11-1.

Table 11-1 The relationship among the signals of EDM, HWBB1, and HWBB2

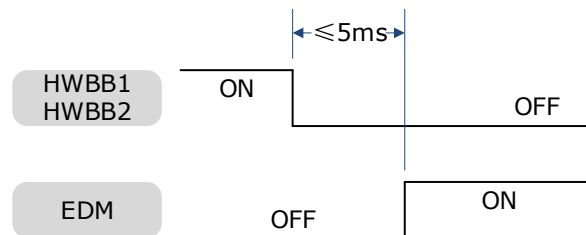
Signal	Logic			
HWBB1	ON	ON	OFF	OFF
HWBB2	ON	OFF	ON	OFF
EDM	OFF	OFF	OFF	ON



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.



11.4.2 Safe State

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

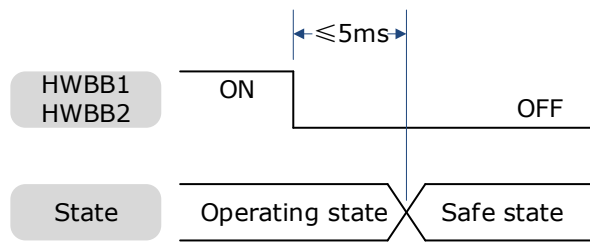


The relationship between the State and the signals of HWBB1 and HWBB2 is shown in Table 11-2.

Table 11-2 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.

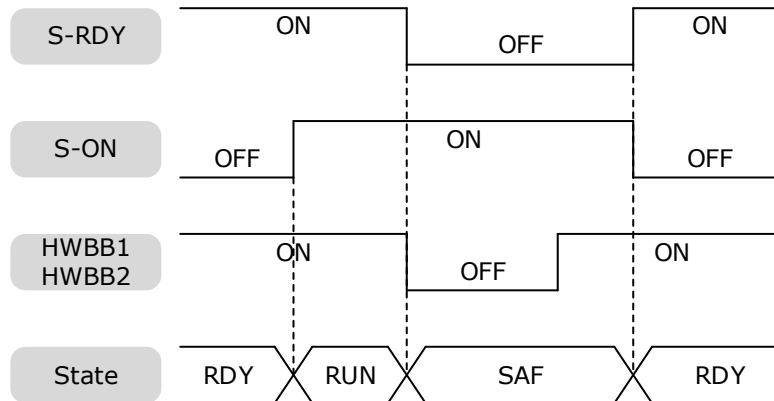


Safety output signal from the safety controller and safety sensor may include L pulse for self-diagnosis. Make sure the off period of safety input signal less than 1 millisecond, and the safety input circuit does not detect this OFF event.

11.4.3 S-RDY (Servo Ready Output) Signal

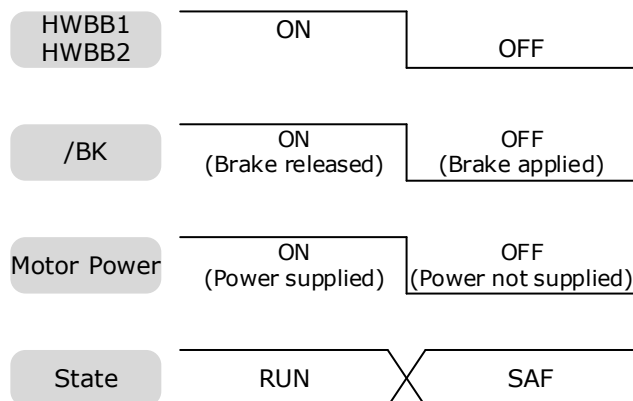
When the Drive is in Safe State, S-RDY (Servo Ready Output) signal is OFF.

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.



11.4.4 /BK (Brake Output) 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.



11.4.5 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	

11.4.6 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.	

11.5 Safety Function Device Connection

11.5.1 Disconnecting a Safety Function Device

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

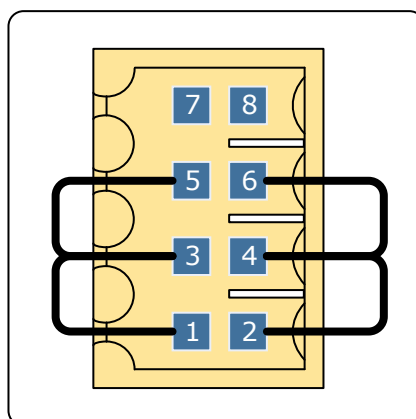
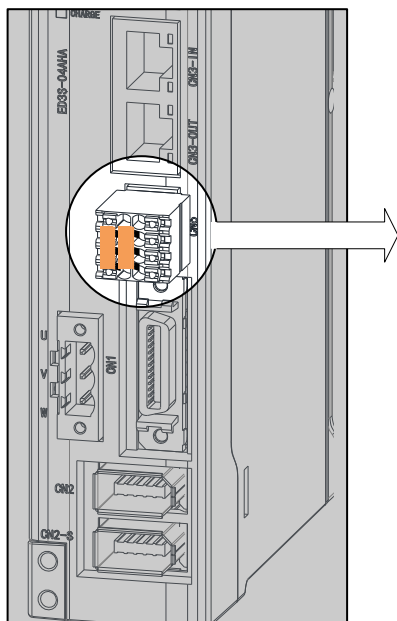


WARNING

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.

keep the Safety Connector plugged into the CN6 port

Shorting pins diagram



**CAUTION**

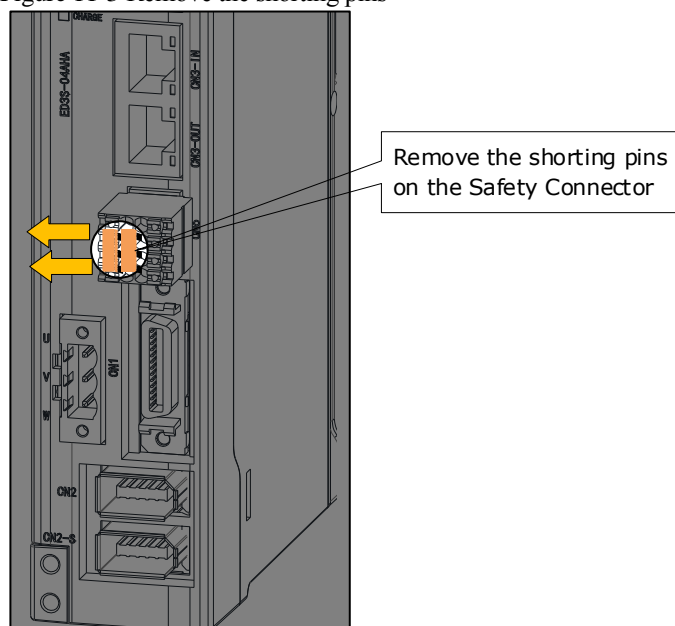
If the shorting pins are removed and the Safety Function Device is not connected, the Drive will enter safe state and not supply the current to the Motor, so that the Motor cannot output torque. At that time, the Panel Operator will display **SAF**.

11.5.2 Connecting a Safety Function Device

Remove the shorting pins on the Safety Connector

Remove the shorting pins on the Safety Connector as shown in Figure 11-3.

