

BD3E Servo System

User Manual



Revision History

Document Revision Number	Date	Notes
0.1	October 2023	BD3E – Initial Release.
0.2	May 2024	Added content for 380V CD enclosure
0.3	October 2024	Updated inaccurate illustrations
0.4	November 2024	Added PM2 motor specifications content
0.5	April 2025	Added PH3 motor specifications content

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Customer Service

Servotronix is committed to providing high-quality customer service and support for all products manufactured by our company. Our goal is to provide customers with sufficient information and resources so they can obtain them promptly when needed. To receive the most efficient service, we recommend that you contact your local sales representative for order status and delivery information, product information and documentation, as well as application and on-site technical assistance. If you are unable to reach your local sales representative for any reason, please choose the most suitable contact method from the following options:

For any inquiries regarding the BD3E Drive or other Servotronix products,

Please contact: servotronix@midea.com

Unpacking

The packaging contains only one BD3E Drive, along with one STO plug (for ST or BK versions only) and one power plug.

Upon arrival, please open the package and remove all packing materials.

Inspect the product to ensure BD3E Servo Drive has no visible damage; if any damage is found, notify the carrier immediately.

Contents

Revision History	2
Disclaimer	2
Trademark	2
Technical Support	3
1. Preface	1
1.1 BD3E Product Overview	1
1.2 Ordering Information	2
1.2.1 BD3E Ordering Information	2
1.2.2 PH3 Ordering Information	3
1.3 Servo System Compatibility Table	5
1.4 BD3E Product Label	6
1.5 BD3E Document Package	7
2. Safety and Standards	8
2.1 Safety Symbols	8
2.2 Safety Guidelines	8
2.2.1 Installation Safety	9
2.2.2 Operational Safety	10
2.2.3 Maintenance Safety	11
2.3 Material Safety Data	11
2.4 Standard Certifications	12
3. BD3E Driver Specifications	13
3.1 Dimensions	13
3.2 Mechanical and Electrical Specifications	15
3.3 Control Specifications	17
3.4 Protection Functions and Environmental Specifications	19
3.5 Communication Specifications	19
3.6 Input/Output Specifications	20
3.7 Motor Feedback Specifications	21
4. PH3 Motor Specifications	22
4.1 General Specifications	22
4.1.1 220V Medium Inertia Frame 60	22
4.1.2 220V Medium Inertia Frame 80	25
4.1.3 220V Medium Inertia Frame 130	28

4.1.4 380V Medium Inertia Frame 130.....	32
5. Drive Settings.....	36
5.1 System Wiring Overview.....	36
5.2 Installation Process Overview.....	37
5.3 Powering On.....	38
5.4 Drive Address.....	38
5.5 Connectors and Cables.....	38
5.5.1 Tools and Accessories.....	38
5.5.2 Mating Connectors and Cables.....	39
5.5.3 Filters.....	41
5.6 Host System.....	44
5.7 Fieldbus Device File.....	45
5.8 Electromagnetic Interference Suppression.....	45
5.8.1 CE Filtering Technology.....	45
5.8.2 Grounding.....	45
5.8.3 Shielding and Bonding.....	47
5.8.4 Input Power Filtering.....	49
5.8.5 Other EMI Suppression Recommendations.....	49
5.9 Electrical System Precautions.....	50
5.9.1 Fuses.....	50
5.9.2 Leakage Current and Protection.....	50
5.10 Mechanical Installation.....	51
5.10.1 Installation BD3E.....	51
5.10.2 Installing Multiple Units.....	51
5.11 Driver Connection.....	52
5.11.1 BD3E Driver Port Definitions.....	53
5.11.2 EtherCAT Communication - C2 and C3.....	54
5.11.3 I/O Interface - C4.....	55
5.11.4 Motor Feedback Interface - C5.....	57
5.11.5 Motor Feedback Wiring.....	57
5.11.6 STO Interface C1.....	58
5.11.7 EtherNet Interface PC.....	60
5.11.8 BD3E Power Port Definitions.....	60
5.11.9 Protective Grounding - 	62
5.12 Regenerative Braking.....	63
5.12.1 Overview of Regenerative Energy.....	63
5.12.2 Overload Protection for Regenerative Resistor.....	64
5.12.3 Parameters of Regenerative Resistor.....	64
5.12.4 Selection of Braking Resistor.....	65

6. Motor Settings.....	69
6.1 Motor Settings Wizard.....	69
6.2 Driver Identification.....	75
6.3 Current Limits.....	75
6.4 Speed Limits.....	75
6.5 Position Limit.....	76
7. Application Settings.....	77
7.1 Parameters.....	77
7.1.1 Configuration Parameters.....	77
7.1.2 Management Parameters - Drive Memory.....	77
7.2 Application Setup Wizard.....	78
7.2.1 Application Setup - Interface.....	78
7.2.2 Application Setup - Operation Mode.....	79
7.2.3 Application Setup - Position Units.....	79
7.2.4 Application Setup - Input/Output.....	80
7.2.5 Application Setup - Return to Zero.....	81
7.2.6 Application Setup - Save.....	81
7.3 Communication.....	81
7.3.1 Connecting BD3E with ServoStudio 2.....	82
7.3.2 Communication Configuration.....	84
7.4 Power Stage.....	85
7.5 Feedback.....	85
7.5.1 Single-turn and Multi-turn Encoders.....	86
7.5.2 Replacement of Multi-turn Encoder Backup Battery.....	86
7.6 Units of Motion.....	87
7.7 Overload Current.....	87
7.8 Digital Input.....	88
7.9 Digital Output.....	88
7.10 Shutdown Modes.....	89
7.10.1 Active Shutdown.....	90
7.10.2 Dynamic Braking.....	92
7.11 Motor Brake Control.....	94
7.12 Return to Zero.....	95
7.12.1 Return to Zero with Z Pulse.....	96
7.12.2 Return to Zero with Positive and Negative Edges.....	96
7.12.3 Set Current Position as Zero Position.....	97
8. Panel Operation.....	98
8.1 Panel Operator.....	98
8.2 Function Switching.....	98

8.3 Status Display	98
8.3.1 Power-On Display	98
8.3.2 Initial Display	99
8.3.3 Status Codes	99
8.4 Monitoring Display (d××××)	100
8.4.1 Display Overview	100
8.4.2 Operation Example	103
8.4.3 Input Signal Monitoring	103
8.4.4 Output Signal Monitoring	104
8.5 Parameter Mode (P××××)	105
8.5.1 Related Notes	105
8.5.2 Operation Example	106
8.6 Auxiliary Functions (C××××)	108
8.6.1 Auxiliary Function Overview	108
8.6.2 C0001 Drive Software Information	110
8.6.3 C0002 Error Log	111
8.6.4 C0003 Panel Servo Enable	112
8.6.5 C0004 Load Inertia Estimation	112
8.6.6 C0005 Speed JOG	114
8.6.7 C0006 Config	115
8.6.8 C0007 Alarm Record Clearing	115
8.6.9 C0008 Absolute Encoder Initialization	116
8.6.10 C0009 Restore Factory Settings	116
8.6.11 C0010 Soft Restart	117
8.6.12 C0011 Servo Parameter Auto-Adjustment	118
8.6.13 C0012 Save to Drive	119
8.6.14 C0100 Panel Password	119
9. Operation	121
9.1 Drive Enable	121
9.2 Drive Operation Mode	122
9.3 Current Operation	122
9.3.1 Serial Current Operation	122
9.3.2 Current Control	123
9.4 Speed Operation	123
9.4.1 Serial Speed Operation	123
9.4.2 Speed Control	123
9.5 Position Operation	124
9.5.1 Serial Position Operation	124
9.5.2 Position Control	126

10. Tuning	127
10.1 Offline Inertia Identification	127
10.1.1 Parameters	127
10.1.2 Operable Tools	127
10.1.3 Panel Operation Steps (AutoTune: C0004)	128
10.1.4 Servostudio 2 Operation Steps	129
10.1.5 Possible Issues and Solutions	134
10.2 Stiffness Table	135
10.2.1 Parameters	135
10.2.2 Example	135
10.3 Parameter Auto-Tuning Function	137
10.3.1 Overview	137
10.3.2 Operable Tools	138
10.3.3 Panel Operation Steps (AutoTune: C0012)	138
10.3.4 Servostudio 2 Operation Steps	139
10.3.5 Parameter Description	143
10.3.6 Precautions	144
10.4 Recording and Evaluating Performance	144
10.4.1 Recording Data in ServoStudio 2	144
10.4.2 Recording Data in the Terminal	145
10.4.3 Evaluating VCMD	146
10.4.4 Evaluating ICMD and/or PE Oscillation	147
11.1 Report Generator	149
11.2 Faults and Warnings	150
11.3 Fieldbus Status LED	151
11.4 Digital Display - Warning Codes	151
11.5 Digital Display - Fault Modes	157
11.6 Warning, Error, and Fault Messages	174
11.6.1 Warning Messages	174
11.6.2 Error Messages - Manufacturer Specific	175
11.6.3 Fault Messages	175
12. Accessories	178
12.1 Docking Connectors	178
12.2 Cables	178
12.3 Line Filters	179
12.4 Regenerative Resistor	179
13. Application Guidelines	181
13.1 Firmware Upgrade	181
13.1.1 Firmware Upgrade	181

13.1.2 Possible Issues and Solutions	184
13.2 Return to Zero Function	188
13.2.1 Steps to Execute in ServoStudio 2 Interface	188
13.2.2 Steps to Execute ServoStudio 2 Terminal Commands	189
13.2.3 Parameter Description	191
13.3 Collision Detection Application	193
13.3.1 Usage Steps	193
13.3.2 Parameter Description	195
13.3.3 Possible Issues and Solutions	196
13.4 Multi-segment Collision Detection Application	197
13.4.1 Usage Steps	197
13.4.2 Parameter Description	198
13.4.3 Precautions	199
13.5 Low-frequency Vibration Suppression	200
13.5.1 Usage Steps	200
13.6 Speed Disturbance Observer	201
13.6.1 Overview	201
13.6.2 Related Parameters	202
13.6.3 Precautions	202
13.7 Notch Filter	203
13.8 Friction Compensation	204
13.8.1 Overview	204
13.8.2 Related Parameters	205
13.8.3 Precautions	206
13.9 Model Tracking	206
13.9.1 Overview	206
13.9.2 Related Parameters	207
13.9.3 Precautions	207
13.10 Gravity Compensation Function	207
13.10.1 Overview	207
13.10.2 Related Parameters	208
13.10.3 Precautions	209
14. Communication	210
14.1 Variables and Commands	210
14.2 Information Format	210
14.2.1 Information Unit	211
14.2.2 Information Termination	211
14.2.3 Units	212

14.3 BD3E Protocol Example	212
14.3.1 Issuing Commands or Variables.....	212
15. Application Cases	215
15.1 Usage Instructions for BD3E Series Servos with SERVOTRONIX SC301 EtherCAT Controller	215
15.1.1 Preparation.....	215
15.1.2 Software Engineering Configuration.....	215
15.2 Usage Instructions for BD3E Series Servos with STEP EtherCAT Controller.....	223
15.2.1 Preparation.....	224
15.2.2 Software Engineering Configuration.....	224
15.3 BD3E Series Servo Operation Guide with Beckhoff TwinCAT3.....	234
15.3.1 Preparation.....	234
15.3.2 Software Engineering Configuration.....	235
15.4 BD3E Series Servo Operation Method with Omron Controller.....	242
15.4.1 Preparation.....	242
15.4.2 Omron NX Software Configuration.....	243
15.5.2 Software Configuration.....	252
16. Appendix.....	258
16.1 Monitoring Display Overview D.....	258
16.2 Auxiliary Function Overview C.....	261
16.3 Parameter Overview P.....	261
16.3.1 P0 Basic Functions.....	261
16.3.2 P1 Gain Adjustment.....	264
16.3.3 P3 Auxiliary Control.....	266
16.3.4 P4 Motion Control.....	273
16.3.5 P5 Special Functions.....	275
16.3.6 P6 I/O Allocation.....	279
16.3.7 P7 Drive Settings.....	282
16.3.8 P8 Motor Settings.....	284
16.3.9 P9 Communication Configuration.....	287

1. Preface

1.1 BD3E Product Overview

The BD3E is a high-performance servo driver specifically designed for lightweight load robots and electronic component equipment in the 3C (computers, communications, and consumer electronics) and semiconductor industries, as well as for applications in robotics and lithium battery industries. The BD3E driver can match servo motors ranging from 100W to 3000W, ensuring that machine manufacturers achieve optimal motion control performance, machine operation efficiency, and high productivity.

The BD3E servo kit is suitable for applications using the EtherCAT fieldbus (controlled by Servotronix softMC multi-axis controllers or any third-party EtherCAT controller). Ethernet communication supports plug-and-play debugging via ServoStudio 2 software; motor installation, application configuration, and auto-tuning wizards simplify the debugging process, making it very convenient for users to perform script programming and monitor the operation status of the servo system;

The BD3E servo kit also includes the PM2 series of high-performance AC servo motors. The PM2 series motors are designed to meet advanced automation requirements, featuring low torque ripple at low speeds, low temperature rise, high torque density, and strong overload capacity; the PM2 motors come equipped with 20-bit magnetic absolute encoders, which support single-turn or multi-turn configuration options. All motor encoder units have a set of motor parameters (motor electronic nameplate MTP, stored in the encoder EEPROM) built-in. When Servo Driver starts and detects the MTP, these parameter values are directly loaded from the encoder memory to Servo Driver memory, enabling automatic identification and matching of Servo Driver and motor without additional operations, ensuring simplicity and reliability during use.

In the BD3E servo assembly, the combination of Servo Drive, motor, and encoder achieves the motion accuracy and smoothness required for precision manufacturing and automated assembly processes.

For various options of the BD3E drive, refer to the ordering information.

1.2 Ordering Information

The ordering options listed in the table below include various drivers and motor models in the BD3E servo assembly product line. To inquire about product availability, please contact Servotronics.

1.2.1 BD3E Ordering Information

Table 1- 1 BD3E Ordering Information

Single axis servo drive		BD	3	E	3D5	-	2A	EB	-	ST
①	Drive Type									
BD	Rotary motor only									
②	Generation									
3	Third generation									
③	Function Positioning									
E	Economical Model									
S	Standard Model									
④	Current Rating									
1D6	Continuous 1.6Arms, Maximum 5.8Arms									
2D8	Continuous 2.8Arms, Maximum 9.8Arms									
3D5	Continuous 3.5Arms, Maximum 11Arms									
5D4	Continuous 5.4Arms, Maximum 14Arms									
5D5	Continuous 5.5Arms, Maximum 16.9Arms									
7D6	Continuous 7.6Arms, Maximum 23.0Arms									
8D4	Continuous 8.4Arms, Maximum 20Arms									
012 (2A)	Continuous 11.6Arms, Maximum 32.0Arms									
012 (4D)	Continuous 11.9Arms, Maximum 29.75Arms									
....										
④	Input Power Voltage									
2A	Single Phase 200V-240V, -10% ~ +10%, 50/60 Hz									
4D	Three Phase 380V-440V, -10% ~ +10%, 50/60 Hz									
⑤	Communication Interface									
AP	Position Pulse									
EB	EtherCAT									
PN	ProfiNET									
CN	CANOpen									
⑥	Special Specifications									
Blank	Standard									
ST	STO									
BS	Braking resistor + STO									

1.2.2 PH3 Ordering Information

Table 1- 2 PH3 Ordering Information

	PH3	S	-	M	04	A	0	06	S	T	-	**
--	-----	---	---	---	----	---	---	----	---	---	---	----

		PH3	S - M	04	A	0	06	S	T	-	**
Serial Number											
PH3 PH3 Series											
Performance Category											
Symbol	Specification										
S	Standard Type (Optical Encoder)										
E	Economy Type (Magnetic Encoder)										
Motor Type											
Symbol	Specification										
L	Low Inertia High Speed										
M	Medium Inertia High Speed										
G	Medium Inertia High Torque										
Rated Power											
Symbol	Specification										
01	100W										
02	200W										
04	400W										
06	600W										
08	750W										
09	850W										
10	1000W										
13	1300W										
18	1800W										
Rated Supply											
Symbol	Specification										
A	220VAC										
B	380VAC										
Electromagnetic Design											
Symbol	Specification										
0	Electromagnetic Design No. 0										
Other	Other Electromagnetic Design										

		PH3		S	-	M		04		A		0		06		S		T	-	**
Frame Size																				
Symbol	Specification																			
04	40mm																			
06	60mm																			
08	80mm																			
13	130mm																			
Brake/Oil Seal																				
Symbol	Specification																			
S	With Oil Seal Without Brake																			
E	With Oil Seal With Brake																			
N	Without Oil Seal Without Brake																			
B	Without Oil Seal With Brake																			
Encoder																				
Symbol	Specification																			
T	Optical Encoder: 23-bit Single Turn Resolution + 16-bit Multi-turn Counting																			
M	Magnetic Encoder: 20-bit Single Turn Resolution + 16-bit Multi-turn Counting																			
G	Magnetic Encoder: 20-bit Single Turn Resolution																			
Custom Code																				
Symbol	Specification																			
None	Standard Product																			
**	Other Custom Codes, Refer to the Custom Product Specification Sheet.																			

1.3 Servo System Compatibility Table

Table 1- 3 PH3 -BD3E Series Matching Table

Voltage Rating	Motor	Rated Power [W]	Rated Torque [Nm]	Peak Torque [Nm]	Rated Speed [rpm]	Inertia	Driver
200V	* PH3 □-L01A004□□	100	0.32	1.12	3000	Small	BD3E -1D62A

Voltage Rating	Motor	Rated Power [W]	Rated Torque [Nm]	Peak Torque [Nm]	Rated Speed [rpm]	Inertia	Driver
	PH3 □-M02A006□□	200	0.64	2.24	3000	Medium	BD3E -1D62A
	PH3 □-M04A006□□	400	1.27	4.77	3000	Medium	BD3E -2D82A
	PH3 □-M06A006□□	600	1.91	6.69	3000	Medium	BD3E -5D52A
	PH3 □-M08A008□□	750	2.39	8.37	3000	Medium	BD3E -5D52A
	PH3 □-M10A008□□	1000	3.18	11.13	3000	Medium	BD3E -7D62A
	PH3 □-G09A013□□	850	5.39	16.17	1500	Medium	BD3E -7D62A
	PH3 □-G13A013□□	1300	8.34	20.85	1500	Medium	BD3E -0122A
	PH3 □-G18A013□□	1800	11.50	28.75	1500	Medium	BD3E -0122A
	PH3 □-G09B013□□	850	5.39	16.17	1500	Medium	BD3E -3D54D
	PH3 □-G13B013□□	1300	8.34	20.85	1500	Medium	BD3E -5D44D
380V	PH3 □-G18B013□□	1800	11.50	28.75	1500	Medium	BD3E -8D44D

*Special Note: The 40 frame size model is under development and is expected to be available on the market by 2025.08.30. Selection data for the 40 frame size product is not provided in this manual. Please refer to updates in subsequent versions of the manual.

1.4 BD3E Product Label

The model and specifications of the BD3E servo drive can be found on the product label on the back panel of Servo Drive.

Table 1- 4 BD3E Product Label Codes

Item	Description
MODEL	Catalog Number (Ordering Information)
S/N	Product Serial Number. Digits 1-14 = Material Code Digits 15-20 = Production Date (Year, Month, Day) Digit 21 = Production Workshop Digit 22 = Production Type Digits 23-27 = Production Line Number



Fig. 1- 1 BD3E Product Label – Sample

1.5 BD3E Document Package

BD3E The document package for the servo driver includes the following manuals.

- BD3E User Manual: Hardware setup, operation, and tuning. For use by personnel qualified to transport, assemble, commission, and maintain Servo Driver.
- ServoStudio 2Reference Manual: The graphical user interface (GUI) provided with BD3E for configuring, operating, and tuning Servo Driver.
- VarCom Reference Manual: Parameters and commands used for configuring, operating, and tuning Servo Driver.
- EtherCAT Reference Manual: Implementation of the CANopen over EtherCAT (CoE) protocol in Servo Driver.

2. Safety and Standards

2.1 Safety Symbols

Safety markings indicate that failure to comply with specified precautions and safe operating practices can result in personal injury or equipment damage.

The following safety warning symbols are used in Servo Driver and documentation.

Table 2-1 Safety Warning Symbols

Symbol	Meaning	Description	ISO 7000/IEC 60417
	Warning	Indicates that care should be taken when operating the equipment. And alerts the operator to understand the current situation, or take action to avoid adverse consequences.	0434
	Dangerous Voltage	Indicates a hazard of dangerous voltage.	5036
	Protective Grounding	Indicates any terminal for connecting external conductors to provide motor protection in the event of a fault, or protective grounding terminals.	5019
	Warning, Hot Surface	Indicates that the object is at a high temperature and should be handled with care.	5041

2.2 Safety Guidelines

BD3E The servo driver is used as an internal component of the machine's electrical control system.

The machine manufacturer and/or integrator must ensure personnel safety and the completeness of the machine system.

The machine manufacturer and/or integrator must consider, when conducting a risk assessment, BD3E the intended use of Servo Driver, and implement appropriate safety measures based on the assessment results.

BD3E The driver must be used in accordance with all applicable safety specifications and commands, as well as all technical specifications and requirements.



BD3E The driver operates at hazardous voltages and must be properly grounded.



The machine manufacturer and machine owner are responsible for the safety of machine operators.



The machine owner and machine operator are responsible for ensuring that personnel do not enter hazardous areas when the machine is powered (unless equipped with appropriate functional safety devices).

Only qualified personnel should perform installation, operation, maintenance, and repair procedures. These qualified personnel must be adequately technically trained and possess sufficient knowledge to anticipate and recognize potential hazards that may arise from using the product, modifying settings, and operating the mechanical, electrical, and electronic components of the entire machine system.

All personnel performing work on the product must be fully familiar with all applicable standards, regulations, and accident prevention rules for such work.

2.2.1 Installation Safety

Note: BD3E Improper handling can cause personal injury and/or equipment damage.



Will BD3E When connecting to other control devices, ensure that the following two basic guidelines are followed to prevent damage to Servo Driver:

- BD3E Safety grounding must be performed through the grounding wire of the AC main power supply.

Any motion controller, PLC, or PC connected to BD3E must have its grounding wire connected to the same grounding wire as BD3E .

- Before installation or commissioning BD3E please review all relevant product documentation.

- Installation must strictly follow the product specifications and installation instructions.

- All system components must be grounded. Electrical safety is provided through a low-resistance grounding connection (Class 1 protection as specified in EN/IEC 61800-5-1 standard). The motor should be connected to the protective grounding wire via a separate grounding conductor with a rating not less than that of the motor wiring.

- As part of the machine design, the machine manufacturer must prepare a machine hazard analysis and take appropriate measures to ensure that unintended movements do not cause bodily injury and/or equipment damage.

- The driver complies with IP20 (IEC 60529 standard) requirements; therefore, the machine manufacturer must select a suitable enclosure. The enclosure must at least meet IP54 (IEC 60529 standard) requirements, be made of metal or material with a flammability rating of 5VA, and have no openings at the bottom.

- The leakage current of the protective grounding wire exceeds 3.5 mA; therefore, to comply with IEC61800-5-1 standard requirements, either a dual PE connection (one through the main power ground wire for grounding, the other through the heat sink connected to the grounded equipment base) can be used, or a copper connection cable with a cross-sectional area greater than 10mm² can be used. Use the installation screws of Servo Driver and the PE connection screws to meet this requirement.

- In addition to being used for protective grounding, yellow-green wires must not be used for any other wiring.

- The power cable rating should be at least 600V/70°C.

- The motor and cables must be properly installed to avoid earth short circuits. Use a residual current circuit breaker to enhance system safety.

2.2.2 Operational Safety

Note: The machine manufacturer is responsible for the implementation, testing, and certification of equipment safety. The machine manual must clearly state the operating and maintenance conditions as well as safety precautions.

- All equipment operations must strictly follow product specifications and installation instructions.

- The equipment manufacturer must provide a power disconnection device in accordance with local regulatory requirements.

- During operation, all protective covers and cabinet doors must remain closed.

- During operation, this equipment has live parts and high-temperature components. The BD3E heat sink temperature can reach 85°C. Even if the motor does not rotate, the control cable and power cable can carry high voltage.

- Moving shafts that bear suspended loads or unbalanced loads must provide additional mechanical safety blocks (such as motor brakes) to prevent uncontrolled load drop. Failure to properly protect the load can result in serious injury.

2.2.3 Maintenance Safety

Note: Improper handling of BD3E can cause injury and/or equipment damage.

- Before performing maintenance on BD3E (or the machine it drives), review all relevant product documentation.

- Strictly follow the product maintenance requirements and instructions when performing maintenance procedures.

- To avoid arc flash, personal injury, and damage to electrical contacts, do not disconnect or connect the product while it is powered on.

- After the equipment is powered off, wait at least 5 minutes before touching or disconnecting parts that are normally energized (such as capacitors, switch contacts, screw connections).

2.3 Material Safety Data

BD3E is marked according to SJ/T 11364 standard, which applies to electronic and electrical products sold within the People's Republic of China.

The hazardous substance data in the table below complies with RoHS 2.0, issued on January 21, 2016, in China: 'Regulation on Restricting the Use of Certain Hazardous Substances in Electrical and Electronic Equipment'.



BD3E contains specific harmful substances and can be safely used for 20 years, after which it should enter the recycling system.

Table 2-2 Harmful Substances

Component Name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr VI)	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
Metal Components	X	O	O	O	O	O
Plastic Components	O	O	O	O	O	O
Electrical Components	X	O	O	O	O	O
Contacts	O	O	O	O	O	O
Cables and Cable Accessories	O	O	O	O	O	O

O: Indicates that the content of the harmful substance in all homogeneous materials of the component is below the limit specified in GB/T 26572.
X: Indicates that the content of the harmful substance in at least one homogeneous material of the component exceeds the limit specified in GB/T 26572.

2.4 Standard Certifications

The BD3E series servo driver has been tested and certified according to the following standards.

Table 2-3 Standard Certifications

Standard	Command/Description	Certification Mark
IEC 61800-5-1	Low Voltage Directive 2014/35/EU Variable Speed Electrical Drive Systems	
IEC 61800-3	Electromagnetic Compatibility (EMC) Directive 2014/30/EU Variable Speed Electrical Drive Systems	
EN 50581	European Regulation 2011/65/EU RoHS (Restriction of Hazardous Substances) Declaration of compliance with the technical documentation required for substance restriction requirements.	
SJ/T 11364	China RoHS 2.0 Mark for Restriction of Hazardous Substances in Electrical and Electronic Products Hazardous substances in electrical and electronic products; environmental protection usage period and recyclability.	
IEC International Electrotechnical Commission EN European Standard (European Norm) EU European Parliament and Council of the European Union		

3.BD3E Driver Specifications

3.1 Dimensions

The external dimensions of BD3E -1D62AEB / BD3E -2D82AEB are shown in the figure below:

Note: The BD3E -1D62AEB/BD3E -2D82AEB/BD3E -2D82AEB-ST series models do not have a fan.

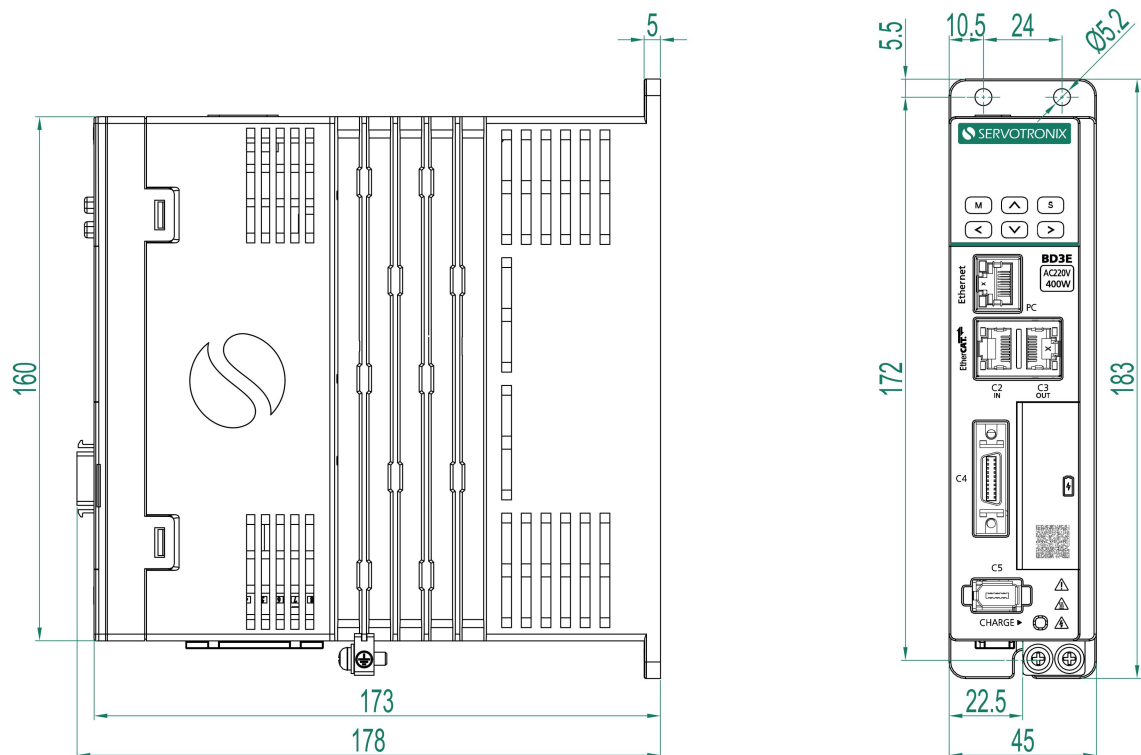


Figure 3-1 BD3E -1D62AEB and BD3E -2D82AEB dimensions (mm)

The external dimensions of BD3E -2D82AEB-BS/BD3E -5D52AEB are shown in the figure below:

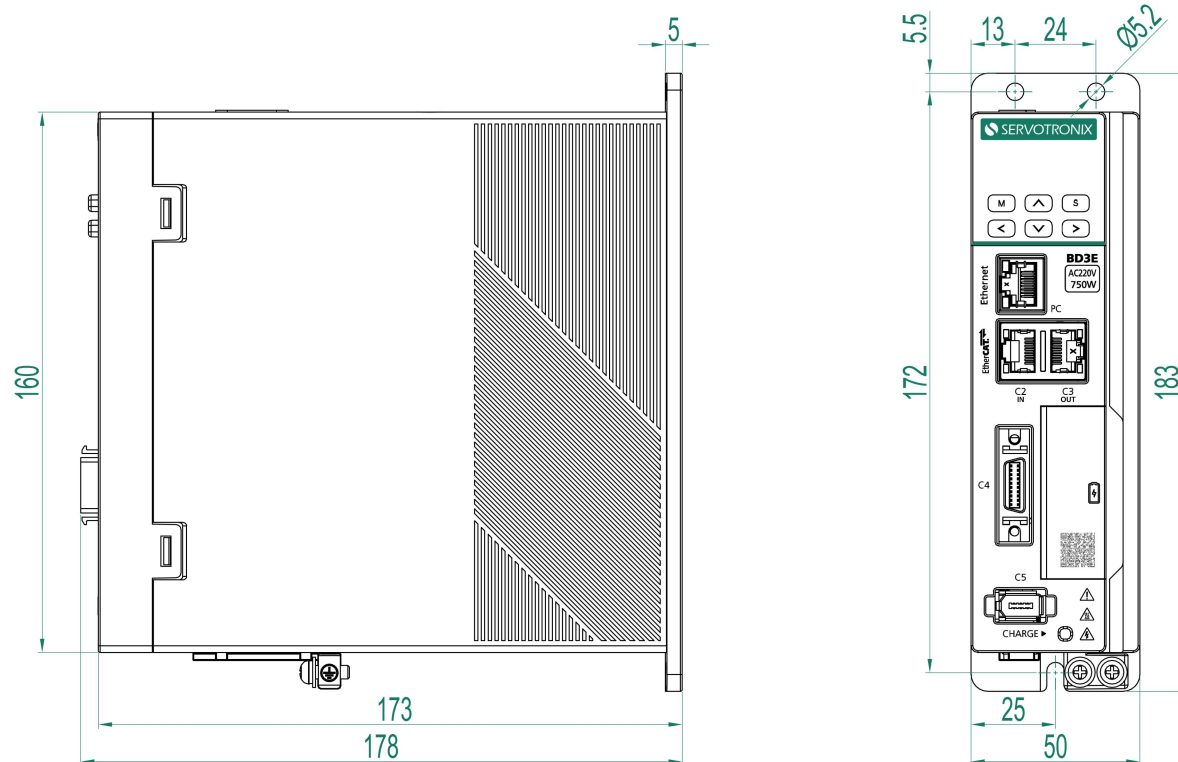


Figure 3-2 BD3E -2D82AEB-BS/BD3E -5D52AEB dimensions (mm)

The external dimensions of BD3E -7D62AEB/BD3E -3D54DEB/BD3E -5D44DEB are shown in the following figure:

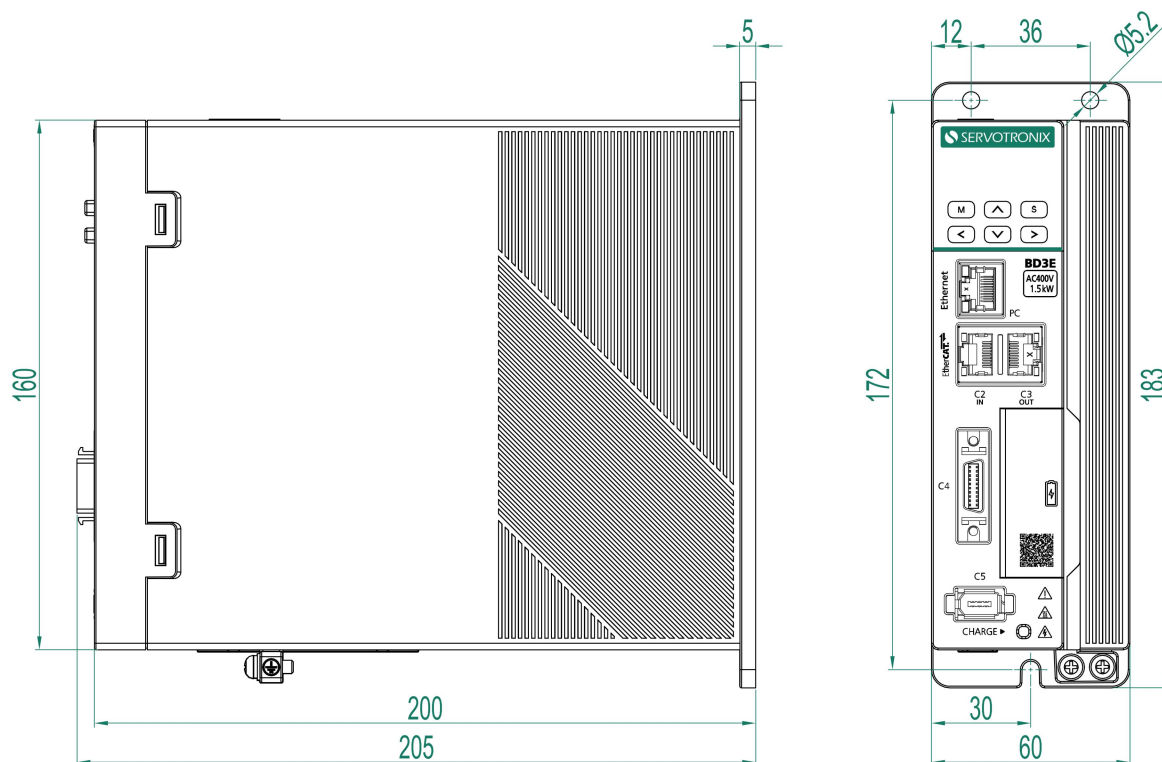


Figure 3-3 BD3E -7D62AEB/BD3E -3D54DEB/BD3E -5D44DEB Dimensions (mm)

The external dimensions of BD3E -0122AEB/BD3E -8D44DEB/BD3E -0124DEB are shown in the following figure:

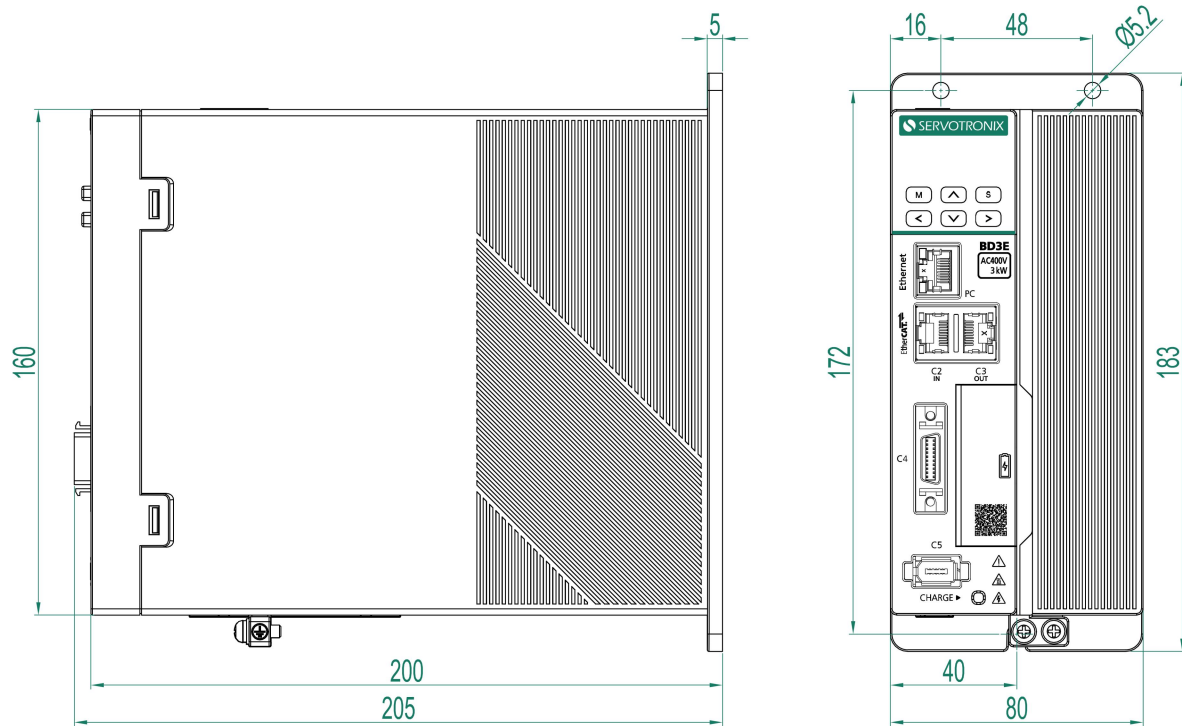


Figure 3-4 BD3E -0122AEB/BD3E -8D44DEB/BD3E -0124DEB Dimensions (mm)

3.2 Mechanical and Electrical Specifications

Table 3-1 Mechanical and Electrical Specifications for 220V Voltage Class

Specification		BD3E - 1D62AEB-□□	BD3E - 2D82AEB-□□	BD3E - 5D52AEB-□□	BD3E - 7D62AEB-□□	BD3E - 0122AEB-□□
Rated Values						
Power Circuit Input L1, L2	Rated Voltage (L-N) $\pm 10\%$	220	220	220	220	220
	Line Frequency (Hz)	50/60	50/60	50/60	50/60	50/60
	AC Voltage 220V	Single Phase	Single Phase	Single Phase	Single Phase/Three- Phase	Single Phase/Three- Phase
	Continuous Current (Single Phase A rms)	2.3	4	7.9	9.6	12.8
	Line Fuse (FRN-R, LPN, or equivalent) (A)	4	6	16	16	20
Driver Output	Continuous Output Current (A rms)	1.6	2.8	5.5	7.6	11.6
	Continuous Output Current (A peak)	2.26	3.96	8.48	10.7	16.4

Specification		BD3E - 1D62AEB-□□	BD3E - 2D82AEB-□□	BD3E - 5D52AEB-□□	BD3E - 7D62AEB-□□	BD3E - 0122AEB-□□
	Peak Output Current (A rms)	5.8	9.8	16.9	23	32
	Peak Output Current (A peak)	8.20	13.86	23.90	32.5	45.2
	kVA, AC Voltage 220V	0.35	0.62	1.21	1.67	2.25
	PWM Frequency (kHz)	8	8	8	8	8
Hardware						
Unit Weight	kg	1.105	1.105	1.232	1.34	1.69
Connection Specifications	PE Grounding Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm
Cable Specifications	Control Circuit (AWG) (3 meters or less)	24-26	24-26	24-26	24-26	24-26
	Main Circuit Motor Circuit (AWG)	20	18	16	16	14
	Main Circuit AC Input (AWG)	20	18	16	16	14
Spacing Specifications	Installation Method	Book Style	Book Style	Book Style	Book Style	Book Style
	Left/Right (mm)	10	10	10	10	10
	Top/Bottom (mm)	50	50	50	50	50
Voltage Protection	Undervoltage Protection Value (DC Voltage)	185	185	185	185	185
	Overvoltage Protection Value (DC Voltage)	410	410	410	410	410
Fan	Fan Start Conditions	None	None	Enable On	Enable On	Enable On
External Regenerative Resistor (P、D)	Minimum Resistance (Ω)	50	40	40	20	15
	Maximum Current (A)	8	10	10	20	30
	Internal DC Bus Capacitance (μF)	440	660	940	1240	2000
	Regenerative Braking Circuit Shutdown Voltage	370	370	370	370	370
	Regenerative Braking Circuit Activation Voltage	390	390	390	390	390

Table 3-2 Mechanical and Electrical Specifications for 380V Voltage Class

Specification		BD3E -3D54DEB-□□	BD3E -5D44DEB-□□	BD3E -8D44DEB-□□	BD3E -0124DEB-□□
Rated Values					
Power Circuit Input L1, L2, L3	Rated Voltage (L1-L2-L3) ±10%	380	380	380	380
	Line Frequency (Hz)	50/60	50/60	50/60	50/60
	AC Voltage 380V	three-phase	three-phase	three-phase	three-phase
	Continuous Current (Single Phase A rms)	2.4	3.6	5.6	8.0
	Line Fuse (FRN-R, LPN, or equivalent) (A)	15	15	15	20
Driver Output	Continuous Output Current (A rms)	3.5	5.4	8.4	11.9
	Continuous Output Current (A peak)	4.9	7.6	11.9	16.8
	Peak Output Current (A rms)	11	14	20	29.75
	Peak Output Current (A peak)	15.6	19.8	28.3	42.1
	kVA, AC Voltage 380V	1.33	2.05	3.19	4.52
	PWM Frequency (kHz)	8	8	8	8
Hardware					
Unit Weight	kg	1.34	1.34	1.69	1.69
Connection Specifications	PE Grounding Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm
Cable Specifications	Control Circuit (AWG) (3 meters or less)	24-26	24-26	24-26	24-26
	Main Circuit Motor Circuit (AWG)	16	16	16	14
	Main Circuit AC Input (AWG)	16	16	16	14
Spacing Specifications	Installation Method	Book Style	Book Style	Book Style	Book Style
	Left/Right (mm)	10	10	10	10
	Top/Bottom (mm)	50	50	50	50
Voltage Protection	Undervoltage Protection Value (DC Voltage)	350	350	350	350
	Overvoltage Protection Value (DC Voltage)	800	800	800	800
Fan	Fan Start Conditions	Enable On	Enable On	Enable On	Enable On
External Regenerative Resistor (P、D)	Minimum Resistance (Ω)	80	60	45	40
	Maximum Current (A)	10.0	13.3	17.8	20.0
	Internal DC Bus Capacitance (μF)	340	340	500	500
	Regenerative Braking Circuit Shutdown Voltage	760	760	760	760
	Regenerative Braking Circuit Activation Voltage	780	780	780	780