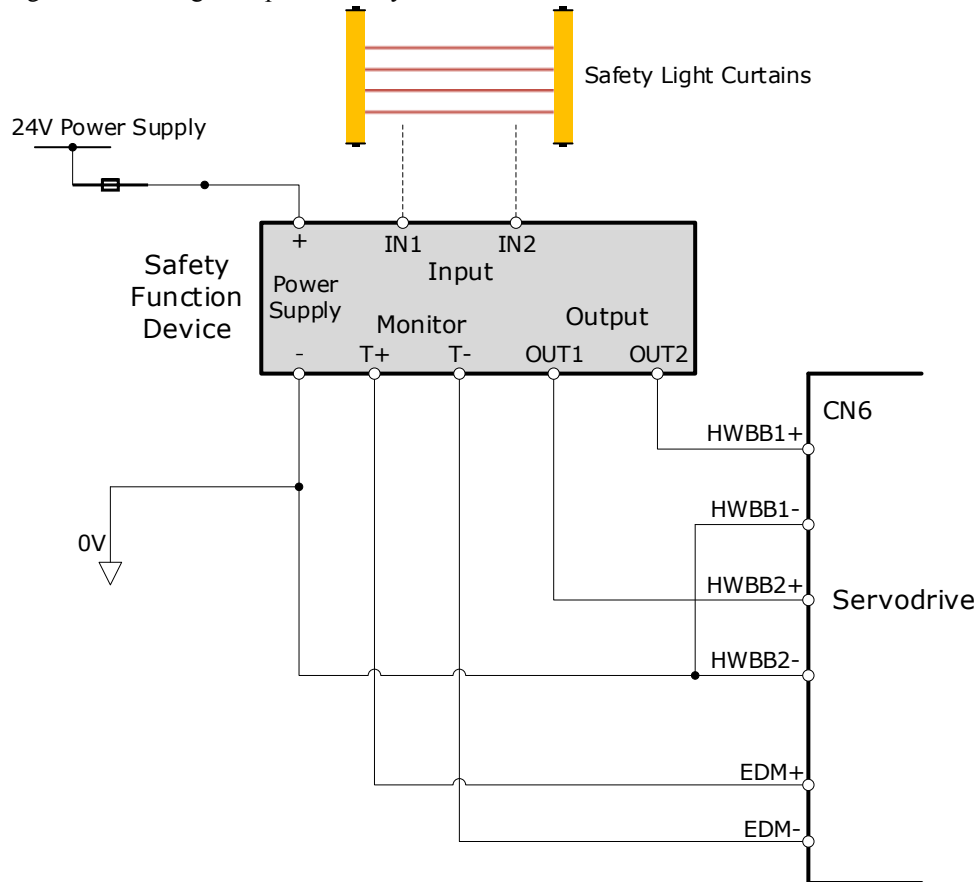
Figure 11-3 Remove the shorting pins



Wiring the Safety Function Device

Connect the Safety Function Device to the CN6 port according to the wiring example shown in Figure 11-4.

Figure 11-4 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.

Validating Safety Functions

When you commission the system or perform maintenance or Drive replacement, you must always perform the following validation test on the STO function after completing the wiring. (It is recommended that you keep the confirmation results as a record.)

- 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 (Un006), 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

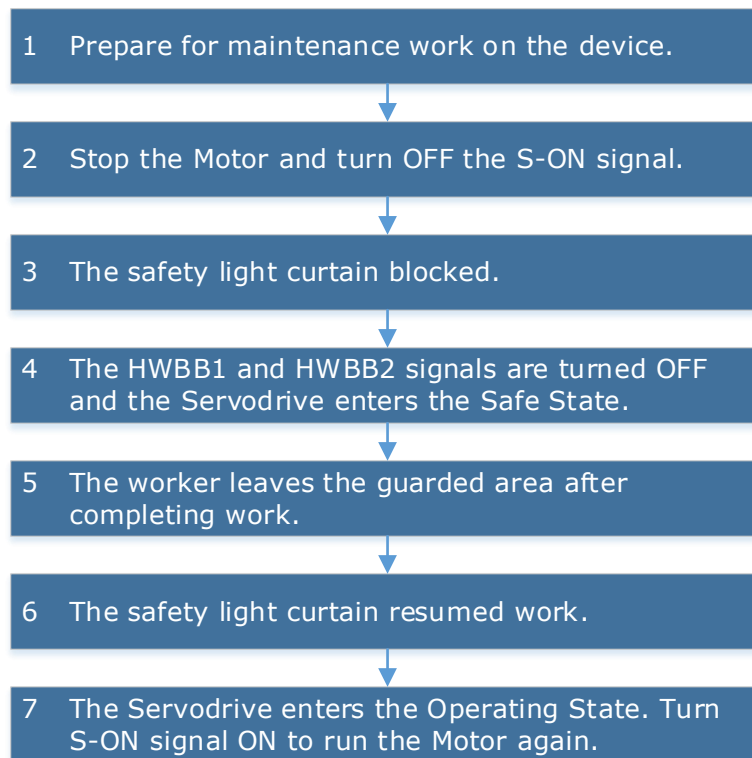
Any one of the input signal HWBB1 or HWBB2 turns OFF, the Drive will enter the Safe State. However, if other signal is still ON for more than 10 seconds, an alarm A30 (STO Disconnected) will occur. At that time, the following must be considered:

- 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.

11.6 Procedure

Taking the wiring of the Safety Function Device shown in Figure 11-4 as an example, use the STO function as follows.



Chapter 12 Appendix

12.1 Parameters List

12.1.1 Interpreting the Parameter Lists

Index of the object dictionary

"When Enabled" indicates the parameter take effective when: [After restart] the power supply is turned OFF and ON again. [Immediately] it was set.

No	Index	Name	Range	Unit	Default	When Enabled
	3164	Basic Function Selections 0	0000 to 0111	—	0000	After restart

Parameter Number

Pn000

Here lists the value of the parameter and their description



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.	

12.1.2 Parameters Detailed

No	Index	Name	Range	Unit	Default	When Enabled
Pn000	3164	Basic Function Selections 0	0000 to 0111	–	0000	After restart
						
	<div>Pn000.0: Servo ON</div> <div>0 Enabled.</div> <div>1 Disabled. When turn the S-RDY signal ON, the motor is excitation automatically.</div>					
	<div>Pn000.1: Forward Drive Prohibit Input</div> <div>0 Enabled. The motor is stopped according to the setting of Pn003.1 when the overtravel occurs.</div> <div>1 Disabled.</div>					
	<div>Pn000.2: Reverse Drive Prohibit Input</div> <div>0 Enabled. The motor is stopped according to the setting of Pn003.1 when the overtravel occurs.</div> <div>1 Disabled.</div>					
	Pn000.3: Reserved setting (Do not change).					
Pn001	3165	Basic Function Selections 1	0000 to 0001	–	0000	After restart
						
	<div>Pn001.0: CCW, CW</div> <div>0 Use CCW as the forward direction.</div> <div>1 Use CW as the forward direction.</div>					
	Pn001.1: Reserved setting (Do not change).					
	Pn001.2: Reserved setting (Do not change).					
	Pn000.3: Reserved setting (Do not change).					

No	Index	Name	Range	Unit	Default	When Enabled
Pn002	3166	Application Function Selections 2	0000 to 0100	–	0000	After restart
						
	<div>Pn002.0: Reserved setting (Do not change).</div>					
	<div>Pn002.1: Reserved setting (Do not change).</div>					
	<div>Pn002.2: Usage of Absolute Encoder</div>					
	<div>0 Use the encoder as an absolute encoder.</div>					
	<div>1 Use the encoder as an incremental encoder.</div>					
	<div>Pn002.3: Reserved setting (Do not change).</div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn003	3167	Application Function Selections 3	0000 to 1032	–	0000	After restart
	<div><div><div>4</div><div>0</div><div>0</div><div>0</div><div>0</div></div></div>					
	<div><div><div><div>Pn003.0: Motor Stopping Methods for Gr.1 Alarms, Servo OFF, STO, and Servo OFF</div><div><div>0</div><div>Applying the dynamic brake and then let the motor coast.</div></div><div><div>1</div><div>Applying the dynamic brake and then place the motor in DB state.</div></div><div><div>2</div><div>Coast the motor to a stop.</div></div></div></div></div>					
	<div><div><div><div>Pn003.1: Motor Stopping Method for Overtravel</div><div><div>0</div><div>Applying the dynamic brake and then let the motor coast.</div></div><div><div>1</div><div>Coast the motor to a stop.</div></div><div><div>2</div><div>Applying the reverse brake and then place the motor in zero clamping state.</div></div><div><div>3</div><div>Applying the reverse brake and then let the motor coast.</div></div></div></div></div>					
	<div><div><div>Pn003.2: Reserved setting (Do not change).</div></div></div>					
	<div><div><div><div>Pn003.3: Overload Enhancement</div><div><div>0</div><div>Disabled.</div></div><div><div>1</div><div>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.</div></div></div></div></div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn004	3168	Application Function Selections 4	0000 to 0025	—	0000	After restart
	<div><div><div><div>4</div><div>0</div><div>0</div><div>0</div><div>0</div></div></div></div>					
	<div><div><div>Pn004.0: Motor Stopping Methods for Gr.2 Alarms</div><div><div>0</div><div>Applying the dynamic brake and then let the motor coast.</div></div><div><div>1</div><div>Applying the dynamic brake and then place the motor in DB state.</div></div><div><div>2</div><div>Coast the motor to a stop.</div></div><div><div>3</div><div>Applying the reverse brake and then place the motor in DB state.</div></div><div><div>4</div><div>Applying the reverse brake and then let the motor coast.</div></div><div><div>5</div><div>Regards Gr.2 Alarms as the Warnings, and the motor will not be stopped.</div></div></div></div>					
	<div><div><div>Pn004.1: Deviation Counter Clear in Local Control Mode</div><div><div>0</div><div>Reset to zero when Servo is OFF or STO is available.</div></div><div><div>1</div><div>Reserved setting (Do not change).</div></div><div><div>2</div><div>Reset to zero when Servo is OFF, or STO is available, or Overtravel is occurred.</div></div></div></div>					
	<div><div><div>Pn004.2: Reserved setting (Do not change).</div></div></div>					
	<div><div><div>Pn004.3: Reserved setting (Do not change).</div></div></div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn005	3169	Application Function Selections 5	00d0 to 33d3	—	00d0	After restart
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>					
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div></div>						
<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><</div></div></div></div></div>						

No	Index	Name	Range	Unit	Default	When Enabled
Pn006	316A	Application Function Selections 6	0000 to 0001	–	0001	After restart
	<div><div><div>H0000</div></div></div>					
	<div><div><div><div>Pn006.0: Bus Selection</div><div><div>0</div><div>Do not use the Bus. Select the control method by the setting of Pn005.1.</div></div><div><div>1</div><div>Use EtherCAT.</div></div></div></div></div>					
	<div><div><div>Pn006.1: Reserved setting (Do not change).</div></div></div>					
	<div><div><div>Pn006.2: Reserved setting (Do not change).</div></div></div>					
	<div><div><div>Pn006.3: Reserved setting (Do not change).</div></div></div>					
Pn007	316B	Application Function Selections 7	0000 to 1120	–	0010	After restart
	<div><div><div>H0000</div></div></div>					
	<div><div><div><div>Pn007.0: Reserved setting (Do not change).</div></div></div></div>					
	<div><div><div><div>Pn007.1: Power Supply Selection</div><div><div>0</div><div>Single-phase AC, for the Drives of ED3S-15A* to ED3S-30A*, this setting is unavailable.</div></div><div><div>1</div><div>Three-phase AC</div></div><div><div>2</div><div>DC</div></div></div></div></div>					
	<div><div><div><div>Pn007.2: Torque Limit Action When Undervoltage Occurs</div><div><div>0</div><div>Disabled.</div></div><div><div>1</div><div>Enabled.</div></div></div></div></div>					
	<div><div><div><div>Pn007.3: AC Supply Frequency</div><div><div>0</div><div>50 Hz</div></div><div><div>1</div><div>60 Hz</div></div></div></div></div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn008	316C	Initial Display Selection When Power On	0 to 9999	–	0010	After restart
	Set the displayed Un Number when power on the device. For example, set this parameter to 0, the display is Un000 after powering on the device.					
Pn009	316D	Application Function Selections 9	0000 to 0001	–	0000	After restart
	<div><div><div><div><div>4</div><div>0</div><div>0</div><div>0</div><div>0</div></div></div><div><div><div><div>Pn009.0: Shared DC Bus Function</div><div><div>0</div><div>Disabled.</div></div><div><div>1</div><div>Enabled.</div></div></div></div><div><div><div>Pn009.1: Reserved setting (Do not change).</div><div><div>Pn009.2: Reserved setting (Do not change).</div><div><div>Pn009.3: Reserved setting (Do not change).</div></div></div></div></div></div></div></div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn100	31C8	Tuning Function	0001 to 1105	–	0001	After restart
	<div><div><div><div><div><div></div></div></div><div><div><div></div></div></div><div><div><div></div></div></div><div><div><div></div></div></div><div><div><div></div></div></div></div><div><div><div></div></div></div></div><div><div><div></div></div></div></div> <div><div><div></div></div></div> <div><div><div></div></div></div>					
	Pn100.0: Tuning Mode					
	1	Tuning-less				
	2	Reserved setting (Do not change).				
	3	One-parameter auto-tuning				
	4	Reserved setting (Do not change).				
	5	Manual tuning				
	Pn100.1: Reserved setting (Do not change).					
	Pn100.2: Automatic Vibration Suppression Selection					
	0	Disabled.				
	1	Enabled.				
	Pn100.3: Damping Selection (This parameter is available when the One-parameter auto-tuning function is selected.)					
0	Standard: Short positioning time, but prone to overshoot.					
1	Stable: Stable positioning, but long positioning time.					
Pn101	31C9	Servo Rigidity	0 to 500	Hz	40	Immediately
	This parameter determines the response characteristic of the servo system. The performance can be improved by increasing this value, and decrease if vibration occurs.					
Pn102	31CA	Speed Loop Gain	1 to 10000	rad/s	500	Immediately
	This parameter determines the bandwidth of the speed loop.					
Pn103	31CB	Speed Loop Integral Time	1 to 5000	0.1ms	125	Immediately
	Reduce this value can shorten positioning time and speed response time.					
Pn104	31CC	Position Loop Gain	0 to 1000	1/s	40	Immediately
	This parameter determines the bandwidth of position loop. Increase this value can improve the stiffness of positioning, decrease if the system vibrates.					

No	Index	Name	Range	Unit	Default	When Enabled
Pn105	31CD	Torque Reference Filter Time	0 to 2500	50	0.01ms	Immediately
	This parameter determines the bandwidth of torque reference filter, the filter is used to filter out the noise in torque reference.					
Pn106	31CE	Load Inertia Percentage	0 to 9999	%	0	Immediately
	This value should be set to the percentage of load inertia and motor inertia.					
Pn107	31CF	Second Speed Loop Gain	1 to 10000	rad/s	250	Immediately
	–					
Pn108	31D0	Second Speed Loop Integral Time	1 to 5000	rad/s	200	Immediately
	–					
Pn109	31D1	Second Position Loop Gain	0 to 1000	1/s	40	Immediately
	–					
Pn110	31D2	Second Torque Reference Filter Time	0 to 2500	0.01ms	100	Immediately
	–					
Pn112	31D4	Speed Feedforward	0 to 100	%	0	Immediately
	This value is a percentage of the internal speed feedforward. This value is available when the internal speed feedforward is selected (Pn005.3=0).					
Pn113	31D5	Speed Feedforward Filter Time	0 to 640	0.1ms	0	Immediately
	This parameter determines the bandwidth of internal speed feedforward filter. The filter is used to filter out the noise in internal speed feedforward.					
Pn114	31D6	Torque Feedforward	0 to 100	%	0	Immediately
	This value is a percentage of the internal torque feedforward. This value is available when the internal torque feedforward is selected (Pn005.2=0).					
Pn115	31D7	Torque Feedforward Filter Time	0 to 640	0.1ms	0	Immediately
	This parameter determines the bandwidth of internal torque feedforward filter. The filter is used to filter out the noise in internal torque feedforward.					