3.3 Control Specifications

Table 3-3 Control Specifications

Features		Specification
Motor	Type	Surface-Mounted Three-Phase Permanent Magnet Synchronous AC Servo Motor
	Motor Phases	Automatic Configuration of Motor Phases and Encoder Direction
Operating Modes	Control Modes	Current (Torque) Control, Speed Control, Position Control, Control Mode Switching
Current (Torque) Control	Control Method	DQ Decoupling, PI Regulator, Feedforward Control
	Reference Command	EtherNet, EtherCAT
	Parameter Tuning Method	Automatic Setting of Current Control Loop Parameters
Speed Control	Control Method	HDM、PDFF
	Filter	First-Order Low-Pass Filter, Notch Filter, Load Disturbance Observer, Speed Observer
	Reference Command	EtherNet, EtherCAT, Segment Speed Command
	Parameter Tuning Method	Rigidity Table, Automatic Parameter Tuning (Load Inertia Ratio Identification), Manual Parameter Setting, Load-Free Adjustment Function
Position Control	Performance	Update Rate 125 μ s (8 kHz)
	Control Method	HDM, P+ Feedforward
	Reference Command	EtherNet, EtherCAT, Segment Command
	Parameter Tuning Method	Rigidity Table, Manual Parameter Setting, Load-Free Adjustment Function
Brake	Method	Dynamic Braking, Motor Regenerative Braking.
Display	User Interface	5-Digit 8-Segment LED Display
GUI	User Interface	Windows-Based ServoStudio 2 Application
	Function	Set Connection, Drive Information, Power Information, Motor, Feedback, Input/Output Selection/Configuration, Motion Setup/Tuning, Fault History/Display, Setup Wizard, Expert View, etc.
Electronic Gear Ratio	Range	1:1000 ~ 8000:1
Safety Control*	STO	SAFE TORQUE OFF Safety Torque Off
Motion Unit	Position	Count (User Unit)
	Speed	Rpm
	Acceleration/Deceleration	rpm/s

*Some functions are only available on certain models, please refer to the ordering information

3.4 Protection Functions and Environmental Specifications

Table 3-4 Protective Functions and Environmental Specifications

Features	Specification
Protective Functions	Including but not limited to: low/overvoltage, overcurrent, drive and motor overheating, motor feedback, drive overload, feedback loss, unconfigured, circuit failure.
Compliance	IEC 61800-5-1: Low Voltage Directive 2014/35/EU. Variable Speed Electrical Drive Systems
	IEC 61800-3: Electromagnetic Compatibility (EMC) Directive 2014/30/EU. Variable Speed Electrical Drive Systems
	EN 50581: Supports the basic requirements of EU RoHS Directive 2011/65/EU. Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
Environment	Environmental Temperature: Operating temperature -20 - 45°C, Storage temperature -20 - 70°C
	Humidity: 10 - 90% (no condensation)
	Altitude: In accordance with the spacing requirements specified in IEC 61800-5-1 standard, BD3E is for use at altitudes below 1000 meters.
	Vibration: 1.0g
Operating Conditions	Protection Class: IP20 Pollution Degree: IEC 60664-1 standard, Degree 2 Do not use in the following locations: corrosive or flammable gases, water, oil, or chemicals, dust (including iron powder), and salt

3.5 Communication Specifications

Table 3-5 Communication Specifications

Features	Specification
EtherCAT*	CiA 301 Application Layer and CiA 402 Device Profile for Drivers and Motion Control
	Communication Cycle: Over 250µs
EtherNet	Based on IEEE802.3 Standard, ServoStudio 2, HyperTerminal
	Baud Rate: Ethernet Specification (10Mbps)
	Maximum Cable Length: 100 meters

*Some functions are only available on certain models, please refer to the ordering information

3.6 Input/Output Specifications

Table 3-6 Input/Output Specifications

Features		Specification
High-Speed Digital Input	Number of Channels	2
	Signal Format	Optical Isolation Configurable as Touch Probe NPN or PNP Wiring Valid Level Configurable
	Voltage Rating	24V (IEC 61131)
	Maximum Input Current	12.5 mA
	Transmission Delay Time	1 μ s
	Maximum Frequency	1MHz
Standard Digital Input	Number of Channels	5
	Signal Format	Optical Isolation Function Configurable NPN or PNP Configuration Configurable Valid Level Configurable
	Voltage Rating	24V (IEC 61131)
	Maximum Input Current	6 mA
	Transmission Delay Time	1 ms
	Maximum Frequency	1 kHz
Standard Digital Output	Number of Channels	3
	Signal Format	Optical Isolation Function Configurable NPN or PNP Configuration Configurable Valid Level Configurable
	Voltage Rating	24V (IEC 61131)
	Maximum Output Current	50 mA
	Short Circuit Protection	Yes
	Transmission Delay Time	1 ms

*Some functions are only available on certain models, please refer to the ordering information

3.7 Motor Feedback Specifications

Table 3-7 Motor Feedback Specifications

Features		Specification
Power Supply	Driver Power Voltage	DC Voltage 5 V
	Maximum Current from Driver to Encoder	200mA @ 5V
Cable	Maximum Length	20 Meters
Serial Asynchronous (RS485) Encoder	Signal	Data for Asynchronous Encoders Only
	Protocol	Tamagawa

Please refer to the table below to select a battery with appropriate specifications:

Table 3-8 Absolute Encoder Battery Specifications

Parameter	Item and Unit	Minimum Value	Typical Value	Maximum Value
Specification Parameter				
3.6V/2500mAh	External Battery Voltage (V)	3.2	3.6	5
	Battery Warning Voltage (V)	-	3	-
	Battery Alarm Voltage (V)	-	2.6	-
	Current Consumption at Shaft Rest (uA)	-	12	-
Environmental Conditions				
Operating Temperature	Battery Operating Environment Temperature (°C)	-20	-	45
Storage Temperature	Battery Storage Environment Temperature (°C)	-20	-	60

4. PH3 Motor Specifications

4.1 General Specifications

Table 4-1 PH3 Motor - General Specifications		Specification	
Characteristics			
Voltage Rating		220V Model	380V Model
Insulation Voltage Rating		1500 VAC for 1 minute, leakage current $\leq 10\text{mA}$	1800 VAC for 1 minute, leakage current $\leq 20\text{mA}$
Rated Operating System		S1 (Continuous)	
Insulation Class		F	
Insulation Resistance		$\geq 10\text{M}\Omega$ @ 500 VDC	
Excitation Method		Permanent Magnet Type	
Installation Method		Flange Mounting	
Drive Connection Method		Direct Connection to Driver via Extension Cable	
Rotation Direction		Viewed from the motor shaft side/load side, the rotor rotating counterclockwise (CCW) is defined as the positive direction, at which time the phase relationship of the motor's back EMF is: $U > V > W$.	
Vibration Level		V15	
Enclosure Protection Class		IP67 (excluding shaft penetration parts, and connectors must be reliably connected)	
Vibration Resistance		Vibration frequency 10~150Hz, amplitude 0.175mm or acceleration 25m/s ² , sweep cycles 10.	
Shock Resistance		Peak acceleration 50m/s ² , pulse duration 30ms, half-sine wave; 3 times in each direction, total 18 times.	
Environmental Conditions	Storage Environment	When storing the motor without power, please comply with the following environmental requirements:	
		Ambient temperature: -10°C to +40°C (non-freezing)	
		Ambient humidity: 20%RH to 85%RH (non-condensing)	
	Usage Environment	Ambient Temperature: -10°C ~ 40°C	
		Ambient Humidity: 20%RH ~ 85%RH (no condensation)	
	Installation Location	• Indoor locations without corrosive or explosive gases	
		• Well-ventilated areas with minimal dust, debris, and moisture	
		• Locations that are easy to inspect and clean	
		• Altitude below 1000m (for altitudes between 1000m and 2000m, use at reduced ratings)	
		• Locations where strong magnetic fields will not be generated	

4.1.1 220V Medium Inertia Frame 60

(1) Rated Parameters Table

Item	Units	M02A006	M04A006	M06A006
Rated Voltage	V	220	220	220
Inertia Type	/	medium inertia	medium inertia	medium inertia
Mounting Flange	mm	60	60	60

Rated Power	W	200	400	600
Rated Torque	N·m	0.64	1.27	1.91
Maximum Torque	N·m	2.24	4.77	6.69
Rated Speed	r/min	3000	3000	3000
Maximum Speed ^{*1}	r/min	7000	7000	7000
Rated Current	Arms	1.5	2.4	3.9
Maximum Current	Arms	5.6	9	14.3
Torque Constant*	N·m/A	0.48	0.6	0.53
Number of Pole Pairs	/	5	5	5
Voltage Constant*	V/Krpm	28.8	36.5	32.2
Electrical Time Constant	ms	1.11	1.62	3
Line Resistance*	Ω	7.93	3.08	1.83
Line Inductance*	mH	8.8	5	5.49
Inductance	q-axis	mH	4.75	2.73
	d-axis	mH	4.1	2.4
Rotor Inertia*	No Brake	x10 ⁻⁴ Kg.m ²	0.24	0.47
	With Brake	x10 ⁻⁴ Kg.m ²	0.25	0.48
Mechanical Time Constant	No Brake	ms	1.45	0.69
	With Brake	ms	1.51	0.70
Quality	No Brake	kg	0.68	1.01
	With Brake	kg	1.03	1.36
Permissible Load	Radial Load	N	245	245
	Axial Load	N	75	75
Brake Specifications ^{*2}	Rated Voltage	VDC	24	24
	Rated Current	A	0.4	0.4
	Rated Power	W	9.6	9.6
	Static Friction Torque	N.m	2.3	2.3
	Engagement Time	ms	<70	<70
	Release Time	ms	<20	<20
	Release Voltage	VDC	0.5~8	0.5~8
	Backlash	°	<0.5°	<0.5°
Encoder Configuration	/	20-bit single-turn/multi-turn magnetic encoder, 23-bit single-turn absolute optical encoder		
Standard Servo Driver	/	BD3E -1D62A	BD3E -2D82A	BD3E -5D52A

* Values in the table are typical values; actual products may have some tolerance:

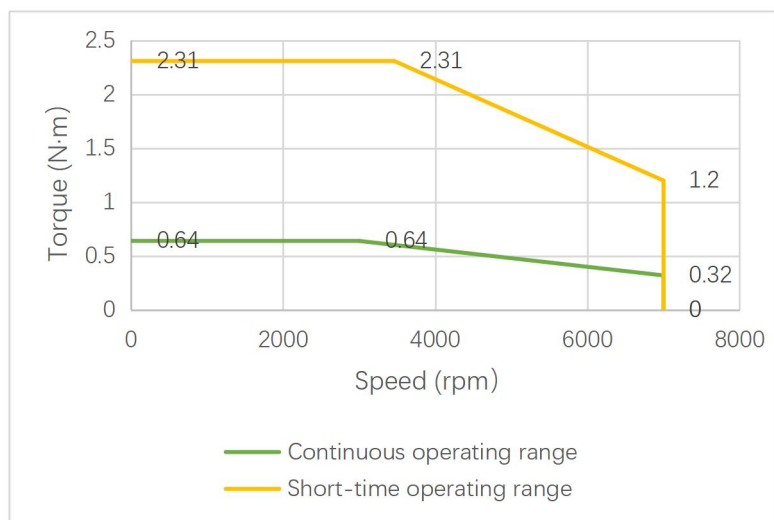
Torque Constant	±5%
Voltage Constant	±5%
Line Resistance	±5%
Line Inductance	±8%
Moment of Inertia	±3%

*1 Represents the performance when the motor is paired with the standard servo driver; performance may vary when used with other drivers.

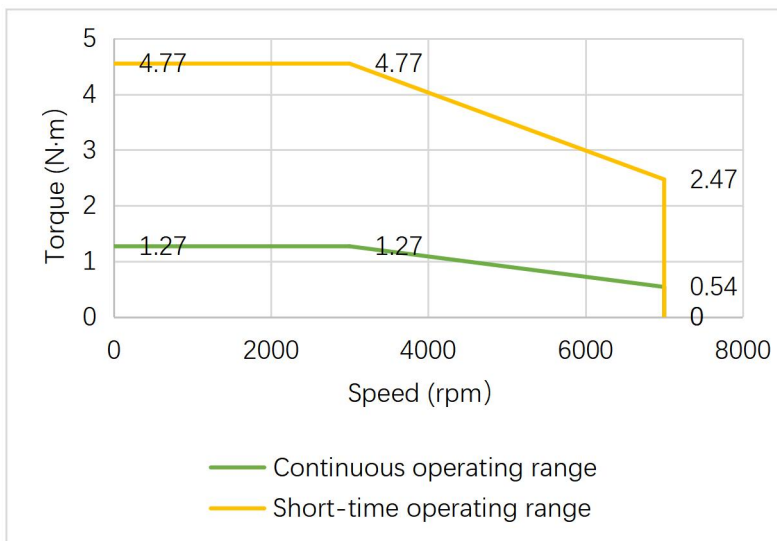
*2 The brake is only for static holding and should not be used for dynamic braking.

(2) TN Curve:

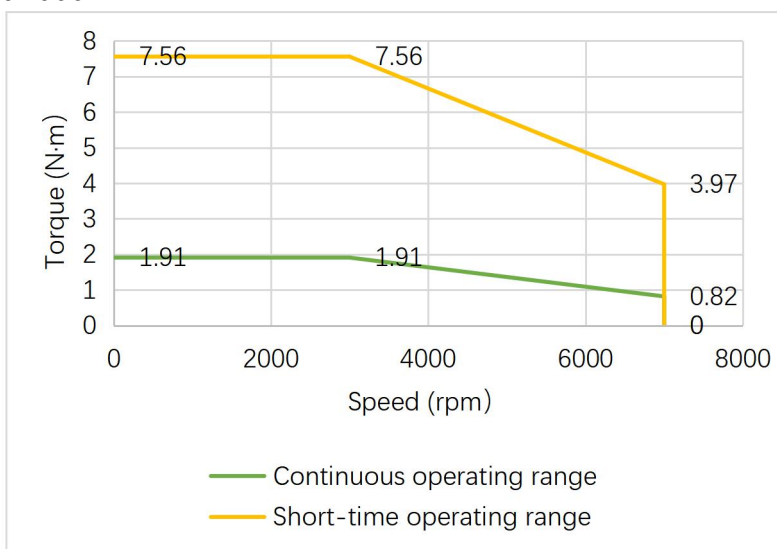
PH3 □-M02A006



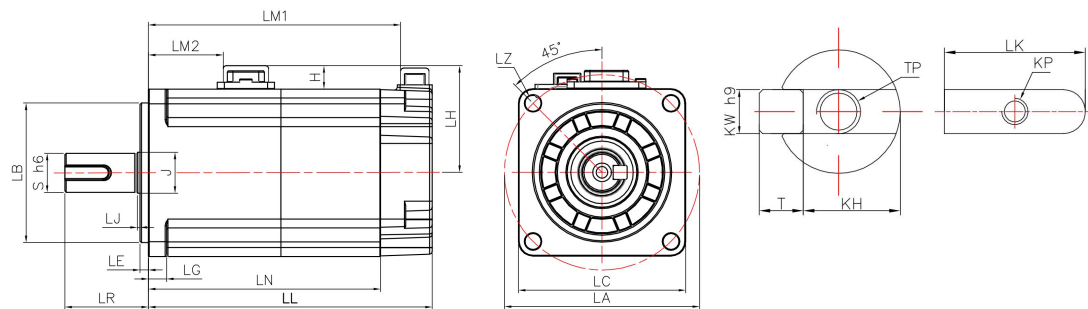
PH3 □-M04A006



PH3 □-M06A006



(3) Structural Dimensions:



Model		M02A006	M04A006	M06A006
LA		φ70	φ70	φ70
LB		φ50	φ50	φ50
LC		60	60	60
LZ		4φ5.7	4φ5.7	4φ5.7
S		φ14h6	φ14h6	φ14h6
J		φ14.7	φ14.7	φ14.7
LH		38.3	38.3	38.3
LR		30	30	30
LE		3	3	3
LG		6.5	6.5	6.5
LJ		0.5	0.5	0.5
LL	No Brake	69.3	84.8	100.3
	With Brake	101.8	117.3	132.8
LM1	No Brake	57.95	146.9	98.83
	With Brake	90.45	211.9	134.94
LM2	No Brake	26.8	84.6	64.22
	With Brake	26.8	84.6	64.22
Key Type		C	C	C
LK Key Length		16	16	16
KP		M3	M3	M3
T Key Thickness		5	5	5
KW Key Width		5	5	5
KH		11	11	11
TP Screw Hole		M5 Depth 12	M5 Depth 12	M5 Depth 12

4.1.2 220V Medium Inertia Frame 80

(1) Rated Parameters Table

Item		Units	M08A008	M10A008
Rated Voltage		V	220	220
Inertia Type		/	medium inertia	medium inertia
Mounting Flange		mm	80	80
Rated Power		W	750	1000
Rated Torque		N·m	2.39	3.18
Maximum Torque		N·m	8.37	11.13
Rated Speed		r/min	3000	3000
Maximum Speed ^{*1}		r/min	7000	7000
Rated Current		Arms	4.2	5.6
Maximum Current		Arms	15.9	21.2
Torque Constant*		N·m/A	0.596	0.599
Number of Pole Pairs		/	5	5
Voltage Constant*		V/Krpm	36.06	36.2
Electrical Time Constant		ms	2.96	2.86
Line Resistance*		Ω	1.17	0.803
Line Inductance*		mH	3.46	2.3
Inductance	q-axis	mH	1.865	1.215
	d-axis	mH	1.64	1.075
Rotor Inertia*	No Brake	$\times 10^{-4}$ Kg.m ²	1.46	2
	With Brake	$\times 10^{-4}$ Kg.m ²	1.51	2.05
Mechanical Time Constant	No Brake	ms	0.720	0.672
	With Brake	ms	0.745	0.689
Quality	No Brake	kg	1.98	2.38
	With Brake	kg	2.27	2.76
Permissible Load	Radial Load	N	147	147
	Axial Load	N	393	393
Brake Specifications ^{*2}	Rated Voltage	VDC	24±10%	24±10%
	Rated Current	A	0.438	0.353
	Rated Power	W	10.5	8.5
	Static Friction Torque	N.m	≥3.2	≥3.8
	Engagement Time	ms	<70	<60
	Release Time	ms	<20	<40
	Release Voltage	VDC	0.5~8	>1.5
	Backlash	°	<0.5°	<0.5°
Encoder Configuration		/	20-bit single-turn/multi-turn magnetic encoder, 23-bit single-turn absolute optical encoder	
Standard Servo Driver		/	BD3E -5D52A	BD3E -7D62A

* Values in the table are typical values; actual products may have some tolerance:

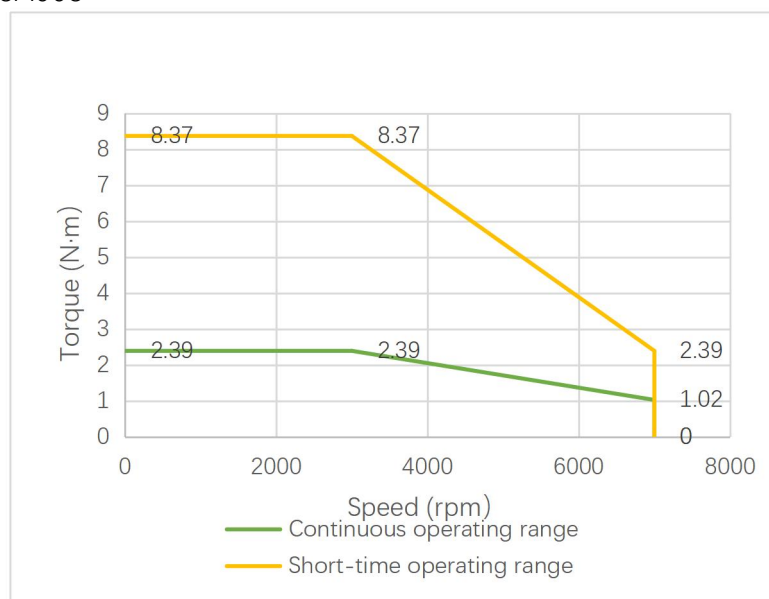
Torque Constant	±5%
Voltage Constant	±5%
Line Resistance	±5%
Line Inductance	±8%
Moment of Inertia	±3%

*1 Represents the performance when the motor is paired with the standard servo driver; performance may vary when used with other drivers.

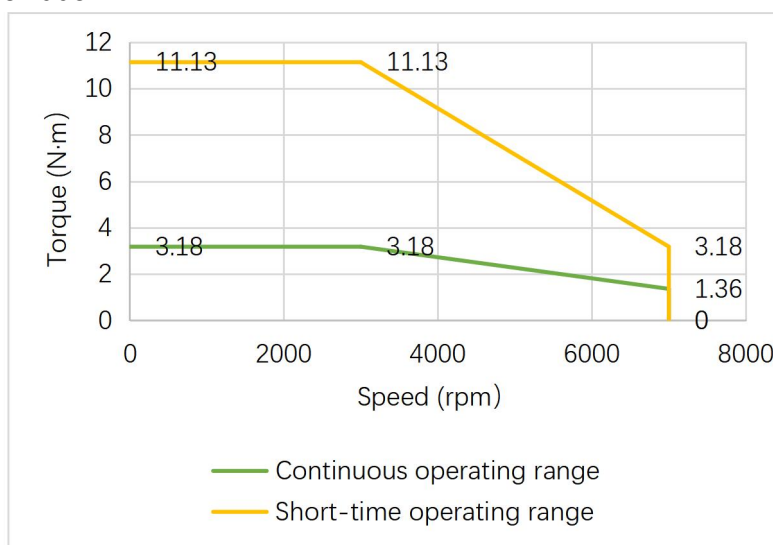
*2 The brake is only for static holding and should not be used for dynamic braking.

(2) TN Curve

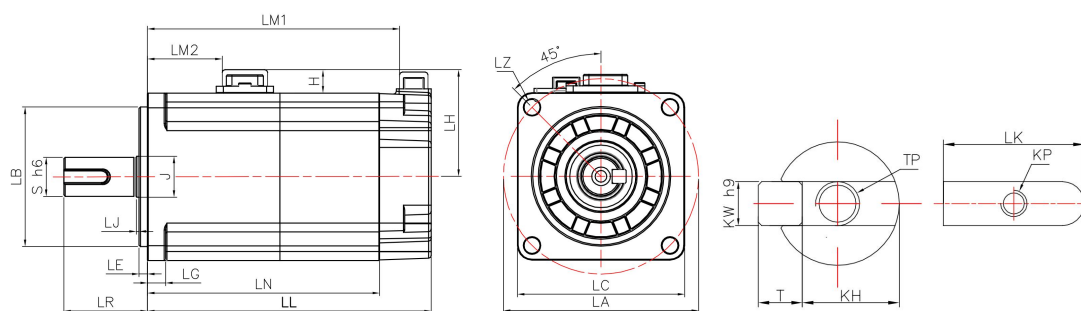
PH3 □-M08A008



PH3 □-M08A008



(3) Structural Dimensions:



Model		M08A008	M10A008
LA		φ90	φ90
LB		φ70	φ70
LC		80	80
LZ		4φ6.6	4φ6.6
S		φ19h6	φ19h6
J		φ19.8	φ19.8
LH		46.5	46.5
LR		35	35
LE		3	3
LG		8	8
LJ		0.5	0.5
LL	No Brake	96	108
	With Brake	126	145
LM1	No Brake	87	99
	With Brake	116	137
LM2	No Brake	60	72
	With Brake	60	72
Key Type		C	C
LK Key Length		25	25
KP		M3	M3
T Key Thickness		6	6
KW Key Width		6	6
KH		15.5	15.5
TP Screw Hole		M6 Depth 14	M6 Depth 14

4.1.3 220V Medium Inertia Frame 130

(1) Rated Parameters Table

Item	Units	G09A013	G13A013	G18A013
Rated Voltage	V	220	220	220
Inertia Type	/	medium inertia	medium inertia	medium inertia
Mounting Flange	mm	130	130	130
Rated Power	W	850	1300	1800
Rated Torque	N·m	5.39	8.28	11.5
Maximum Torque	N·m	13.5	20.85	28.75
Rated Speed	r/min	1500	1500	1500
Maximum Speed ^{*1}	r/min	4500	4500	4500
Rated Current	Arms	5.96	9.7	11.4
Maximum Current	Arms	15.7	25.2	29.8
Torque Constant*	N·m/A	0.92	0.88	1.03
Number of Pole Pairs	/	5	5	5
Voltage Constant*	V/Krpm	55.91	53.05	62.13

Electrical Time Constant	ms	7.95	17.45	50.32
Line Resistance*	Ω	0.97	0.44	0.39
Line Inductance*	mH	7.7	7.7	19.6
Inductance	q-axis	mH	2.94	1.6
	d-axis	mH	2.29	1.2
Rotor Inertia*	No Brake	$\times 10^{-4} \text{Kg.m}^2$	13.14	18.91
	With Brake	$\times 10^{-4} \text{Kg.m}^2$	15.4	21.2
Mechanical Time Constant	No Brake	ms	2.60	1.87
	With Brake	ms	3.05	2.09
Permissible Load	Radial Load	N	686	686
	Axial Load	N	343	343
Brake Specifications*2	Rated Voltage	VDC	24	24
	Rated Current	A	0.94	0.94
	Rated Power	W	23	23
	Static Friction Torque	N.m	16	16
	Engagement Time	ms	80	80
	Release Time	ms	40	40
	Release Voltage	VDC	>0.5	>0.5
	Backlash	°	<0.5	<0.5
Encoder Configuration	/	20-bit single-turn/multi-turn magnetic encoder, 23-bit single-turn absolute optical encoder		
Standard Servo Driver	/	BD3E -7D62A	BD3E -0122A	BD3E -0122A

* Values in the table are typical values; actual products may have some tolerance:

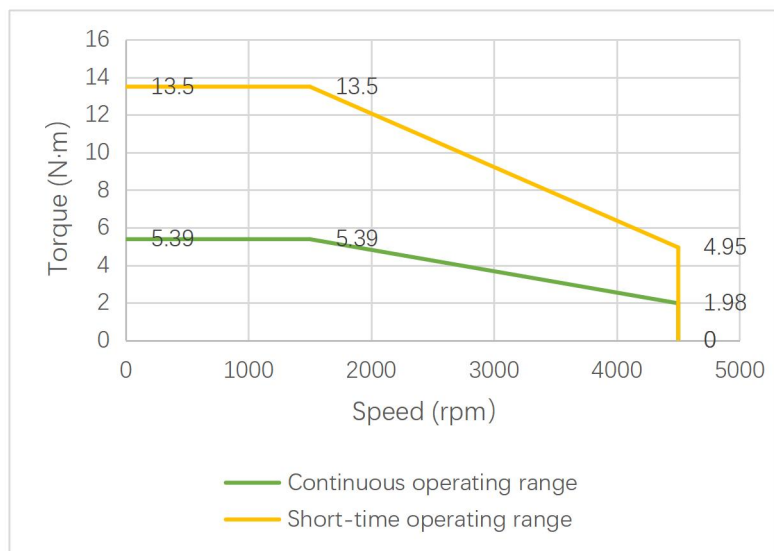
Torque Constant	±5%
Voltage Constant	±5%
Line Resistance	±5%
Line Inductance	±8%
Moment of Inertia	±3%

*1 Represents the performance when the motor is paired with the standard servo driver; performance may vary when used with other drivers.

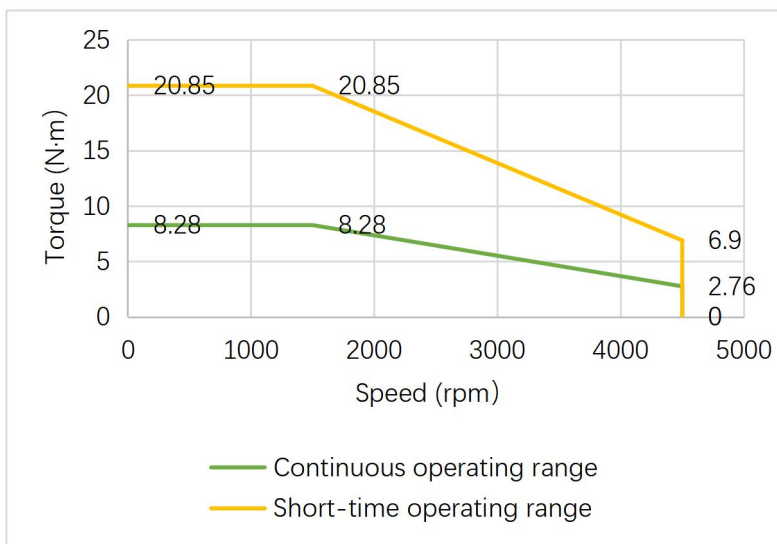
*2 The brake is only for static holding and should not be used for dynamic braking.

(2) TN Curve:

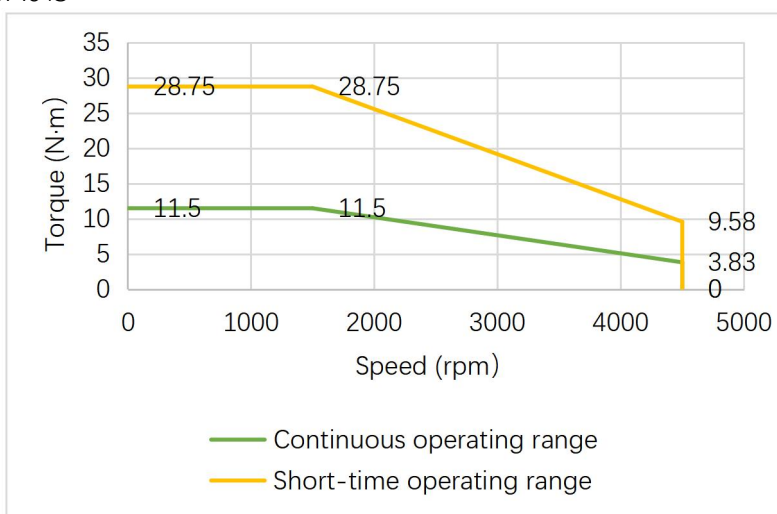
PH3 □-G09A013



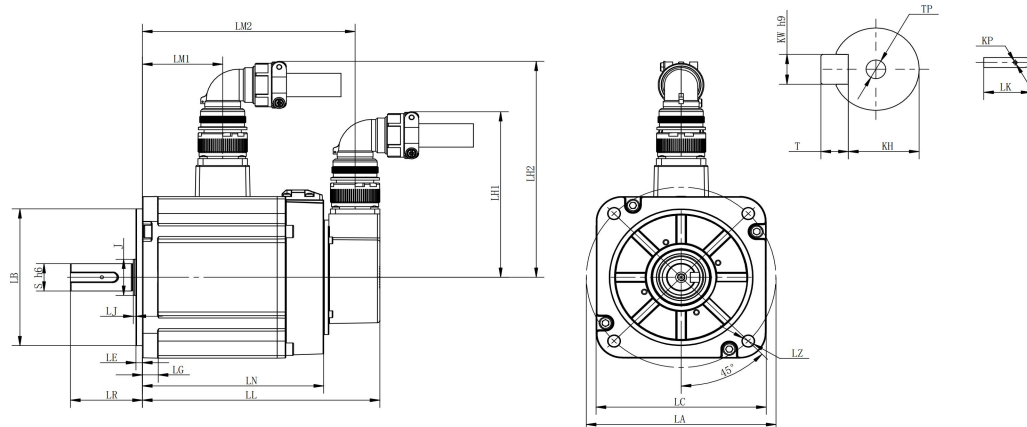
PH3 □-G13A013



PH3 □-G13A013



(3) Structural Dimensions:



Model		G09A013	G13A013	G18A013
LA		130	130	130
LB		110	110	110
LC		145	145	145
LZ		9	9	9
S		22	22	22
J		φ29	φ29	φ29
LH1		135	135	135
LH2		175	175	175
LR		55	55	55
LE		5	5	5
LG		12	12	12
LJ		2	2	2
LL (Magnetic Encoder)	No Brake	135	151.5	168
	With Brake	164	180.5	197
LL (Optical Encoder)	No Brake	145	161.5	178
	With Brake	174	190.5	207
LM1	No Brake	115.5	132	148.5
	With Brake	144.5	161	177.5
LM2	No Brake	58.5	75	91.5
	With Brake	58.5	75	91.5
Key Type		C	C	C
LK Key Length		36	36	36
KP Take Keyway		M3	M3	M3
T Key Thickness		7	7	7
KW Key Width		8	8	8
KH		18	18	18
TP Screw Hole		M6	M6	M6

4.1.4 380V Medium Inertia Frame 130

(1) Rated Parameters Table

Item	Units	G09B013	G13B013	G18B013
Rated Voltage	V	380	380	380
Inertia Type	/	medium inertia	medium inertia	medium inertia
Mounting Flange	mm	130	130	130
Rated Power	W	850	1300	1800
Rated Torque	N·m	5.41	8.28	11.46
Maximum Torque	N·m	13.5	20.7	28.65
Rated Speed	r/min	1500	1500	1500
Maximum Speed ^{*1}	r/min	4500	4500	4500
Rated Current	Arms	3.4	5.1	8
Maximum Current	Arms	8.5	13	20
Torque Constant*	N·m/A	1.59	1.62	1.43
Number of Pole Pairs	/	5	5	5
Voltage Constant*	V/Krpm	103.13	106.1	96.64
Electrical Time Constant	ms	2.78	8.13	12.23
Line Resistance*	Ω	3.42	1.77	0.96
Line Inductance*	mH	9.5	14.4	11.7
Inductance	q-axis	mH	6.4	3.7
	d-axis	mH	4.85	2.83
Rotor Inertia*	No Brake	$\times 10^{-4} \text{Kg.m}^2$	18.91	25.05
	With Brake	$\times 10^{-4} \text{Kg.m}^2$	21.2	27
Mechanical Time Constant	No Brake	ms	1.89	1.62
	With Brake	ms	2.12	1.75
Permissible Load	Radial Load	N	686	686
	Axial Load	N	343	343
Brake Specifications ^{*2}	Rated Voltage	VDC	24	24±10%
	Rated Current	A	0.94	0.81±10%
	Rated Power	W	23	19.5
	Static Friction Torque	N.m	16	≥8
	Engagement Time	ms	80	≤100
	Release Time	ms	40	≤60
	Release Voltage	VDC	>0.5	>1.5
	Backlash	°	<0.5	<0.5
Encoder Configuration	/	20-bit single-turn/multi-turn magnetic encoder, 23-bit single-turn absolute optical encoder		
Standard Servo Driver	/	BD3E -3D54D	BD3E -5D44D	BD3E -8D44D

* Values in the table are typical values; actual products may have some tolerance:

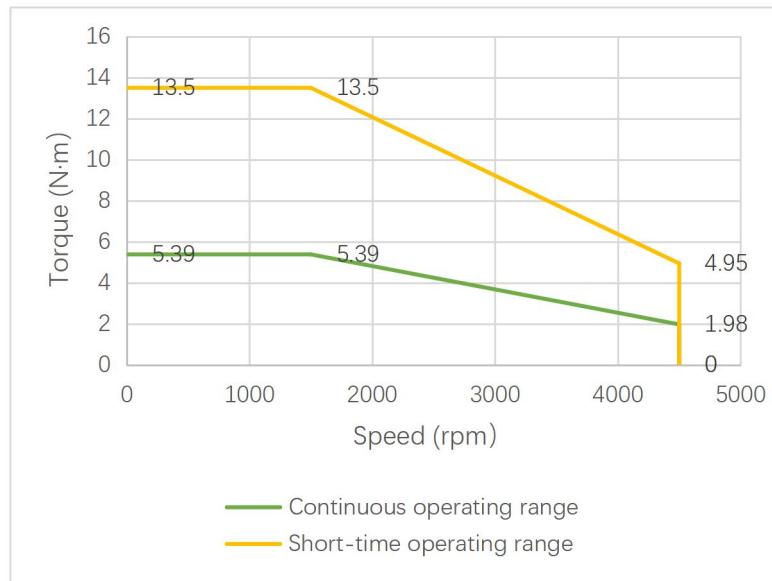
Torque Constant	±5%
Voltage Constant	±5%
Line Resistance	±5%
Line Inductance	±8%
Moment of Inertia	±3%

*1 Represents the performance when the motor is paired with the standard servo driver; performance may vary when used with other drivers.

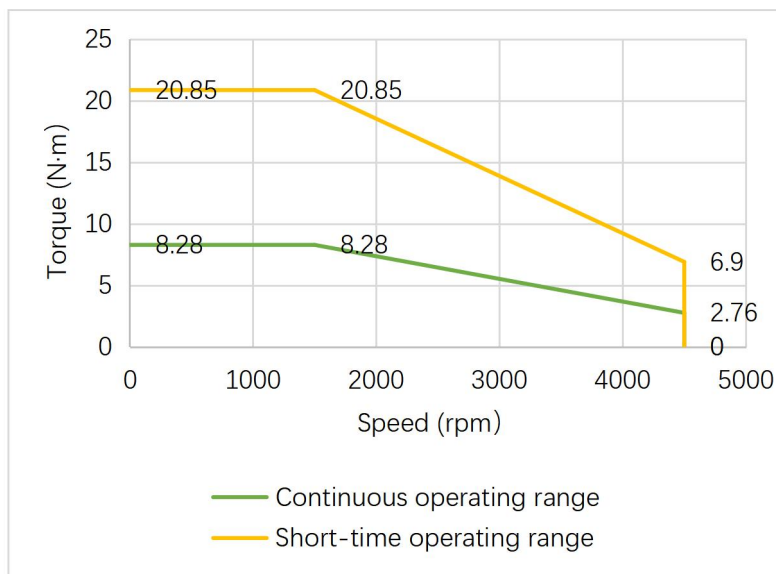
*2 The brake is only for static holding and should not be used for dynamic braking.

(2) TN Curve:

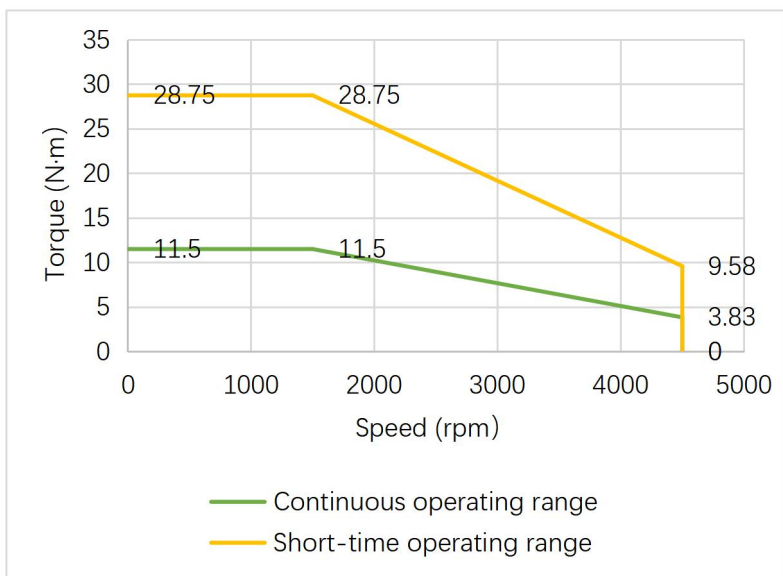
PH3 □-G09B013



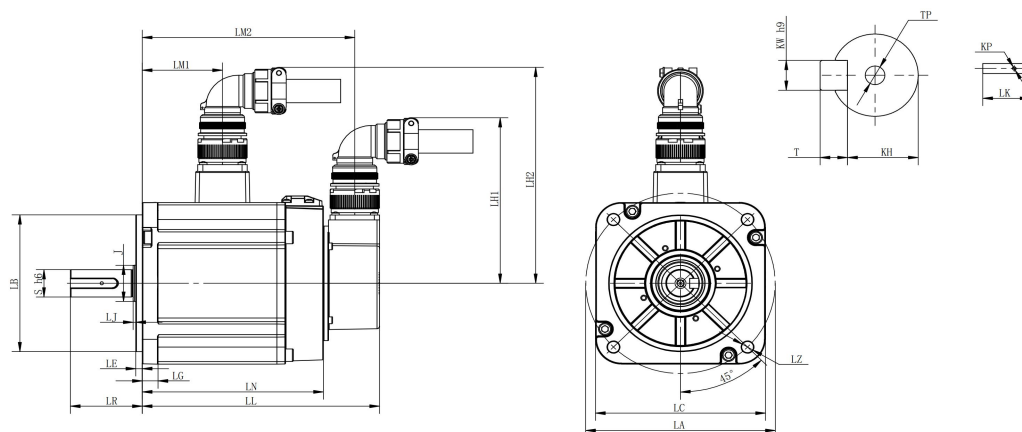
PH3 □-G13B013



PH3 □-G18B013



(3) Structural Dimensions:



Model		G09B013	G13B013	G18B013
LA		130	130	130
LB		110	110	110
LC		145	145	145
LZ		9	9	9
S		22	22	22
J		φ29	φ29	φ29
LH1		135	135	135
LH2		175	175	175
LR		55	55	55
LE		5	5	5
LG		12	12	12
LJ		2	2	2
LL (Magnetic Encoder)	No Brake	135	151.5	168
	With Brake	164	180.5	197
LL (Optical)	No Brake	145	161.5	178

Model		G09B013	G13B013	G18B013
Encoder)	With Brake	174	190.5	207
LM1	No Brake	115.5	132	148.5
	With Brake	144.5	161	177.5
LM2	No Brake	58.5	75	91.5
	With Brake	58.5	75	91.5
Key Type		C	C	C
LK Key Length		36	36	36
KP Take Keyway		M3	M3	M3
T Key Thickness		7	7	7
KW Key Width		8	8	8
KH		18	18	18
TP Screw Hole		M6	M6	M6

5. Drive Settings

5.1 System Wiring Overview

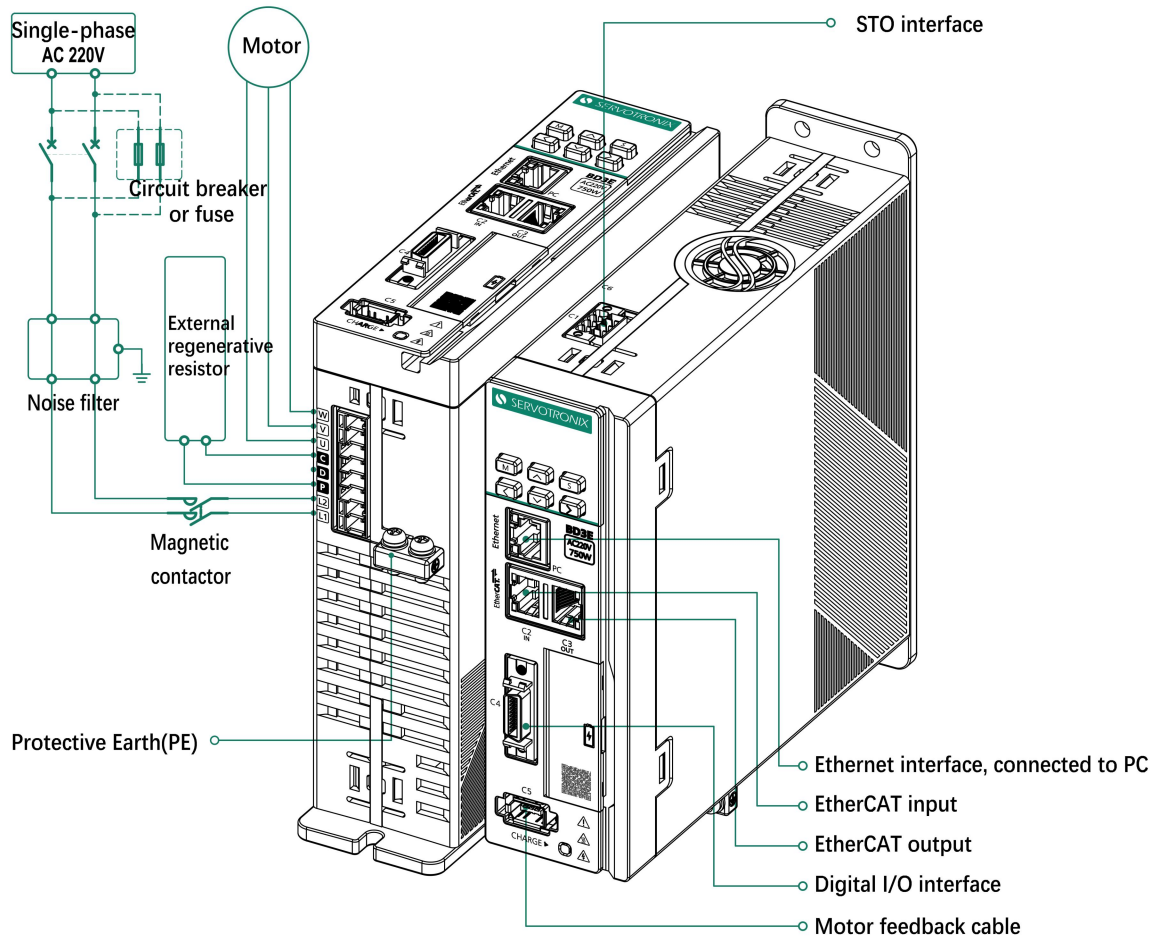


Fig. 5-1 Wiring for 200V Servo System

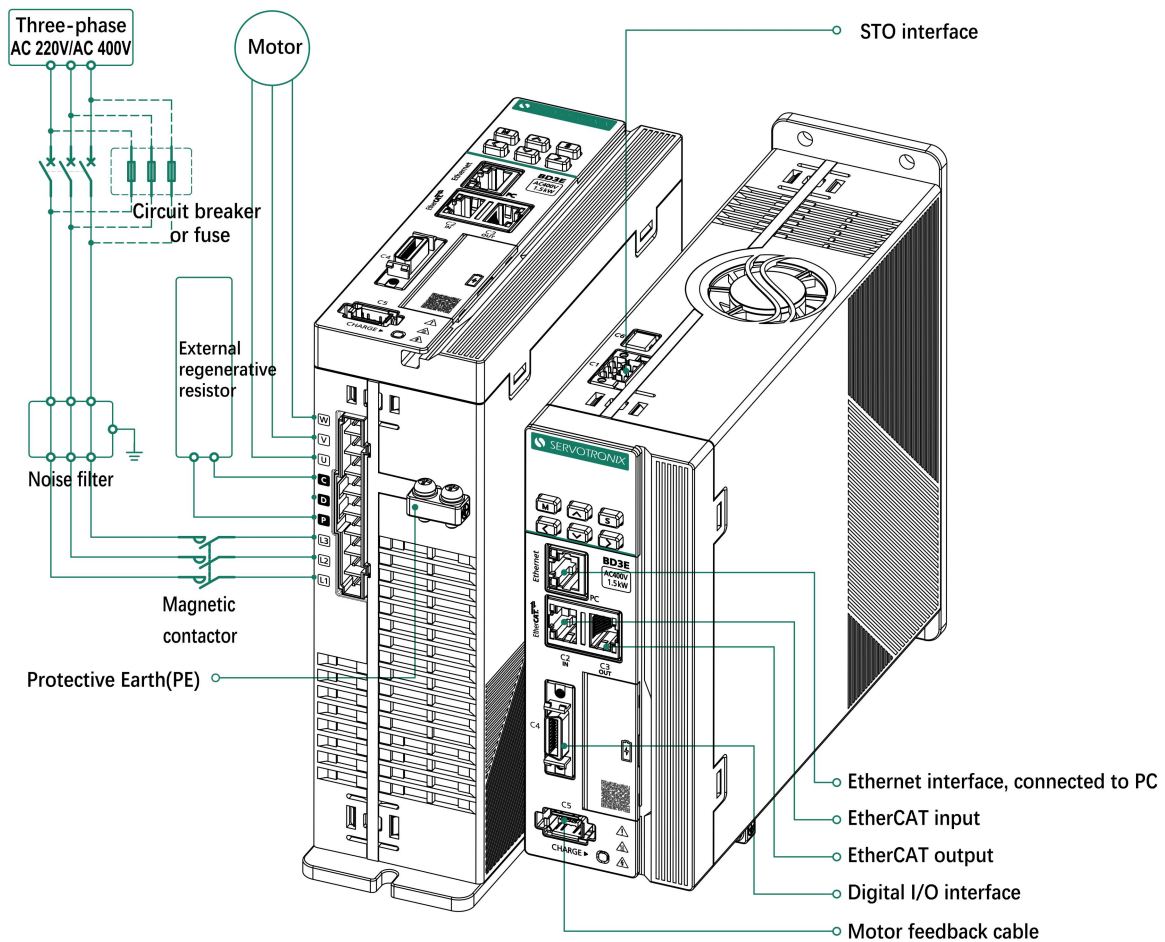


Fig. 5-2 Wiring for 400V Servo System

5.2 Installation Process Overview

Follow these steps to install and set up the BD3E system.