No	Index	Name	Range	Unit	Default	When Enabled
Pn116	31D8	P/PI Switch Mode	0 to 4	–	0	After restart
	[0] Use torque reference as the condition (threshold setting: Pn117). [1] Use position deviation counter as the condition (threshold setting: Pn118). [2] Use acceleration reference as the condition (threshold setting: Pn119). [3] Use the speed reference as the condition (threshold setting: Pn120). [4] Fixed to PI Control.					
Pn117	31D9	Torque Reference Threshold for P/PI Switch	0 to 300	%	200	Immediately
	The threshold is used to switch speed controller from PI to P. This value is a percentage of torque reference.					
Pn118	31DA	Deviation Counter Threshold for P/PI Switch	0 to 10000	1 pulse	0	Immediately
	The threshold is used to switch speed controller from PI to P. This value is a pulse number.					
Pn119	31DB	Acceleration Reference Threshold for P/PI Switch	0 to 3000	10 rpm/s	0	Immediately
	The threshold is used to switch speed controller from PI to P. This value is an acceleration reference.					
Pn120	31DC	Speed Reference Threshold for P/PI Switch	0 to 10000	rpm	0	Immediately
	The threshold is used to switch speed controller from PI to P. This value is a speed reference.					
Pn121	31DD	Gain Switch Mode	0 to 10	–	0	After restart
	[0] Fixed to first group gains. [1] Use external signal (G-SEL) as the condition. [2] Use torque reference as the condition (threshold setting: Pn117). [3] Use position deviation counter as the condition (threshold setting: Pn118). [4] Use acceleration as the condition (threshold setting: Pn119). [5] Use speed reference as the condition (threshold setting: Pn120). [6] Use position reference as the condition (threshold setting: Pn123). [7] Use actual speed as the condition (threshold setting: Pn124). [8] Use position reference (Pn123) and actual speed (Pn124) as the condition. [9] Fixed to second group gains. [10] Use positioning completed flag as the condition.					
Pn122	31DE	Delay Time for Gain Switch	0 to 20000	0.1 ms	0	Immediately
	The delay time for gain switching after the condition has satisfied.					
Pn123	31DF	Threshold for Gain Switch	0 to 20000	–	0	Immediately
	The threshold of speed reference for gain switching.					



No	Index	Name	Range	Unit	Default	When Enabled
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).					

No	Index	Name	Range	Unit	Default	When Enabled
Pn150	31FA	Model Following Control Function	0000 to 0002	—	0000	After restart
	<div><div><div>H0000</div></div><div><div><div>Pn150.0: Model Following Control Selection</div><div><div>0</div><div>Do not use.</div></div><div><div>1</div><div>Use the model following control.</div></div><div><div>2</div><div>Use the model following control and load oscillation suppression.</div></div></div><div><div>Pn150.1: Reserved setting (Do not change).</div></div><div><div>Pn150.2: Reserved setting (Do not change).</div></div><div><div>Pn150.3: Reserved setting (Do not change).</div></div></div></div>					
	31FB	Model Following Control Gain	10 to 1000	1/s	50	Immediately
	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.					
	31FC	Model Following Control Gain Correction	20 to 500	%	100	Immediately
	This parameter is used for correcting the setting of the model following control gain.					
	31FD	Model Following Control Speed Feedforward	0 to 200	%	100	Immediately
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.						
Pn154	31FE	Model Following Control Torque Feedforward	0 to 200	%	100	Immediately
	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.					
Pn155	31FF	Load Oscillation Frequency	50 to 500	0.1 Hz	100	Immediately
	In general, this setting is the anti-resonance frequency of the two-mass servo system.					

No	Index	Name	Range	Unit	Default	When Enabled
Pn156	3200	Filter Time for Load Oscillation Suppression	2 to 500	0.1 ms	10	Immediately
	If you increase this setting, the response characteristic can be softer but the effect of vibration suppression will be worse.					
Pn157	3201	Limit for Load Oscillation Suppression	0 to 1000	rpm	100	Immediately
	To set a compensation limiting for the jitter suppression at speed feedforward. If you decrease this setting, the response characteristic can be softer but the effect of vibration suppression will be worse.					
Pn160	3204	Load Torque Compensation	0 to 100	%	0	Immediately
	This parameter is a coefficient (percentage) to compensate load torque. Increase this value can improve load disturbance rejection performance but may cause vibration.					
Pn161	3205	Load Torque Observer Gain	0 to 1000	Hz	200	Immediately
	This parameter is used to adjust the response characteristic of the load observer.					
Pn162	3206	Feedback Speed Selection	0 to 1	–	0	After restart
	[0] Use encoder speed as the feedback speed. [1] Use observed speed as the feedback speed.					
Pn164	3208	Turns for PJOG0	-50 to 50	rotation	5	Immediately
	–					
Pn165	3209	Max Speed for PJOG0	100 to 3000	rpm	1000	Immediately
	–					
Pn166	320A	Acc./Dec. Time for PJOG0	50 to 2000	ms	500	Immediately
	–					
Pn167	320B	Stop Time for PJOG0	100 to 10000	ms	1000	Immediately
	–					
Pn168	320C	Turns for PJOG1	-50 to 50	rotation	5	Immediately
	–					
Pn169	320D	Max Speed for PJOG1	100 to 3000	rpm	1000	Immediately
	–					

No	Index	Name	Range	Unit	Default	When Enabled
Pn170	320E	Acc./Dec. Time for PJOG1	50 to 2000	ms	500	Immediately
	–					
Pn171	320F	Stop Time for PJOG1	100 to 10000	ms	1000	Immediately
	–					
Pn172	3210	Turns for Inertia Identification	0 to 1	–	0	Immediately
		To set the turns towards the forward direction in Inertia Identification operation. [0] 8 rotations. [1] 4 rotations.				
Pn173	3211	Frequency of Vibration Suppression Filter	100 to 2000	Hz	2000	Immediately
	–					
Pn174	3212	Adjust Bandwidth of Vibration Suppression Filter	1 to 100	–	30	Immediately
	–					
Pn175	3213	Vibration Suppression	0 to 500	–	100	Immediately
	–					
Pn176	3214	Lowpass Filter Time for Vibration Suppression	0 to 50	0.1ms	0	Immediately
	–					
Pn177	3215	Highpass Filter Time for Vibration Suppression	0 to 1000	0.1ms	1000	Immediately
	–					
Pn178	3216	Damping of Vibration Suppression Filter	0 to 500	–	100	Immediately
	–					
Pn179	3217	Amplitude Threshold for Vibration Detection	5 to 500	–	100	Immediately
		This parameter is used for automatic vibration suppression.				
Pn180	3218	Frequency Threshold for Vibration Detection	0 to 100	Hz	100	Immediately
		This parameter is used for automatic vibration suppression.				

No	Index	Name	Range	Unit	Default	When Enabled
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	Pulse Numbers for PG Frequency Division	16 to 16384	1 pulse	16384	After restart
	This parameter is used for setting the orthogonal differential-pulse numbers output by the encoder when the motor runs one revolution.					

No	Index	Name	Range	Unit	Default	When Enabled
Pn210	3236	External Encoder Setting 1	0000 to 1111	–	0000	After restart
						
	<div>Pn210.0: External Encoder Selection</div>					
	0	Do not use an external encoder.				
	1	Use an external encoder.				
	<div>Pn210.1: External Encoder Output Pulse Setting</div>					
	0	Use the Motor encoder setting as the frequency division.				
	1	Use the external encoder setting as the frequency division.				
	<div>Pn210.2: External Encoder Phase Sequence Selection</div>					
	0	Keep the current phase sequence.				
	1	Invert the frequency division pulse phase.				
	<div>Pn210.3: Direction of External Encoder</div>					
0	Keep the current direction.					
1	Invert the counter direction.					
Pn211	3237	External Encoder Setting 2	0000 to 0001	–	0001	After restart
						
	<div>Pn211.0: C-pulse of External Encoder</div>					
	0	Do not use C-pulse of the external encoder.				
	1	Use C-pulse of the external encoder.				
	<div>Pn211.1: Reserved setting (Do not change).</div>					
	<div>Pn211.2: Reserved setting (Do not change).</div>					
	<div>Pn211.3: Reserved setting (Do not change).</div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn212	3238	Resolution of External Encoder	1 to 1048576	1 pulse	10000	After restart
	—					
Pn213	3239	Position Deviation Threshold between Encoder and External Encoder	0 to 134217728	1 pulse	1000	Immediately
	—					
Pn214	323A	Position Deviation Clear between Encoder and External Encoder	0 to 100	0	%	Immediately
	—					
Pn304	3294	Inner Speed Reference	-6000 to 6000	rpm	500	Immediately
	To set the inner motor speed reference. This setting is available when servo is in inner speed control mode (Pn006.0 = 0 and Pn005.1 = 1).					
Pn305	3295	Jogging Speed	0 to 6000	rpm	500	Immediately
	To set a speed for the motor in JOG operation, and the rotation direction is determined by the reference.					
Pn306	3296	Soft Start Acceleration Time	0 to 10000	ms	0	Immediately
	To set ramp acceleration time per 1000 rpm.					
Pn307	3297	Soft Start Deceleration Time	0 to 10000	ms	0	Immediately
	To set ramp deceleration time per 1000 rpm.					
Pn308	3298	Speed Reference Filter Time	0 to 10000	ms	0	Immediately
	To set speed reference filter time.					
Pn309	3299	S-Curve Rise Time	0 to 10000	ms	0	Immediately
	To set a rise time for transiting from one speed point to another speed point in the S-curve.					
Pn310	329A	Speed Reference Smooth Mode Selection	0 to 3	—	0	After restart
	[0] Ramp [1] S-Curve [2] Primary filtering [3] Secondary filtering					

No	Index	Name	Range	Unit	Default	When Enabled
Pn311	329B	S-Curve Selection	0 to 3	—	0	After restart
	To set the transition form of the S-curve.					
Pn323	32A7	Overspeed Detection Threshold	1 to 8000	—	8000	Immediately
	A03 alarm occurs if the Motor velocity exceeds this threshold.					
Pn331	32AF	Touch Probe Signal Allocation	0000 to 0022	—	0010	After restart
	<div><div><div>0010</div></div></div>					
	Pn331.0: Touch Probe 1 signal Allocated Pin Number					
	0	Allocate the signal to CN1-1.				
	1	Allocate the signal to CN1-3.				
	2	Use the C-Pulse instead of the allocation.				
	Pn331.1: Touch probe 2 Signal Allocated Pin Number					
	0	Allocate the signal to CN1-1.				
	1	Allocate the signal to CN1-3.				
	2	Use the C-Pulse instead of the allocation.				
Pn331.2: Reserved setting (Do not change).						
Pn331.3: Reserved setting (Do not change).						
Pn332	32B0	Touch Probe Digital Input Filtering Time	0 to 1000	10ns	0	Immediately
	—					
Pn401	32F5	Forward Internal Torque Limit	0 to 350	%	350	Immediately
	—					
Pn402	32F6	Reverse Internal Torque Limit	0 to 350	%	350	Immediately
	—					
Pn403	32F7	Forward External Torque Limit	0 to 350	%	100	Immediately
	—					

No	Index	Name	Range	Unit	Default	When Enabled
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.					
Pn504	335C	Position Deviation Counter Overflow Threshold	1 to 83886080	1 pulse	41943040	Immediately
	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.					

No	Index	Name	Range	Unit	Default	When Enabled
Pn505	335D	Servo ON Waiting Time	-2000 to 2000	ms	0	Immediately
	<p>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.</p> <ul style="list-style-type: none"> • 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. 					
Pn506	335E	Servo OFF Waiting Time	0 to 500	10 ms	0	Immediately
	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.					
Pn507	335F	Brake Enable Speed Threshold	10 to 100	rpm	100	Immediately
	The /BK signal will turn ON when the motor speed is lower than this setting after the Servo is OFF.					
Pn508	3360	Brake Enable Waiting Time	10 ~ 100	10 ms	50	Immediately
	<p>The /BK signal will turn ON when the delay exceeds this setting after the Servo is OFF.</p> <p>The /BK signal turns ON as long as one of the conditions, Brake Reference Waiting Speed and Brake Reference Waiting Time, is satisfied.</p>					


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

No	Index	Name	Range	Unit	Default	When Enabled
Pn510	3362	Digital Input Signal Allocations 2	0000 to 0007	–	0004	After restart
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>4</div></div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>0</div></div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>0</div></div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>0</div></div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>4</div></div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div></div></div></div></div></div></div></div></div></div>					
	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					
Pn510.1: Reserved setting (Do not change).						
Pn510.2: Reserved setting (Do not change).						
Pn510.3: Reserved setting (Do not change).						

No	Index	Name	Range	Unit	Default	When Enabled
Pn511	3363	Digital Output Signal Allocations	0000 to 0bbb	–	0210	After restart
	<div><div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>4</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>0</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>2</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>1</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>0</div></div></div></div><div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>0</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>1</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>2</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>3</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>4</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>5</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>6</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>7</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>8</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>9</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>a</div></div><div><div><div></div><div></div><div></div><div></div><div></div><div></div></div><div>b</div></div></div></div><div>Pn511.0: Allocate signal to CN1-6, -7</div><div><div>0</div><div>COIN/VCMP</div></div><div><div>1</div><div>TGON</div></div><div><div>2</div><div>S-RDY</div></div><div><div>3</div><div>CLT</div></div><div><div>4</div><div>BK</div></div><div><div>5</div><div>PGC</div></div><div><div>6</div><div>OT</div></div><div><div>7</div><div>RD</div></div><div><div>8</div><div>TCR</div></div><div><div>9</div><div>Remote0</div></div><div><div>a</div><div>Remote1</div></div><div><div>b</div><div>Remote2</div></div></div> <div>Pn511.1: Allocate signal to CN1-10, -11</div> <div><div>0 to b: same as the allocation of CN1-6, -7.</div></div> <div>Pn511.2: Allocate signal to CN1-12, -13</div> <div><div>0 to b: same as the allocation of CN1-6, -7.</div></div> <div>Pn511.3: Reserved setting (Do not change).</div>					
	3364	Digital Input Signals (Low Bits) from Bus Master	0000 to 1111	–	0000	After restart
	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.					
	3365	Digital Input Signals (High Bits) from Bus Master	0000 to 1111	–	0000	After restart
	Use the bit-24 in the sub-index 01 of the object 0x60FE in CiA402 as the input, corresponding to CN1-18.					