1. InstallationBD3E .
2. Perform all wiring and cable connections as required by the application:
 - Grounding
 - Fieldbus or motion control equipment
 - Input/Output
 - Motor feedback
 - Motor
 - Regenerative resistor (if required)
 - Motor brake (if required)

- AC input power
3. Connect Servo Driver to the host.
 4. Power on Servo Driver and host. Refer to the Power On section.
 5. Install ServoStudio 2 software. Refer to the ServoStudio 2 manual.

5.3 Powering On

After completing all hardware connections, you can power on Servo Driver.

Note: If the logic power supply and Servo Drive power supply are connected separately, it is recommended to turn on the logic power supply before turning on Servo Drive power supply.

Check the digital display on the front panel of BD3E to show the current status of Servo Driver.

5.4 Drive Address

In the EtherCAT network, the physical node address (identification number) of Servo Driver is assigned by the EtherCAT master controller.

Two or more drivers connected in the EtherCAT network can be set to the same physical address; the EtherCAT controller will automatically set the slave ID.

5.5 Connectors and Cables

5.5.1 Tools and Accessories

System setup does not require special tools.

Grounding requires an M4 ring terminal.

The system comes with a power board mating connector kit.

5.5.2 Mating Connectors and Cables

Table 5-1 C4-I/O Mating Connectors

Manufacturer	Name	Manufacturer Part Number	Servotronic Part Number
Antek	BD3 C4 Control Terminal Plug	HPPCS02CNS-20SBK113S1	11201707001975

Table 5-2 C5-Encoder Feedback Connector

Manufacturer	Name	Manufacturer Part Number	Servotronic Part Number
Sanzhu	Welding Plug Connector	SC-06-4	12119400000273

Table 5-3 C5-PH3 Power Cable and Kit Package

Encoder Type	PH3 Motor Model	Servotronic Part Number			
		Length	Front Exit (High Flex Cable)	Rear Exit (High Flex Cable)	Connector Kit Package
No Brake	L01、M02/04/06	3 meters 5 meters 10 meters 15 meters 20 meters	SPC-A61011-0303-F SPC-A61011-0305-F SPC-A61011-0310-F SPC-A61011-0315-F SPC-A61011-0320-F	SPC-A63011-0303-F SPC-A63011-0305-F SPC-A63011-0310-F SPC-A63011-0315-F SPC-A63011-0320-F	Front wiring: CAP-A6-01-A Rear wiring: CAP-A6-01-B
	M08/10	3 meters 5 meters 10 meters 15 meters 20 meters	SPC-A61031-0503-F SPC-A61031-0505-F SPC-A61031-0510-F SPC-A61031-0515-F SPC-A61031-0520-F	SPC-A63031-0503-F SPC-A63031-0505-F SPC-A63031-0510-F SPC-A63031-0515-F SPC-A63031-0520-F	Front wiring: CAP-A6-03-A Rear wiring: CAP-A6-03-B
	G09/13/18	3 meters 5 meters 10 meters 15 meters 20 meters	CBL-PWPH220000A003 CBL-PWPH220000A005 CBL-PWPH220000A010 CBL-PWPH220000A015 CBL-PWPH220000A020		CAP-PWPH20000A0
With Brake	L01、M02/04/06	3 meters 5 meters 10 meters 15 meters 20 meters	SPC-A62021-0403-F SPC-A62021-0405-F SPC-A62021-0410-F SPC-A62021-0415-F SPC-A62021-0420-F	SPC-A64021-0403-F SPC-A64021-0405-F SPC-A64021-0410-F SPC-A64021-0415-F SPC-A64021-0420-F	Front wiring: CAP-A6-02-A Rear wiring: CAP-A6-02-B
	M08/10	3 meters 5 meters 10 meters 15 meters 20 meters	SPC-A62041-0603-F SPC-A62041-0605-F SPC-A62041-0610-F SPC-A62041-0615-F SPC-A62041-0620-F	SPC-A64041-0603-F SPC-A64041-0605-F SPC-A64041-0610-F SPC-A64041-0615-F SPC-A64041-0620-F	Front wiring: CAP-A6-04-A Rear wiring: CAP-A6-04-B
	G09/13/18	3 meters 5 meters 10 meters 15 meters 20 meters	CBL-PWPH220001A003 CBL-PWPH220001A005 CBL-PWPH220001A010 CBL-PWPH220001A015 CBL-PWPH220001A020		CBL-PWPH20001A0

Table 5-4 C5-PH3 Encoder Wires and Kit Package

Encoder Type	PH3 Motor Model	Servotronics Part Number			
		Length	Front Exit (High Flex Cable)	Rear Exit (High Flex Cable)	Connector Kit Package
Single-turn Absolute Encoder	L01、M02/04/06/08/10	3 meters 5 meters 10 meters 15 meters 20 meters	SFC-A71A41-0103-F SFC-A71A41-0105-F SFC-A71A41-0110-F SFC-A71A41-0115-F SFC-A71A41-0120-F	SFC-A73A41-0103-F SFC-A73A41-0105-F SFC-A73A41-0110-F SFC-A73A41-0115-F SFC-A73A41-0120-F	CAP-A7-A4-1 (No Battery)
	G09/13/18	3 meters 5 meters 10 meters 15 meters 20 meters	CBL-FBPH22S301A003 CBL-FBPH22S301A005 CBL-FBPH22S301A010 CBL-FBPH22S301A015 CBL-FBPH22S301A020		CAP-FBPH2S301A0 (No Battery)
Multi-turn Absolute Encoder	L01、M02/04/06/08/10	3 meters 5 meters 10 meters 15 meters 20 meters	SFC-A72A43-0103-F SFC-A72A43-0105-F SFC-A72A43-0110-F SFC-A72A43-0115-F SFC-A72A43-0120-F	SFC-A74A43-0103-F SFC-A74A43-0105-F SFC-A74A43-0110-F SFC-A74A43-0115-F SFC-A74A43-0120-F	CAP-A7-A4-3 (With Battery)
	G09/13/18	3 meters 5 meters 10 meters 15 meters 20 meters	CBL-FBPH22T203A003 CBL-FBPH22T203A005 CBL-FBPH22T203A010 CBL-FBPH22T203A015 CBL-FBPH22T203A020		CAP-FBPH2T203A0 (With Battery)

Note:

BD3 Series Battery Assembly: Model BT01, Purchase Code 17419450001421.

Table 5-5 PH3 Interface Conversion Cable

Motor Type	Servotronics Part Number			
	Length	Front Exit	Rear Exit	Connector Kit Package
Power Line - No Brake	0.3 meters	SPC-A61D11-05A3-S (Standard Cable) SPC-A61D11-05A3-F (High Flex Cable)	SPC-A63D11-05A3-S (Standard Cable) SPC-A63D11-05A3-F (High Flex Cable)	Front Exit: CAP-A6-D1-A Rear Exit: CAP-A6-D1-B
Power Line - With Brake	0.3 meters	SPC-A62D31-06A3-S (Standard Cable) SPC-A62D31-06A3-F (High Flex Cable)	SPC-A64D31-06A3-S (Standard Cable) SPC-A64D31-06A3-F (High Flex Cable)	Front Exit: CAP-A6-D3-A Rear wiring: CAP-A6-D3-B
Encoder cable - single/multi-turn universal	0.3 meters	SFC-A72D51-01A3-S (standard cable) SFC-A72D51-01A3-F (high-flex cable)	SFC-A74D51-01A3-S (standard cable) SFC-A74D51-01A3-F (high-flex cable)	CAP-A7-D5

Purpose:

- To convert the motor interface of PH3 series M02/04/06/08/10 motors to the AMP connector interface used by the older PH2/PM2/PM1 series 40/60/80 frame sizes, allowing the use of corresponding cables from the older series and meeting the application requirements of various generations of servo drivers.
- When customers need to upgrade from the older SERVOTRONIX PM1/PM2/PH2 series servo motors to the standard 60/80 frame size motors of the PH3 series, the PH3 motor interface is a quick-connect version and cannot be directly connected to the AMP plastic connector cables on their equipment. This adapter cable can convert the PH3 motor interface to the AMP connector of the older motors, enabling connection to the existing cables on the equipment.

Table 5-6 P1-Power and Motor Connection Connectors

Driver Model	Manufacturer	Name	Manufacturer Part Number	Servotronics Part Number
BD3E -1D62AEB BD3E -2D82AEB BD3E -5D52AEB	Sanzhu	Plug for Pluggable Terminal Blocks	SC-T3005008SB0XT-45	11201707001675
BD3E -7D62AEB BD3E -0122AEB BD3E -3D54DEB BD3E -5D44DEB BD3E -8D44DEB BD3E -0124DEB	Kosong	Plug for Pluggable Terminal Blocks	9EDGK-7.5-09P-13-1051Z(H)	11201707002135

5.5.3 Filters

The manufacturers and part numbers of filters recommended for the BD3E are listed in the following table.

Table 5- 8 BD3E Recommended Filters

Driver	Manufacturer Part Number
BD3E -1D62AEB BD3E -2D82AEB	LCR: 055M.80601.00
	LCR: 092.00623.00
	Schaffner: FN2070-6
BD3E -5D52AEB	LCR: 0923.01021.00
	LCR: 092.01023.00

Driver	Manufacturer Part Number
	LCR: 055.81011.00
	Schaffner: FN2070-10
BD3E -7D62AEB BD3E -0122AEB	LCR: 096B.02001.00
	LCR: 097.01601.00
	Schaffner: FN3258
BD3E -3D54DEB BD3E -5D44DEB BD3E -8D44DEB BD3E -0124DEB	LCR: 096B.02001.00
	LCR: 097.01601.00
	Schaffner: FN3258-16-44

5.5.4 Regenerative Resistor

Section BD3E The driver comes with an integrated regenerative resistor; users decide whether to use the internal regenerative resistor or an external one based on the application conditions.

The resistance value and power rating of the external resistor are determined by the application conditions. Once selected, these parameters must be programmed into the BD3E servo drive.

Table 5-7 Built-in Regenerative Resistor for BD3E

Driver	Built-in Regenerative Resistor Value	Built-in Regenerative Resistor Power
BD3E -1D62AEB	-	-
BD3E -1D62AEB-ST	-	-
BD3E -2D82AEB	-	-
BD3E -2D82AEB-ST	-	-
BD3E -2D82AEB-BS	40Ω	50W
BD3E -5D52AEB	40Ω	50W
BD3E -5D52AEB-ST	40Ω	50W
BD3E -7D62AEB	25Ω	80W
BD3E -7D62AEB-ST	25Ω	80W
BD3E -0122AEB	25Ω	80W
BD3E -0122AEB-ST	25Ω	80W
BD3E -3D54DEB	100Ω	80W

Driver	Built-in Regenerative Resistor Value	Built-in Regenerative Resistor Power
BD3E -3D54DEB-ST	100Ω	80W
BD3E -5D44DEB	100Ω	80W
BD3E -5D44DEB-ST	100Ω	80W
BD3E -8D44DEB	50Ω	80W
BD3E -8D44DEB-ST	50Ω	80W
BD3E -0124DEB	50Ω	80W
BD3E -0124DEB-ST	50Ω	80W

The manufacturers and part numbers of regenerative resistors recommended for BD3E are listed in the following table.

Table 5-8 Recommended Regenerative Resistors for BD3E

Driver	Power (W)	Resistance Value	Manufacturer Part Number
BD3E -1D62AEB BD3E -2D82AEB BD3E -5D52AEB	150	40Ω	Lifoo: RXLG-150W-40RJ
	300		Lifoo: RXLG-300W-40RJ
	600		Lifoo: RXLG-600W-40RJ
	1000		Lifoo: RXLG-1000W-40RJ
	2000		Lifoo: RXLG-2000W-40RJ
BD3E -7D62AEB BD3E -0122AEB	150	20Ω	Lifoo: RXLG-150W-20RJ
	300		Lifoo: RXLG-300W-20RJ
	600		LaiFu: RXLG-600W-20RJ
	1000		LaiFu: RXLG-1000W-20RJ
	2000		LaiFu: RXLG-2000W-20RJ
BD3E -3D54DEB BD3E -5D44DEB	150	100Ω	LaiFu: RXLG-150W-100RJ
	300		LaiFu: RXLG-300W-100RJ
	600		LaiFu: RXLG-600W-100RJ
	1000		LaiFu: RXLG-1000W-100RJ
	2000		LaiFu: RXLG-2000W-100RJ
BD3E -8D44DEB BD3E -0124DEB	150	50Ω	LaiFu: RXLG-150W-50RJ
	300		LaiFu: RXLG-300W-50RJ
	600		LaiFu: RXLG-600W-50RJ
	1000		LaiFu: RXLG-1000W-50RJ
	2000		LaiFu: RXLG-2000W-50RJ

5.6 Host System

The following computer systems and software are required:

- 2 GHz CPU
- 1 GB RAM
- Hard disk drive free space 1000 MB (after installing .NET 4)
- RJ45 interface, for communication with Servo Driver
- Operating system: Windows 7, Windows 8, Windows 10, 32-bit or 64-bit.
- For ServoStudio 2, it is recommended that the screen resolution be 1280x800;
- Minimum resolution is 1024x800.
- It is recommended to set the Windows display settings to smaller - 100% (default).
- .Net4 (for more details, see .NET Framework system requirements). If .NET 4 is not

installed on your computer, ServoStudio 2 will guide you through the installation, but will not install it automatically.

- ServoStudio 2, a graphical software interface used for configuring and testing Servo Driver.

- Download from the Servotronics website or contact technical support.
- Refer to the 'Software Installation' section in the ServoStudio 2 manual.

Installation ServoStudio 2

1. Download the ServoStudio 2 software installation files from the Servotronics website or contact technical support.

2. Install on the hostServoStudio 2software.

3. After installation is complete, start ServoStudio 2 from the Windows 'Start' menu or the shortcut on the desktop.

Note:

If an error occurs during software installation indicating that the system cannot find the specified file, do the following:

- Copy the installation files to the computer's hard drive.
- Right-click the installation file and then select 'Run as administrator'.

5.7 Fieldbus Device File

The BD3E XML EtherCAT device description file must be installed on the host or PLC controller. Download this file from the Servotronics website or contact technical support.

5.8 Electromagnetic Interference Suppression

5.8.1 CE Filtering Technology

The BD3E drive complies with the CE standards specified in the 'Standard Recognition', and appropriate shielding, grounding, and filtering techniques must be adopted to meet these standards.

Noise currents typically have two types: the first type is conductive noise discharge through ground loops, where the quality of the system's grounding scheme is inversely proportional to the amplitude of line noise; these conducted emissions have common-mode characteristics from line to neutral (or ground). The second type is radiated high-frequency noise discharge, usually capacitive coupling between lines, and is specific in nature.

To correctly install the EMI filter, the enclosure should have an unpainted metal surface, which will provide more surface area for contact with the filter enclosure and offer a lower impedance path between the enclosure and the back panel; in turn, the back panel has a high-frequency grounding bus connection to the enclosure or ground.

5.8.2 Grounding



When connecting BD3E to other control devices, ensure that you follow two basic guidelines to prevent damage to Servo Driver:

- BD3E must be grounded through the main AC power supply.
- Any motion controller, PLC, or PC connected to BD3E must be grounded to the same ground point as BD3E the same ground point.

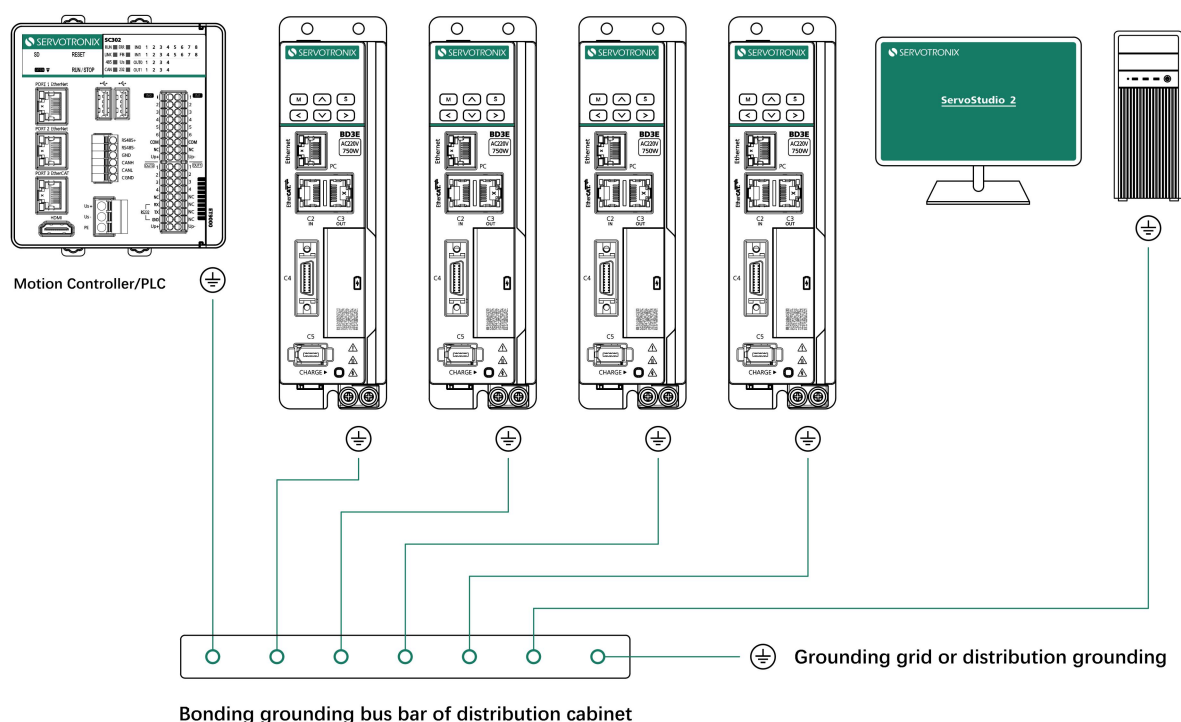


Figure 5-3 BD3E System Grounding

System grounding is crucial for the proper operation of Servo Drive system.

The AC input power ground wire must be connected to the PE terminal on the front panel of BD3E , which helps ensure safety and reduces electromagnetic interference.

The system uses a single-point ground to avoid ground loops.

It is strongly recommended to install BD3E on a metal backplate and provide high-frequency grounding for the backplate. Provide an electrical connection across the entire back of Servo Drive panel. Conductive plates such as aluminum or galvanized steel plates are recommended. For painted or coated metal panels, remove all coatings from the back of Servo Drive. The goal is to provide a very low impedance path for high-frequency signals that can cause electromagnetic interference between the filter, drive, power supply, and ground. Use flat braided wire or copper busbars for high-frequency grounding. When connecting high-frequency grounding, use the shortest possible braided wire.

Ensure good connections between cabinet components: Use multiple conductive braided wires to connect the rear panel and cabinet door to the main body of the cabinet; do not rely on hinges or mounting bolts for grounding connections. Ensure that the cabinet is properly grounded to an appropriate grounding system, and the grounding lead should be the same gauge as or one gauge smaller than the main power lead.

The host must also be properly grounded.

5.8.3 Shielding and Bonding

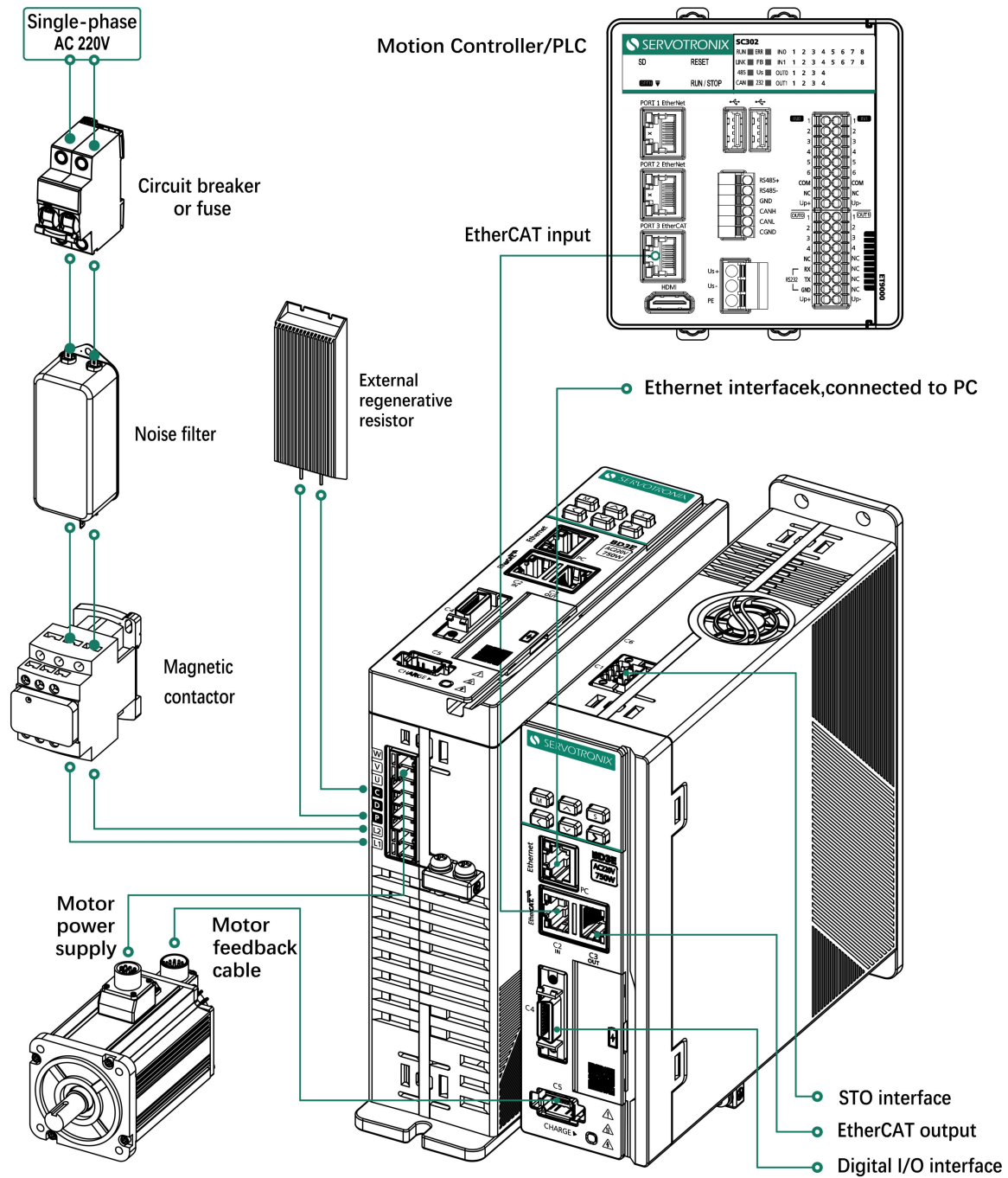


Figure 5-4 BD3E 220V System Shielding and Bonding

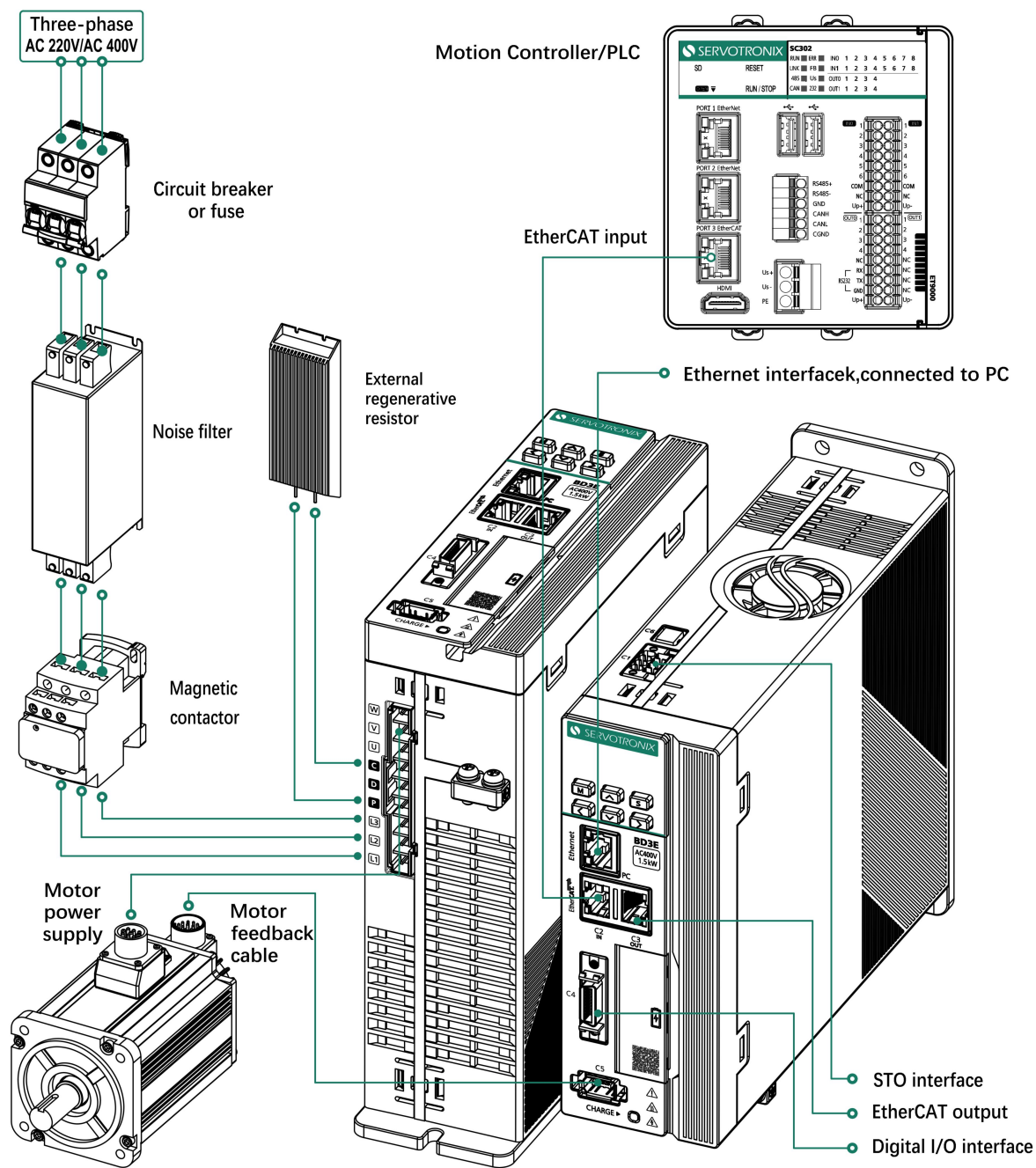


Figure 5-5 BD3E 400V System Shielding and Bonding

To minimize noise emission and maximize Servo Drive system's immunity, the motor and feedback cables must be shielded and properly connected to the grounding surface.

Shielding must be grounded at both ends of the cable, which serves to reduce the impedance between the cable shield and the rear panel.

It is recommended that all shielded cables be bonded to the rear panel.

The motor and feedback shield cables should be as close to Servo Driver as possible, and the exposed cable shields should be bonded to the rear panel using non-insulated metal cable clamps or cable bonding clamps.

It is recommended to use a shielded bus for star shielding connections.

5.8.4 Input Power Filtering

The BD3E electronic system components require EMI AC line filtering in the input power lines to meet CE requirements in industrial environments.

It is essential to properly specify the system specifications; the type of filter is determined based on the system's rated voltage and rated current values, as well as whether the input line is single phase or three phase.

For information on recommended filter manufacturers and part numbers for BD3E , refer to the 'Line Filter' section.

The implementation of the input power filter must follow these guidelines:

- The filter should maintain the separation of wires entering and exiting the power filter.
- The filter must be installed on the same panel as Servo Driver.
- The filter must be installed as close as possible to Servo Driver to prevent noise caused by capacitive coupling to other signal lines and cables.
- When installing the filter on the panel, remove all paint or material coatings. If possible, use an unpainted metal backplate.
- The filter is equipped with a grounding terminal, which must be grounded.
- Do not touch the filter within 10 seconds after removing power.

5.8.5 Other EMI Suppression Recommendations

Power and control cables should be routed separately, with a recommended separation distance of at least 200 mm to enhance interference resistance.

If the input power and wires need to cross, ensure they intersect at a 90° angle.

Avoid using spliced extension cables for motor feedback lines as this can cause a break in shielding and potentially interfere with signal processing.

For normal cable connections: If you need to tap into the cable, use a connector with a metal backshell to ensure that both shells are connected around the jacket; no part of the wiring should be unshielded, and do not tap into the cable via a terminal block.

5.9 Electrical System Precautions

5.9.1 Fuses

Circuit protection must comply with the National Electrical Code and/or regulations set by national, state, provincial, and/or local authorities.

- US Fuses: RK5, CC, J, or T type, 600 V AC 200 kA, time-delay. They must be UL and CSA certified; UR recognition alone is not sufficient.
- EU Fuses: gRL or gL type, 400 V/500 V, time-delay.
- Fuse Holders: Standard fuse holders, or finger-safe fuse holders that meet IEC 60529 fuse standards. For example:
 - Bussmann: CH series modular fuse holders, fuse ratings below 30A, J type, 3-pole: CH30J3.
 - Ferraz: Ultrasonic Fuses, Fuse Rating Below 30A, Class J, 3Poles: US3J3I.

5.9.2 Leakage Current and Protection

The leakage current of the PE conductor comes from the combination of leakage currents from the equipment and cables. Please install a residual current device (RCD) on the primary side of the power supply and select it according to the following conditions:

- Please use a residual current device (RCD) of type B (DC-sensing type) as specified in IEC60947-2 and JISC8201-2-2.
- When the servo driver is operating, it generates a certain amount of high-frequency leakage current. To avoid false tripping of the RCD, please select an RCD with a rated tripping current of at least 100mA for each servo driver.

- When multiple servo drivers share one RCD, an RCD with a rated tripping current of at least 300mA should be selected.
- It is recommended to use RCDs from brands such as Chint, Schneider, etc.

5.10 Mechanical Installation

5.10.1 Installation BD3E

Use the brackets on the back of the BD3E to mount it on a grounded conductive metal panel, which must be sufficiently sturdy.

For installation dimensions, refer to the 'External Dimensions'.

5.10.2 Installing Multiple Units

When multiple BD3E units are installed side by side in a cabinet or enclosure, the recommended minimum unit spacing is 10 mm. For all BD3E models, the recommended minimum top and bottom clearance is 50 mm.

It is important to ensure that the ambient temperature inside the enclosure does not exceed 45°C. If the BD3E unit is installed on a backplate, it is also necessary to ensure that the backplate temperature does not exceed 45°C. It is recommended to install a cooling fan at the bottom of the cabinet for optimal circulation.

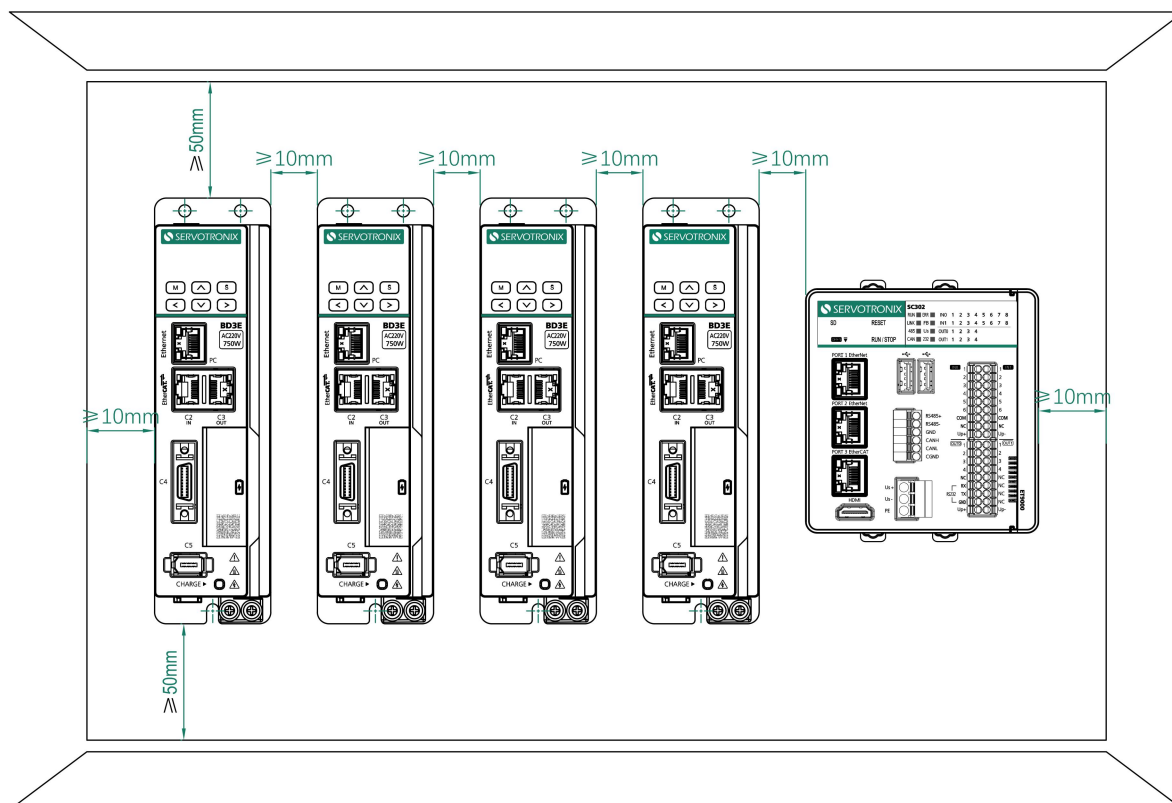


Figure 5-6 Installing Multiple BD3E Units in the Cabinet

5.11 Driver Connection

Refer to the power board pinout diagram.



Ensure that the main voltage rating complies with Servo Driver specifications; applying incorrect voltage may cause Servo Driver to fail.

Do not power on until all hardware connections are completed.



Prevent Inrush Current:

Bus Power (L1-L2(-L3)): After turning off the bus power, wait for 1 minute before powering on.

5.11.1 BD3E Driver Port Definitions

BD3E -□□XXXEB-□□ Driver

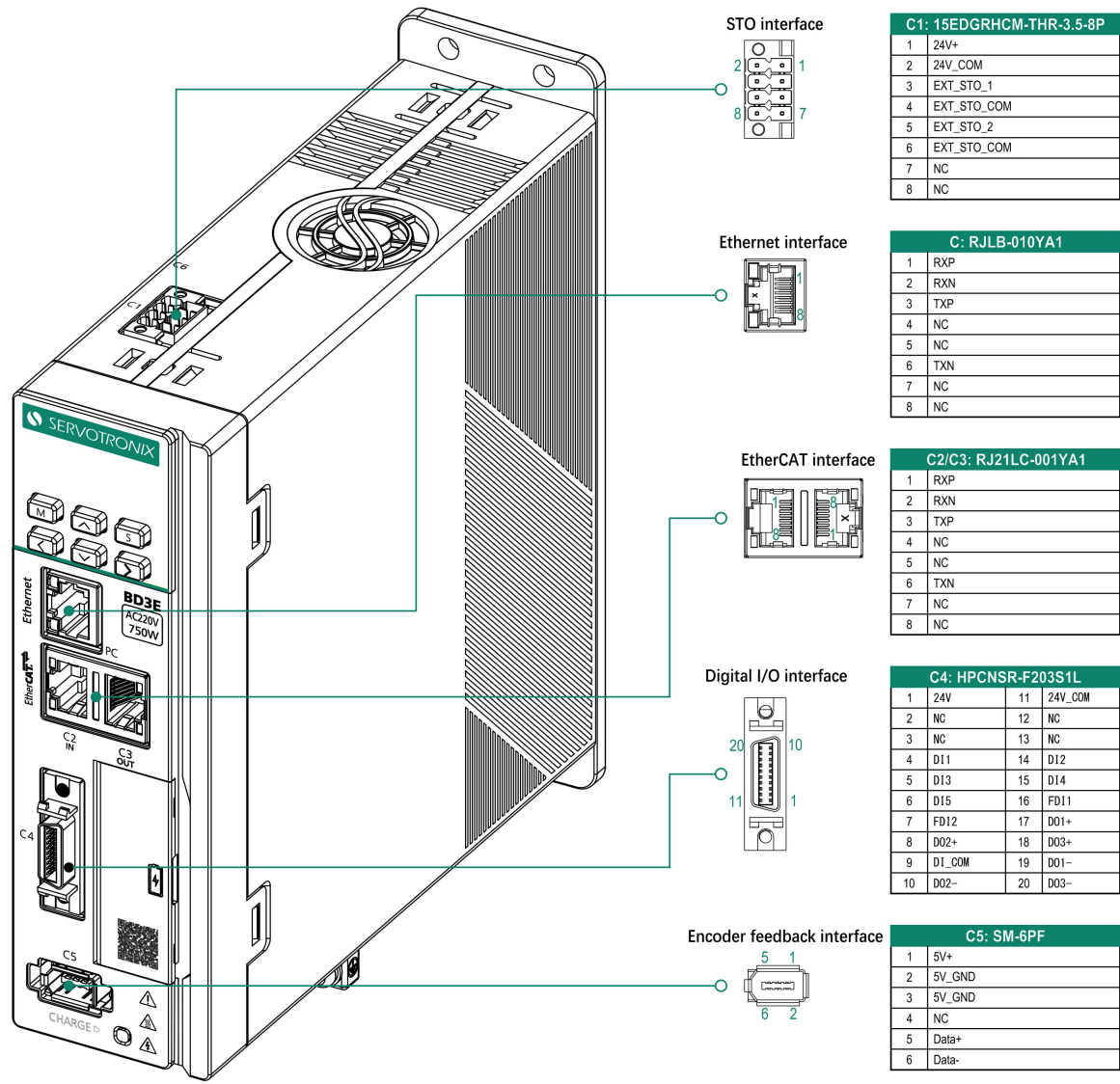


Figure 5-7 BD3E -□□XXXEB-□□ Control Board Pinout

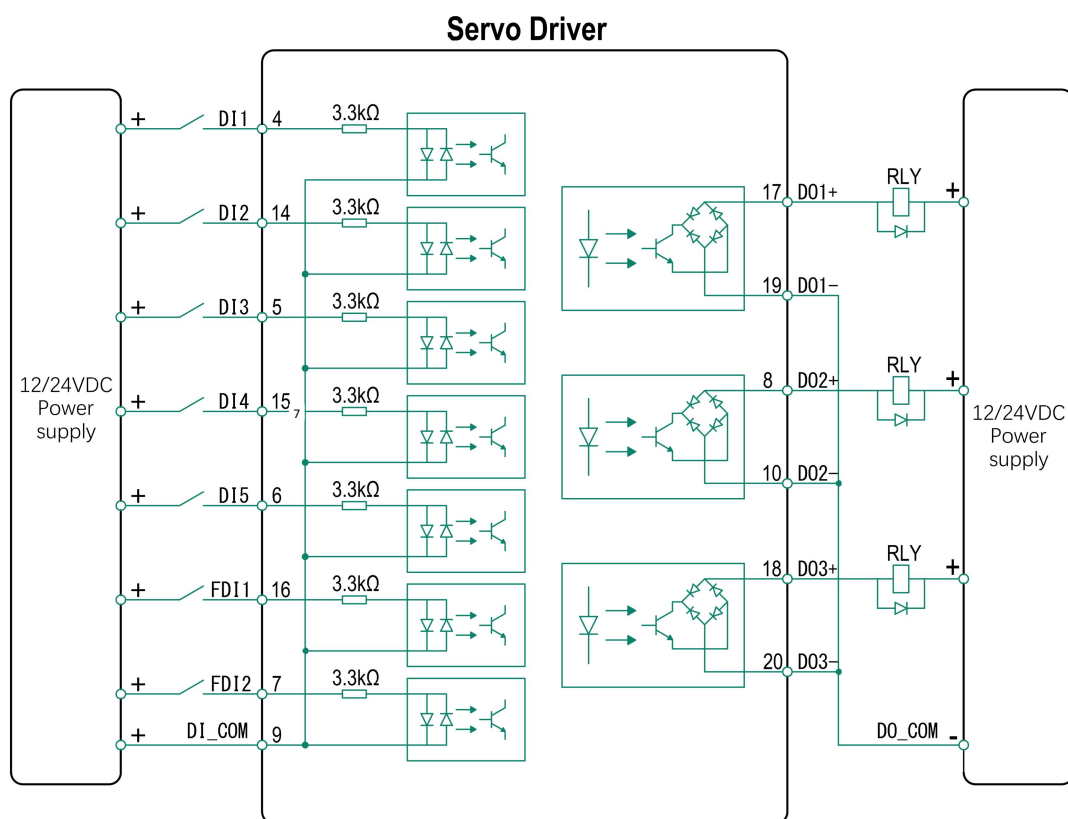


Figure 5-8 BD3E -□□XXXEB-□□ Default IO Wiring Diagram

Note: 1. The brake coil has no polarity.