No	Index	Name	Range	Unit	Default	When Enabled
Pn514	3366	Digital Input Signals Filter Time	0 to 1000	1 cycle	1	Immediately
	To set a filtering time for the input signals. If you increase this setting, the signal changes on the input port will be delayed.					
Pn515	3367	Alarm Output Signal Filter Time	0 to 3	2 cycle	1	Immediately
	To set a filtering time for the alarm signals. If you increase this setting, the alarm will be delayed.					
Pn516	3368	Digital Input Signal Inverts 1	0000 to 1111	–	0000	After restart
	<div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div><div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div></div></div></div> <div><</div>					

No	Index	Name	Range	Unit	Default	When Enabled
Pn517	3369	Digital Input Signal Inverts 2	0000 to 0001	–	0000	After restart
	<div><div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>						
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.					
Pn521	336D	Alarm Masks	0000 to 0011	–	0000	After restart
	<div><div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
	<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>					
<div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div><div><div></div><div></div></div></div></div>						

No	Index	Name	Range	Unit	Default	When Enabled
Pn525	3371	Motor Overload Detection Start Threshold	100 to 150	%	100	Immediately
	A04 alarms occurs if the load percentage exceeds this setting more than a certain time. The recommended setting is 120 or less, otherwise the servo drive and motor may be damaged. This setting is always 115 for the EM3A Motors.					
Pn528	3374	Digital Output Signal Inverts	0000 to 1111	–	0000	Immediately
						
	Pn516.0: CN1-06, -07 inverse selection					
	0	The signal is not inverted.				
	1	The signal is inverted.				
	Pn516.1: CN1-08, -09 inverse selection					
	0	The signal is not inverted.				
	1	The signal is inverted.				
	Pn516.2: CN1-10, -11 inverse selection					
	0	The signal is not inverted.				
	1	The signal is inverted.				
	Pn516.3: CN1-12, -13 inverse selection					
	0	The signal is not inverted.				
	1	The signal is 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.					

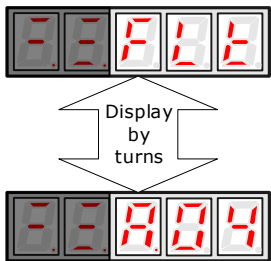
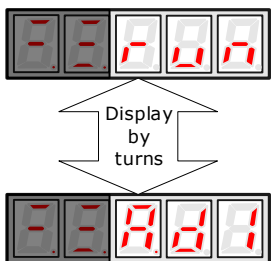
No	Index	Name	Range	Unit	Default	When Enabled
Pn535	337B	Discharging Resistor Resistance	10 to 300	Ω	–	After restart
	To set the resistance value for the braking. This setting is not reset when the default setting is restored. The default settings are as following: <ul style="list-style-type: none"> • ED3S-A5A* to ED3S-10A*: 50Ω • ED3S-15A*: 40Ω • ED3S-20A* and ED3S-30A* <input type="checkbox"/> <input type="checkbox"/>: 20Ω 					
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. The default setting are as following: <ul style="list-style-type: none"> • ED3S-A5A* to ED3S-04A*: 40W • ED3S-08A* and ED3S-10A*: 60W • ED3S-15A*: 80W • ED3S-20A* and ED3S-30A*: 150W 					
Pn538	337E	Momentary Power Interruption Hold Time	0 to 50	1 cycle	1	Immediately
	Even if the main power supply to the drive is interrupted momentarily, power supply to the motor (servo ON status) will be maintained for the time set by this parameter. The setting is a number of periods, and the time of one period depends on the setting of Pn007.3: <ul style="list-style-type: none"> • Pn007.3=0, the time of one period is 1/50s. • Pn007.3=1, the time of one period is 1/60s. 					
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.					
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.					

No	Index	Name	Range	Unit	Default	When Enabled
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.					

12.2 Alarms Displays

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 7.4.1 Motor Stop Methods for Gr.1 Alarms, Safety State and Servo OFF .	<p>The Panel Operator displays between Alarm No and Servo state FLT by turns.</p> 
Gr.2	Stops the Motor according to the setting of Pn004.0 For details, refers to 7.4.3 Motor Stop Methods for Gr.2 Alarms .	
Warning	Do not stop the Motor, and keep the current operation	<p>The Panel Operator displays between Alarm No and Servo state run by turns.</p> 

Alarms Detailed

No.	Classification	Name	Meaning	Solution
A01	Gr.1	Parameter Checksum Error	There is an error in the parameter data in the FRAM.	Reset the parameters to the default setting. If it does not work, contact ESTUN or the Authorized Distributor.
A03	Gr.1	Overspeed	The motor speed has exceeded the calculated limit of 100 rpm or more.	<ul style="list-style-type: none"> • Check the setting of Pn323, and increase the setting if necessary. • Check the power line wiring of the Motor. • Contact ESTUN or the Authorized Distributor.
A04	Gr.1	Motor Overload	When the value of Un016 is accumulated to 100, the motor is overloaded.	Resizing the servo drive and servo motor to match the load condition.
A05	Gr.1	Position Deviation Overflow	The value of the position deviation counter exceeds 0x40000000.	<ul style="list-style-type: none"> • Try to reduce the reference pulse frequency. • Increase the position loop gain. • Check the mechanical.
A06	Gr.1	Position Deviation Overflow: the pulse exceeds the setting of Pn504	When Pn005.1 (Deviation Counter Alarm) is set to 1 (Enabled), the value of the deviation counter Ek exceeds the product that Pn504 multiplied by electronic gear.	<ul style="list-style-type: none"> • Try to reduce the reference pulse frequency. • Increase the position loop gain. • Check the mechanical.
A07	Gr.1	Electronic Gear Error	<p>For Motor encoders with different bit, the setting ranges of the gear ratio are as following:</p> <ul style="list-style-type: none"> • 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 <p>If the setting exceeds the above range, this alarm will occur.</p>	Change the electronic gear ratio to a proper value.
A08	Gr.1	1st Channel Current Detection Error	The average of the Iu digital quantity read from the 1st channel for 2048 times is greater than 1500 during Servo ON.	Contact ESTUN or the Authorized Distributor.

No.	Classification	Name	Meaning	Solution
A09	Gr.1	2nd Channel Current Detection Error	The average of the Iv digital quantity read from the 2st channel for 2048 times is greater than 1500 during Servo ON.	Contact ESTUN or the Authorized Distributor.
A0A	Gr.1	Handshake Error	The handshake between DSP and FPGA failed.	Contact ESTUN or the Authorized Distributor.
A11	Gr.1	IPM Junction Temperature Error	The junction temperature of the Intelligent Power Module is greater than the setting value of Pn534.	Reduce the load.
A12	Gr.1	Overcurrent	An overcurrent flowed through the Intelligent Power Module.	Check if the motor was blocked.
A13	Gr.1	Overvoltage	The bus voltage is greater than 420 V.	Try to modify the motor running track to make it run more smoothly.
A14	Gr.1	Undervoltage	The bus voltage is lower than 165 V.	If the main power supply system is normal, contact ESTUN or the Authorized Distributor.
A15	Gr.2	Discharge Resistor Damaged	The discharge resistor is damaged or unconnected.	Check whether the regenerative resistor is connected
A16	Gr.1	Discharging Error	The discharging operation is abnormal.	Check the sizing of regenerative resistor.
A18	Gr.1	IPM Overheated	The temperature of the Intelligent Power Module is greater than threshold.	Check the ambient temperature and derating the load.
A1A	Gr.2	Charging Resistor Overload	The main circuit power supply was frequently turned ON and OFF.	Delay the interval between the two power-up.
A1B	Gr.2	DB Circuit Damaged	The circuit of the Dynamic Brake is damaged.	Contact ESTUN or the Authorized Distributor.
A1C	Gr.2	Built-in Fan Error	The fan on the control board had not worked for more than 30 seconds.	Contact ESTUN or the Authorized Distributor.
A1D	Gr.1	Temperature Sensor of Drive Board Error	The NTC temperature sensor is not connected or broken	Contact ESTUN or the Authorized Distributor.
A1E	Gr.1	Main Circuit Charging Error	The charging resistor on the main circuit was damaged or the P1 terminal and the P2 terminal are not shorted.	Check if the P1 terminal and P2 terminal is properly connected.
A1F	Gr.1	Main Circuit Grounding Error	The main circuit was not grounded.	Check if short cut of drive or motor occurs.
A20	Gr.1	Power Supply Line Lost	The voltage was low for more than one second for phase R, S, or T when the main power supply was ON.	Check if the three-phase power supply is connected to the drive properly.

No.	Classification	Name	Meaning	Solution
A24	Gr.1	Main Circuit Power Supply Wiring Error	The main circuit power supply wiring is incorrect.	Check if the power supply (DC/AC) for the main circuit is consistent with the parameter settings.
A30	Gr.2	STO Disconnected	The STO module may not be connected or disconnected.	Check if the terminal wiring of STO is correct.
A31	Gr.1	STO Circuit Failure	A failure occurred in the STO circuit.	Contact ESTUN or the Authorized Distributor.
A33	Gr.2	USB Power Supply Error	The power supply of USB is abnormal.	Contact ESTUN or the Authorized Distributor.
A34	Gr.2	Control Board overheated	The key chip component is overheated within a long time.	Improve the ambient temperature condition.
A35	Gr.2	Control Board Temperature Sensor Disconnected	The temperature sensor on the control board was disconnected.	Contact ESTUN or the Authorized Distributor.
A36	Gr.2	Key Chip Component Power Supply Error	The monitor signal of key chip component is abnormal.	Contact ESTUN or the Authorized Distributor.
A37	Gr.1	Panel Operator Communication Error	The Panel Operator had failed communication for 1 second	Repower up the system, or else, contact ESTUN or the Authorized Distributor.
A42	Gr.1	Power Mismatch	The selection between the drive and motor was mismatched.	Re-select the motor to match the corresponding drive.
A43	Gr.1	Encoder Type Error	The data stored in the encoder E2ROM is different from the data read from the internal of the encoder.	Contact ESTUN or the Authorized Distributor.
A45	Gr.1	Multi-turn Data Error	There is a multi-turn data error in the encoder. The cause may be code wheel pollution, strong electromagnetic interference.	Check if the encoder battery is available, and try to reset the data by Fn010 or Fn011, then repower up the Drive.
A46	Gr.1	Multi-turn Data Overflow	The multi-turn data exceeded the limit value.	Check if the encoder battery is available, and try to reset the data by Fn010 or Fn011, then repower up the Drive.
A47	Gr.1	Battery Error (lower than 2.45V)	The battery power of the absolute encoder is lower than 2.45V	Replace the battery case.
A48	Gr.1	Battery Error (lower than 3.1V)	The battery power of the absolute encoder is lower than 3.1V	Replace the battery case.
A49	Gr.1	Encoder Data Abnormal	There is an internal data error in the encoder.	Check if the encoder battery is available, and try to reset the data by Fn010 or Fn011, then repower up the Drive.
A4A	Gr.2	Encoder Overheated	The internal temperature of encoder is too high.	Reduce the motor load and improve the cooling environment.

No.	Classification	Name	Meaning	Solution
A50	Gr.1	Encoder Disconnected	The encoder may not be connected or disconnected.	Check if the encoder cable is connected properly, and keep it away from the electromagnetic interference.
A51	Gr.1	Overspeed Detected	The encoder detected the motor has been overspeed, it may be caused by: <ul style="list-style-type: none"> • The battery power is too lower or disconnected. • The value of the motor acceleration is too large 	Reduce the Motor speed.
A52	Gr.1	Encoder Internal Error	There is an internal error in the encoder. The causes may be code wheel contamination or damage, low encoder supply voltage, encoder aging.	Repower up the device.
A53	Gr.1	Single-turn Data Error	There is an internal error in the encoder. Maybe the read and write operations are too frequent, or internal BUSY was set.	Repower up the device.
A54	Gr.1	Check-bit and End-bit Error	There is an error in the check-bit and end-bit of the encoder control domain.	Repower up the device.
A58	Gr.1	Zone 1 Data Error	The data such as the phase of the encoder zone 1 is empty or incorrect.	Replace the Motor.
A59	Gr.1	Zone 2 Data Error	<ul style="list-style-type: none"> • The data such as the phase of the encoder zone 2 is empty or incorrect. • The information about the motor version in the encoder is incorrect. 	Replace the Motor.
A65	Gr.1	Position Value Overflow	The difference between two reference position values is too large in IP mode or CSP mode.	Check if the position trajectory planning of the master station is correct.
A70	Gr.1	DC Sync Error	There is an error in DC synchronization operation.	Check if the DC setting value of the master station is incorrect.
A71	Gr.1	SM Event Sync Error (The event arrived too early)	The synchronization operation of SM Event was too early.	Check the setting of the master station.
A72	Gr.1	SM Event Sync Error (The event overtime)	The synchronization operation of SM Event was overtime.	Check the setting of the master station.
A73	Gr.1	EtherCAT Processor Error	An internal error occurred in the EtherCAT processor.	Repower up the system, or else, contact ESTUN or the Authorized Distributor.
A74	Gr.1	Cycle Time Error in Cubic interpolation algorithm	An algorithm cycle error is detected by the Cubic interpolation algorithm, which is equal to the DC synchronization period.	Check if the setting of DC synchronization period is proper and it shall not be 0.

No.	Classification	Name	Meaning	Solution
A75	Gr.1	DC Sync Cycle Time Error	The DC synchronization period or the setting value of the 60C2 object is not an integer multiple of 125us, or less than 125us.	<ul style="list-style-type: none"> • Check if the setting of DC synchronization period is proper. • Check and correct the setting of 60C2h.
A76	Gr.1	Acceleration Object Set Error	Acceleration is set to 0 in PP/PV mode.	Change the Object 6086h, 6084h and 6085h to a proper value.
A81	Gr.1	U, V, W Wiring Error	The U, V, W wiring of the motor is not correct.	Check if the motor power lines (U, V, and W phases) is connected properly.
A82	Gr.1	Motor Mismatched	When Pn895.0 was set to 0 (Use the data in the encoder zone 1), and Pn895.1 was set to 1 (Use the parameter settings), this alarm occurred if the set value of Pn807 is different from data (motor power) in the encoder zone 1.	Replace the Motor.
A83	Gr.1	Motor Running Error	<ul style="list-style-type: none"> • The wiring of the motor was abnormal. • The motor was driven in reverse for power generation. 	<ul style="list-style-type: none"> • Check and correct the order of phases U, V, and W in the motor wiring. • Check and determine the motor is not driven in the reverse direction.
A90	Gr.1	Phase A Disconnected	Phase A of the external encoder is disconnected.	<ul style="list-style-type: none"> • Check the setting of Pn210. • Check the wiring of the external encoder.
A91	Gr.1	Phase B Disconnected	Phase B of the external encoder is disconnected.	
A92	Gr.1	Phase C Disconnected	Phase C of the external encoder is disconnected.	
A93	Gr.1	Encoder Communications Error	Communications between the external encoder and the servo drive is unavailable.	Contact ESTUN or the Authorized Distributor.
A94	Gr.1	Position Deviation Overflow	The setting of Pn212 (Excessive Position Deviation Alarm Level) was exceeded by the position deviation while the servo was ON.	<ul style="list-style-type: none"> • Check the settings of Pn210, Pn212, Pn213 and Pn214. • Check the wiring of the external encoder. • Check if the mechanical connection structure is loose, slippery or has a large gap.