2. The power supply for the brake must be provided by the customer. In addition, do not use the same power supply for the brake power and the control signal power (V_{DC}).

3. Do not apply more than 24V of voltage or more than 50mA of current to the control signal output terminals.

4. When directly driving a relay with the control signal output, install a diode in parallel with the relay as shown in the figure. Failure to install it or installing it incorrectly can damage Servo Driver.

5. It is recommended to use relays such as MY2N-D2_GSDC24V/ MY2N-D2-DSDC12V or other relays with internal flyback diodes, or to connect a fast recovery diode such as FR102/ FR103 or another diode with a breakdown voltage of at least 70V and an overcurrent capacity greater than 1A in parallel with the relay coil.

5.11.2 EtherCAT Communication - C2 and C3

Interfaces C2 and C3 are RJ45 ports, used as transmitters and receivers for drivers operating on the EtherCAT network in the EB type.

The LEDs on interfaces C2 and C3 (EB type) indicate the status of the fieldbus; refer to Fieldbus Status LEDs.

For detailed information on the installation, configuration, and operation of drivers used on the EtherCAT network, refer to the BD3E EtherCAT Reference Manual.

5.11.3 I/O Interface - C4

Connect inputs and outputs according to the requirements of the application.

Unused pins must remain unconnected.

All inputs on the I/O interface (C4) share a common input, and all outputs share a common output.

All digital inputs and digital outputs on BD3E models are optically isolated.

When configuring the digital output channel for brake function, refer to the wiring section of the motor brake.

The motor brake requires a separate power supply; do not share it with digital inputs or pulse inputs.

Table 5- 9 BD3E -□□X2AEB-□□ I/O Interface

Pin	Name	Function	Description	Pin	Name	Function	Description
1	24V	Internal 24V Power Positive	Internal 24V Power Positive	11	24V_C OM	Internal 24V Power Negative	Internal 24V Power Negative
2	NC	Reserved	/	12	NC	Reserved	/
3	NC	Reserved	/	13	NC	Reserved	/
4	DI3	Digital Input 3	Optically Isolated Programmable Digital Input Sink/Source	14	DI4	Digital Input 4	Optically Isolated Programmable Digital Input Sink/Source
5	DI5	Digital Input 5	Optically Isolated Programmable Digital Input Sink/Source	15	DI6	Digital Input 6	Optically Isolated Programmable Digital Input Sink/Source
6	DI7	Digital Input 7	Optically Isolated Programmable Digital Input Sink/Source	16	FDI1	Digital Input 1 (High Speed)	Optically Isolated Programmable Fast Digital Input Sink/Source
7	FDI2	Digital Input 2 (High Speed)	Optically Isolated Programmable Fast Digital Input Sink/Source	17	DO1+	Digital Output 1+	Optically Isolated Programmable Digital Output Sink/Source
8	DO2+	Digital Output 2+	Optically Isolated Programmable Digital Output Sink/Source	18	DO3+	Digital Output 3+	Optically Isolated Programmable Digital Output Sink/Source

Pin	Name	Function	Description	Pin	Name	Function	Description
9	DI_CO M	Digital Input Common Terminal	24V or 0V (depending on sink or source)	19	DO1-	Digital Output 1-	Optically Isolated Programmable Digital Output Sink/Source
10	DO2-	Digital Output 2-	Optically Isolated Programmable Digital Output Sink/Source	20	DO3-	Digital Output 3-	Optically Isolated Programmable Digital Output Sink/Source

*Some functions are only available on certain models, please refer to the ordering information

Brake Wiring

The brake is an institution that prevents the servo motor shaft from moving when the servo driver is not in operation, keeping the motor position locked so that the mechanical moving parts do not move due to their own weight or external forces.

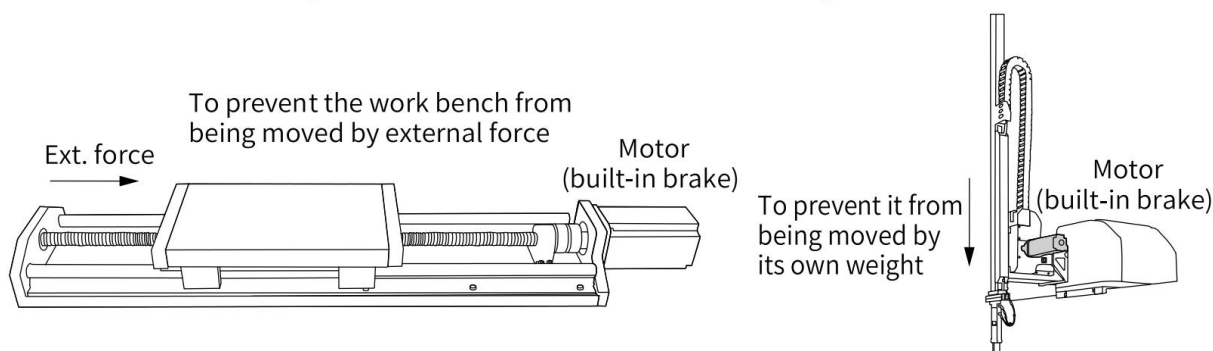


Figure 5-9 Schematic Diagram of Brake Application

For brake connection, users need to prepare a 24V power supply. The connection diagram for the brake signal and brake power is shown below:

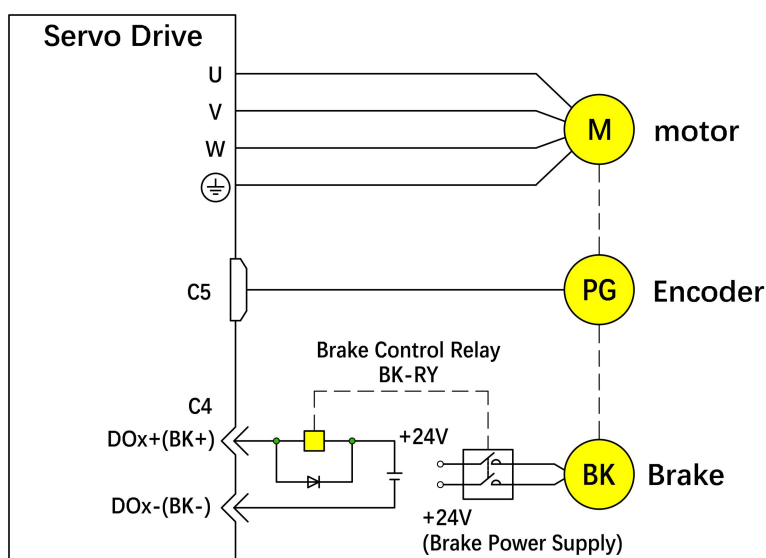


Figure 5-10 Schematic Diagram of Brake Wiring

5.11.4 Motor Feedback Interface - C5

BD3E supports Tamagawa protocol feedback; the following pin assignment describes the connection between the feedback and Servo Driver.

Connect the motor feedback interface according to the encoder being used. Refer to the table in the motor feedback wiring section.

Unused pins must remain unconnected.

Table 5- 10 Feedback Interface (C5)

Pin #	Name	Function	Pin #	Name	Function
1	5V+	5V Power	4	NC	Reserved
2	5V_GND	5V Power Ground	5	Data+	Data +
3	5V_GND	5V Power Ground	6	Data-	Data -

5.11.5 Motor Feedback Wiring

The table below shows the feedback wiring for the BD3E servo kit.

Wiring - Single-turn Absolute Encoder

Table 5- 11 Feedback Wiring - Single-turn Absolute Encoder - AMP Connector

C5 Pin #	Twisted Pair	Motor Interface Pin #	Signal Description
5	Twisted Pair	1	Serial Data +
6		2	Serial Data -
1	Twisted Pair	6	DC Voltage 5 V
2		7	GND
Metal Housing		8	Shielding

Table 5- 12 Feedback wiring - Single-turn absolute encoder - MIL connector

C5 Pin #	Twisted Pair	Motor Interface Pin #	Signal Description
5	Twisted Pair	E	Serial Data +
6		F	Serial Data -
1	Twisted Pair	H	DC Voltage 5 V
2		G	GND

C5 Pin #	Twisted Pair	Motor Interface Pin #	Signal Description
See Note 1		J	Shielding

Wiring - Multi-turn absolute encoder

Table 5- 13 Feedback wiring – Multi-turn absolute encoder - AMP connector

C5 Pin #	Twisted Pair	Motor Interface Pin #	Signal Description
5	Twisted Pair	1	Serial Data +
6		2	Serial Data -
1	Twisted Pair	6	DC voltage 5V
2		7	GND
See Note 1		8	Shielding
See Note 2		4	Battery +
See Note 2		5	Battery -

Table 5- 14 Feedback wiring – Multi-turn absolute encoder - MIL connector

C5 Pin #	Twisted Pair	Motor Interface Pin #	Signal Description
5	Twisted Pair	E	Serial Data +
6		F	Serial Data -
1	Twisted Pair	H	DC voltage 5V
2		G	GND
See Note 1		J	Shielding
See Note 2		T	Battery +
See Note 2		S	Battery -

Note 1: The shielding wire must be connected to the metal housing of the connector.

Note 2: It must be connected to the battery.

The encoder battery is located in the battery compartment of the BD3E drive.

The recommended battery is a 3.6V, 2500mAh lithium battery.

Use the spare battery recommended by the encoder manufacturer.

5.11.6 STO Interface C1

The STO function disables motor output through external hardware terminals STO1 and STO2. The pin definitions for the input connector are listed in the table below.

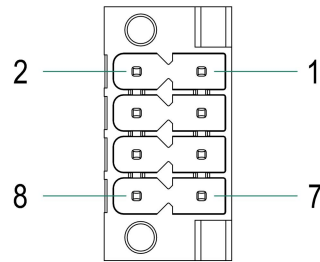


Table 5- 15 STO Interface (C6)

C6 Pin #	Name	Function	C6 Pin #	Name	Function
1	24V+	Internal 24V Power Supply	2	24V COM	Internal 24V Power Supply Ground
3	EXT_STO_1	STO1 Control Input	4	EXT_STO_COM	STO Signal Ground
5	EXT_STO_2	STO2 Control Input	6	EXT_STO_COM	STO Signal Ground
7	NC	Reserved	8	NC	Reserved

Note 1: The 24V STO power supply is used exclusively for the STO circuit and should not be used for any other purpose.

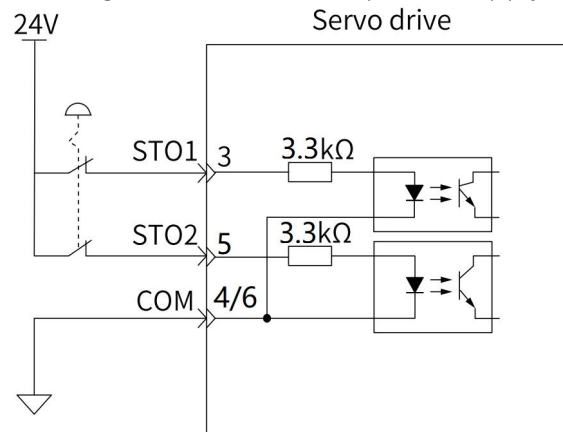
The servo driver operates normally only when both STO1 and STO2 inputs are at a high level.

If one of STO1 and STO2 is at a high level and the other is at a low level, or if both are at a low level, the servo driver will not operate.

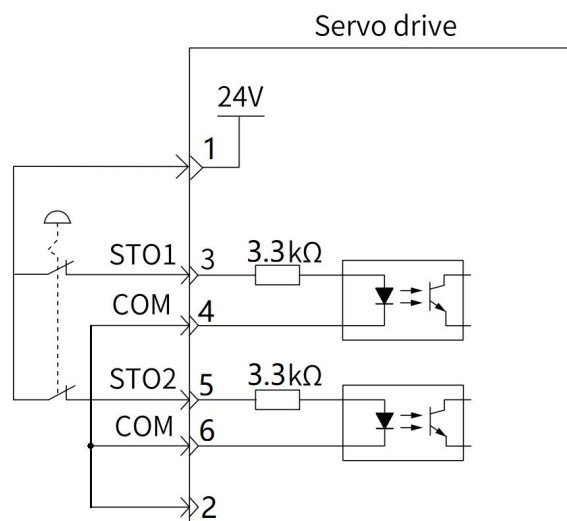
The electrical characteristics of the STO input are as follows:

Item	Value	Description
Voltage	24VDC (±10%)	External power supply requirements
Current	7.3mA (typical value)	Current required for one channel

- Diagram for connecting with external 24V power supply



- Diagram for connecting with internal 24V power supply



5.11.7 EtherNet Interface PC

During debugging, Servo Driver can be connected to a computer via the interface PC (Ethernet port).

Table 5- 16 Ethernet interface (PC)

PC pin #	Name	Function	PC pin #	Name	Function
1	RXP	Receive data+	2	RXN	Receive data-
3	TXP	Transmit data+	4	NC	Reserved
5	NC	Reserved	6	TXN	Transmit data-
7	NC	Reserved	8	NC	Reserved

5.11.8 BD3E Power Port Definitions

Pin #	Name	Function	Pin #	Name	Function
1	W	Motor W phase	6	P	Brake resistor P
2	V	Motor V Phase	7	L2\L3	AC Power L2 (Single Phase)\L3 (Three-Phase)
3	U	Motor U Phase	8	L1\L2	AC Power L1 (Single Phase)\L2 (Three-Phase)
4	C	Braking Resistor C	9	L1	AC Power L1 (Three-Phase)
5	D	Braking Resistor D			

- If an external regenerative resistor is required for the application, remove the shorting terminal between P and D first, then connect the regenerative resistor between terminals P and C. Refer to the Regeneration section.

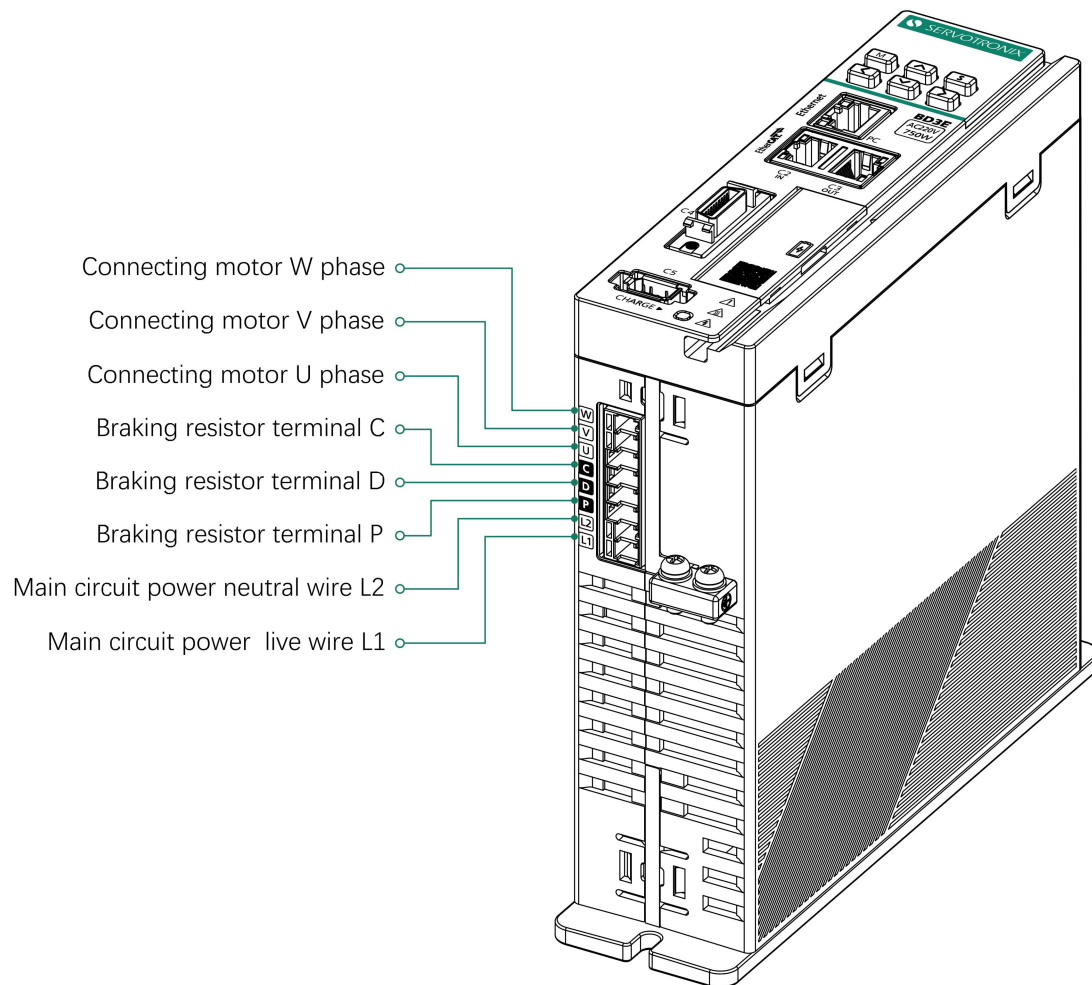


Figure 5-11 BD3E - 1D62A/2D82A/5D52A Power Pin Allocation

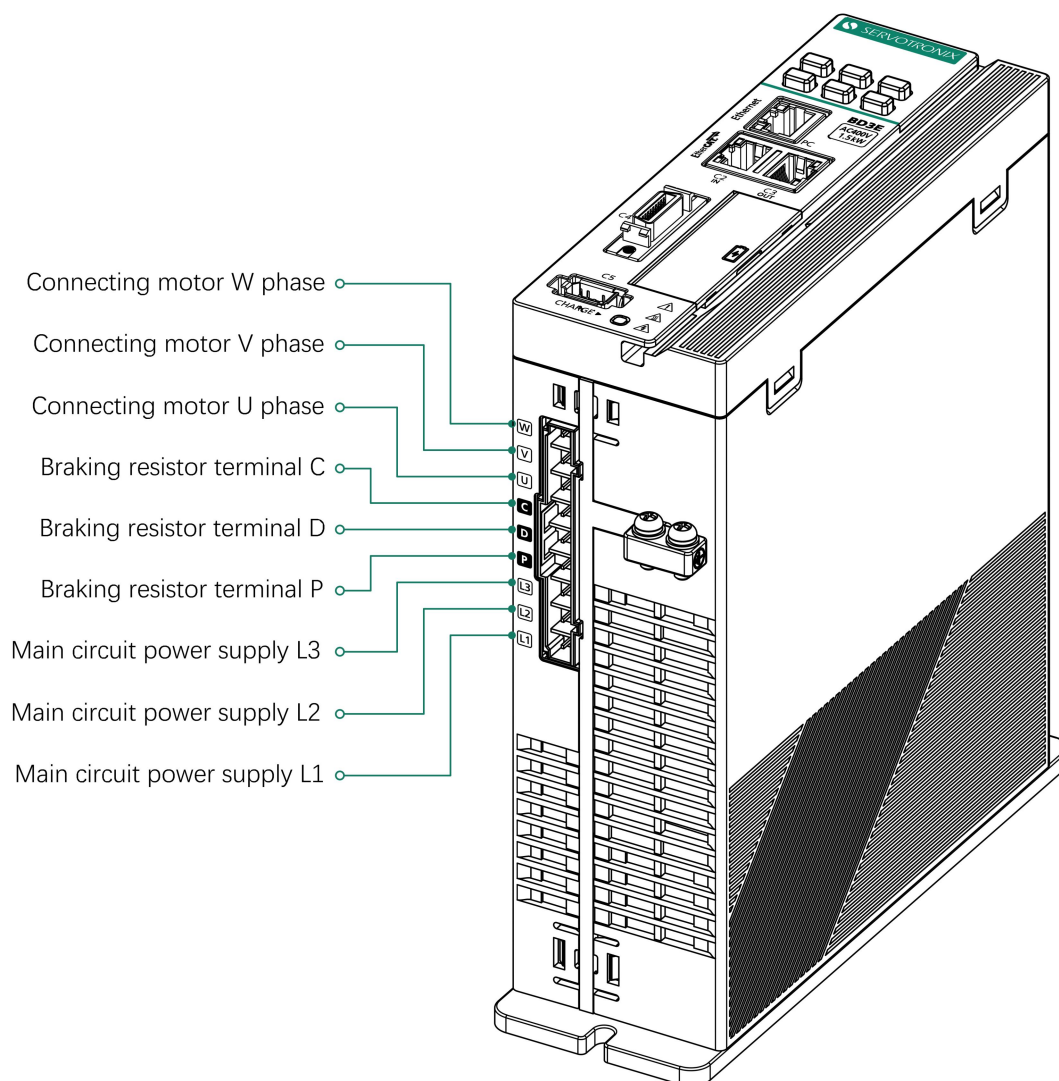


Figure 5-12 BD3E -7D62A/0122A/3D54D/5D44D/8D44D/0124D Power Pin Allocation

5.11.9 Protective Grounding -

Connect the AC input power ground wire to the functional grounding terminal on the front panel of BD3E using an M4 ring terminal.



BD3E must be grounded. Ensure that the AC input power ground wire is connected to the functional grounding terminal of BD3E .

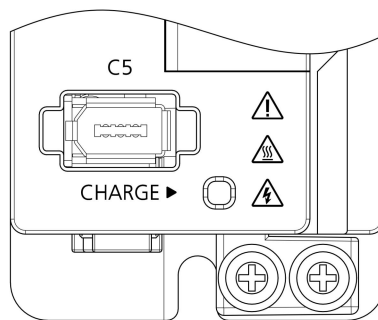


Figure 5-13 Grounding Terminal

5.12 Regenerative Braking

5.12.1 Overview of Regenerative Energy

When the motor and load decelerate rapidly, the kinetic energy of the load releases energy back to Servo Drive through the motor shaft, which is known as regenerative energy or regeneration. This energy must be dissipated or absorbed.

Unreleased regenerative energy will be stored in the DC bus capacitors. If the capacitors can store this energy, the system does not require a regenerative resistor.

In some cases, typically due to high inertia mismatch between the load and the motor, excessive energy is added to the capacitor, causing the voltage on the capacitor to reach an overvoltage threshold, which then leads to Servo Driver being disabled. To prevent overvoltage and potential damage to the system, the excess regenerative energy must be dissipated through a regenerative resistor.

BD3E Some drivers come with built-in regenerative resistors, and users decide whether to use the built-in regenerative resistor or an external regenerative resistor based on the application conditions.

Determine whether the system requires an external regenerative resistor and the required capacity level.

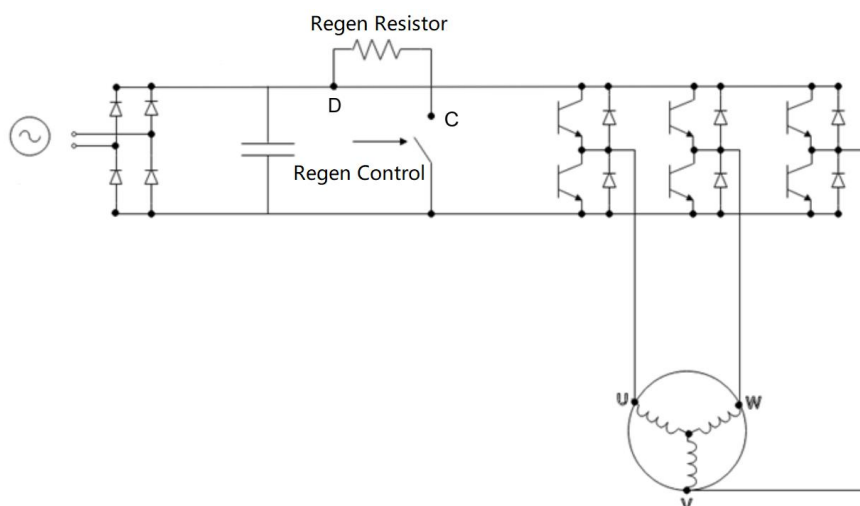


Figure 5-14 Regenerative Resistor Circuit

5.12.2 Overload Protection for Regenerative Resistor

The motor energy regeneration in BD3E is always enabled.

There are two modes for the motor energy regeneration function:

- Regeneration with resistor overload protection.

The regenerative resistor circuit itself requires overload protection to ensure reliable operation of the resistor. In this mode, protection is provided using configurable BD3E regenerative resistor parameters.

- Regeneration without resistor overload protection. This mode is also known as the bang-bang mode.

In bang-bang mode, when the threshold upper limit level (390V for AC200V driver; 780V for AC400V driver) is exceeded, Servo Driver will activate the regenerative resistor; when the DC bus voltage drops to the threshold lower limit level (370V for AC200V driver; 760V for AC400V driver), the regenerative resistor will be disabled.



Please use the regenerative resistor protection with caution.
If the motor increases the DC bus voltage, causing the protection mechanism to activate, it may lead to an overvoltage condition.

5.12.3 Parameters of Regenerative Resistor

The capacity of the regenerative resistor is defined by several parameters.

Drivers with built-in regenerative resistors do not require configuration of related parameters if using the built-in regenerative resistor; if using an external regenerative resistor, parameters such as REGENTYPE, REGENRES, REGENPOW, and REGENMAXONTIME must be configured according to actual conditions.

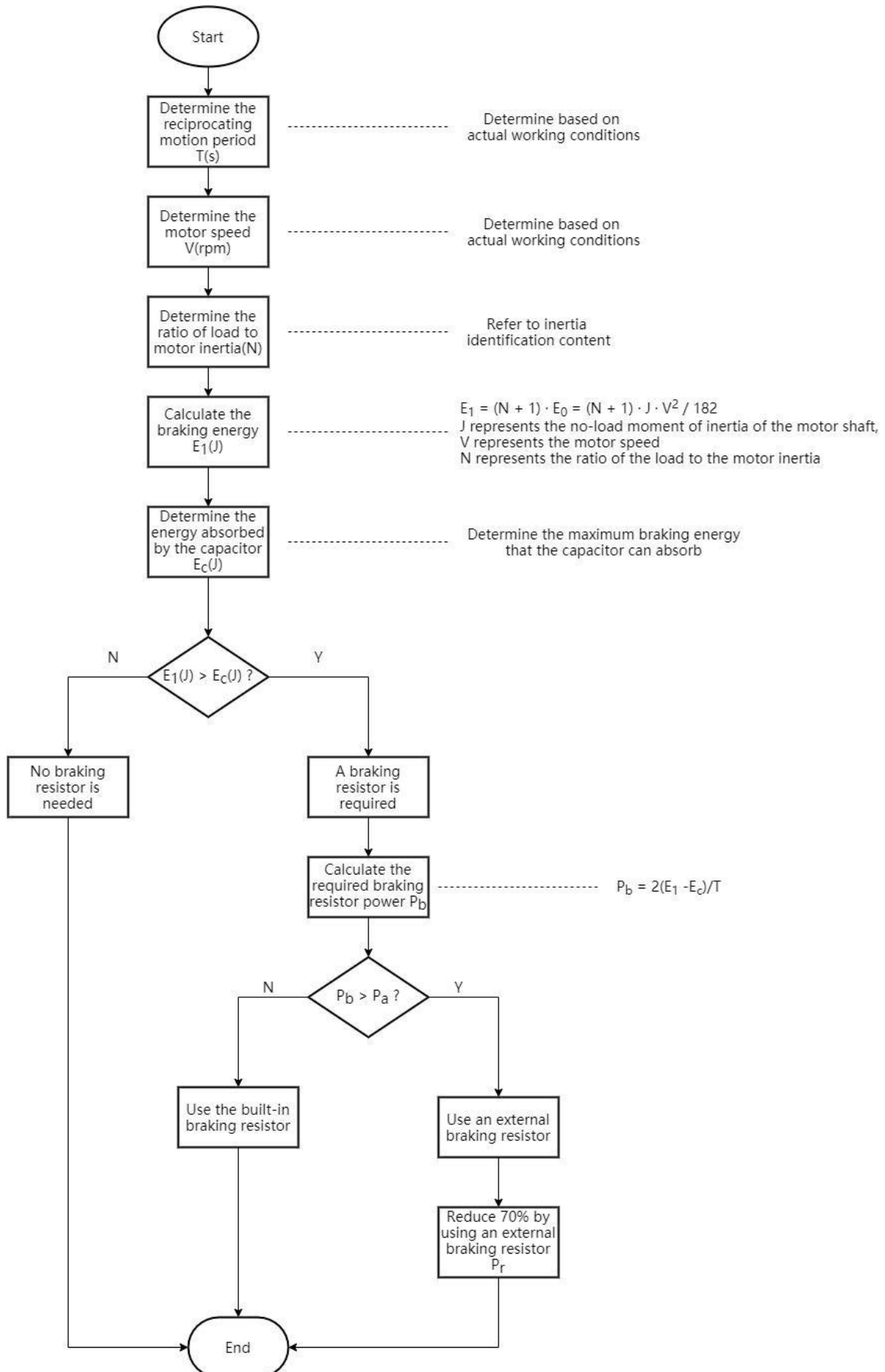
BD3E -1D62AEB、BD3E -1D62AEB-ST、BD3E -2D82AEB、BD3E -2D82AEB-ST drivers do not have a built-in regenerative resistor. If you want to use an external regenerative resistor, you must first set REGENTYPE to 1, and parameters REGENRES and REGENPOW must be set to values other than -1; otherwise, regenerative resistor overload protection and fault detection will not be activated. If there is no external regenerative resistor, set REGENRES = -1 and REGENPOW = -1.

VarCom	Description
REGENTYPE	Regenerative resistor type, default 0: built-in regenerative resistor; 1: external regenerative resistor.
REGENRES	Regenerative resistor resistance, unit is ohms.
REGENPOW	Regenerative resistor power, unit is watts.
REGENMAXONTIME	Maximum continuous activation (on) time for the regenerative resistor, unit is milliseconds.

Note: If the system has a regenerative resistor, setting the value of REGENRES or REGENPOW to -1 will disable the regenerative resistor overload protection function.

5.12.4 Selection of Braking Resistor

Braking resistor selection process



Energy data generated by PM2 motor during the process of decelerating from rated speed to a stop under no-load conditions:

Servo motor model	Rotor Inertia (10-4Kg.m ²)	Rated Speed (rpm)	Braking energy E _o (J) generated during deceleration from rated speed to a stop under no-load conditions	Matching driver model	Maximum braking energy E _c (J) that Servo Driver can absorb
PH3x-M02A006S/N	0.24	3000	1.184	BD3E-1D62AEB-□□	18.48
PH3x-M02A006E/B	0.25	3000	1.234	BD3E-1D62AEB-□□	
PH3x-M04A006S/N	0.47	3000	2.319	BD3E-2D82AEB-□□	
PH3x-M04A006E/B	0.48	3000	2.369	BD3E-2D82AEB-□□	
PH3x-M06A006S/N	0.68	3000	3.356	BD3E-5D52AEB-□□	26.32
PH3x-M06A006E/B	0.69	3000	3.405	BD3E-5D52AEB-□□	
PH3x-M08A008S/N	1.46	3000	7.205	BD3E-5D52AEB-□□	
PH3x-M08A008E/B	1.51	3000	7.452	BD3E-5D52AEB-□□	
PH3x-M10A008S/N	2	3000	9.870	BD3E-7D62AEB-□□	34.72
PH3x-M10A008E/B	2.05	3000	10.116	BD3E-7D62AEB-□□	
PH3x-G09A013S/N	13.14	1500	16.211	BD3E-7D62AEB-□□	
PH3x-G09A013E/B	15.4	1500	18.999	BD3E-7D62AEB-□□	
PH3x-G13A013S/N	18.91	1500	23.329	BD3E-0122AEB-□□	56.00
PH3x-G13A013E/B	21.2	1500	26.154	BD3E-0122AEB-□□	
PH3x-G18A013S/N	25.05	1500	30.904	BD3E-0122AEB-□□	
PH3x-G18A013E/B	27	1500	33.310	BD3E-0122AEB-□□	
PH3x-G09B013S/N	18.91	1500	23.329	BD3E-3D54DEB-□□	54.22
PH3x-G09B013E/B	21.2	1500	26.154	BD3E-3D54DEB-□□	
PH3x-G13B013S/N	25.05	1500	30.904	BD3E-5D44DEB-□□	54.22
PH3x-G13B013E/B	27	1500	33.310	BD3E-5D44DEB-□□	
PH3x-G18B013S/N	25	1500	30.843	BD3E-8D44DEB-□□	79.74
PH3x-G18B013E/B	25.28	1500	31.188	BD3E-8D44DEB-□□	

Taking a 750W motor as an example, assuming the reciprocating motion period T=1S, maximum speed 3000rpm, and the load inertia is four times that of the motor, then the required braking resistor power:

$$P_b = \frac{2 \times [(N + 1) \times E_o - E_c]}{T} = \frac{2 \times [(4 + 1) \times 7.205 - 26]}{1} = 20.05W$$

Less than the capacity that the built-in braking resistor can handle $P_a = 40W$, therefore, the built-in braking resistor can meet the requirements.

If the load inertia in the above assumption is changed from four times to ten times, with other conditions remaining unchanged, then the required braking resistor power:

$$P_b = \frac{2 \times [(N + 1) \times E_O - E_C]}{T} = \frac{2 \times [(10 + 1) \times 7.205 - 26]}{1} = 106.51W$$

Greater than the power that the built-in braking resistor can handle $P_a = 40W$, therefore, an external braking resistor is required. The power of the external braking resistor is recommended to be

$$P_b \div (1 - 70\%) = 355.03W$$

6. Motor Settings

When the BD3E drive is powered on, it will attempt to detect the motor feedback device and electronic motor nameplate (MTP). If the electronic motor nameplate (MTP) is detected, the motor and feedback parameters will be directly transmitted to Servo Drive, and no additional operations are required.

Since all motors in BD3E are equipped with MTP, the electronic nameplate makes debugging very simple and reliable.



The drive cannot be enabled before operating the motor and feedback parameters.

Many parameters can be modified when Servo Drive is enabled.

However, please proceed with caution, as the motion behavior will change.

If parameters cannot be modified when Servo Drive is enabled, ServoStudio 2 will prompt you to disable Servo Drive.

6.1 Motor Settings Wizard

The ServoStudio 2 'Motor Setup' wizard provides the fastest and easiest way to start and run Servo Drive and motor. The wizard configures basic parameters and current control loops for an unloaded motor.

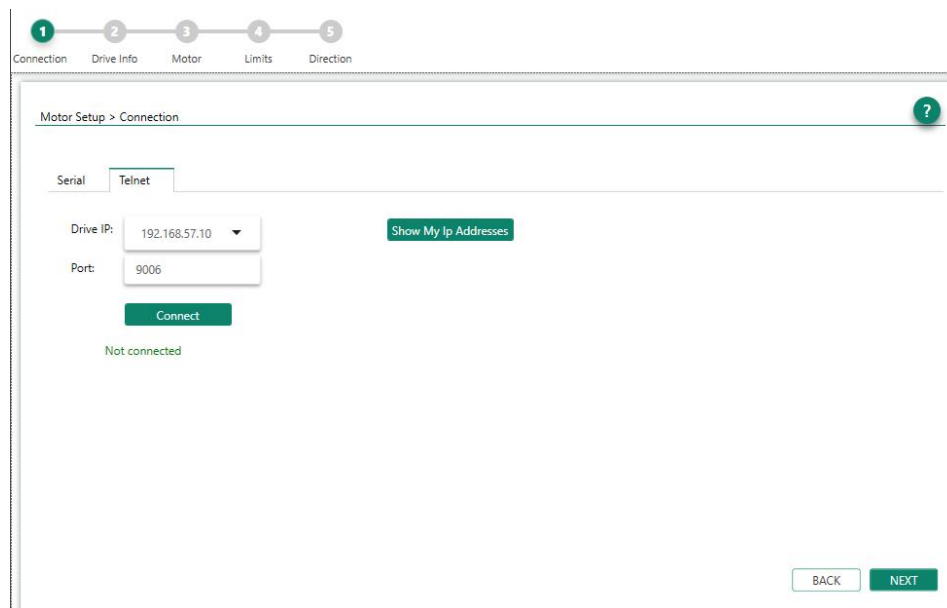
When connecting the host, driver, and motor for the first time, it is recommended that you use the 'Motor Setup' wizard.

This chapter describes the functions and parameters configured during motor setup and initialization.

Motor Setup - Connection

Typically, the first step of the wizard establishes communication between Servo Driver and ServoStudio 2 software.

If ServoStudio 2 has already communicated with Servo Driver, the wizard will skip this step.



The screenshot shows the 'Motor Setup > Connection' screen of the ServoStudio 2 software. At the top, a progress bar indicates five steps: 1. Connection (active), 2. Drive Info, 3. Motor, 4. Limits, and 5. Direction. The 'Serial' tab is selected, and the 'Telnet' sub-tab is active. Below this, there are input fields for 'Drive IP' (set to 192.168.57.10) and 'Port' (set to 9006). A green 'Show My Ip Addresses' button is located to the right of the IP field. A green 'Connect' button is positioned below the port field. Below the 'Connect' button, the text 'Not connected' is displayed in green. At the bottom right, there are 'BACK' and 'NEXT' buttons.

Figure 6-1 Motor Setup Wizard - Connection

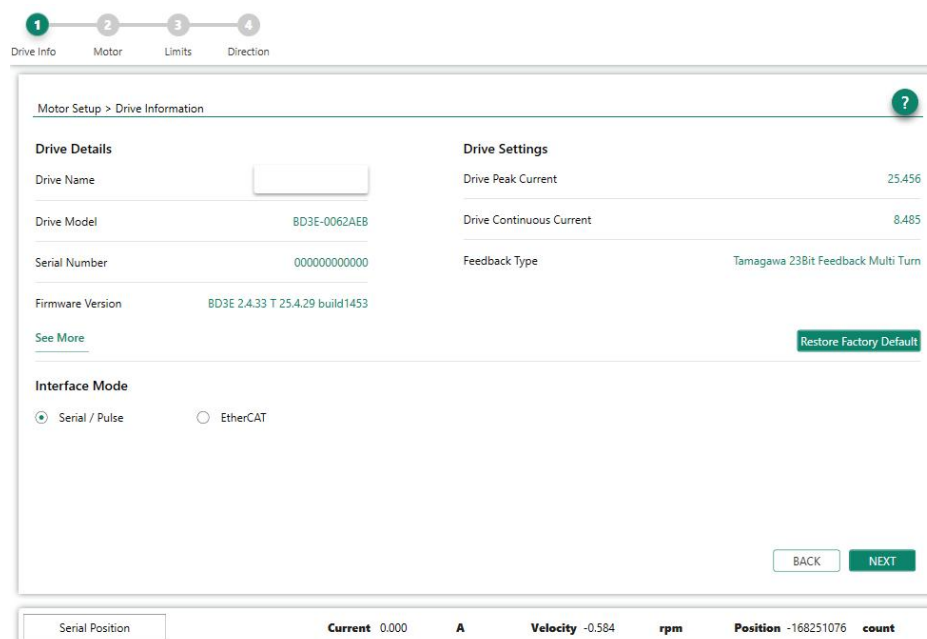
1. Enter the IP and Port of Servo Driver.

2. Click 'Connect'.

Refer to Section 7.3 'Communication'.

Motor Setup - Driver Identification

If ServoStudio 2 has already communicated with Servo Driver, the wizard will start with driver information.



The screenshot shows the 'Motor Setup > Drive Information' screen. The progress bar at the top shows four steps: 1. Drive Info (active), 2. Motor, 3. Limits, and 4. Direction. The screen is divided into two main sections: 'Drive Details' and 'Drive Settings'. The 'Drive Details' section includes fields for 'Drive Name' (empty), 'Drive Model' (BD3E-0062AEB), 'Serial Number' (000000000000), and 'Firmware Version' (BD3E 2.4.33 T 25.4.29 build1453). Below these fields is a 'See More' link. The 'Drive Settings' section includes 'Drive Peak Current' (25.456), 'Drive Continuous Current' (8.485), and 'Feedback Type' (Tamagawa 23Bit Feedback Multi Turn). A green 'Restore Factory Default' button is located to the right of the 'Feedback Type' field. Below these sections is the 'Interface Mode' section, which has two radio buttons: 'Serial / Pulse' (selected) and 'EtherCAT'. At the bottom right, there are 'BACK' and 'NEXT' buttons. At the very bottom of the screen, there is a status bar with the following information: 'Serial Position', 'Current 0.000 A', 'Velocity -0.584 rpm', and 'Position -168251076 count'.

Figure 6- 2 Motor Setup Wizard - Driver Information

1. View driver information.

2. Enter Servo Driver's name, press the Enter key after typing the name, the name field will change from blue to white, indicating that the name has been sent to Servo Driver.

This step also includes an option to restore Servo Driver to factory settings: Restore Factory Default.

This step also displays and allows setting of the "Interface Mode":

- Serial/Pulse indicates that after Servo Driver is enabled, motion commands are transmitted to Servo Driver via serial communication/pulse input interface, at this time COMMODE = 0 (and P0101 = 0).

- EtherCAT indicates that after Servo Driver is enabled, motion commands are transmitted to Servo Driver via the EtherCAT interface, at this time COMMODE = 1 (and P0101 = 1).

The ServoStudio 2 Driver Information screen allows you to view driver properties and define Servo Driver name.

The following parameters are used to view and configure driver information:

VarCom	Description
INFO	Hardware definition. Returns Servo Driver model and serial number, as well as the firmware, control board, power board, and FPGA version numbers.
DRIVENAME	Optional user-defined parameters. This is very useful when the application has multiple drivers. It is recommended to provide a name for Servo Driver that reflects its function, such as Axis-1.

- Motor Settings - Motor Selection

The motor selection and properties are given and confirmed in the motor installation wizard.

Since the PH3 motor in the BD3E kit has an electronic motor nameplate, the parameters on the motor selection screen are automatically set and cannot be modified.

Just click Next to continue to the next step.

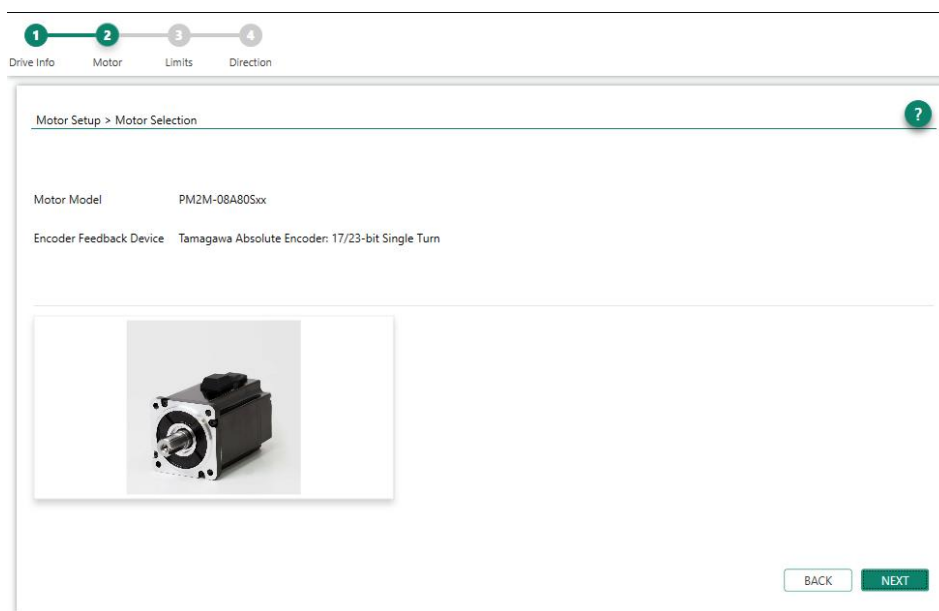


Figure 6- 3 Motor Setup Wizard – Motor Settings

- Motor Settings – Current, Speed, and Position Limits

The “Limits” interface allows you to define current limits, speed limits, and position error limits.

The wizard provides recommendations for low, medium, or high limit values for current and speed. These values correspond to 25%, 50%, and 100% of the maximum range, respectively.

See Current Limits, Speed Limits, and Position Limits.

This wizard also allows you to set the position error threshold level, which is the maximum value that will not trigger a position overrun fault.

See VarCom PEMAX.

Note: If the limit is set too low, the “Auto Tuning” wizard may not produce optimal results.

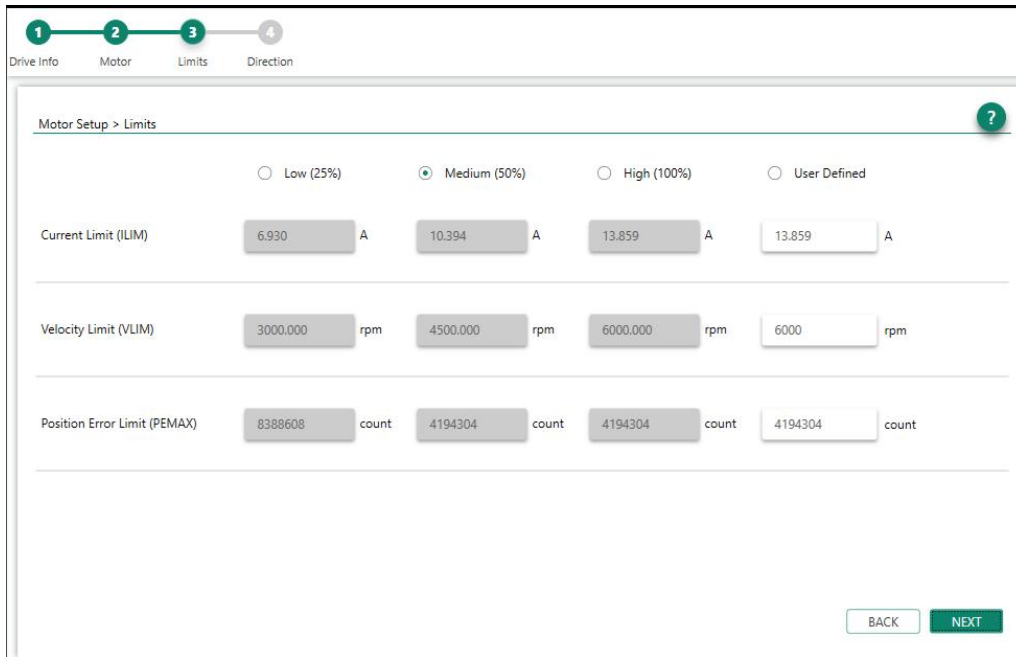


Figure 6- 4 Motor Setup Wizard - Limits

1. Perform any of the following to set speed limits, current limits, and position error limits:

- Select the recommended low, medium, or high value.
- Select user-defined, then enter your preferred value.

2. Click "Agree" to send the values to Servo Driver.

If the current limit or speed limit is set to the user-defined value 0, motion will be prevented.

If the position error limit is set to the user-defined value 0, no position error limit is set, and no faults will occur.

The following parameters are used to define the system's maximum current and set the application's current limit.

VarCom	Description
DIPEAK	The driver's rated peak current, hardware-defined, read-only.
MIPEAK	The motor's rated peak current, value can be modified.
IMAX	This value is the maximum current for the combination of Servo Driver and motor, calculated by software, read-only.
ILIM	The current current limit for the application, this parameter allows you to limit Servo Driver's peak current to a value below DIPEAK.
ILIMACT	Actual driver current limit, read-only.

Motor Settings - Save

After completing the 'Motor Settings,' it is recommended that you save the parameters to Servo Driver's EEPROM and a file on the host for backup.

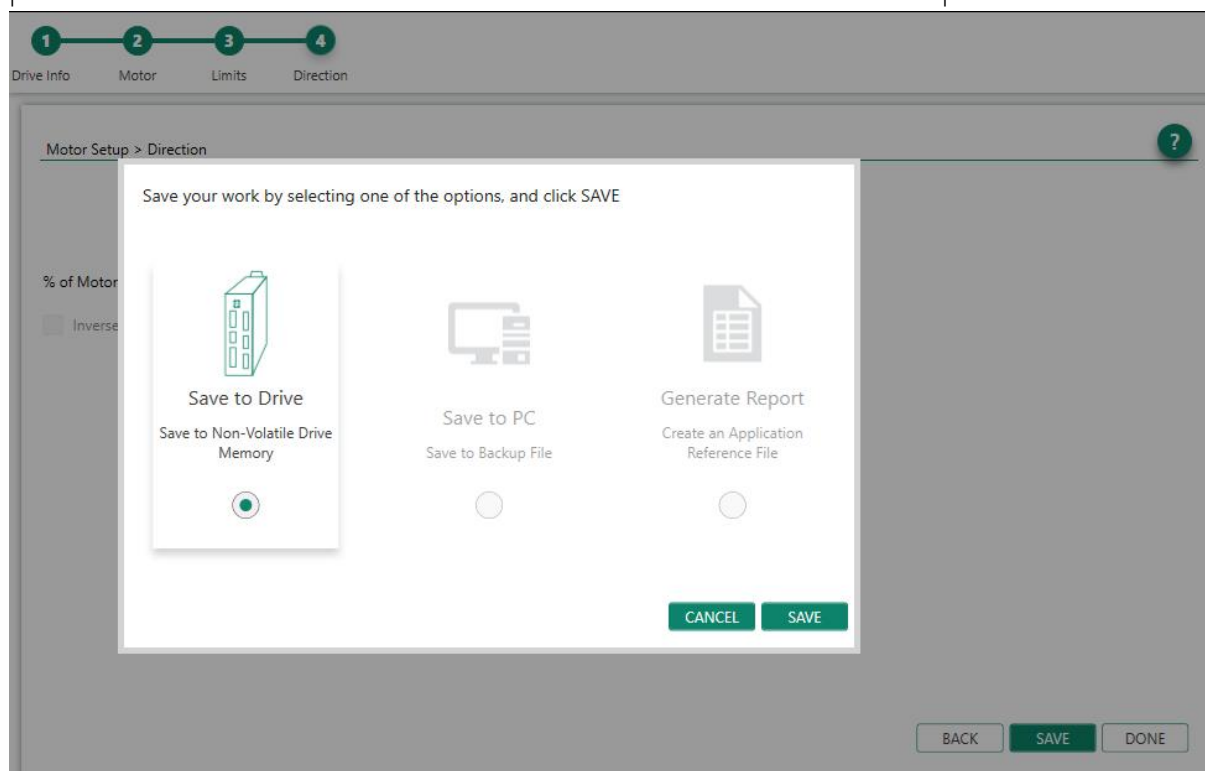


Figure 6- 5 Motor Setup Wizard - Save

Perform the following two actions:

- Click Save to Driver to save the parameters in Servo Driver's RAM to its permanent memory.
- Click Save to Computer to save the parameters in Servo Driver RAM to a backup file on your computer. The parameters are saved in a text file with a TXT or SSV extension. The text file can be edited using Notepad or any other text editor.

It is also recommended that you create an application report:

- Click Generate Report.

After activation, the report generator will open a dialog box allowing you to enter application and user information. It then generates a set of CSV and TXT files in a compressed file, which can be attached to an email sent to technical support. You can change the address and send it to other recipients.

Refer to the Report Generator section in the ServoStudio 2 manual.

6.2 Driver Identification

Display and confirm Servo Driver information in the Motor Settings wizard.

The ServoStudio 2 'Driver Information' screen allows you to view driver properties and define Servo Driver name.

The following parameters are used to view and configure driver information:

VarCom	Description
INFO	Hardware definition, returns Servo Driver model and serial number, as well as the firmware, control board, power board, and FPGA version numbers.
DRIVENAME	Optional user-defined parameters. This is very useful when the application has multiple drivers. It is recommended to provide a name for Servo Driver that reflects its function, such as Axis-1.

6.3 Current Limits

Modify and/or confirm current limits in the 'Motor Setup Wizard'.

The Current Limit tab on the ServoStudio 2 'Limits' screen allows you to define current limits.

The following parameters are used to define the system's maximum current and set the application's current limit.

VarCom	Description
DIPEAK	The driver's rated peak current, hardware-defined, read-only.
MIPEAK	The motor's rated peak current, value can be modified.
IMAX	This value is the maximum current for the combination of Servo Driver and motor, calculated by software, read-only.
ILIM	The current current limit for the application, this parameter allows you to limit Servo Driver's peak current to a value below DIPEAK.
ILIMACT	Actual driver current limit, read-only.

6.4 Speed Limits

Modify and/or confirm speed limits in the 'Motor Setup' wizard.

The Speed Limit tab on the ServoStudio 2 'Limits' screen allows you to define speed limits.

Hardware-defined maximum speed that Servo Driver can calculate.

The following parameters are used to define the system's maximum speed and set the application speed limit.

VarCom	Description
MSPEED	The maximum motor speed defined in the motor data sheet.
VMAX	This value is the maximum speed of Servo Driver and motor combination, VMAX is based on the maximum motor speed, read-only.
VLIM	Maximum application speed, this parameter allows you to limit the motor's maximum speed to a value lower than VMAX.

6.5 Position Limit

Modify and/or confirm position limits during the 'Motor Setup' wizard process.

The position limit tab in the 'Limits' screen of ServoStudio 2 allows you to define position limits.

The following parameters are used to define the positioning limit mechanism and error tolerance.

VarCom	Description
PEMAX	The maximum allowable position error that will not cause a fault, expressed in encoder counts.
PEINPOS	Declare the tolerance window for the 'in position' status.
INMODE # 5	Define the digital input number as the signal indicating whether the positive direction position limit has been reached.
INMODE # 6	Define the digital input number as the signal indicating whether the negative direction position limit has been reached.
LIMSWITCHPOS LIMSWITCHNEG	Indicates the status of all positive and negative limit events, read-only.
POSLIMMODE	Enable and disable software position limits, transient position limits, and/or return-to-zero limits.
POSLIMPOS POSLIMNEG	The maximum and minimum values for software position limits.

7. Application Settings

7.1 Parameters

7.1.1 Configuration Parameters

VarCom is a set of proprietary commands, variables, and parameters used to configure driver functions between the host and driver via EtherNet communication.

VarCom parameters can be accessed through ServoStudio 2 software, on graphical interface screens or command line terminal screens.



When setting parameters, please pay close attention ServoStudio 2 to any alarms or fault messages that appear, as well as any alarm or fault codes on Servo Driver's digital display.

Many parameters can be modified under the condition that Servo Driver is enabled.

However, special attention should still be paid to the fact that modifying parameters may change the motor behavior.

If parameters cannot be modified under the condition that Servo Driver is enabled, a prompt to disable Servo Driver will be displayed.

7.1.2 Management Parameters - Drive Memory

BD3E The driver has two types of memory for storing driver parameters:

- EEPROM: Non-volatile memory. Stores default parameter values (included in Servo Driver firmware) and parameter sets.
- RAM: Volatile memory. The driver's working memory. Parameter values are stored in RAM when you configure and test Servo Driver and adjust parameters. Any unsaved parameter modifications will be lost if Servo Driver loses power.

During power-on, BD3E parameter values are loaded from EEPROM to RAM, and a checksum of these parameter values is calculated. If the checksum is invalid, default parameter values (embedded in Servo Driver firmware) will be loaded into RAM, and a "Parameter Memory Checksum Failure" fault will be set.

All BD3E motor encoder units come with a set of motor parameters stored on the electronic motor nameplate (MTP) in the encoder EEPROM. When Servo Driver detects

the MTP, these parameter values are directly loaded from the encoder memory into Servo Driver RAM.

In ServoStudio 2 the process, you can save Servo Driver parameters to the EEPROM at any time by clicking the Save button in the toolbar.

7.2 Application Setup Wizard

Enter ServoStudio 2 the “Application Settings” wizard screen.

7.2.1 Application Setup - Interface

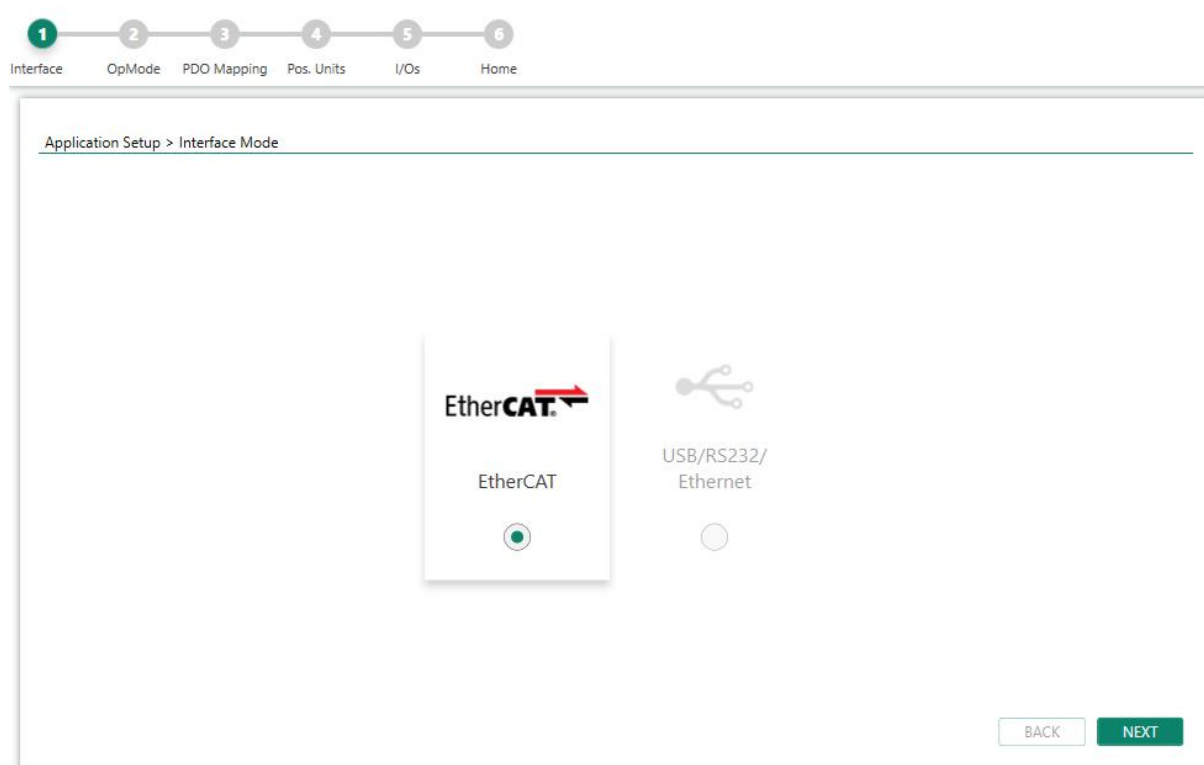


Figure 7-1 ServoStudio 2 - Application Setup Wizard - Interface Mode

The “Application Setup” wizard will guide you through setting up driver parameters according to specific applications.

In the first step, the specific application settings are determined by the selected “Interface Mode.” Subsequent steps may include PDO mapping, position unit definition, electronic gear ratio, limits, return to zero, and input/output functions.

Note: When the software is offline, all “Interface Modes” will be displayed.

When the software communicates with Servo Driver, only relevant modes will be displayed.

BD3E currently supports the following interface modes:

- EtherCAT
- EtherNet

7.2.2 Application Setup - Operation Mode

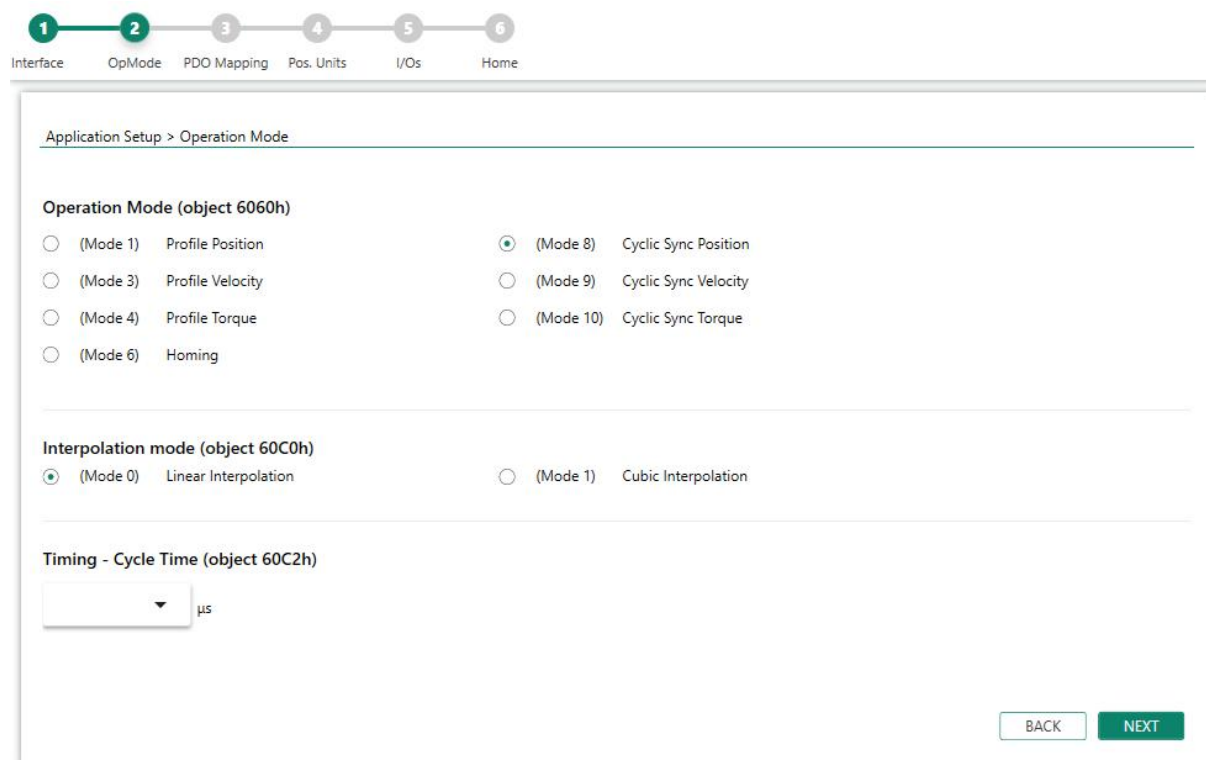


Figure 7-2 ServoStudio 2 - Application Setup Wizard - Operation Mode (EtherCAT)

Displayed when the "Interface Mode" is EtherCAT.

Define the operation mode of Servo Drive system running on the EtherCAT network.
Refer to the BD3E EtherCAT Reference Manual.

7.2.3 Application Setup - Position Units

Displayed when the interface mode is EtherCAT mode:

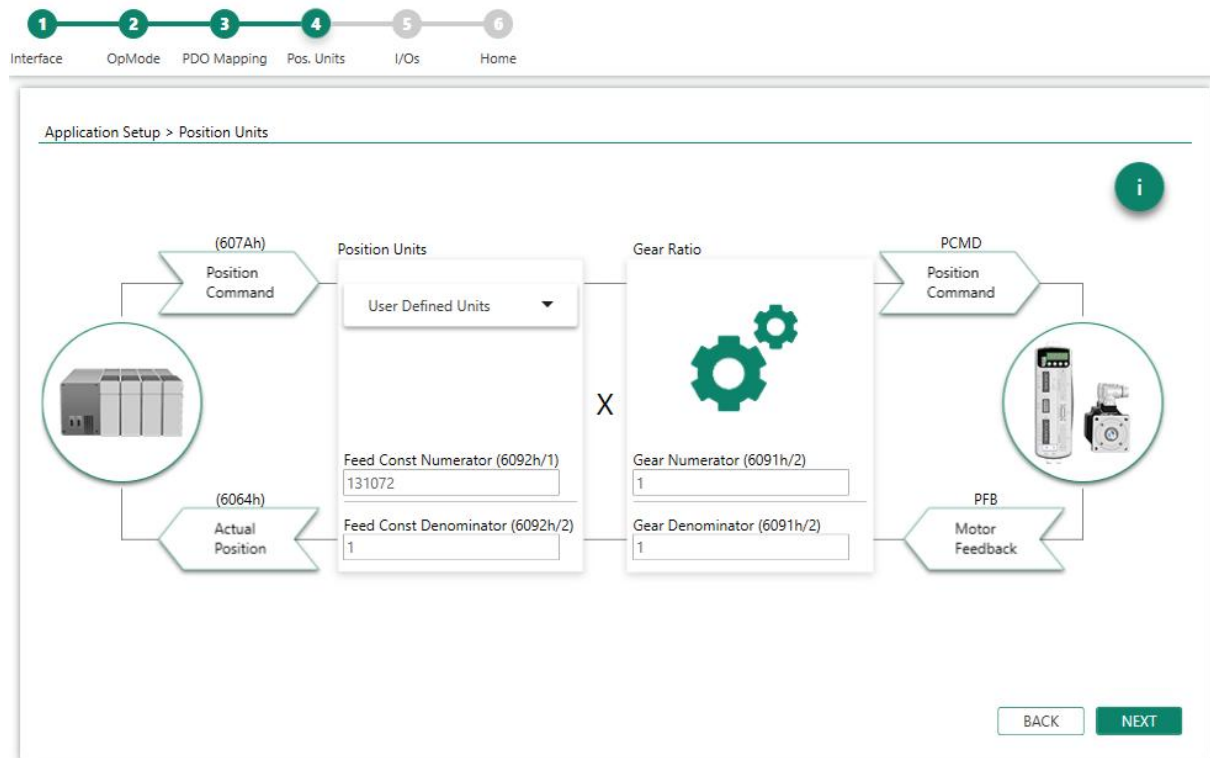


Figure 7-3 ServoStudio 2 - Application Setup Wizard - Position Units

7.2.4 Application Setup - Input/Output

- Displayed when the interface mode is EtherCAT or EtherNet mode:

1 2 3 4 5 6
Interface OpMode PDO Mapping Pos. Units I/Os Home

Application Setup > Inputs/Outputs

Input			Output		
Input	Function	Polarity	Output	Function	Polarity
☒ -	Emergency Stop		☒ -	Brake Release Signal	
☒ 5	Positive Limit Switch	Active High	☒ 2	Alarm	Active High
☒ 3	Negative Limit Switch	Active High			
☒ 4	Home Switch	Active High			
☒ 1	Touch Probe	Active High			

BACK NEXT

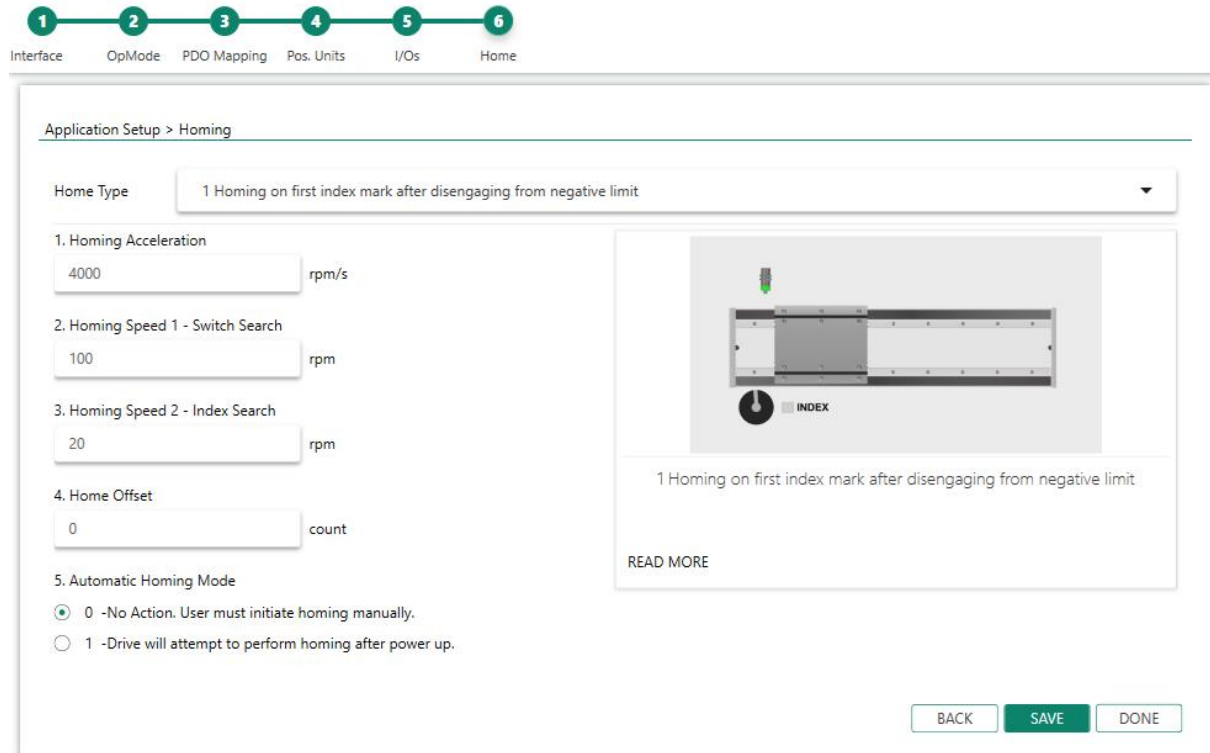
Figure 7-4 ServoStudio 2 - Application Setup Wizard - Input/Output

Supported interface modes are:

- EtherCAT
- EtherNet

7.2.5 Application Setup - Return to Zero

Displayed when the interface mode is EtherCAT or EtherNet mode:



Application Setup > Homing

Home Type: 1 Homing on first index mark after disengaging from negative limit

1. Homing Acceleration: 4000 rpm/s

2. Homing Speed 1 - Switch Search: 100 rpm

3. Homing Speed 2 - Index Search: 20 rpm

4. Home Offset: 0 count

5. Automatic Homing Mode

☒ 0 -No Action. User must initiate homing manually.

☐ 1 -Drive will attempt to perform homing after power up.

1 Homing on first index mark after disengaging from negative limit

[READ MORE](#)

BACK SAVE DONE

Figure 7-5 ServoStudio 2 - Application Setup Wizard - Return to Zero

Supported interface modes are:

- EtherCAT
- EtherNet

7.2.6 Application Setup - Save

This option is displayed in the "Application Setup - Return to Zero" step when the software communicates with Servo Driver.

7.3 Communication

7.3.1 Connecting BD3E with ServoStudio 2

1. Network Communication

Through network communication connection, the BD3E digital driver can communicate with the host (terminal, PC, or high-end controller) by transmitting ASCII code information via EtherNet.

When the host and BD3E communicate over the network, a series of commands and variables (referred to as VarCom) are used to configure, control, and monitor Servo Driver.

The communication interface can be a graphical software interface, such as ServoStudio2, or a user-designed application, or a basic terminal.

2. Default Network Parameters at Factory

The BD3E digital driver acts as a TCP server, with default network parameters: 192 168 57 10, port number: 9006.

3. Connection Procedure

a. Configure the PC subnet to be the same as the BD3E digital driver: 192.168.57.x.

Note: The PC IP address must not be the same as Servo Driver's IP address.

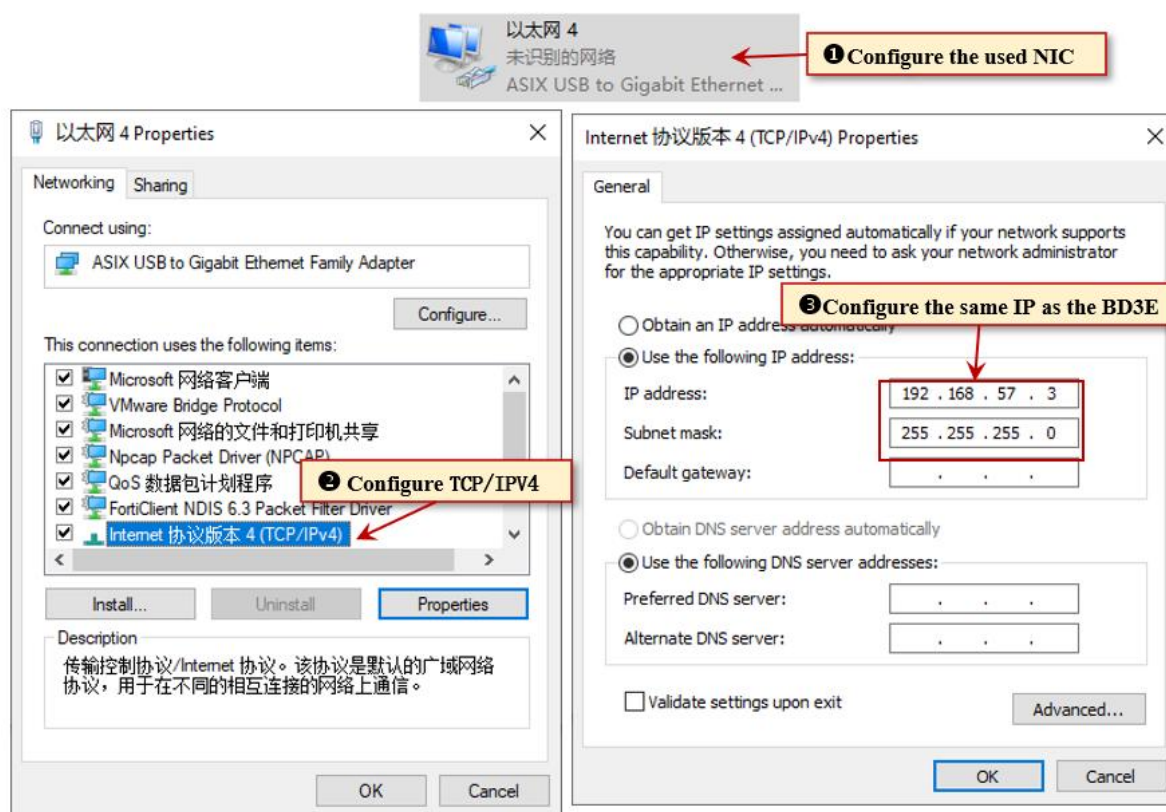


Figure 7-6 ServoStudio 2 - Application Setup Wizard - Connecting to the Driver

b.The PC and BD3E digital driver are connected directly via an Ethernet cable. The connection diagram is shown below:

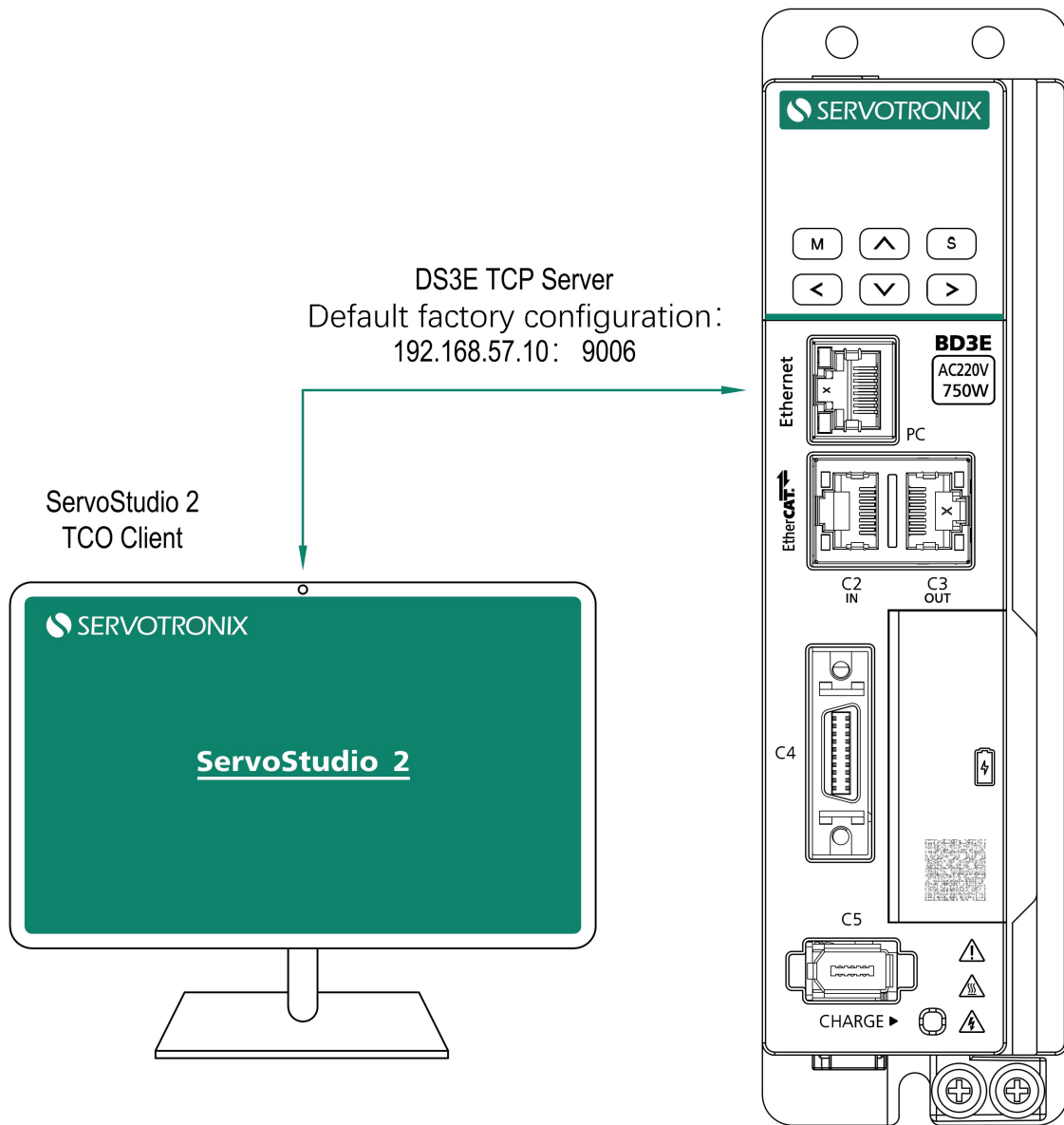


Figure 7-7 ServoStudio 2 - Application Setup Wizard - Connecting to the Driver

c.Using ServoStudio 2, enter the BD3E TCP Server network parameters: 192.168.57.10:9006, click Connect, and a prompt will indicate that the connection is online and successful.

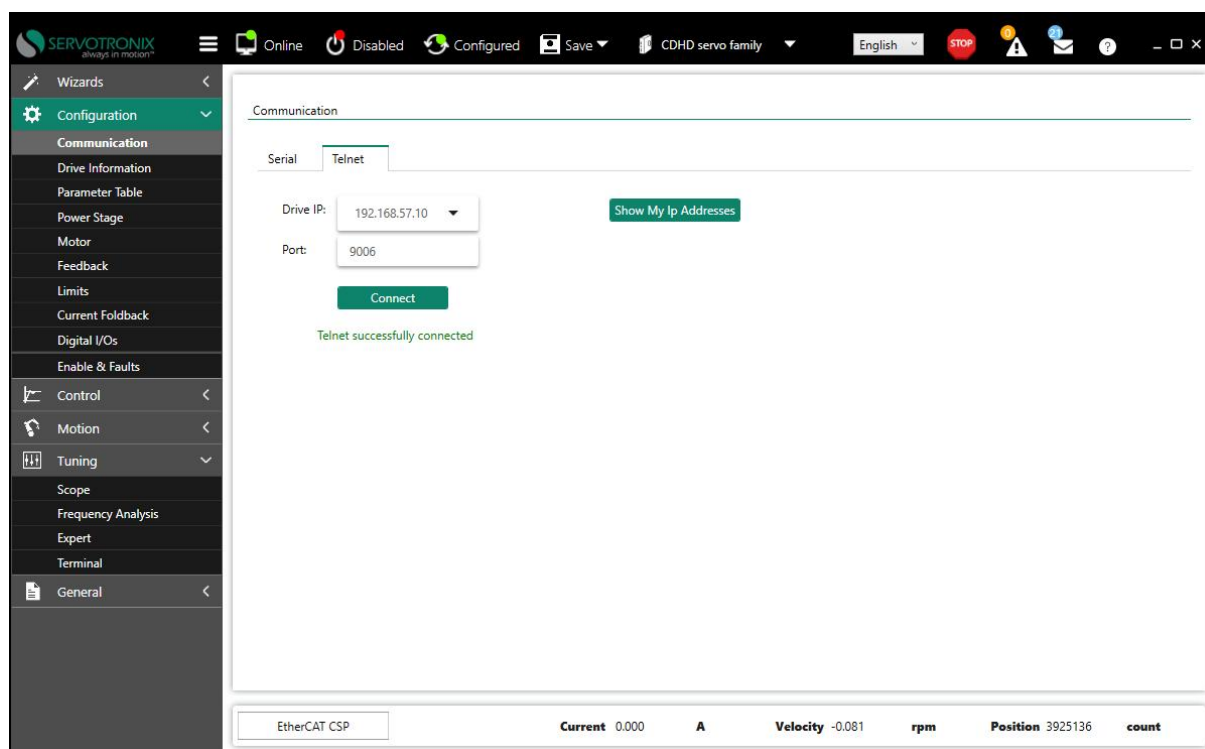


Figure 7-8 ServoStudio 2 - Application Setup Wizard - Connecting to the Driver

7.3.2 Communication Configuration

Through ServoStudio 2To test-run Servo Driver, an EtherNet connection is required. After configuring Servo Driver, you can connect it to a PLC or controller via the EtherCAT network.

Note:

To communicate over EtherNet, Servo Driver must be set to COMMODE 0. COMMODE 1 is the default setting for Servo Driver at the factory.

When communicating via the EtherCAT network, Servo Driver must be set to COMMODE 1.

The following parameters are used for configuring and monitoring communication:

VarCom	Description
COMMODE	When COMMODE 0 is effective: Enable EtherNet communication. Disable EtherCAT communication. Accept commands only through ServoStudio 2. The driver can be controlled via ServoStudio 2full control (enable, motor action, parameter modification).

VarCom	Description
COMMODE	When COMMODE 1 is effective: Enable EtherCAT communication. The driver can be fully controlled via the fieldbus device. Reference commands can be received via ServoStudio 2the fieldbus. It cannot be enabled or operated via ServoStudio 2the fieldbus to start the motor. Note: Specific functions must be performed via ServoStudio 2the fieldbus. These functions are limited to parameters that do not interfere with fieldbus operation. If you want to set parameters that will interfere with fieldbus operation, Servo Driver will display an error code on the digital display, and/or in ServoStudio 2to post error messages.

You can use ServoStudio 2the “Communication” tab to establish communication between the serially connected host and driver. Additionally, the first step of the “Motor Setup” wizard is to configure communication between the host and driver.

7.4 Power Stage

Predefined rated power parameters are written into Servo Driver. These parameters are defined by the manufacturer and cannot be modified by the user; if you wish to modify these parameters, please contact technical support.

Use ServoStudio 2the “Power Level” screen to view current and voltage values, and set certain voltage parameters.

The following parameters are used for monitoring and controlling power ratings.

VarCom	Description
DICONT	Driver continuous current, hardware-defined, read-only.
DIPEAK	Driver peak current, hardware-defined, read-only.
OVTRESH	DC bus overvoltage protection level, hardware-defined, read-only.
UVMODE	Define how Servo Driver will respond to an undervoltage fault.
UVRECOVER	Define how Servo Driver will return to normal operation after an undervoltage fault.
UVTRESH	DC bus undervoltage protection level.
UVTIME	Duration of conditions for an undervoltage fault to occur.
VBUS	DC bus voltage.
VBUSREADOUT	Actual DC bus voltage of Servo Driver, hardware-defined, read-only.

7.5 Feedback

The motor in the BD3E servo kit is equipped with one of the following encoders:

- Absolute magnetic encoder with single-turn resolution of 20 bits;
- Absolute magnetic encoder with single-turn resolution of 20 bits + multi-turn counting capacity of 16 bits;

- Absolute optical encoder with single-turn resolution of 23 bits + multi-turn counting capacity of 16 bits;
 Note: All use Tamagawa 23-bit data protocol.

These encoders include a motor nameplate (MTP), which means that certain motor parameters are transmitted directly to Servo Driver upon power-up and cannot be modified.

FEEDBACKTYPE defines the type of motor feedback used in Servo Drive application.

7.5.1 Single-turn and Multi-turn Encoders

The BD3E servo kit provides two types of motor encoders:

- Single-turn absolute encoder: No multi-turn counting function. After a restart, the encoder retains its absolute position within one mechanical rotation, but the multi-turn absolute position is 0.
- Multi-turn absolute encoder: Has a multi-turn counting function. After a restart, the encoder retains its absolute position within one mechanical rotation and the total number of turns of the motor since the last restart. Multi-turn encoders do not need to return to the origin after each restart. With an external backup battery, multi-turn encoders can store up to 65535 turns. The encoder battery is located in the battery box on Servo Driver. If the cable between the motor and the battery box is disconnected, or if the encoder does not receive battery or driver voltage, the encoder will lose the multi-turn count; however, it retains the single-turn absolute position.

The following command is used to configure and enable the multi-turn absolute encoder.

VarCom	Description
MTTURNRESET	Reset the multi-turn position of the encoder to clear the multi-turn position fault in the encoder.
IGNOREBATFLT	Prevent faults in the multi-turn absolute encoder due to backup battery depletion, cable disconnection, or absence, allowing the encoder to function as a single-turn absolute encoder.

7.5.2 Replacement of Multi-turn Encoder Backup Battery

Battery voltage is measured only during the power-up sequence. If the battery voltage drops below the specified value during operation, no warning or fault will be issued until the next power-up.

- If the battery voltage drops below 3.15V, the encoder issues a low battery voltage warning, indicating that the battery should be replaced as soon as possible.

When replacing the battery, keep Servo Driver powered on to maintain the multi-turn position in memory during the replacement process. Remove the old battery and insert the new one.

- If the battery voltage drops below 3.0V, the encoder issues a low battery fault; Servo Driver detects the fault and disables the motor, at which point the multi-turn data is no longer reliable.

If this occurs, turn off Servo Driver's power before replacing the battery, then remove the old battery and insert the new one, connect Servo Driver's power, and issue the command to reset the multi-turn encoder (MTTURNRESET) position counter.

7.6 Units of Motion

BD3E Supports units for physical quantities such as acceleration, speed, and position, and can be configured through ServoStudio 2View in the 'Motion Unit' interface.

The following parameters are used for monitoring and operating the motion unit.

VarCom	Description
PNUM	Electronic gear unit conversion factor numerator.
PDEN	Electronic gear unit conversion factor denominator.
FBGDS	Fieldbus drive shaft speed conversion coefficient.
FBGMS	Fieldbus gear shaft speed conversion coefficient.

7.7 Overload Current

Overload current is BD3E A mechanism to protect Servo Driver and motor from overheating due to overcurrent. The overload current of Servo Driver and motor must be set separately.

The overload current limits the root mean square (RMS) value of the current supplied to Servo Driver and/or motor.

Use ServoStudio 2View and configure the overload current parameters for the motor and driver on the 'Overload Current' screen.

The following parameters are used for monitoring and operating overload attributes.

VarCom	Description
IFOLD	Driver Overload Current
DICONT	Driver Continuous Current
IFOLDFTHRESH	Driver Overload Fault Threshold
DIPEAK	Driver Peak Current
MIFOLD	Motor Overload Current
MICONT	Motor Continuous Current
MIFOLDFTHRESH	Motor Overload Fault Threshold
MIPEAK	Motor Peak Current
MFOLDD	Motor Overload Delay
MFOLDT	Motor Overload Time Constant
MFOLDR	Motor Overload Recovery Time
MFOLDDIS	Enable/Disable Motor Overload

7.8 Digital Input

The transmission delay for BD3E standard digital inputs is $\leq 1\text{ms}$, and for high-speed digital inputs, it is $\leq 1\mu\text{s}$.

Use ServoStudio 2The "Digital I/O" tab interface is used to configure and view the status of digital inputs.

Use the following parameters to configure and monitor digital inputs.

VarCom	Description
IN	Read the input status of the specified digital input channel, with values ranging from 1-5.
INPUTS	Read the input status of all digital input channels.
INMODE	Define digital input functionality.
ININV	Convert the specified input polarity.

7.9 Digital Output

The transmission delay of BD3E digital output $\leq 1\text{ms}$.

Use ServoStudio 2Configure and view the status of digital outputs on the 'Digital I/O' tab interface.

Use the following parameters to configure and monitor digital outputs.

VarCom	Description
--------	-------------

VarCom	Description
OUT	Read the output status of the specified digital output channel, with values ranging from 1-3.
OUTPUTS	Read the output status of all digital output channels.
OUTMODE	Define digital output functionality.
OUTINV	Convert the specified output polarity.

7.10 Shutdown Modes

Disabling Servo Driver enable is an action performed due to the motion controller issuing a disable command or Servo Driver responding to a fault condition. When Servo Driver is disabled, the 'Active Stop' function can be used under special circumstances: before shutting down the motor power, control the motor to decelerate, allowing the motor to stop quickly, thus reducing the distance the motor coasts.

Use ServoStudio 2 On the "Emergency Stop" screen, select the method and parameters for stopping the motor when disabling Servo Driver.

The shutdown mode function includes two mechanisms:

- **Active Shutdown:** By controlling the speed to decelerate to zero, the motor stops running, and then Servo Driver disables the enable signal. Active shutdown cannot be implemented when Servo Driver is operating in current control mode (OPMODE 2 or OPMODE 3).
- **Dynamic Braking:** When Servo Driver disables the enable signal, the motor can be controlled through the dynamic braking function, at which point only the motor's back EMF is used to generate braking current.