No.	Classification	Name	Meaning	Solution
AD1	Warning	Undervoltage Warning	The main circuit DC voltage is too low.	<ul style="list-style-type: none"> • Check if the main power input voltage is normal. • Check if the power cable wiring of the Drive is correct.
AD5	Warning	Built-in Fan Warning	The fan on the control board had not worked within 30 seconds.	<ul style="list-style-type: none"> • Check if the working of the build-in fan in the Drive is proper. • Contact ESTUN or the Authorized Distributor.
AD6	Warning	Control Board Overheated Warning	The junction temperature of NetX52 is greater than 113 °C.	Check if the ambient temperature is proper.
AF0	Gr.1	Internal Program Error	An error occurred in the internal program (Assertion failure).	Contact ESTUN or the Authorized Distributor.

12.3 Object Dictionary

12.3.1 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 (Servo drive)

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

Bit	Data	M / O
1	Current	O
2	Voltage	O
3	Temperature	O
4	Communication error (overrun, error state)	O
5	Device profile specific	O
6	Reserved (always 0)	O
7	Manufacturer-specific	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).

12.3.2 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

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

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
	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

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
	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

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

12.3.3 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 12.1 Parameters List.

12.3.4 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
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)

Bit5	Bit4	Description
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 <i>Halt Option Code</i> (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 <i>Halt Option Code</i> (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.
		1	Stops the axis according to <i>Halt Option Code</i> (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

Bit	Data	Value	Description
8	–	0	Reserved
8	Halt	0	Enables Bit4
		1	Stops the axis according to <i>Halt Option Code</i> (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 <i>Halt Option Code</i> (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	–
7	Warning	–
8	Reserved	–
9	Remote	–
10	Target reached	–
11	Internal limit active	–
12, 13	Operation mode specific	–

Bit	Data	Description
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
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

Bit	Data	Value	Description
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 <i>Profile Deceleration</i> (6084h) for decelerating to a stop and moves to the No Fault state
2	Decelerates according to <i>Quick Stop Deceleration</i> (6085h) for decelerating to a stop and moves to the No Fault state
5	Decelerates according to <i>Profile Deceleration</i> (6084h) for decelerating to a stop and stays at the QuickStop state
6	Decelerates according to <i>Quick Stop Deceleration</i> (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 <i>Profile Deceleration</i> (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 <i>Profile Deceleration</i> (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 <i>Profile Deceleration</i> (6084h) for decelerating to a stop
2	Decelerates according to <i>Quick Stop Deceleration</i> (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	VI (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

12.3.5 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

12.3.6 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
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

Value	Description
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

12.3.7 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

12.3.8 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)) \times 10^{Interpolation time index (60C2h: 02)} [s]

The interpolation period must be an integer multiple of 125us and greater than 125us.

12.3.9 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%]

12.3.10 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

12.3.11 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	–

12.3.12 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

12.3.13 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
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

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value
	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
24	CN1-6, -7	Remote0
25	CN1-8, -9	Remote1
26	CN1-10, -11	Remote2
27	CN1-12, -13	Remote3
28 to 31	–	Reserved

12.3.14 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	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
	08	Standard error field 8	UINT32	RO	No	—	—	—
1010	Store parameters							
	00	Highest sub-index supported	UINT8	RO	No	—	—	—
	01	Reserved	UINT32	RO	No	—	—	—
	02	Reserved	UINT32	RO	No	—	—	—
	03	save application parameters	UINT32	RW	No	—	—	—
1018	Identity Object							
	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	—	—	—
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	—	—	—
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	—	—	—

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	–	–	–
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	–	–	–
	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	–	–	–

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	–	–	–
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	–	–	–
	07	Mapping entry 7	UINT32	RW	No	–	–	–
	08	Mapping entry 8	UINT32	RW	No	–	–	–
1A03	4th 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	–	–	–

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	–	–	–
1C12	Sync Manager PDO assignment 2							
	00	Number of assigned PDOs	UINT8	RW	No	–	–	–
	01	Index of assigned RxPDO 1	UINT16	RW	No	–	–	–
	02	Index of assigned RxPDO 2	UINT16	RW	No	–	–	–
1C13	Sync Manager PDO assignment 3							
	00	Number of assigned PDOs	UINT8	RW	No	–	–	–
	01	Index of assigned TxPDO 1	UINT16	RW	No	–	–	–
	02	Index of assigned TxPDO 2	UINT16	RW	No	–	–	–
1C32	Sync Man 2 Synchronization							
	00	Number of elements	UINT8	RO	No	–	–	–
	01	Synchronization type	UINT16	RW	No	–	–	–
	02	Cycle time/ns	UINT16	RW	No	–	–	–
1C33	Sync Man 3 Synchronization							
	00	Number of elements	UINT8	RO	No	–	–	–
	01	Synchronization type	UINT16	RW	No	–	–	–
	02	Cycle time/ns	UINT16	RW	No	–	–	–

Group 3000h

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
30A5	–	SinglePos	DINT	RO	No	–	–	–
30A6	–	MultiPos	UDINT	RO	No	–	–	–
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

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
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

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
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

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
3208	Pn164	Turns for PJO G0	INT32	RW	No	rotation	-50 to 50	5
3209	Pn165	Max Speed for PJO G0	INT32	RW	No	rpm	100 to 3000	1000
320A	Pn166	Acc./Dec. Time for PJO G0	INT32	RW	No	ms	50 to 2000	500
320B	Pn167	Stop Time for PJO G0	INT32	RW	No	ms	100 to 10000	1000
320C	Pn168	Turns for PJO G1	INT32	RW	No	rotation	-50 to 50	5
320D	Pn169	Max Speed for PJO G1	INT32	RW	No	rpm	100 to 3000	1000
320E	Pn170	Acc./Dec. Time for PJO G1	INT32	RW	No	ms	50 to 2000	500
320F	Pn171	Stop Time for PJO G1	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

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
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

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
32F5	Pn401	Forward Internal Torque Limit	INT32	RW	No	%	0 to 350	350
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	–

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
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
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
337B	Pn535	Discharging Resistor Resistance	INT32	RW	No	Ω	10 to 300	–

Index	Parameter	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
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
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

Group 6000h

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
603F	00	Error code	UINT16	RW	Yes	–	–	–
6040	00	Control word	UINT16	RW	Yes	–	–	–
6041	00	Status word	UINT16	RO	Yes	–	–	–
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	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
6061	00	Modes of operation display	INT8	RO	Yes	–	–	–
6062	00	Position demand value	INT32	RO	Yes	position units	–	–
6063	00	Position actual value	INT32	RO	Yes	inc	–	–
6064	00	Position actual value	INT32	RO	Yes	position units	–	–
6065	00	Following error window	UINT32	RW	Yes	position units	–	–
6066	00	Following error time out	UINT16	RW	Yes	ms	–	–
6067	00	Position window	UINT32	RW	Yes	position units	–	–
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	–	–	–
6077	00	Torque actual value	INT16	RO	Yes	–	–	–
6078	00	Current actual value	INT16	RO	Yes	–	–	–
607A	00	Target position	INT32	RW	Yes	–	–	–
607C	00	Home offset	INT32	RW	Yes	–	–	–
607D	Software Position Limit							
	00	Number of entries	UINT8	RO	No	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
	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	–	–
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	–	–	–
	02	divisor	UINT32	RW	No	–	–	–
6098	00	Homing method	INT8	RW	Yes	–	–	–
6099	Homing speeds							
	00	Number of entries	UINT8	RW	Yes	–	–	–

Index	Subindex	Name	Data Type	Access	PDO Mapping	Unit	Range	Default
	01	Speed during search for switch	UINT32	RW	Yes	speed units	–	–
	02	Speed during search for zero	UINT32	RW	Yes	speed units	–	–