VarCom	Description
DISMODE	Define how Servo Driver will respond during shutdown.
DISMODE 0	Non-Active Shutdown, Non-Dynamic Braking
DISMODE 1	Non-active shutdown, dynamic braking only during faults
DISMODE 2	Non-active shutdown, dynamic braking during active shutdown
DISMODE 3	Active shutdown due to fault, non-dynamic braking
DISMODE 4	Active shutdown due to fault, dynamic braking only during faults
DISMODE 5	Active shutdown due to fault, dynamic braking during active shutdown

Note: Faults that require immediate disablement (to prevent driver damage) and feedback faults that may cause communication errors (motor runaway conditions) cannot perform active shutdown.

There are four parameters that influence the prohibition and braking behavior.

VarCom	Description
DISSPEED	Defines the speed threshold for brake engagement, below which the motor brake will engage.
DISTIME	Defines the brake engagement time for Servo Driver, after which Servo Driver disables itself following the delay.
DECSTOP	Define the active shutdown deceleration rate.
DECSTOPTIME	Define the active shutdown time; when the active shutdown is triggered, after this delay, regardless of whether the motor speed is below DISSPEED, the brake will engage.

7.10.1 Active Shutdown

Active shutdown can prevent the motor from freewheeling during shutdown.

The active shutdown mechanism controls the speed to quickly drop to zero to stop the motor operation, then Servo Driver disables the enable function.

Note: Active shutdown cannot be implemented when Servo Driver is in current control mode (OPMODE 2 or OPMODE 3); it is effective in all other operating modes.

Figure 7-9 shows that without using active shutdown, the motor will freewheel. After Servo Driver disables the enable function, the speed command is immediately set to zero, Servo Driver disconnects power to the motor, and the actual speed decreases according to the curve of inertia and friction.

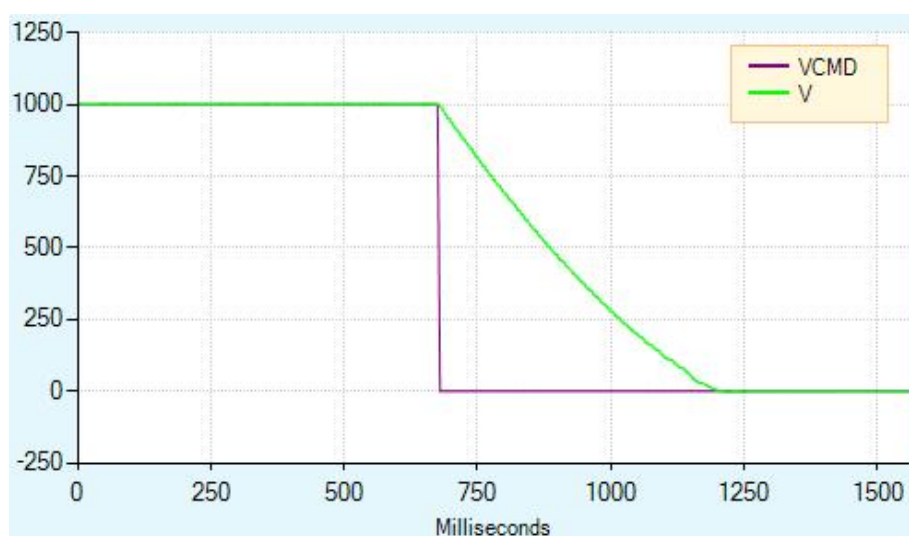


Figure 7-9 Disable (Do Not Use Active Shutdown)

Figure 7-10 shows the situation when active shutdown takes effect. After Servo Driver receives the disable command, the speed command and speed feedback will immediately ramp down to zero according to the set slope, after which Servo Driver will disable the enable signal.

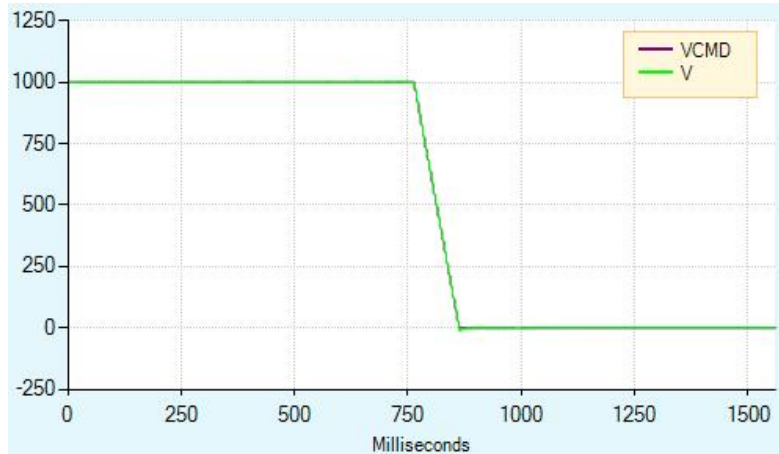


Figure 7-10 Disable (Use Active Shutdown)

Figure 7-11 illustrates the effects of DISSPEED and DISTIME. In this example, DISSPEED is set to 800 rpm, and DISTIME is set to 20 ms. When the motor speed remains below 800 rpm, Servo Driver outputs a brake engage signal, and after a delay of 50 ms, Servo Driver disables the enable signal.

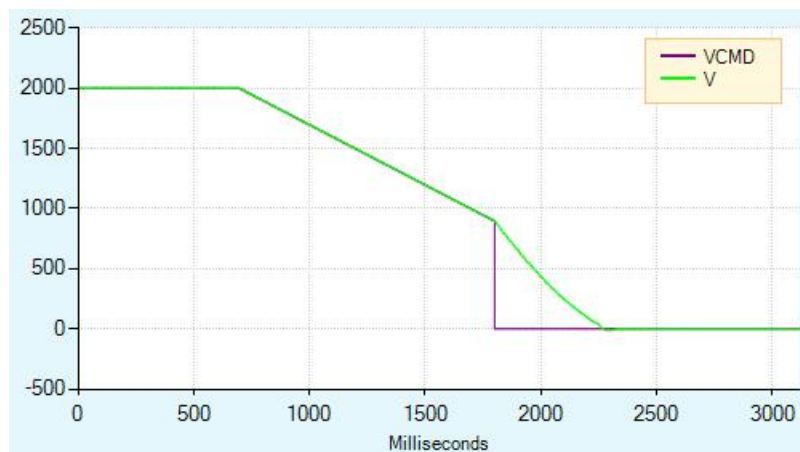


Figure 7-11 Effects of DISSPEED and DISTIME on Active Shutdown

ServoStudio 2The legend shown on the 'Emergency Stop' interface indicates active shutdown behavior.

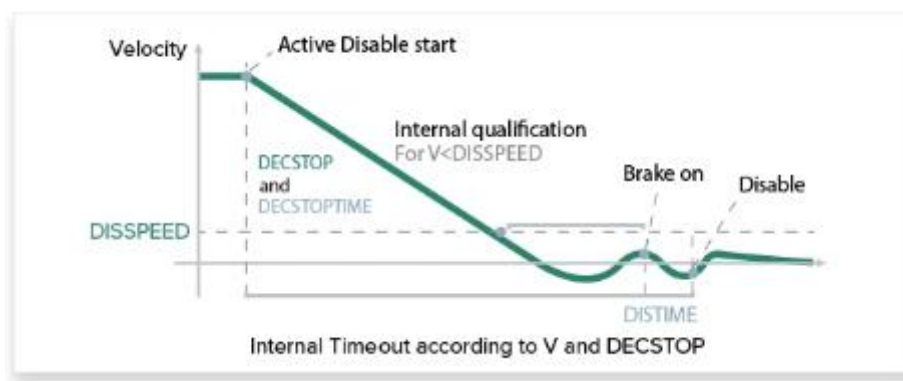


Figure 7-12 Active Shutdown

Note:

If a digital output is configured for brake control, the DISTIME timer will start counting immediately, and braking will be enabled; once the counter reaches DISTIME, Servo Driver will disable the enable signal.

If the internal timeout (based on actual speed and DECSTOP) expires, the deceleration mechanism will also terminate, as shown in Figure 7-12 for active shutdown.

7.10.2 Dynamic Braking

When Servo Driver disables the enable signal, the motor can be controlled using the dynamic braking function, at which point only the motor's back EMF is used to generate brake current. During dynamic braking, the variable ISTOP is used to set the maximum allowable current.

Figure 7-13 illustrates the free coasting process of the motor, which is the stopping process without dynamic braking and without an active shutdown mechanism. Once Servo Driver disables the enable signal, the speed command immediately drops to 0, and the actual motor speed will decelerate to 0 under the effect of friction.

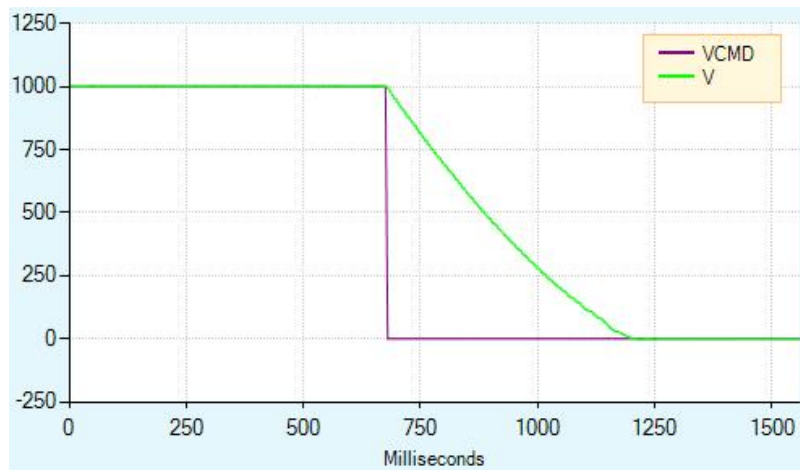


Figure 7-13 Free Coasting Curve of the Motor Without Dynamic Braking Mechanism

Figure 7-14 illustrates the motion curve when the dynamic braking mechanism is active. Once Servo Driver disables the enable signal, the speed command is set to 0, and due to the dynamic braking function, the actual speed quickly drops to 0.

Unlike the active shutdown feature, the actual speed does not follow a specific motion curve to drop to 0; the deceleration is the result of the maximum braking current (variable ISTOP) and the system's inertia and friction acting together.

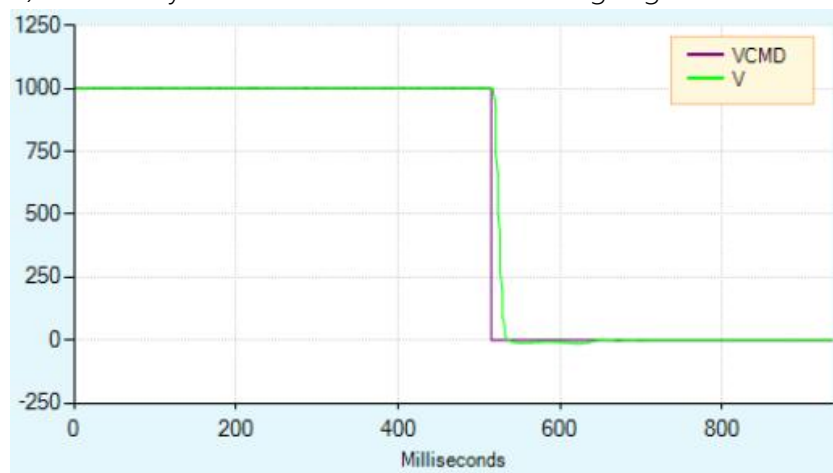


Figure 7-14 Dynamic Braking Curve

Figure 7-15 shows the dynamic braking curve when the value of the ISTOP variable is very small. In this example, it takes a long time for the motor to stop, demonstrating the role of the ISTOP variable in the dynamic braking process.

It takes a long time for the motor to stop, illustrating the function of the ISTOP variable in the dynamic braking process.

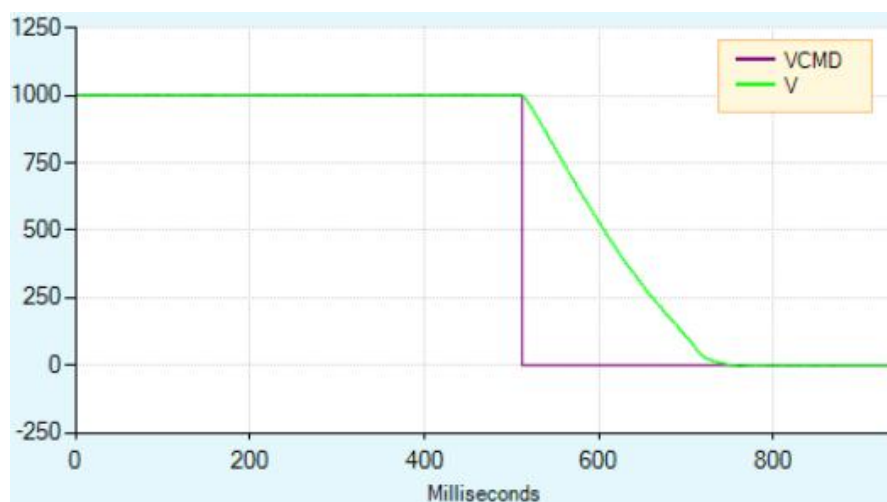


Figure 7-15 Dynamic Braking Curve with a Very Small ISTOP Value

Both DISMODE4 and DISMODE5 modes support active shutdown and dynamic braking. In these examples, active shutdown is used to stop the motor, and dynamic braking only becomes effective after DISTIME.

7.11 Motor Brake Control

BD3E has a dedicated brake output.

Refer to the 'Motor Brake Wiring' and the following procedures.

The polarity of digital outputs can be changed to match Servo Driver electronics with the motor control circuit.

BD3E The disable time can be set through the DISTIME and DECSTOPTIME parameters. When Servo Driver receives a disable command, it first decelerates according to the active shutdown mode, then closes the brake drive signal based on DISSPEED or DECSTOPTIME, waits for the brake engagement time to end, and finally actually disables the enablement.

The brake release time can be set by OUTBRAKERELEASETIME. When Servo Driver receives an enable command, it simultaneously opens the brake output, delays the brake release time, and completes the enablement after the delay.

The driver takes up to 1.5 seconds to complete the enablement, while the brake release typically requires tens of milliseconds.

Steps to configure digital output control for the brake:

When configuring digital output, please perform ServoStudio 2The following steps.

1. Define output.

Go to the "Digital Input/Output" interface, set output 3 (Output 3) to mode 2 - Brake Release Signal.

Digital Outputs				
State	Name	Mode	Polarity	Connector
	Output 1	29 -Servo Ready	Active High	C-17
	Output 2	3 -Alarm Any Fault	Active High	C-8
	Output 3	0 -Idle	Active High	C-18

Figure 7-16 Digital Output Settings for Motor Brake Control

Default:

- When BD3E Enabled, the brake output is turned on.
- When BD3E When disabled, the brake output is turned off.

2. Go to the "Emergency Stop" interface, set the "Active Stop Time" (DISTIME). For example, set this value to 30 ms.

DISTIME defines the time period after the motor falls below the "Active Stop Speed Threshold" (DISSPEED) until Servo Driver is disabled via the "Active Stop" function.

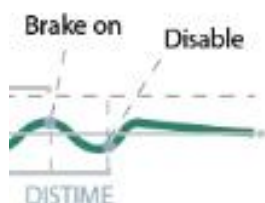


Figure 7-17 Active Stop Time (DISTIME)

When the 'Disable Enable' command is executed, after waiting for the speed to drop below DISSPEED, BD3E immediately changes the brake output value and disables the enable after the 'Active Shutdown Time' (DISTIME) has elapsed.

In case of hardware overcurrent or loss of feedback faults, Servo Driver immediately switches the brake output value and disables the enable.

7.12 Return to Zero

BD3E provides multiple return to zero modes.

Use ServoStudio 2The 'Return to Zero' interface defines and executes the return to zero procedure.

The following parameters are used to define and execute the return to zero procedure.

VarCom	Description
HOMEACC	Acceleration and deceleration values during the return to zero process.
HOMECMD	Start the return to zero process.
HOMECMD 0	Stop the return to zero process.
HOMEOFFSET	Set the 'Zero' position offset (count).
HOMESPEED1	Initial speed used during the return to zero process for searching limit switches and zero position switches.
HOMESPEED2	The speed used during the homing process while searching for the homing trigger (which may be the Z pulse (the zero position of single-turn position data), limit switch transition, home switch transition, or other sources (defined by HOMETYPE)).
HOMESTATE	Displays the current status of the system's homing process.
HOMETYPE	Defines the type of homing process to be executed.

Parameter HOMETYPE defines the time for reversing the direction of motion during the homing process, the homing trigger (e.g., switch, index), and other conditions.

Homing modes 1-14, 17-30, and 33-35 are standard homing methods; definitions and diagrams can be found in the 'CiA Draft Standard Proposal 402'.

7.12.1 Return to Zero with Z Pulse

The Z pulse position used for homing is the zero position of the single-turn data.

Return to Zero Method: HOMETYPE 1-14, 33, 34.

In these methods, use HOMESPEED1 before detecting the limit switch or zero position switch.

Once the signal edge of the switch (limit switch, zero position switch) is detected, the axis moves at HOMESPEED2 to detect the Z pulse.

7.12.2 Return to Zero with Positive and Negative Edges

Return to Zero Method: HOMETYPE 17-30

Return to zero at the rising/falling edge of the positive/negative limit switch or the rising/falling edge of the zero position switch.

7.12.3 Set Current Position as Zero Position

Return to Zero Method: HOMETYPE 35

Set the current position as the zero position.

8. Panel Operation

8.1 Panel Operator

The panel operator consists of a 5-digit 8-segment LED display and 6 buttons.

The panel operator can display the status of the servo driver, monitor parameter changes, set parameters, and perform auxiliary functions.

The names and functions of the panel operator buttons are as follows:

Button	Mode	Function
	Short Press	Mode Switch, Return
	Short Press	Value Increase
	Long Press	Value Rapid Increase
	Short Press	Value Decrease
	Long Press	Value Rapid Decrease
	Short Press	Settings
	Short Press	Move Right
	Short Press	Move Left
	Press Simultaneously	Clear Error

8.2 Function Switching

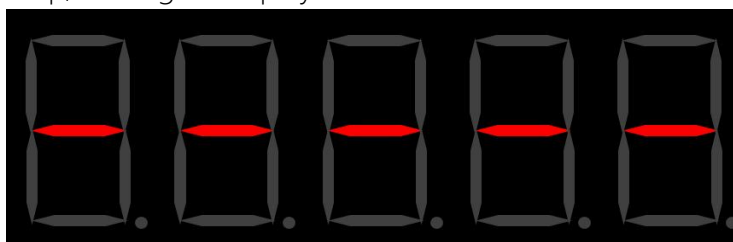
The panel operator has 4 functional modes: Status Display, Monitoring Display, Parameter Setting, Auxiliary Function. Press the M key to switch between the 4 functional modes, and press S to enter the selected mode after confirmation.

8.3 Status Display

In Status Mode, the panel display shows the status of Servo Driver, including Servo Driver operation mode, enabled/disabled status, errors, and warnings.

8.3.1 Power-On Display

During power-up, the digital display shows 5 short dashes

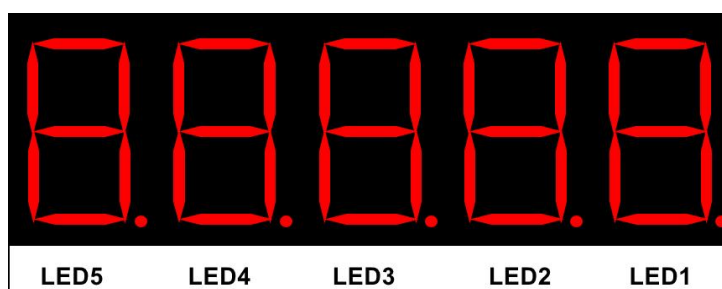


8.3.2 Initial Display

After power-on, if there are no errors, the display shows Sx-CP.

If there are errors, they are displayed with priority, up to a maximum of 5 errors.

8.3.3 Status Codes



1. COMMODE=1, displays S- □ □ x, where xxx represents the control mode under EtherCat mode, such as 'CSP'

2. COMMODE =0, displays S- x, where x represents the control mode under EtherNet mode, such as '8'

3. Enable bit, indicated by a decimal point on the far right of the digital tube; a decimal point indicates enabling.

LED5	S	Status Display
	E	Error Display
	A	Warning Display
	P	Parameter Mode
	d	Monitoring Mode
	C	Command Mode
LED 1&2&3		Operation Mode (COMMODE = 0)
		If COMMODE 0: Serial (OPMODE)
	0	Serial Speed Mode

	2	Serial Current Mode
	8	Serial Position Mode
		If COMMODE 1: (Object 6061)
	PP	1 = Fieldbus Trajectory Position Mode
	PV	3 = Fieldbus Trajectory Speed Mode
	PT	4 = Fieldbus Trajectory Torque Mode
	HH	6 = Return to Zero Mode
	CSP	8 = Fieldbus Synchronous Position Mode
	CSV	9 = Fieldbus Synchronous Speed Mode
	CST	10 = Fieldbus Synchronous Torque Mode
LED1 at the Lower Right Corner	.	Enable
		Disable Enable

8.4 Monitoring Display (d××××)

In monitoring display mode, the panel can show the command values set in the servo driver, the status of input/output signals, and the internal state of Servo Driver (such as speed, pulse frequency, position, current, etc.). The display on the panel starts with the letter d followed by a number.

8.4.1 Display Overview

	VarCom	Range	Units	Default Value
d0001	SYSST	0 to 9	--	0
	System Status			
d0002	APPST	0 to 7	--	1
	Current state of the applied state machine			
d0003	PCMD	-4294967296 to 4294967295	count	0
	Low bit of position command			
d0004	PCMD	-4294967296 to 4294967295	count	0
	High bit of position command			
d0005	PFB	-4294967296 to 4294967295	count	0
	Low bit of position feedback			
d0006	PFB	-4294967296 to 4294967295	count	0
	High bit of position feedback			

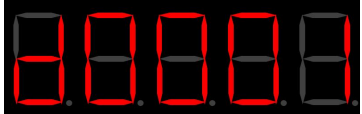
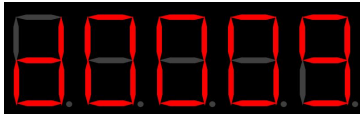
	VarCom	Range	Units	Default Value
d0007	PE	-4294967296 to 4294967295	count	0
	Low bit of position error			
d0008	PE	-4294967296 to 4294967295	count	0
	High bit of position error			
d0009	V	-10000 to 10000	rpm	0
	Speed			
d0010	VCMD	-10000 to 10000	rpm	0
	Speed Command			
d0011	ICMD	-100.0 to 100.0	A	0
	Current Command			
d0012	IDCMD	-100.0 to 100.0	A	0
	D-axis Current Command			
d0013	IQ	-100.0 to 100.0	A	0
	Q-axis Current			
d0014	ID	-100.0 to 100.0	A	0
	D-axis Current			
d0015	I	-100.0 to 100.0	A	0
	Motor Current			
d0016	VBUSREADOUT	0.0 to 850.0	V	0
	Bus Voltage Value			
d0017	ELECTANGLE	0 to 65535	0-65535	0
	Electrical Angle			
d0018	MFB	0 to 4294967295	count	0
	Low bit of motor position feedback			
d0019	MFB	0 to 4294967295	count	0
	Motor Position Feedback High			
d0020	ENCMULTITURN	-4294967296 to 4294967295	rev	0
	Encoder Multi-turn Value Low			
d0021	ENCMULTITURN	-4294967296 to 4294967295	rev	0
	Encoder Multi-turn Value High			
d0022	ENC SINGLETURN	-2147483648 to 2147483647	count	0
	Encoder Single-turn Value			

	VarCom	Range	Units	Default Value
d0023	ENC SINGLETURN2	-2147483648 to 2147483647	count	0
	Encoder Single-turn Value 2			
d0024	MECHANGLE	0 to 65535	65536/rev	0
	Motor Mechanical Angle			
d0025	HWPEXT	-2147483648 to 2147483647	count	0
	Pulse Count Accumulated Value			
d0026	IN	1 to 5	--	0
	Input Status			
d0027	OUT	0 to 3	--	0
	Output Status			
d0028	MENCCRCVALUE	0 to 65535	--	0
	Motor Encoder CRC Count, Including Incremental and Absolute Encoders			
d0029	SYSLOADNUM	0 to 6	--	0
	System Overload Flag			
d0030	COLDETCURACT	-100.0 to 100.0	--	0
	Collision Current Value			
d0031	COLDETI	-100.0 to 100.0	A	0
	Collision Detection Current Value For Collision Detection 11			
d0032	COLDETJLPFOUT	-1000000 to 1000000	rad/s^2	0
	Collision Low-pass Filter Output			
d0033	COLDETPFB	-2147483648 to 2147483647	count	0
	Collision Detection Position Value For Collision Detection 11			
d0034	STOST	0 to 1	--	0
	Safe Torque Off Status			
d0035	MENCTIMEOUTVALUE	0 to 65535	--	0
	Encoder Communication Timeout Error Count			
d0036	MFOLD	0 to 1	--	0
	Motor Overload Status			
d0037	MFOLDR	0 to 1000000	s	0
	Motor Overload Recovery Time			
d0038	MIFOLD	0 to 300000	A	0
	Motor Overload Current			

	VarCom	Range	Units	Default Value
d0039	MFOLD	0 to 1	--	0
	Motor Overload Status 1: Normal 0: Abnormal			
d0040	IMAX	0.0 to 100000.0	A	11879
	Driver Current Limit			
d0041	VMAX	10 to 9000	rpm	6000
	Maximum Speed			
d0042	GEARTOTALMAX	1 to 10000000	--	8000000
	Maximum Value of Electronic Gear Ratio Product			
d0043	HOMINGERRCODE	0 to 14	--	0
	Return to Zero Fault Code			

8.4.2 Operation Example

Using Motor Speed (d0009) as an Example:

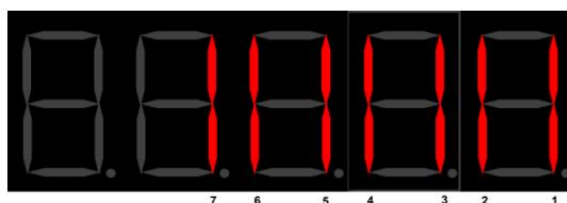
Steps	Panel Display After Operation	Keys Used	Operation
1			Use the M key to adjust the panel to the monitoring display d××××
2			If the parameter displayed is not d0009, use "<" or ">" to select the position to be adjusted, and use "Λ" or "V" to set it to d0009
3			Press the S key to enter the motor speed monitoring mode; a display of 1600 means the motor is running at 1600 rpm
4			Press the M/S key to return to the Step 2 interface

8.4.3 Input Signal Monitoring

The status of the input signal can be confirmed through "Input Signal Monitor (d0026)".

(1) Display Discrimination Method

The correspondence between input terminals and LED numbers is shown in the table below.



Upper: Input signal valid

Lower: Input signal invalid

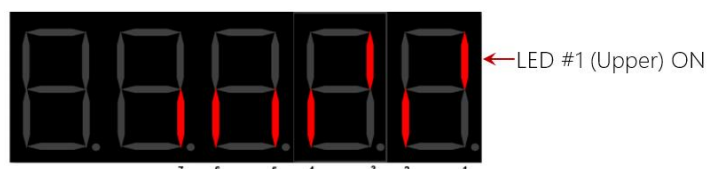
- ◆ The upper segment (LED) lights up when the input signal is in an active state.
- ◆ The lower segment (LED) lights up when the input signal is in an inactive state.

Display LED Number	Input Pin	Signal Name (Factory Setting)
1	C4-16-F	27 - Probe 1
2	C4-7-F	28 - Probe 2
3	C4-4	6 - Negative Limit Switch
4	C4-14	8 - Return to Zero Switch
5	C4-5	5 - Positive Limit Switch
6	C4-15	0 - Idle
7	C4-6	0 - Idle

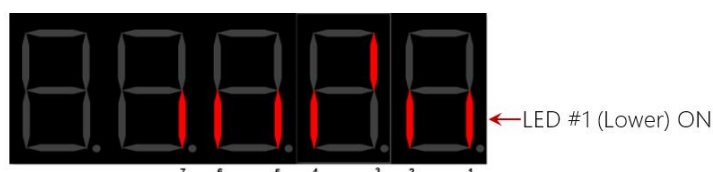
(2) Display Example

DI1 mode is configured for the 6-Negative Limit Switch function, with polarity set to high-active. The display of the input signal is as follows:

DI1 signal is active, DI1 input is high level.



DI1 signal is invalid, DI1 input is low level.

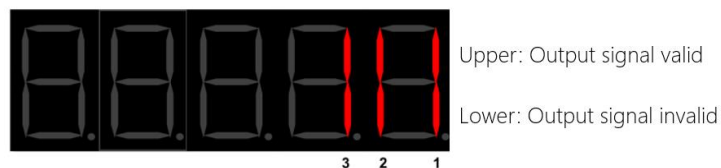


8.4.4 Output Signal Monitoring

The status of the output signals can be confirmed through "Output Signal Monitoring (d0027)".

(1) Display Discrimination Method

The correspondence between output terminals and LED numbers is shown in the table below.



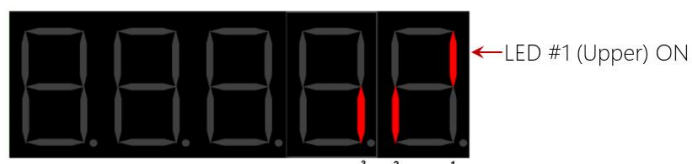
- ◆ When the output signal is in an active state, the upper segment (LED) lights up.
- ◆ When the output signal is in an inactive state, the lower segment (LED) lights up.

Display LED Number	Output pin	Signal Name (Factory Setting)
1	C-17	29 - Servo Ready
2	C-8	3 - Alarm Any Fault
3	C-18	2 - Brake Release Signal

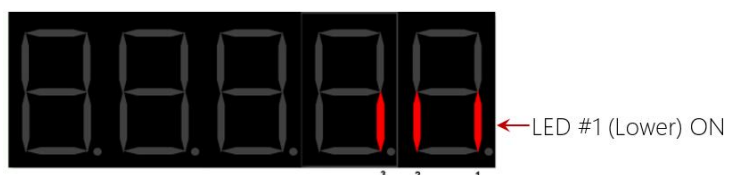
(2) Display Example

DO1 mode is configured as 14 - Presence Warning Function, polarity is configured as high active, the display of the output signal is as follows.

DO1 signal is active, DO1 outputs high level, Servo Driver currently has a warning.



DO1 signal is inactive, DO1 outputs low level, Servo Driver currently does not have a warning.



8.5 Parameter Mode (P××××)

In parameter mode, the panel can set parameters for the servo driver, which are displayed on the panel display as numbers prefixed with P.

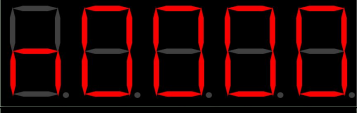
8.5.1 Related Notes

(1) Overview of Parameter Mode

See Appendix 15.3 Parameter List P.

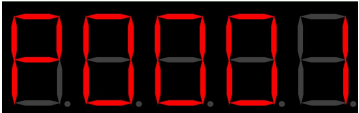
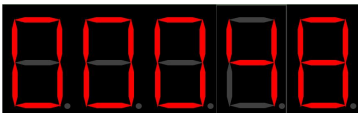
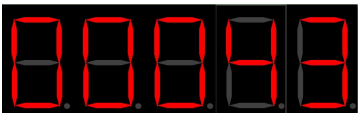
(2) Data Types

The most significant digit on the display indicates the data type.

Display Symbol	Explanation
	Indicates that the parameter is set to decimal and the data is unsigned.
	The most significant digit displays "n", indicating that the parameter is set to low hexadecimal, with each setting range being 0-F.
	The most significant digit displays "u", indicating that the parameter is set to high hexadecimal, with each setting range being 0-F.

8.5.2 Operation Example

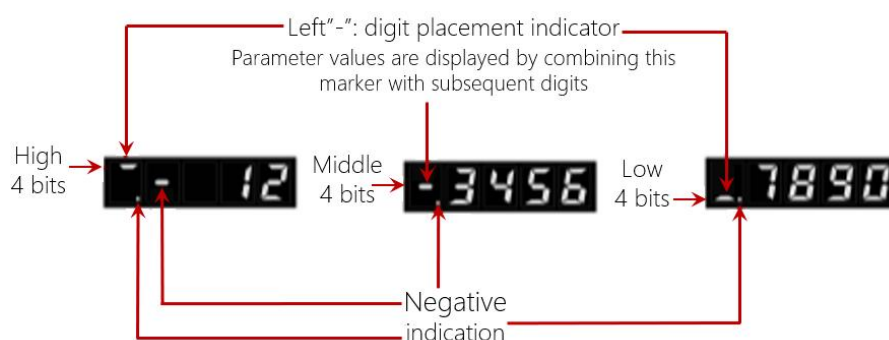
(1) When the parameter setting range is within 5 digits, for example, setting the position loop bandwidth P1201, change the value from the default of 48 to 123.

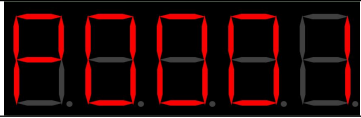
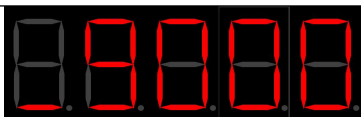
Steps	Panel Display After Operation	Keys Used	Operation
1			Press the M key to switch the panel to parameter mode P××××
2			If the parameter displayed is not P1201, use "<" or ">" to select the position to be adjusted, and use "Λ" or "V" to set it to P1201
3			Press the S key to enter the parameter editing interface; the panel displays the current value 48, with the digit 8 flashing
4			Press the "V" key five times to decrease the digit 8 to 3
5			Press "<" to select the digit 4, then press the "V" key twice to decrease it to 2
6			Press "<" again to move left, then press the "Λ" key once to increase it to 1

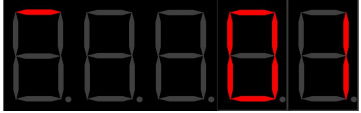
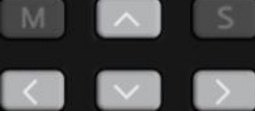
Steps	Panel Display After Operation	Keys Used	Operation
7			Press the S key to write the parameter; the display will flash donE, indicating successful parameter writing
8			Press the M/S key to return to the parameter setting interface, then press the M key to return to step 2 interface

(2) When setting the range to more than 5 digits, using the maximum position P0504 limited by the software as an example, adjust 10000 to 10019000.

The panel display can only show five digits, so the setting values above five digits are displayed as follows.



Steps	Panel Display After Operation	Keys Used	Operation
1			Press the M key to switch the panel to parameter mode P××××
2			If the parameter displayed is not P0504, use "<" or ">" to select the digit to be adjusted, and use "Λ" or "V" to adjust to P0504;
3			Press the SET key to enter the parameter editing interface, where the panel displays the current lower four-digit value 0000;
4			Press "<" to select the thousandth digit to be adjusted, and use "Λ" to set the lower four digits to 9000;
5			Press the "<" key again to enter the middle four-digit editing, displaying the original middle four digits 0001.
6			Use "<" or ">" to select the digit to be adjusted, and use "Λ" or "V" to set the middle four digits to 0011.

Steps	Panel Display After Operation	Keys Used	Operation
7			Press the "<" key again to enter the interface for editing the higher 2 bits of the parameter, displaying the original higher 2 bits as 00
8			Select the bit to be adjusted using "<" or ">", and adjust the higher 2 bits to 01 using "^" or "v"
9			Press the S key to write the parameter; the display will flash showing done, indicating successful parameter writing
10			Press the M/S key to return to the parameter setting interface, then press the M key to return to step 2 interface

8.6 Auxiliary Functions (C××××)

In auxiliary functions, the panel can perform functions related to the operation and adjustment of the servo motor, which are displayed on the panel screen with codes starting with C.

8.6.1 Auxiliary Function Overview

Auxiliary functions are indicated by codes starting with C and perform functions related to the operation and adjustment of the servo motor. The table below lists an overview of the auxiliary functions.

Command Code	Function	Operation Description
C0001	Display driver software information	no.01 Firmware version, e.g., 2.4.1t23.7.15 no.02 Boot Program Version Example: 1.0
C0002	Error Log	no.1-no.40 Display 40 historical error records with time and error number Example: 200-7-3 FL78
C0003	Panel Servo Enable	1.C0003 Press the 'S' key 2.Servo Enabled, display 'ON'; Servo Disabled, display "OFF" 3.Press "^" or "v" key (1)Conditions for enabling or disabling not met: display 'no-op' (2)"^" key: Servo Enabled, display 'on' (3)"v" key: Servo Disabled, display 'off'
C0004	Load Inertia Estimation	1. C0004 Press the 'S' key 2. Display 'J-ESt' 3. Hold down "<" or ">" key: (1) Error: Displays 'no-op' (2) Hold down "<" or ">" key a.Identifying, displays '-----' b.Identification error, displays 'FAIL'

Command Code	Function	Operation Description
		c.Does not meet identification conditions, displays 'no-op' d.Identification successful, displays inertia ratio (LMRJ), press 'SET' key, write LMRJ. (3) Release the key when holding it down, the identification process stops, displays 'J-ESt'
C0005	Speed JOG	1. C0005 Press 'S' key 2. Display 'uJoG' 3. Hold down "<" (forward operation) or ">" (reverse operation) key: (1) Error: display 'no-op' (2) Release the key while holding it down: JOG stops (3) "<" Key: Forward JOG, displays running light '-----' (4) ">" Key: Reverse JOG, displays running light '-----' Motor operation error, panel switches to status display mode
C0006	CONFIG	1.C0006 Press the 'S' key 2.Display 'cFG' 3.Press the 'S' key Configuration successful: Display 'done' for 3s then switch to display 'cFG'
C0007	Alarm record cleared	1.C0007 Press the 'S' key 2.Display 'FcLr' 3.Press the 'S' key (1)Servo enabled state (clearing alarm records not allowed) Display 'no-op' for 3s then switch to display 'FcLr' (2)Servo disabled: a.Clearing failed: Display 'err' for 3s Switch to status display mode b.Clear successful: Display 'done' for 3s then switch to 'FcLr'
C0008	Absolute Encoder Initialization	1.C0008 Press the 'S' key 2.Display 'c-Enc' 3.Press the 'S' key If the conditions Servo Off Enabled && TAMAGAWA Encoder && Encoder Initialization Function Idle are met (1) Initialization Failed: Display 'FAIL' for 3s Switch to status display mode (2) Initialization Successful: Display 'done' for 3s then switch to 'c-Enc' Otherwise (3) Display 'no-op' for 3s then switch to display 'c-Enc'
C0009	Restore Factory Settings	1.C0009 Press the 'SET' key 2.Display 'couEr' 3.Press the 'S' key (1)Servo Enabled (Factory Reset Not Allowed): Display 'no-op' for 3s then switch to display 'couEr' (2)Servo disabled: a. Factory reset failure: Displays 'err' for 3 seconds before switching to status display mode b. Factory reset success: Displays 'done' for 3 seconds before switching to 'couEr'

Command Code	Function	Operation Description
C0010	Soft reboot	1.C0010 Press the 'S' key 2.Display 'rSt' 3.Press the 'S' key (3)Servo enable (soft reboot not allowed): Display 'no-op' for 3 seconds before switching to display 'rSt' (4)Servo disable: Success, driver soft reboots, if no action within 3 seconds, display 'FAIL'
C0011	Servo parameter auto-tuning	1. C0011 Press the 'S' key 2. Display 'AtUnE' 3. Press the 'S' key (1) If operating conditions are met a. Servo runs according to P0601, P0602, P0603 settings, LED displays "-----"; at this point, pressing the "M" key will exit AutoTune, stop servo operation, and turn off the servo. b. If AutoTune succeeds, the LED displays "AtUnE". c. If AutoTune fails, the LED flashes "fail" for 3s, then displays "AtUnE" (2) If the operating conditions are not met Display 'no-op' for 3s before switching to display 'AtUnE'
C0012	Save to driver	1. C0012 Press the 'S' key 2. Display 'SAuE' 3. Press the 'S' key (1) Failed to save to driver, display 'fail' for 3s before switching to 'SAuE' (2) Successfully saved to driver, display 'done' for 3s before switching to 'SAuE'
C0100	Panel password	1. C0100 Press the 'S' key 2. Display '00000' 3. Enter password Success: Display 'done' for 3s Failure: Display 'no-op' for 3s before switching to '00000'

8.6.2 C0001 Drive Software Information

Function to display servo driver software information. There are two versions, no.01 firmware version and no.02 resident version.

To check the firmware version number, follow these steps:

1. Use the M key to switch the panel to the auxiliary function mode $C \times \times \times \times$;
2. If the parameter displayed is not C0001, use "<" or ">" to select the position to be adjusted, and use "^" or "V" to set it to C0001;
3. Press the S key to enter Servo Driver software information display interface, showing number no.01;

4. If the number displayed is not no.01, use "<" or ">" to select the position to be adjusted, and use "Λ" or "V" to set it to no.01;
5. Press the S key to enter, the display shows 23.2.13, press "<" to show 2.2.12t, meaning the current firmware version is 2.2.12T23.2.13;
6. Press the M key to return to the interface of step 3;
7. Press the M key to return to the interface of step 2;
8. Operation complete.

8.6.3 C0002 Error Log

The servo driver has a function to trace and display historical error records, capable of recording up to 40 alarm records. Each error record includes an error number and an error time (timestamp).

The operating procedure is as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××
 2. If the parameter displayed is not C0002, select the position to be adjusted using "<" or ">", and adjust to C0002 using "Λ" or "V";
 3. Press the S key to enter the error log interface, where the latest error number no.01 will be displayed on the monitor;
 4. Press the "Λ" or "V" key to display old/new error numbers; the larger the no.××, the older the recorded error;
 5. Select the error number you want to view (e.g., no.05), then press the S key to display the error code under that error number (FL 86);
 6. Press the <- key twice to view the error time in hours-minutes-seconds, for example, the first display shows 04-15, pressing the <- key again displays 135-, combining these gives the error time as 135-04-15;
 7. Press the M/S key to return to the interface of step 4;
 8. Press the M key to return to the interface of step 2;
- Ps. If there is no error under the error number, step 5 will flash nULL and then return to displaying the error number;

9. End of operation.

8.6.4 C0003 Panel Servo Enable

Panel servo enable is used to enable the servo function through the panel without connecting to a higher-level device.

(1) Pre-operational settings

To enable Servo Driver, the following settings must be performed in advance.

- Clear all driver errors and some warnings, and operate in COMMODE = 0 state.
- Please take necessary safety measures to ensure it can be stopped at any time in an emergency.
- For safety, please set up a stop device on the mechanical side.

(2) Operating Procedures

The operating procedures for panel servo enablement are as follows.

1. Press the M key to select auxiliary functions.
2. If the parameter number displayed is not C0003, use "<" or ">" to select the position to be adjusted, and press "Λ" or "V" to display C0003.
3. If the servo is in a non-operational state and ready, press the S key to enter the enable interface displaying the current driver enable status ON or OFF.
4. Press the "Λ" key to enable Servo Driver. If currently in the servo OFF state and the enable conditions are met, the panel first displays "-----". After successful enabling, it shows ON. If currently in the servo ON state, the panel displays "NO-OP".
5. Press the "V" key to disable Servo Driver. After successful disabling, it displays "OFF".
6. If the servo is enabled on the panel and no disable operation is performed, pressing the M key to exit will also automatically perform the disable operation.
7. Operation complete.

8.6.5 C0004 Load Inertia Estimation

Load inertia estimation is a function that estimates the load inertia ratio through specific motor movements.

(1) Pre-operational settings

To perform load inertia estimation, the following settings must be made in advance.

- Please set the parameters for load inertia estimation after considering the operating range of the mechanical system, including

Parameter Number	VARCOM	Description
P5001	LOADESTMOTION	Inertia Estimation Operation Mode 0: Motor runs forward then backward 1: Motor runs backward then forward 2: Motor runs forward 3: Motor runs backward
P5002	LOADESTMAXVEL	Maximum Speed for Inertia Estimation Operation Default 800rpm
P5003	LOADESTACC	Acceleration for Inertia Estimation Operation Default 20000rpm/s
P5004	LOADESTDIST	Distance for Inertia Estimation Operation Default 2revs
P5005	LOADESTLOAD	Inertia Estimation Control Parameter Settings 0: Automatic setting of control parameters 1~10: Update control parameters according to load

- Please take necessary safety measures to ensure it can be stopped at any time in an emergency.

- For safety, please set up a stop device on the mechanical side.

(2) Operating Procedures

The operation steps for inertia estimation of the load are as follows.

1. Press the M key to select auxiliary functions.
2. If the parameter number displayed is not C0004, press the "Λ" or "V" key to display "C0004".
3. If the servo is not running and is ready, press the S key to enter the load inertia estimation operation interface displaying J-Est.
4. Hold down the "<" key or ">" key; if the identification conditions are met, the servo will move in the mode set by P5001 during the key press. Otherwise, the LED displays no-op.

5. Hold down until the LED displays the identification result. If successful, the LED displays the inertia ratio, and press the S key to update the parameters and save them. If unsuccessful, the LED displays fail.

6. If the "<" key or ">" key is released during the recognition process, the servo stops running and enters the OFF state.

7. Operation complete.

8.6.6 C0005 Speed JOG

JOG operation is a function that allows you to confirm the operation of the servo motor through speed control without connecting to a higher-level device.

The overtravel prevention function is invalid during JOG operation. The operating range of the mechanical equipment must be considered while running.

(1) Pre-operational settings

To perform JOG operation, the following settings must be made in advance.

- Please set the JOG speed after considering the operating range of the mechanical equipment. The JOG operation speed is set via P4111, with a default value of 100rpm.

- Please take necessary safety measures to ensure it can be stopped at any time in an emergency.

- For safety, please install a stop device on the mechanical side.

(2) Operating Procedures

The steps for JOG operation are as follows.

1. Press the M key to select auxiliary functions.

2. If the parameter number displayed is not C0005, use "<" or ">" to select the position to be adjusted, and press "∧" or "∨" to display "C0005".

3. If the servo is not running and is ready, press the S key to enter the JOG operation interface displaying 'uJoG'.

4. Hold down the "<" key (forward) or ">" key (reverse), during which the servo motor rotates at the speed set by P4111.

5. Release the "<" key or ">" key, the servo stops running and enters the OFF state.

6. Operation complete.

8.6.7 C0006 Config

Config is the configuration function

The operation steps are as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××
2. If the parameter number displayed is not C0006, use "<" or ">" to select the position that needs adjustment, press "Λ" or "V" to display "C0006";
3. Press the S key to enter the Config interface, displaying cFG;
4. Press the S key, configuration successful, the display will flash showing done for 3 seconds before returning to the cFG interface;
5. Operation complete.

8.6.8 C0007 Alarm Record Clearing

The function to delete all error records in the servo driver. Clearing alarm records must be performed when the servo is in the OFF state; it cannot be successfully executed when the servo is in the ON state.

The operating procedure is as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××
2. If the parameter number displayed is not C0007, use "<" or ">" to select the position that needs adjustment, press "Λ" or "V" to display "C0007";
3. Press the S key to enter the alarm record clearing interface; the display shows FcLr;
4. Press the S key to execute the clear operation

If the servo is in the ON state, the display will flash showing no-op for 3 seconds before returning to the FcLr interface;

If the servo is in the OFF state, the clear operation is successful, and the display will flash showing donE four times before returning to the FcLr interface;

If the clear operation fails, the display will show err for 3 seconds before returning to the FcLr interface;

If the clear operation is in progress, the display will show "-----", and upon completion, it will return to the FcLr interface;

5. Press the M key to return to the interface of step 2;

6. Operation complete.

8.6.9 C0008 Absolute Encoder Initialization

Absolute encoder initialization is the function to reset the multi-turn count of the encoder.

- Parameter setting value initialization must be performed when the servo is in the OFF state. It cannot be executed when the servo is in the ON state.

The operation steps are as follows:

1. Press the M key to select auxiliary functions.

2. If the parameter number displayed is not C0008, use "<" or ">" to select the position to be adjusted, and press "^" or "v" key to display "C0008".

3. Press the S key to display "CFG".

4. If the servo is not in operation, press the S key; after "done" flashes, return to the previous screen.

5. If the servo is in operation, "no-op" will be displayed, indicating that this auxiliary function cannot be performed.

6. Press the M key to exit this auxiliary function and return to the display of step 2.

7. Operation complete.

8.6.10 C0009 Restore Factory Settings

The function used to reset the servo driver parameters to factory settings.

- Resetting to factory settings must be performed when the servo is in the OFF state; it cannot be successfully executed in the ON state. After the operation, the power to the servo driver must be reconnected for the factory reset function to take effect.

The operation steps are as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××

2. If the parameter number displayed is not C0009, use "<" or ">" to select the position that needs adjustment, and press "^" or "v" key to display "C0009";

3. Press the S key to enter Servo Driver software information display interface, showing covEr;

4. Press the S key to confirm:

If the servo is in the On state, the display will show no-op for 3 seconds before returning to the COVER display;

If the servo is in the OFF state, after successfully restoring factory settings, the display will flash donE for 3 seconds before showing rSt, indicating that Servo Driver needs to be restarted;

If the restoration fails, the display will flash err for 3 seconds before returning to the initial status interface, showing the current driver error;

5. Press the M key to return to the interface of step 3;

6. Press the M key to return to the interface of step 2;

7. Operation complete.

8.6.11 C0010 Soft Restart

The function to restart the servo driver without power interruption must be performed when the servo is in the OFF state; it cannot be restarted when the servo is in the ON state.

The operating procedure is as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××

2. If the parameter number displayed is not C0010, select the position to be adjusted using "<" or ">", then press the "^" or "v" key to display "C0010";

3. Press the S key to enter the restart interface; the display shows RST;

4. Press the S key to confirm the restart:

If the servo is in the OFF state, the servo driver will restart, and the display will show the power-on status "-----";

If the servo is in the ON state, the servo driver cannot be restarted, and the display will show no-op for 3 seconds before returning to the RST interface;

If the system has not successfully restarted after 3 seconds, it will display FAIL.

5. Operation complete.

8.6.12 C0011 Servo Parameter Auto-Adjustment

Servo parameter self-adjustment is achieved by setting the corresponding curve trajectory and required parameters through a guided process; the servo will then automatically run and learn the optimal gain parameters. After learning is complete, the parameters can be saved and exported for use in other servos of the same model.

(1) Pre-operational settings

To perform AutoTune operation, the following settings must be made in advance.

- Please set the AutoTune parameters considering the operating range of the machine, including:

Parameter Number	VARCOM	Description
P0601	AUTOTUNEDIST	Autotune travel distance Unit: rev (revolutions) Default value: 5 rev Range: 0.5~8 rev
P0602	AUTOTUNEMAXVEL	Autotune maximum speed Unit: rpm Default value: 3000 Range: 100~6000
P0603	AUTOTUNEACC	Autotune Acceleration Unit: rpm/s Default Value: 10000 Range: 500~200000

- Please take necessary safety measures to ensure it can be stopped at any time in an emergency;

- For safety, please set up a stop device on the mechanical side.

(2) Operating Procedures

The operation steps for AutoTune are as follows.

1. Press the M key to select auxiliary functions.
2. If the parameter number displayed is not C0012, press " $\wedge$ " or " $\vee$ " to display "C0012".

3. If the servo is in a non-operational state and ready, press the "S" key to enter the AutoTune operation interface displaying "AtUnE".
4. Press the "S" key; if the operating conditions are met, the servo will run according to the settings of P0601, P0602, and P0603, and the LED will display a running light "-----". Otherwise, the LED will display no-op.
5. Wait until the LED running light ends. If AutoTune is successful, the LED displays "AtUnE". If AutoTune fails, the LED flashes "fail" for 3 seconds, then displays "AtUnE".
6. If the "M" key is pressed during AutoTune operation, it will exit AutoTune, the servo will stop running, and the servo will be in the OFF state.
7. Operation complete.

8.6.13 C0012 Save to Drive

After a successful trial run of the servo self-tuning function or if parameters need to be saved to Servo Driver for other reasons, ensure that the parameters are not lost after power-off.

The operating procedure is as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××
2. If the parameter number displayed is not C0012, use "<" or ">" to select the position to be adjusted, and press the "Λ" or "V" key to display "C0012";
3. Press the S key to enter, the display shows "SAuE";
4. Press the S key to execute saving to Servo Driver. If the save is successful, it displays "done"; if the save fails and an error occurs, it displays "fail" and switches to the error display page;
5. Press the M/S key to return to the interface of step 2;
6. Operation complete.

8.6.14 C0100 Panel Password

Some servo parameters are provided for professional personnel to adjust and are password protected. After the correct password verification, the protected parameters pxxxx can be set.

The operating procedure is as follows:

1. Use the M key to switch the panel to the auxiliary function mode C××××;
2. If the parameter number displayed is not C0011, use "<" or ">" to select the position to be adjusted, press "Λ" or "V" key to display "C0011";
3. Press the S key to enter the password input interface, the display shows "00000";
4. Press "Λ" or "V" key to enter the password;
5. Press the S key to verify the password, if correct, it displays "done", if incorrect, it displays "no-op";
6. Press the M/S key to return to the interface of step 2;
7. Operation complete.

9. Operation

9.1 Drive Enable



Warning! Enabling Servo Drive motor may cause movement.

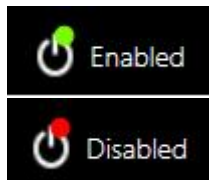
Enabling the BD3E drive requires three conditions:

- No faults.
- The software enable switch must be on (ON) (SWEN=1).
- The remote enable switch must be on (ON) (REMOTE=1).

Use ServoStudio 2The “Enable and Fault” interface allows you to view and control the conditions required to enable Servo Drive.

The following elements provide visual indications of Servo Drive's enabled or disabled status:

- ServoStudio 2The Enable|Disable button in the toolbar indicates Servo Drive status.



If the light is on, Servo Drive is enabled (active). Power is being supplied to the motor.

If the light is off, Servo Drive is in a disabled state.

- The decimal point on Servo Driver's digital display indicates Servo Driver enable/disable status.

If it is lit during the display of the operating mode, Servo Driver is enabled, as shown in this example.



If it is not lit, Servo Driver is in the disabled state.



9.2 Drive Operation Mode

BD3E It can operate in multiple operating modes. Each operating mode has a primary control loop (current/torque, speed, or position) and a specific type of command input.

When using the VarCom command, the operating mode is set by the OPMODE value:

- 0 = Speed Control, using serial commands
- 2 = Current Control, using serial commands
- 8 = Position Control, using serial commands

When using CANopen over EtherCAT (CoE) communication, the operating mode can be set via object 6060h, and the current actual operating mode is reflected by object 6061h.

- 1 = Contour Position
- 3 = Contour Speed
- 4 = Contour Torque
- 6 = Return to Zero
- 8 = Periodic Synchronous Position
- 9 = Periodic Synchronous Speed
- 10 = Periodic Synchronous Torque

For more details, please refer to the "BD3E EtherCAT Reference Manual".

9.3 Current Operation

9.3.1 Serial Current Operation

In serial current mode (OPMODE 2), only the current loop is active, and Servo Driver responds to commands received via Ethernet.

In addition to tuning the current loop, no driver variables need to be set to operate Servo Driver in this mode.

In ServoStudio 2In the "Motion" interface, select "Operating Mode" - Serial Current, to modify and test parameters.

9.3.2 Current Control

Note: Do not change the values in the “Current Loop” interface unless requested by technical support.

Current control loop tuning originates from motor parameters and bus voltage, and can be ServoStudio 2tuned using the “Motor Settings” wizard.

9.4 Speed Operation

9.4.1 Serial Speed Operation

In serial speed mode (OPMODE 0), Servo Driver current loop and speed loop are activated, and Servo Driver responds to commands received via EtherNet, commanding the specified speed to comply with set acceleration and deceleration limits.

In ServoStudio 2In the “Motion - Operating Mode” interface, select “Operating Mode” - Serial Speed for modifying and testing parameters.

9.4.2 Speed Control

Refer to VarCom VELCONTROLMODE.

- PDFF Controller (using KVP, KVI, KVFR)

Pseudo-Differential Feedforward Feedback (PDFF) Controller

Please refer to VarCom VELCONTROLMODE 1.

The figure below shows the PDFF controller. Like the PI controller, the PDFF controller has an integral gain (KVI) and a proportional gain (KVP), plus a feedforward ratio (KVFR).

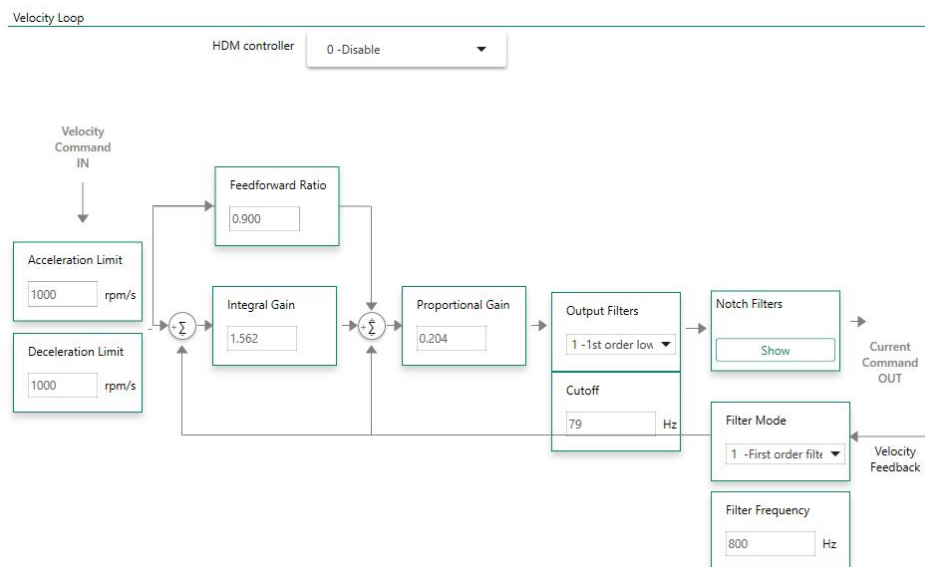


Fig. 9- 6 Speed Control Loop – PDFF Controller

When fast responsiveness is required in practical applications, KVFR can be set to a higher value. When lower overshoot is required in practical applications, KVFR can be set to a lower value, but this will also result in a slower system response.

9.5 Position Operation

9.5.1 Serial Position Operation

BD3E There is a dedicated operating mode for simple positioning applications using the serial port (OPMODE 8). The host sends serial commands through the serial port, which include the target position and cruise speed, as well as additional motion profile information (such as acceleration, deceleration, and trajectory type).

Available at ServoStudio 2 Select "Operation Mode" - Serial Position on the "Motion" interface to modify and test parameters.

VarCom	Description
ACC	Acceleration
DEC	Deceleration
PE	Position Error, PE is the difference between the Position Command PCMD and the Position Feedback PFB
PCMD	Position Command
PFB	Actual Position Feedback

Incremental (Relative) Motion

Incremental or Relative Motion, movement relative to the current position.

VarCom	Description
MOVEINC	Execute incremental position motion according to settings

The parameter PFBOFFSET can be used to modify or compensate for the Position Feedback (PFB) value. This parameter is used for manual return to zero or testing incremental motion.

Program: Set the current position to 0

1. Enable Servo Driver (PFBOFFSET can only be set when Servo Driver is disabled).
2. Set PFBOFFSET to 0 (zero).
3. Read position feedback (PFB).
4. Set PFBOFFSET to the negative position feedback (PFB) value.

Absolute Motion

Absolute motion is always relative to the absolute reference point.

The point where the reference position feedback (PFB) = 0.

VarCom	Description
MOVEABS	Execute absolute position movement according to the settings.

End of Movement

The following parameters are used to define and represent the motor state at the end of movement.

VarCom	Description
PEMAX	Maximum allowable position error (without causing a fault).
PEINPOS	Tolerance window for declaring the 'positioning complete' status. When the PE (position error) value is less than the PEINPOS (position error tolerance) value, the motor is considered to be in position. When the PE (position error) remains below PEINPOS for the time defined by PEINPOSTIME, the motor is considered stable.
INPOS	Indicates the 'Motor in Position' status. Read-only. When the motor is in position, INPOS=1, regardless of the motion trajectory status. If the motor is not in position, INPOS=0.
STOPPED	Indicates the 'Motor Stabilized' status. Read-only. STOPPED=0, the motion trajectory is in progress. STOPPED=1, the trajectory is completed.

9.5.2 Position Control

BD3E Uses a linear position control algorithm.

Linear Position Controller

The linear position controller is a P controller + feedforward, with an option for saturation limit.

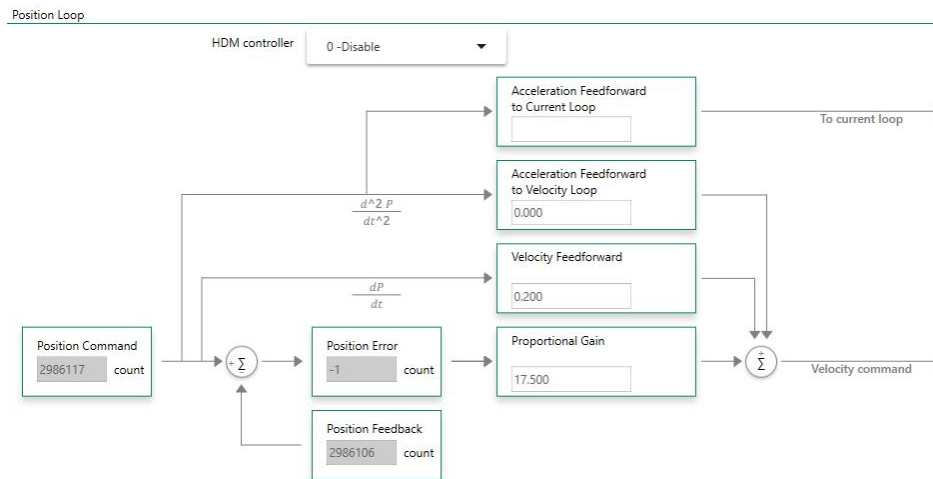


Figure 9-2 Position Control Loop – Linear

10. Tuning

10.1 Offline Inertia Identification

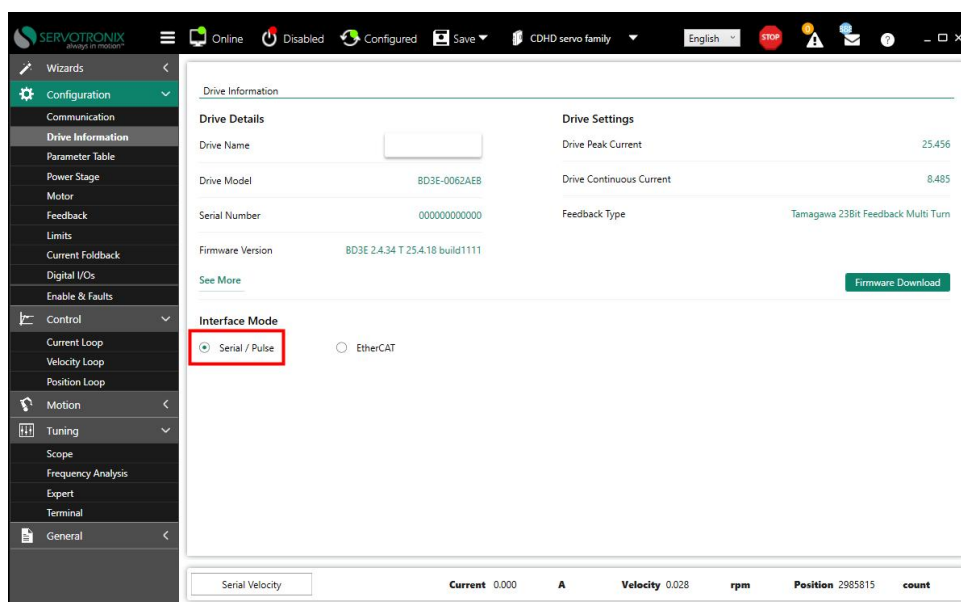
When you are unsure about the inertia ratio of the load to the motor, you can use the 'Inertia Identification' function to estimate the load inertia ratio.

10.1.1 Parameters

VarCom	Description
LOADESTACC	Acceleration values during the acceleration and deceleration processes of offline inertia identification. Range: 5000rpm/s~60000rpm/s
LOADESTDIST	Travel distance during the offline inertia identification process, unit: revolutions. Range: 0.25rev~3.0rev
LOADESTEN	Switch for the offline inertia identification function. LOADESTEN 1 Start offline inertia identification LOADESTEN 0 Stop offline inertia identification
LOADESTMAXVEL	Maximum operating speed during the offline inertia identification process. Range: 300rpm~1000rpm
LOADESTMOTION	Operating mode for offline inertia identification. LOADESTMOTION 0 Motor rotates forward first, then reverses LOADESTMOTION 1 Motor reverses first, then turns forward LOADESTMOTION 2 Motor turns forward only LOADESTMOTION 3 Motor reverses only
LOADESTRATIO	The load inertia ratio obtained from offline inertia identification.
LOADESTSTATUS	Display the current status of offline inertia identification. LOADESTSTATUS 0 Initialization, inertia identification not started LOADESTSTATUS 1 Inertia identification in progress LOADESTSTATUS 2 Conditions for identification not met, current speed feedback exceeds 50rpm or position error PE exceeds 100count. LOADESTSTATUS 3 Inertia identification failed to enable during the process, or an error occurred causing it to drop out of enablement. LOADESTSTATUS 5 The load inertia ratio after identification exceeds 50. LOADESTSTATUS 6 Inertia identification successful.
LOADESTVAL	The total system inertia obtained from offline inertia identification (including motor inertia and load inertia).
LMJR	Motor control uses load inertia ratio

10.1.2 Operable Tools

Offline inertia identification can only be performed in Serial/Pulse interface mode (COMMODE=0).



Operation tools	Operating procedures
Panel operator	10.1.3 Operating procedures
Servostudio 2	10.3.4 Operating procedures

10.1.3 Panel Operation Steps (AutoTune: C0004)

Load inertia estimation is a function that estimates the load inertia ratio through specific motor movements.

(1) Pre-operational settings

To perform load inertia estimation, the following settings must be made in advance.

- Please set the parameters for load inertia estimation after considering the operating range of the mechanical system, including

Parameter Number	VARCOM	Description
P5001	LOADESTMOTION	Inertia Estimation Operation Mode 0: Motor runs forward then backward 1: Motor runs backward then forward 2: Motor runs forward 3: Motor runs backward
P5002	LOADESTMAXVEL	Maximum Speed for Inertia Estimation Operation Default 800rpm
P5003	LOADESTACC	Acceleration for Inertia Estimation Operation Default 20000rpm/s
P5004	LOADESTDIST	Distance for Inertia Estimation Operation Default 2revs

Parameter Number	VARCOM	Description
P5005	LOADESTLOAD	Inertia Estimation Control Parameter Settings 0: Automatic setting of control parameters 1~10: Update control parameters according to load

- Please take necessary safety measures to ensure it can be stopped at any time in an emergency.

- For safety, please install a stop device on the mechanical side.

(2) Operating Procedures

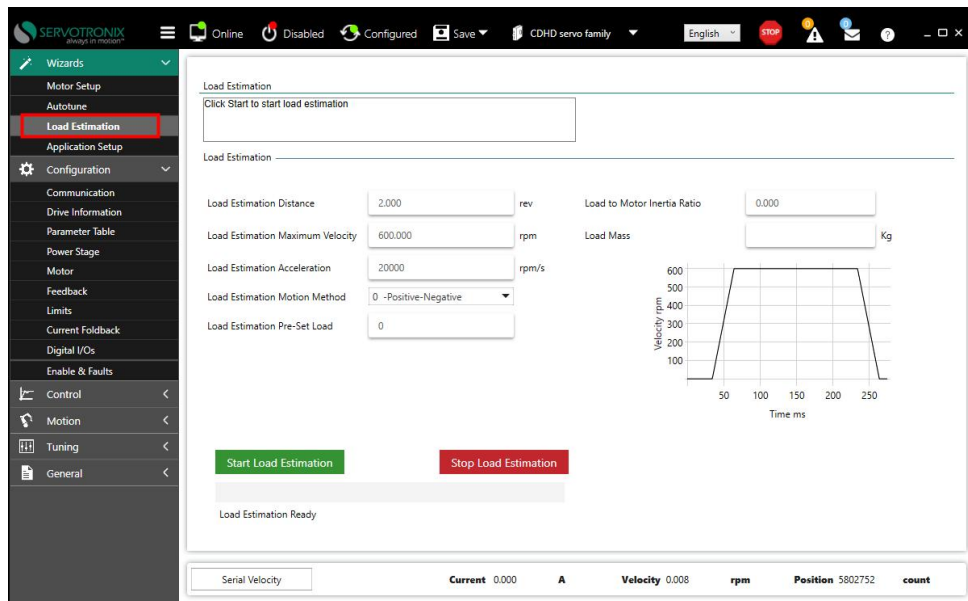
The operation steps for inertia estimation of the load are as follows.

1. Press the M key to select auxiliary functions.
2. If the parameter number displayed is not C0004, press the "Λ" or "V" key to display "C0004".
3. If the servo is not running and is ready, press the S key to enter the load inertia estimation operation interface displaying J-Est.
4. Hold down the "<" key or ">" key; if the identification conditions are met, the servo will move in the mode set by P5001 during the key press. Otherwise, the LED displays no-op.
5. Hold down until the LED displays the identification result. If successful, the LED displays the inertia ratio, and press the S key to update the parameters and save them. If unsuccessful, the LED displays fail.
6. If the "<" key or ">" key is released during the recognition process, the servo stops running and enters the OFF state.
7. Operation complete.

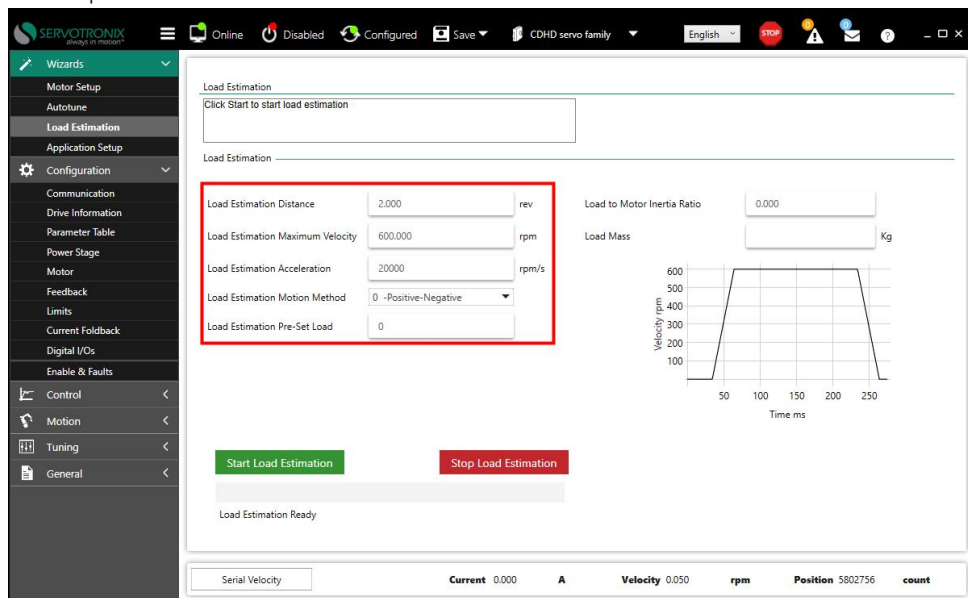
10.1.4 Servostudio 2 Operation Steps

1. Servostudio interface operation steps

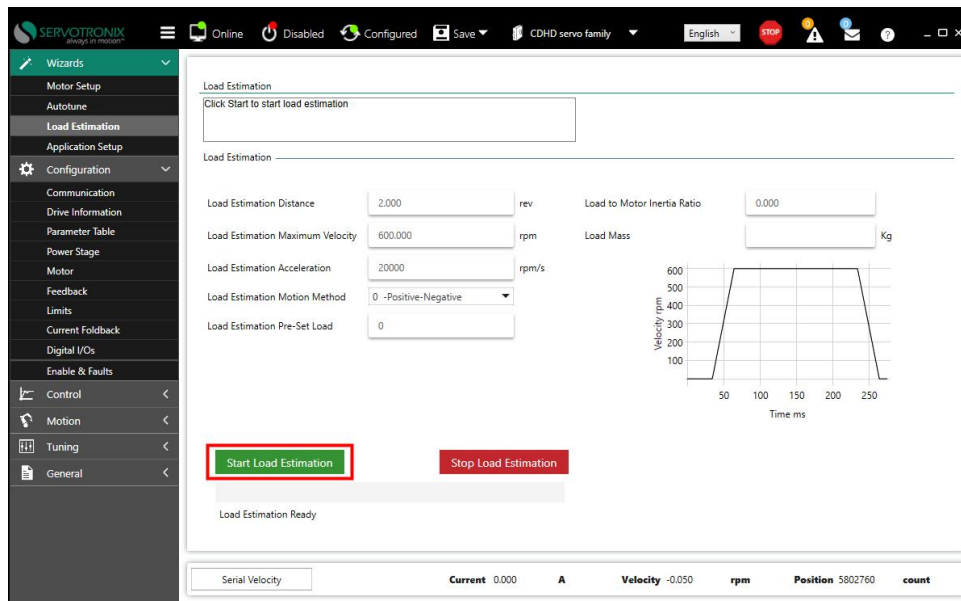
- 1) Open ServoStudio 2 software and enter the "Load Estimation" interface.



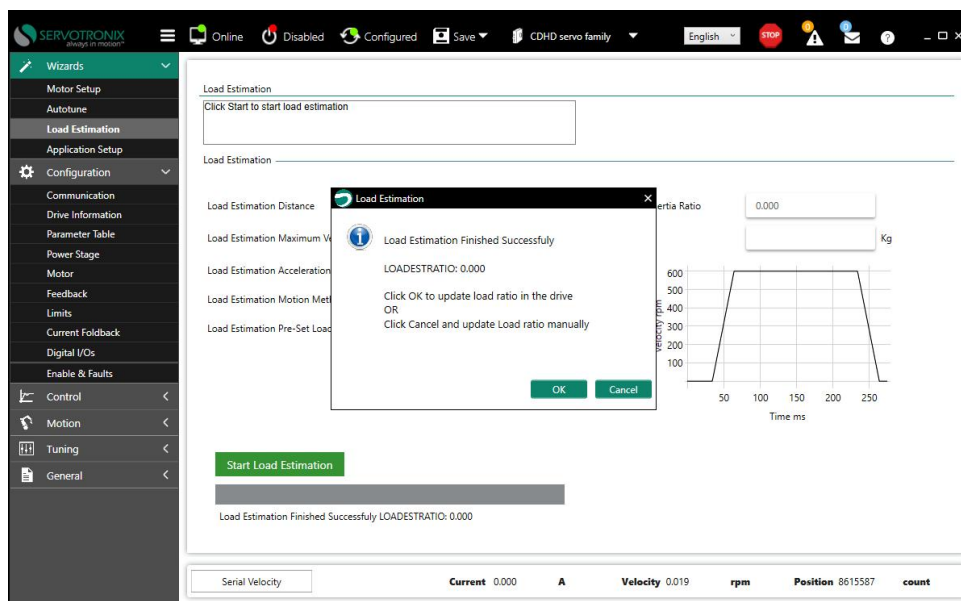
2) Set the parameters for offline inertia identification.



3) Click "Start Load Estimation" to begin inertia identification.

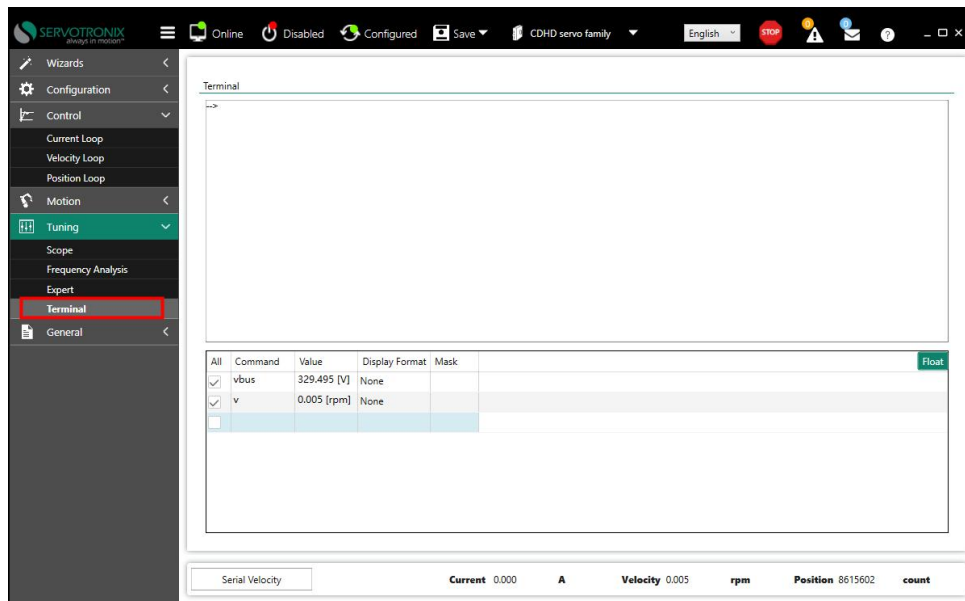


4) After successful identification, click "OK" to automatically assign the identified load inertia ratio to the variable LMJR; click "Cancel" to return to the inertia identification interface, where you need to manually assign the identified load inertia ratio to the variable LMJR.

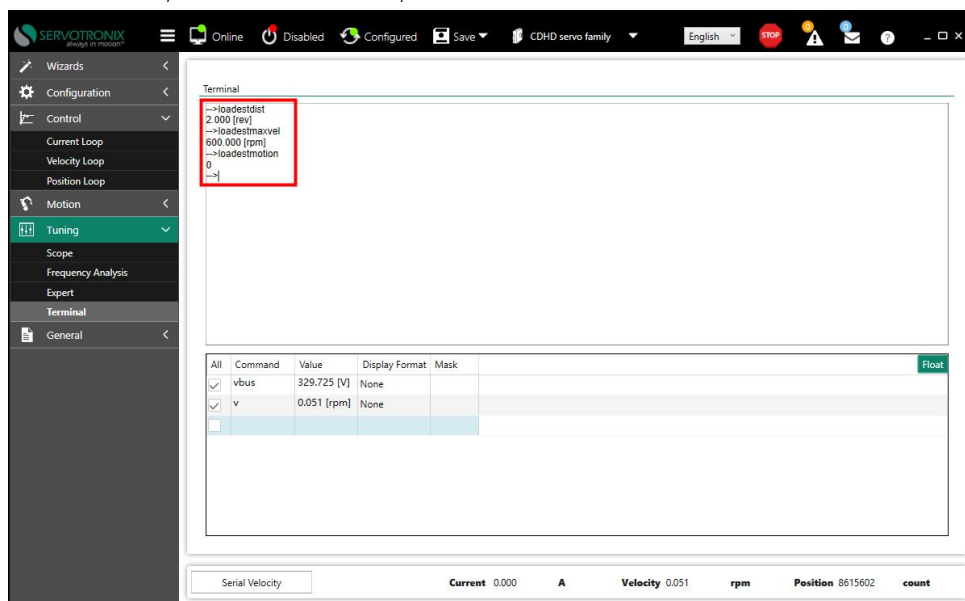


2. Servostudio Terminal Command Execution Steps

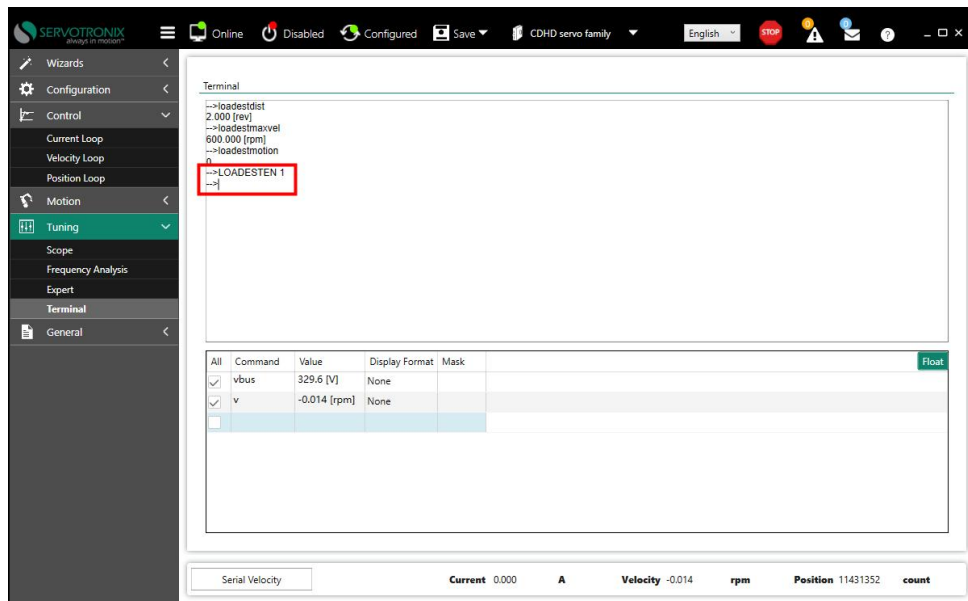
1) Open ServoStudio 2 software and enter the Terminal interface.



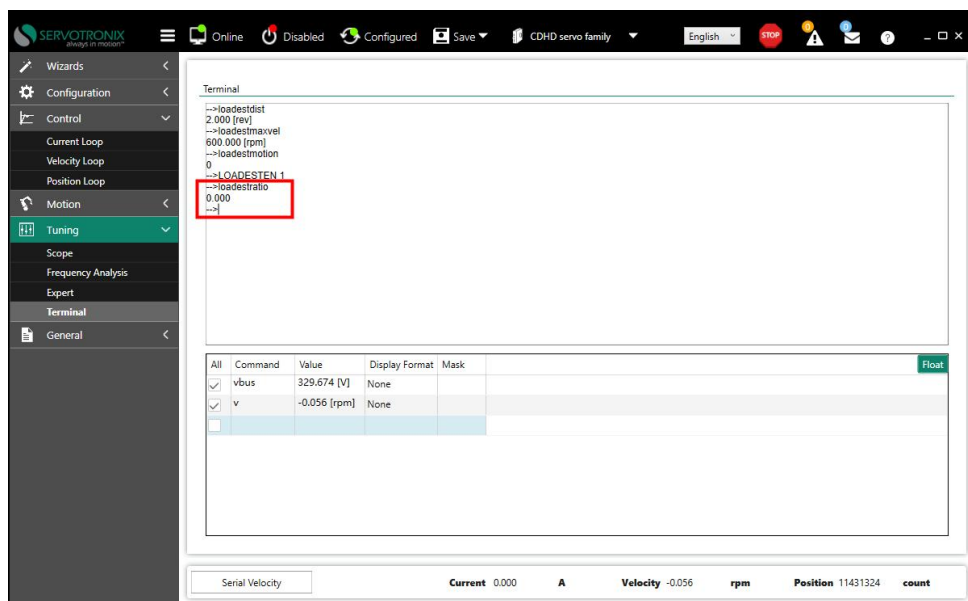
2) In the Terminal, set the offline inertia identification parameters using commands such as "loadestdist", "loadestmaxvel", and "loadestmotion".



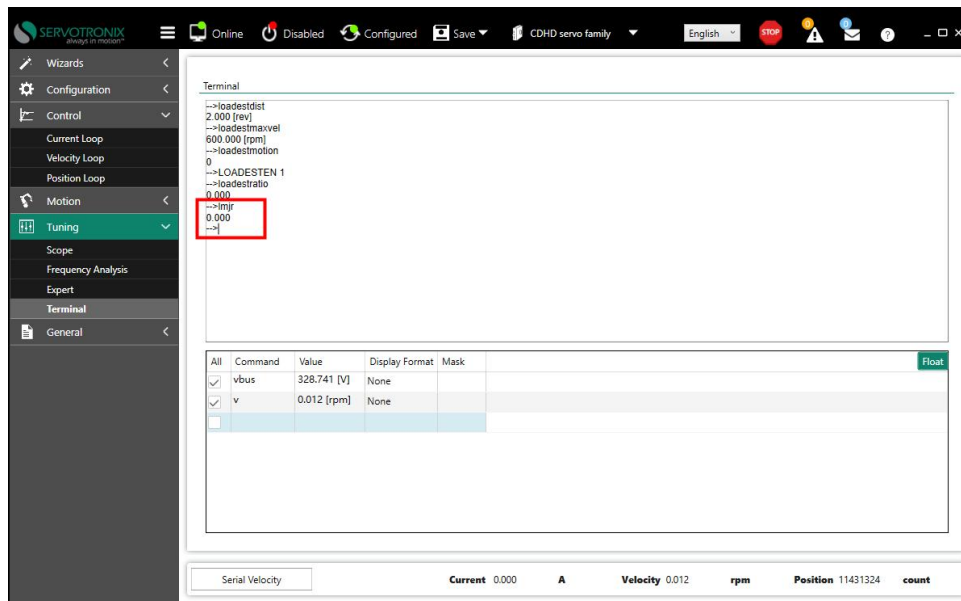
3) In the Terminal, enter the command "LOADESTEN 1" to enable the inertia identification function.



4) After successful identification, check the identified load inertia ratio through the variable "loadestratio".



5) Through the variable "LMJR", write the load inertia ratio into the servo system.



The figure below shows the speed response curves before and after setting the moment of inertia ratio based on the identification results.

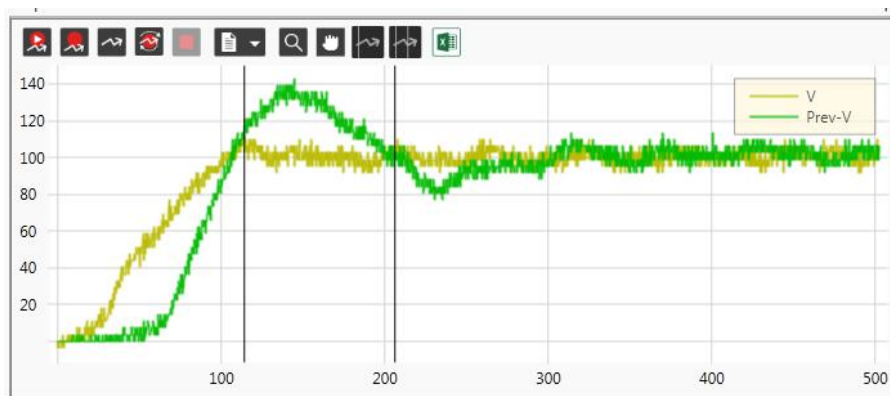


Figure 10-1 Speed Response Curves Before and After Setting the Moment of Inertia Ratio Based on Identification Results

10.1.5 Possible Issues and Solutions

1) Current Saturation Issue

When the load is large, current saturation may occur during the acceleration or deceleration stages of the inertia identification process, leading to the failure of the offline identification process.

Solution: Reduce the acceleration during the identification process by adjusting the variable "loadestacc".

2) Failure to Automatically Enable During Identification Process

If the DI configuration for “Remote Enable” is invalid, or if an error occurs during the identification process, the offline inertia identification function will not automatically enable, resulting in the failure of the offline inertia identification.

Solution: Set the DI “Remote Enable” to valid or clear the error and then re-perform the inertia identification.

3) When the system load inertia ratio is very high, the offline inertia identification process may also experience current saturation and oscillation issues due to inappropriate loop parameters.

In such cases, even if the identification is successful, the results are not reliable and should only be used as a reference.

Solution: Manually adjust the load level using the variable “loadestload”. (The default value of loadestload is 0, and the loop parameters are set values.) If the current remains saturated, reduce the acceleration during the identification process by adjusting the variable “loadestacc”. After adjusting these parameters, perform the inertia identification again.

10.2 Stiffness Table

The Rigidity Table stores combinations of gain and filter parameters for the control loop, where different rigidity levels (RIGID) correspond to different system dynamic response performances.

10.2.1 Parameters

VarCom	Description
RIGID	Rigidity Level 0~31, default value: 13; the higher the value, the higher the rigidity.

10.2.2 Example

In ServoStudio 2 Enter RIGID {rigidity level} in the command terminal.

The following figure compares the speed response of rigid 13 and rigid 16.

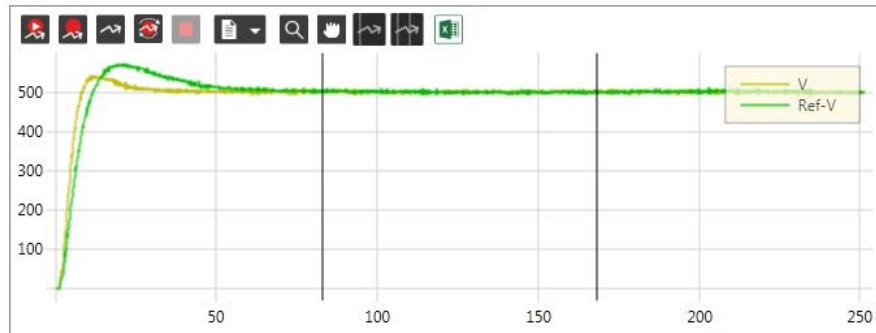


Figure 10-2 Speed Response Comparison for Different Rigidity Levels (1)

The following figure compares the speed response of rigid 13 and rigid 10.

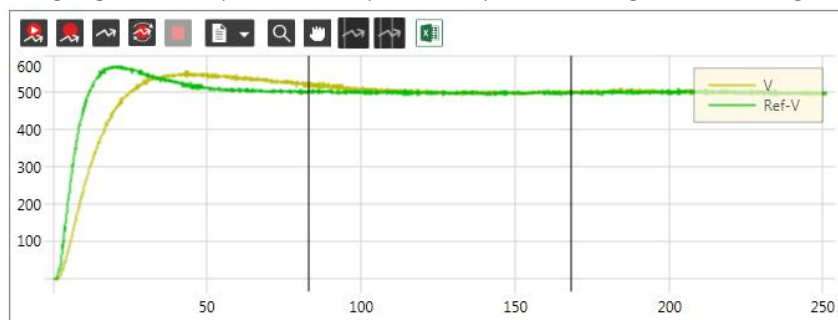


Figure 10-3 Speed Response Comparison for Different Rigidity Levels (2)

Rigidity Level	Position Loop Gain (1/s)	Velocity Loop Gain (Hz)	Velocity Integral Time Constant (ms)	Torque Filter Time Constant (ms)
1	2.5	2.0	280.0	11.0
2	3.0	2.5	220.0	9.0
3	4.0	3.0	190.0	8.0
4	4.5	3.5	160.0	6.0
5	5.5	4.5	120.0	5.0
6	7.5	6.0	90.0	4.0
7	9.5	7.5	70.0	3.0
8	11.5	9.0	60.0	3.0
9	14.0	11.0	50.0	2.0
10	17.5	14.0	40.0	2.0
11	32.0	18.0	31.0	1.26
12	39.0	22.0	25.0	1.03
13	48.0	27.0	21.0	0.84
14	63.0	35.0	16.0	0.65

Rigidity Level	Position Loop Gain (1/s)	Velocity Loop Gain (Hz)	Velocity Integral Time Constant (ms)	Torque Filter Time Constant (ms)
15	72.0	40.0	14.0	0.57
16	90.0	50.0	12.0	0.45
17	108.0	60.0	11.0	0.38
18	135.0	75.0	9.0	0.30
19	162.0	90.0	8.0	0.25
20	206.0	115.0	7.0	0.20
21	251.0	140.0	6.0	0.16
22	305.0	170.0	5.0	0.13
23	377.0	210.0	4.0	0.11
24	449.0	250.0	4.0	0.09
25	500.0	280.0	3.5	0.08
26	560.0	310.0	3.0	0.07
27	610.0	340.0	3.0	0.07
28	660.0	370.0	2.5	0.06
29	720.0	400.0	2.5	0.06
30	810.0	450.0	2.0	0.05
31	900.0	500.0	2.0	0.05

10.3 Parameter Auto-Tuning Function

10.3.1 Overview

Servo parameter self-adjustment is achieved by setting the corresponding curve trajectory and required parameters through a guided process; the servo will then automatically run and learn the optimal gain parameters. After learning is complete, the parameters can be saved and exported for use in other servos of the same model.

The self-adjustment items are as follows:

- Moment of Inertia Ratio (LMJR)
- Gain Adjustment (Velocity Loop Gain, Position Loop Gain)
- Filter Adjustment (Torque Command Filter, Notch Filter)

- Type A Vibration Suppression Control
- Model Following Control

10.3.2 Operable Tools

Operation tools	Operating procedures
Panel operator	10.3.3 Operating Procedures
Servostudio 2	10.3.4 Operating procedures

10.3.3 Panel Operation Steps (AutoTune: C0012)

1) Pre-Operation Settings

To perform AutoTune operation, the following settings must be made in advance.

- Please set the parameters of AutoTune after considering the operating range of the mechanical system, including

Parameter Number	VARCOM	Description
P0601	AUTOTUNEDIST	Autotune travel distance Unit: rev (revolutions) Default value: 5 rev Range: 0.5~8 rev
P0602	AUTOTUNEMAXVEL	Autotune maximum speed Unit: rpm Default value: 3000 Range: 100~6000
P0603	AUTOTUNEACC	Autotune Acceleration Unit: rpm/s Default Value: 10000 Range: 500~200000

- Please take necessary safety measures to ensure it can be stopped at any time in an emergency.

- For safety, please install a stop device on the mechanical side.

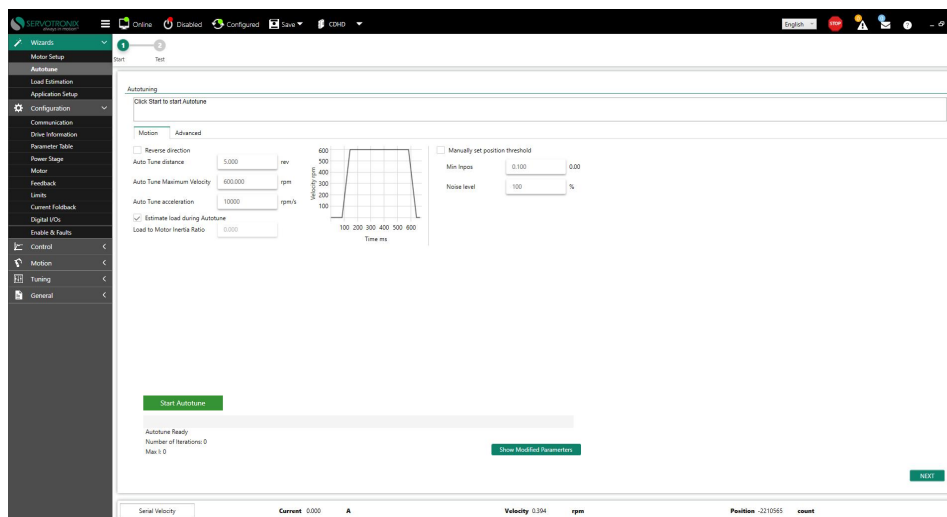
2) Operating Procedures

The operation steps for AutoTune are as follows.

1. Press the M key to select auxiliary functions.
2. If the parameter number displayed is not C0012, press the " $\wedge$ " or " $\vee$ " key to display "C0012".
3. If the servo is in a non-operational state and ready, press the "S" key to enter the AutoTune operation interface displaying "AtUnE"
4. Press the "S" key; if the operating conditions are met, the servo will run according to the settings of P0601, P0602, and P0603, and the LED will display a running light "-----". Otherwise, the LED will display no-op.
5. Wait until the LED running light ends. If AutoTune is successful, the LED displays "AtUnE". If AutoTune fails, the LED flashes "fail" for 3 seconds, then displays "AtUnE".
6. If the "M" key is pressed during AutoTune operation, it will exit AutoTune, the servo will stop running, and the servo will be in the OFF state.
7. Operation complete.

10.3.4 Servostudio 2 Operation Steps

1. Open ServoStudio 2 software and enter the "Auto Tuning" interface.



2. In the parameter setting interface for auto tuning, there are two tabs, i.g. Motion and Advance. Relevant parameters for autotune can be set.

(1) Motion

① Movement direction, the default is for the motor to first rotate counterclockwise by a set distance, then return to the starting point clockwise. If "Reverse direction" is selected, it indicates reverse movement, where the motor will first rotate clockwise by a set distance, then return to the starting point counterclockwise.

② Auto tuning travel distance, corresponding parameter AUTOTUNEDIST, default value is 5 rev

③ Auto tuning maximum speed, corresponding parameter AUTOTUNEMAXVEL, default value is 600 rpm

④ Automatically adjust the maximum acceleration during operation, corresponding parameter AUTOTUNEACC, default value is 10000 rpm/s

⑤ Whether to perform inertia identification, automatic adjustment defaults to performing inertia identification. If you uncheck "Estimate load during Autotune," automatic adjustment will not perform inertia identification, and you need to input the set inertia ratio (LMJR). The driver will use this inertia ratio as the basis for subsequent automatic adjustment procedures.

⑥ Minimum inpos, corresponding parameter autotunemininpos, and the default value is 0.1(0.001rev). This parameter is used for settling time calculation in autotune. If

"Manually set position threshold" is selected, this parameter is tuned automatically during autotune, otherwise, it can be set manually.

⑦ Noise level, corresponding parameter `noisethresh`, and the default value is 100%. If large noise is generated during autotune, this parameter can be set smaller.

(2) Advanced

① Default KVBW, corresponding parameter `autotunedefkvbw`, and the default value is 40Hz.

② Default ICMDLPF, corresponding parameter `autotunedefilpf`, and the default value is 600Hz.

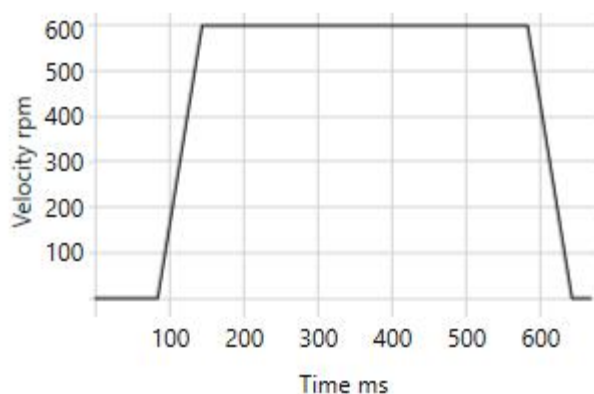
③ Default VELFILTRQ, corresponding parameter `autotunedefvlpf`, and the default value is 800Hz.

④ Default LMJR, corresponding parameter `autotunedeflmjr`, and the default value is 3.

⑤ Whether to perform model following control (MFC). MFC tune is enabled during autotune when its checked.

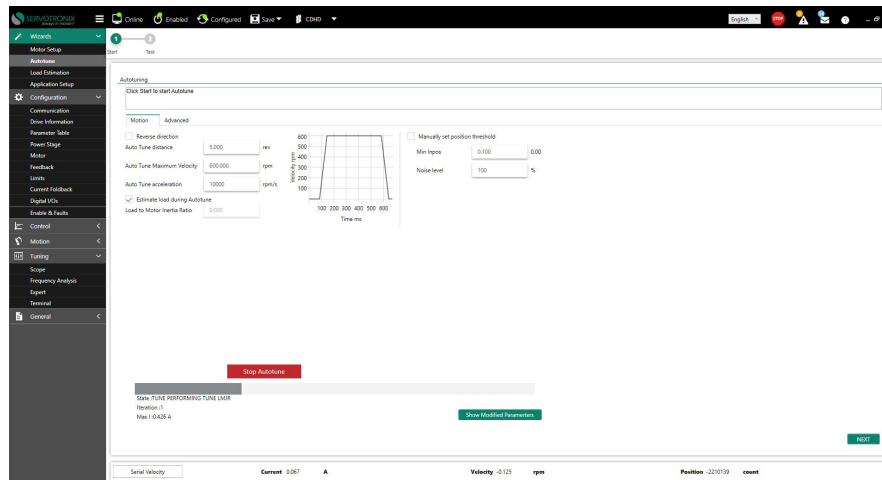
⑥ Whether to perform speed disturbance observer (SDOB). SDOB tune is enabled during autotune when its checked.

3. Trajectory curve display, based on the set parameters of the automatic adjustment, the travel distance, maximum speed, and maximum acceleration are displayed on the right side of the interface.

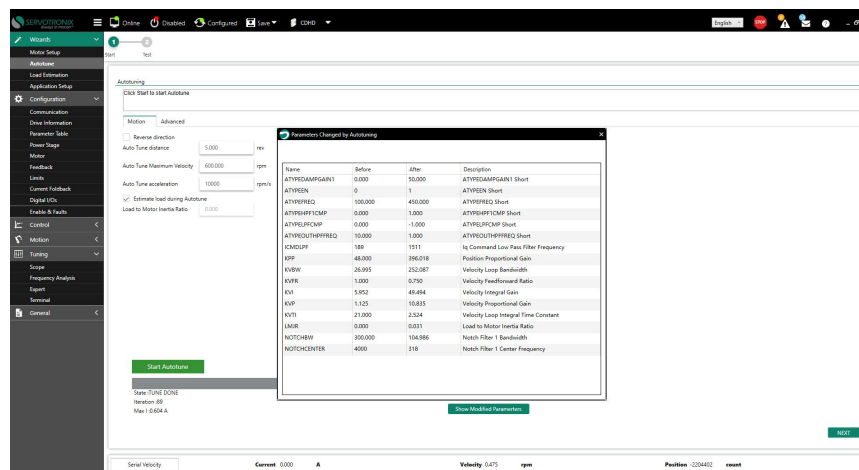


4. Click the "Start Auto-Tuning" button, and the servo will automatically enable and complete a series of automatic adjustment movements. Clicking "Stop Auto-Tuning" can interrupt the auto-tuning program. Below the buttons, the progress and current status of

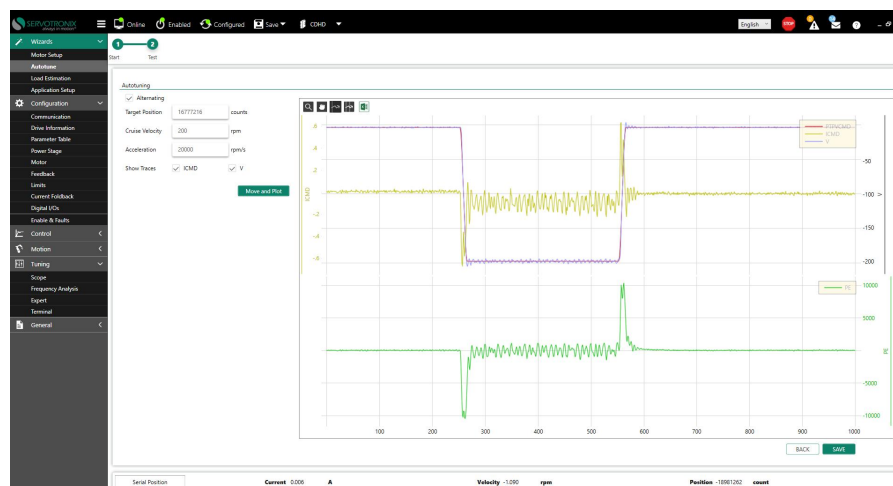
the auto-tuning are displayed. Status variables include: the current tuning step, the number of trajectory runs, and the maximum current.



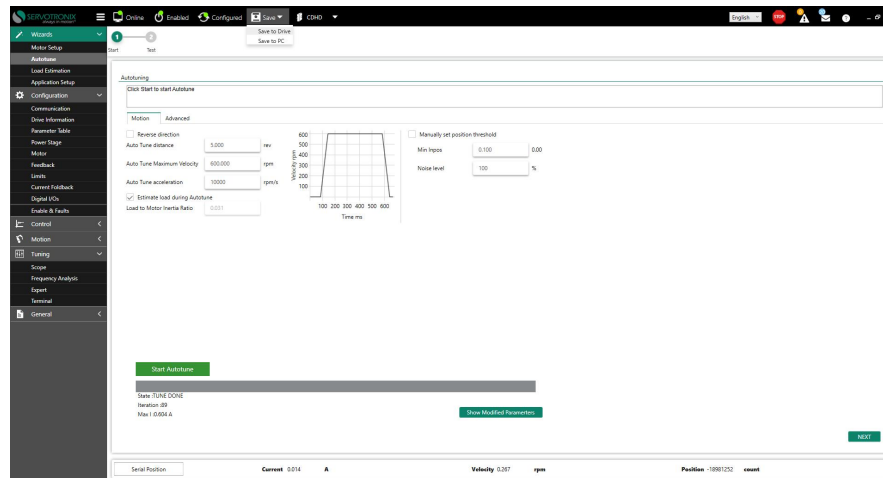
5. After self-tuning is completed, click “Compare Parameters Before and After Self-Tuning” to view the specific values of parameters before and after self-tuning.



6. Click “Next”, set the “Target Position”, “Speed”, “Acceleration”, whether to “Reciprocate” and other automatic tuning parameters, click “Run and Plot” to view the effect of self-tuning, if satisfied with the effect, click “Save”.



7. At this point, you can click on the menu above "Save" >> "Save to Driver" to save the self-tuning parameters.



10.3.5 Parameter Description

Definition of Self-Tuning Parameters:

VarCom	Range	Units	Default Value	Effective Method
AUTOTUNEABORT	0~1	--	0	Immediate
Self-Tuning Exit Request				
AUTOTUNEACC	500~200000	rpm/s	10000	Immediate
Self-Tuning Acceleration Set Value				
AUTOTUNEACCACT	500~200000	rpm/s	10000	Immediate
Self-Tuning Actual Acceleration Value				
AUTOTUNEATYPEEN	0~1	--	0	Immediate
Self-Tuning Speed Disturbance Observer Enable				
AUTOTUNEDIR	0~3	--	0	Immediate
Self-Tuning Movement Direction				
AUTOTUNEDIST	500~8000	rev	5000	Immediate
Self-Adjusting Movement Distance				
AUTOTUNEEN	0~1	--	0	Immediate
Self-Adjusting Enable				
AUTOTUNEIPHRESH	0~1000	0.001rev	100	Immediate
Self-Adjusting Position Deviation Threshold				
AUTOTUNEIPTIME	0~1000000	us	500000	Immediate
Self-Adjusting Time Threshold				
AUTOTUNEITERATION	0~300	--	0	Immediate
Self-Adjusting Iteration Count				

VarCom	Range	Units	Default Value	Effective Method
AUTOTUNELESTRATIO	0~100000	--	0	Immediate
Self-Adjusting Load Estimation Value				
AUTOTUNELMJREN	0~1	--	1	Immediate
Self-Adjusting Load Estimation Enable				
AUTOTUNEMAXI	-100000~100000	A	0	Immediate
Self-Adjusting Maximum Current				
AUTOTUNEMAXVEL	100000~6000000	rpm	600000	Immediate
Self-Adjusting Trajectory Maximum Speed Setting				
AUTOTUNESETTLETIME	0~100000	ms	0	Immediate
Self-Adjusting Adjustment Time				
AUTOTUNESTATE	0~4	--	0	Immediate
Self-Adjusting Status				

10.3.6 Precautions

1. After self-adjustment starts, the motor will first rotate counterclockwise for the set distance, then clockwise back to the starting point. If "Reverse direction" is selected, the motor will first rotate clockwise for the set distance, then counterclockwise back to the starting point. Please note that there should be sufficient mechanical clearance to prevent collisions.

2. After the self-tuning function is activated, there is no need to set the stiffness level (RIGID) and load inertia ratio (LMJR) again.

3. The self-tuning function is not suitable for applications where the load inertia ratio is particularly high (>20).

10.4 Recording and Evaluating Performance

10.4.1 Recording Data in ServoStudio 2

Program: Recording Data in ServoStudio 2 - Example

1. In the ServoStudio 2 "Tuning — Oscilloscope" interface, select the Run tab.

- Ensure that the operation mode is set to Serial Position.
- Set the value of the target position.

- Set the motion parameters, including speed, acceleration, deceleration, etc.
- If forward and backward movement is required, select the “Alternating” option.

The goal is to obtain a motion profile with sufficient acceleration, smooth, and deceleration phase durations.

2. In the “Oscilloscope” panel, select the “Record Variables” you need to monitor:

For example, PTPVCMD (speed command generated by position command), ICMD (current command), V (actual speed)

3. In the “Oscilloscope” panel, enter the sample values and trigger variables:

- Samples: 2000 (collect 2000 data points, the maximum value can be set to 2048)
- Time Interval: 8, i.e., record one data point every 8 control cycles (125us)

Total recording time: $2000 \times 125\mu s \times 8 = 2000\text{ms}$

- Trigger Setting: IMM (Immediate Trigger Mode)

4. Ensure Servo Driver is enabled, then click the “Run Recording and Plot” button in the “Oscilloscope” toolbar.

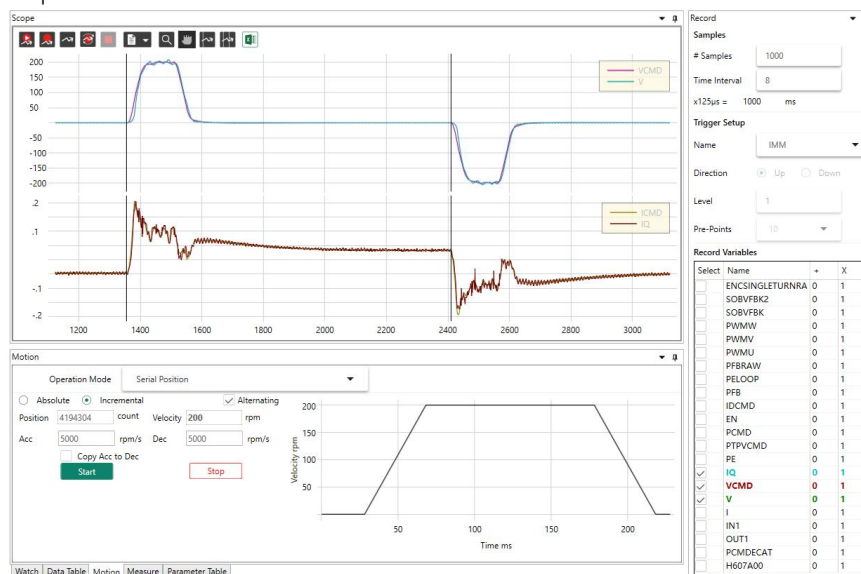


Figure 10-4 Example of Data Recorded by ServoStudio2

10.4.2 Recording Data in the Terminal

Program: Record Data (Terminal)

1. Use the RECORD command to define the variables to be recorded, the time interval, and the number of samples.

The syntax for the record command is:

RECORD {sampling time} {number of points} {variable1} [variable2] [variable3]

For example: RECORD 32 100 "VCMD "V "ICMD

Record 100 points of VCMD, V, and ICMD every 1 millisecond

Note that a quotation mark (") must precede each variable.

2. Use the RECTRIG command to define the variable and conditions for triggering sampling.

The syntax for the sample trigger command is:

RECTRIG {name} [level] [pre-trigger points] [up|down]

Note: If the specified number of pre-trigger sample points is greater than the actual number of samples taken before the trigger, the pre-trigger segment of the sampling will include variable sample values before the motion starts.

For example, recording a Jog (J) that accelerates from 0 to 1000 rpm at 10000 rps/s; with a specified trigger speed of 1 rpm, direction upwards, 128 pre-trigger points, and 1 time interval. Since there will not be 128 pre-trigger actions, the recorded data will be padded with zeros (zero speed command before motion).

3. Use the variables RECORD (recording completed) and/or RECING (recording in progress) to determine if the recorded data is available.

4. In BD3E , recordable variables and trigger variables support all VarCom.

Function	VarCom	Description
Record Activation Command	RECORD	Define the variables to be recorded, as well as the recording duration and sampling time.
	RECTRIG	Define the trigger conditions for starting the recording, as well as the pre-trigger duration.
	RECOFF	Close Active Recording.
Status Flags	RECRDY	Indicates that the recording is ready.
	RECING	Indicates that the trigger condition has occurred and the recording is active.
	RECDONE	Indicates that the recording is complete.
Data Retrieval	GETMODE	Define the format of the recorded data (Binary/ASCII).
	GET	Retrieve the recorded data.

10.4.3 Evaluating VCMD

The parameter PTPVCMD (Position Command Generator Velocity) displays the derivative of the position command in velocity units. PTPVCMD can be used to record and view the velocity command, which is only available as the derivative of position.

PTPVCMD is the trajectory velocity command applicable to all position loops.

The figure below shows an example of a PTPVCMD record indicating poor performance.

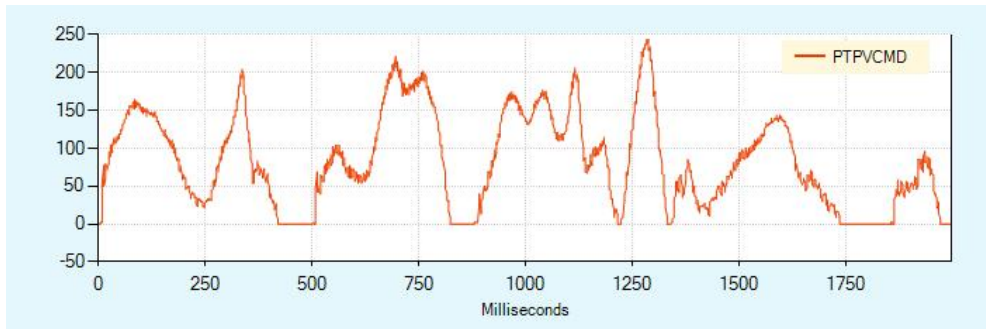


Figure 10-5 Poor PTPVCMD Performance

10.4.4 Evaluating ICMD and/or PE Oscillation

The figure below shows an example of oscillation in ICMD (current command) and PE (position error) indicating poor performance.

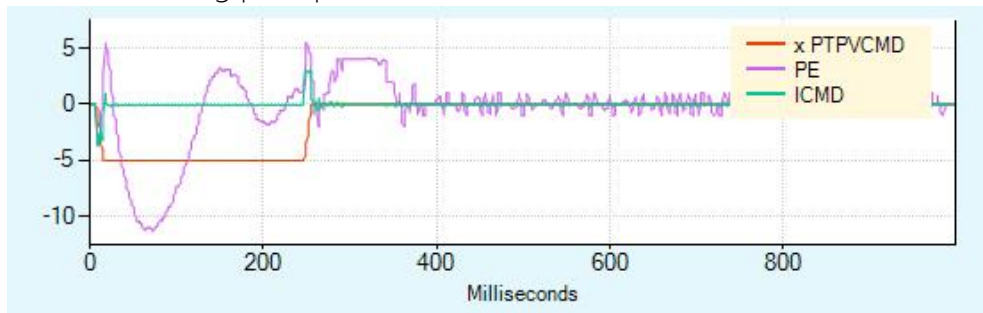


Figure 10-6 Poor ICMD and PE Performance

To determine if there is oscillation and the oscillation frequency, use the ServoStudio 2 FFT function on the PE or ICMD record:

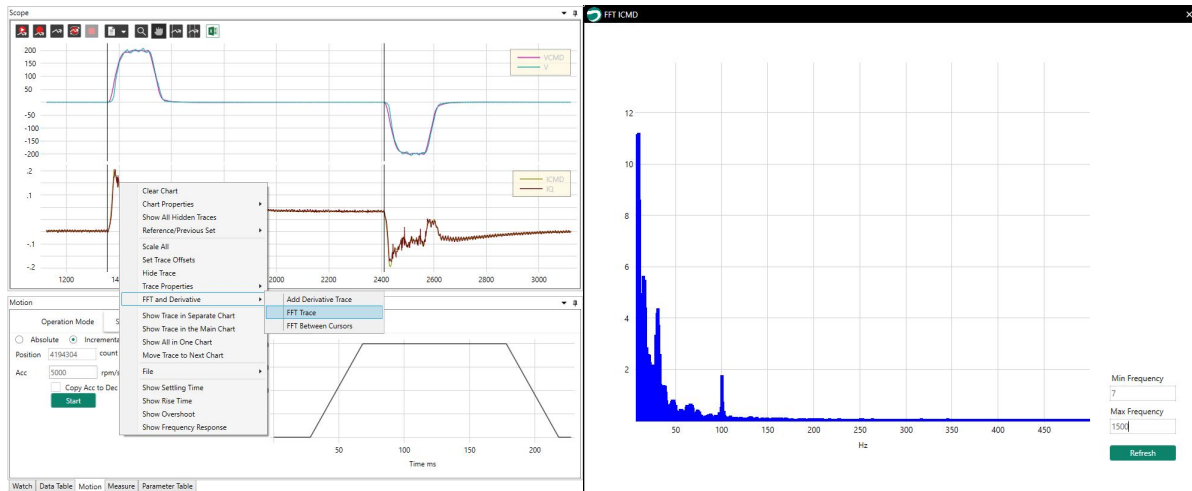


Figure 10-7 FFT Trace Evaluation

11. Troubleshooting

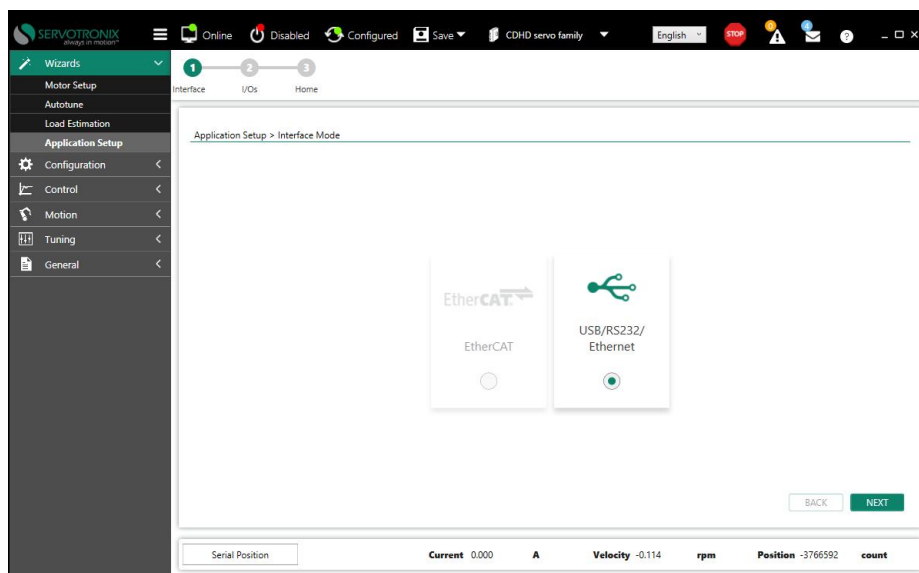
11.1 Report Generator

Before contacting technical support, generate an application settings report using the ServoStudio 2report generator. The information contained in the report file will assist technical support in troubleshooting your issue and providing assistance.

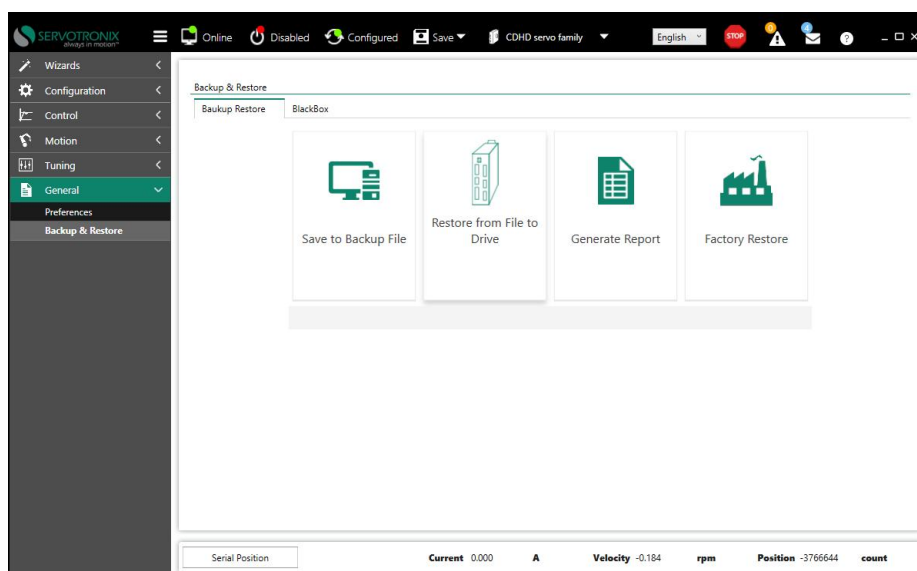
In general, it is strongly recommended that you generate a report each time you complete application configuration, even when the system is operating normally.

Available at ServoStudio 2The report generator options can be accessed from two locations:

- Application Setup Wizard (last step)



- Backup and Restore interface



11.2 Faults and Warnings

If BD3E is connected to the host via the Ethernet interface, it transmits fault codes to the host through text messages. This message is stored in the Fault History Log (FLTHIST) in Servo Driver's EEPROM, so the fault history will not be lost when power to Servo Drive is restored.

- Warnings are not considered faults and do not trigger shutdown operations. The warning state is automatically cleared by the system when the conditions that generated the warning no longer exist.
- A fault will occur when settings or conditions may cause improper operation of Servo Driver/motor and/or damage to the equipment. The fault will automatically set Servo Driver to a disabled state and display the fault status on Servo Driver's display and software interface.
- The driver fault status is typically latched, and Servo Driver cannot be enabled until the fault status is explicitly cleared. The fault status can only be cleared when the fault condition no longer exists.
- Some faults are referred to as fatal faults because these faults will disable almost all driver functions (sometimes even including communication functions), preventing Servo Driver from being enabled. This condition is a typical characteristic of internal failure faults,

such as watchdog events or internal power failures. Fatal faults require technical support guidance.

VarCom	Description
CLEARFAULTS	Clear all latched faults.
FLT	Return the list of faults latched by Servo Driver.
FLTHIST	Return the contents of the fault buffer history.
K EN	Disable driver Enable driver
READY	Indicates whether Servo Driver is ready to be enabled.
REMOTE	Indicates the status of the external remote enable input.
ST	Returns detailed status messages from Servo Driver.

11.3 Fieldbus Status LED

Interfaces C2 and C3 each have two LEDs that indicate the fieldbus status during communication on the EtherCAT network.

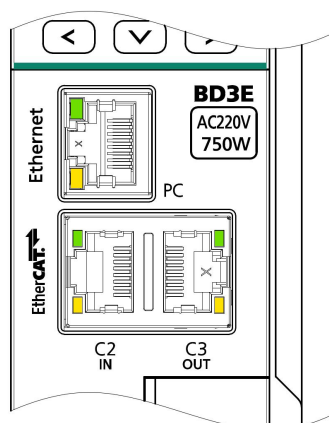


Figure 11-1 EtherCAT Ports and LEDs

Indicator lights	Meaning
Green	Blinking: Communication activity
	Off: No communication activity
Orange	On: Operational (OP) state
	Slow blinking: Safe operational (SAFEOP) state
	Rapid Flashing: Pre-Operation (PREOP) Status
	Constantly Off: Initialization (INIT) Status

11.4 Digital Display - Warning Codes

A1 STO Warning

Definition	STO Warning
Type	Warning
SST Message #	WRN 1
Panel Display	A1
Description	STO Signal Disconnection
Action Required	Check if the STO signal is disconnected.

A2 Driver Overload

Definition	Driver Overload
Type	Warning
SST Message #	WRN 2
Panel Display	A2
Description	Driver overload current IFOLD is below IFOLDFTRESH or IFOLDWTHRESH.
Action Required	Check if Servo Driver output current is overloaded, or if the mechanical load and acceleration are too high.

A3 Motor

Definition	Motor Overload
Type	Warning
SST Message #	WRN 3
Panel Display	A3
Description	Motor overload current MIFOLD is below MIFOLDFTRESH or MIFOLDWTHRESH.
Action Required	Check if the motor selection is appropriate, if the phase angle is correct, if the mechanism is jammed, and if the acceleration is too high.

A4 Undervoltage

Definition	Undervoltage
Type	Warning
SST Message #	WRN 4
Panel Display	A4
Description	Bus voltage is below the detection threshold.
Action Required	Check if the main circuit power is disconnected from Servo Driver, and read the undervoltage threshold using the UVTHRESH command.

A5 Power Module Overtemperature

Definition	Power Module Overtemperature
Type	Warning
SST Message #	WRN 5
Panel Display	A5

Definition	Power Module Overtemperature
Description	Power board temperature exceeds the threshold
Action Required	Read the temperature setting threshold using the DRIVEOTTHRESH command

A15 Hardware Positive Limit Switch Triggered

Definition	Hardware Positive Limit Switch Triggered
Type	Warning
SST Message #	WRN 15
Panel Display	A15
Description	Positive hardware limit switch triggered.
Action Required	No action required.

A16 Hardware Negative Limit Switch Triggered

Definition	Hardware Negative Limit Switch Triggered
Type	Warning
SST Message #	WRN 16
Panel Display	A16
Description	Negative hardware limit switch triggered.
Action Required	No action required.

A17 Positive and Negative Hardware Limit Switches Triggered

Definition	Positive and Negative Hardware Limit Switches Triggered
Type	Warning
SST Message #	WRN 17
Panel Display	A17
Description	Both Positive and Negative Hardware Limit Switches Triggered.
Action Required	Check if DI Wiring is Normal.

A18 Positive Software Limit Switch Triggered

Definition	Positive Software Limit Switch Triggered
Type	Warning
SST Message #	WRN 18
Panel Display	A18
Description	Positive Software Limit Switch Triggered. Position Feedback (PFB) > POSLIMPOS and POSLIMMODE = 1.
Action Required	No action required.

A19 Negative Software Limit Switch Triggered

Definition	Negative Software Limit Switch Triggered
Type	Warning
SST Message #	WRN 19
Panel Display	A19
Description	Negative Software Limit Switch Triggered. Position Feedback (PFB) < POSLIMPOS and POSLIMMODE = 1.
Action Required	No action required.

A20 Software Limit Switch Triggered

Definition	Software limit switch triggered
Type	Warning
SST Message #	WRN 20
Panel Display	A20
Description	Positive and negative software limit switches triggered. Position feedback (PFB) > POSLIMPOS and position feedback (PFB) < POSLIMNEG and POSLIMMODE = 1.
Action Required	No action required.

A22 Encoder battery voltage low

Definition	Encoder battery voltage low
Type	Warning
SST Message #	WRN 22
Panel Display	A22
Description	Detected low multi-turn encoder battery voltage.
Action Required	Confirm encoder battery, replace with a new one if necessary.

A23 Main circuit power phase missing

Definition	Main circuit power phase missing
Type	Warning
SST Message #	WRN 23
Panel Display	A23
Description	One phase of the main circuit power is not connected.
Action Required	Check the power supply lines.

A32 Main circuit power supply disconnected

Definition	Main circuit power line disconnected
Type	Warning
SST Message #	WRN 32
Panel Display	A32
Description	Main circuit power line disconnected.
Action Required	Check the power supply lines.

A34 Overload of Braking Resistor

Definition	Overload of Braking Resistor
Type	Warning
SST Message #	WRN 34
Panel Display	A34
Description	Overload of Braking Resistor.
Action Required	Please check if the braking resistor value is appropriate.

A36 MCU Real-time Task Overload Warning

Definition	MCU Real-time Task Overload Warning
Type	Warning
SST Message #	WRN 36
Panel Display	A36
Description	The driver has detected that the CPU is approaching its computational limit.
Action Required	Please contact technical support.

A38 IPM Module Overtemperature

Definition	IPM Module Overtemperature
Type	Warning
SST Message #	WRN 38
Panel Display	A38
Description	The Integrated Power Module (IPM) temperature exceeds the preset limit.
Action Required	Check if the ambient temperature exceeds Servo Driver's specifications. Otherwise, contact technical support.

A48 Default Driver Configuration

Definition	Default Driver Configuration
Type	Warning
SST Message #	WRN 48
Panel Display	A48
Description	The current driver configuration is set to the manufacturer's default values.
Action Required	No action required

A65 Failed to restore default parameter settings

Definition	Failed to restore default parameter settings
Type	Warning
SST Message #	WRN 65
Panel Display	A65
Description	The driver is enabled; failed to restore factory default parameters
Action Required	Disable Servo Driver, reset to factory defaults. If the error persists, contact technical support.

A66 Failed to read EEPROM parameters

Definition	Failed to read EEPROM parameters
Type	Warning
SST Message #	WRN 66
Panel Display	A66
Description	Failed to read EEPROM parameters.
Action Required	Reset to factory defaults. If the error persists, contact technical support.

A67 Failed to clear error history

Definition	Failed to read EEPROM parameters
Type	Warning
SST Message #	WRN 67
Panel Display	A67
Description	Failed to read EEPROM parameters.
Action Required	Reset to factory defaults. If the error persists, contact technical support.

A68 EEPROM parameter read out of range

Definition	EEPROM parameter read out of range
Type	Warning
SST Message #	WRN 68
Panel Display	A68
Description	When reading EEPROM parameters, the read parameter exceeds the range.
Action Required	Power cycle the device. If the error persists, contact technical support.

A69 Sync0 time does not match interpolation time

Definition	Sync0 time does not match interpolation time
Type	Warning
SST Message #	WRN 69
Panel Display	A69
Description	Synchronization time does not match parameter settings
Action Required	Modify interpolation time using commands FBITDX and FBITPRD

A71 Failed to write to power board EEPROM

Definition	Failed to write to power board EEPROM
Type	Warning
SST Message #	WRN 71
Panel Display	A71
Description	Failed to write to power board EEPROM.
Action Required	Restore factory settings; if the error persists, contact technical support,

A72 Failed to write to control board EEPROM

Definition	Failed to write to control board EEPROM
Type	Warning
SST Message #	WRN 72
Panel Display	A72
Description	Failed to write to control board EEPROM.
Action Required	Restore factory settings; if the error persists, contact technical support,

A75 Collision detection

Definition	Collision detected
Type	Warning
SST Message #	WRN 75
Panel Display	A75
Description	Collision detected by collision detection function.
Action Required	Collision detected, reverse operation required

A77 Cooling fan failure

Definition	Cooling fan failure
Type	Warning
SST Message #	WRN 77
Panel Display	A77
Description	Cooling air duct/fan is blocked, or the fan is damaged.
Action Required	Check if the cooling air duct/fan is blocked

A78 Position command interpolation calculation out of range

Definition	Position command interpolation abnormal
Type	Warning
SST Message #	WRN 78
Panel Display	A78
Description	Position command cubic polynomial interpolation calculation out of range
Action Required	Check if the position command is reasonable

A79 Vibration detected

Definition	Vibration detected
Type	Warning
SST Message #	WRN 79
Panel Display	A79
Description	Driver detects vibration occurrence
Action Required	Check if there is any abnormality in the load; if the load is normal, please reduce the stiffness level of Servo Driver

A80 Torque fluctuation compensation data abnormal

Definition	Torque fluctuation compensation data abnormal
Type	Warning
SST Message #	WRN 80
Panel Display	A80
Description	Abnormal motor torque fluctuation compensation data
Action Required	Restart Servo Driver. If the warning persists after restarting, disable the torque fluctuation compensation function.

11.5 Digital Display - Fault Modes

Fault codes are represented using a combination of letters and numbers in the following format:

Definition	Short name. In ServoStudio 2use.
Type	Fault, refer to the fault type description in the 'Faults and Warnings' section.
Active shutdown	Indicates whether the fault can trigger the active shutdown function. Refer to the 'Shutdown Modes' section.
SST Message #	Number of fault messages displayed in the terminal.
Panel Display	Displayed on the panel display
Description	Describes the state or fault indicated by the fault code.
Action Required	Describes the recommended steps to correct the fault.

E2 Parameter memory checksum failure

Definition	Parameter Storage Checksum Failure
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 2
Panel Display	E2
Description	The EEPROM used for storing drive parameters is cleared or data is corrupted. This fault is displayed after the first power-on. The fault will be cleared after configuring Servo Drive and saving the parameters to Servo Drive's EEPROM. This fault may also occur during power-off if the save operation has not been completed.
Action Required	Reconfigure Servo Drive or restore parameters and save them. If the problem persists, contact technical support.

E3 Software Overcurrent

Definition	Software Overcurrent
Type	Fault
Active shutdown	No
SST Message #	FLT 3
Panel Display	E3
Description	Software overcurrent, where the actual current exceeds the software overcurrent threshold and persists for the overcurrent time threshold. This fault will disable Servo Drive.
Action Required	Check if the motor connections are short-circuited. Check if the current loop has excessive overshoot.

E4 STO

Definition	STO Fault
Type	Fault
Active shutdown	No
SST Message #	FLT 4
Panel Display	E4
Description	STO Signal Triggered This fault will disable Servo Drive.
Action Required	Check the STO fault signal.

E6 Control Board EEPROM Fault

Definition	Control Board EEPROM Fault
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 6
Panel Display	E6
Description	Control Board EEPROM access issue. The driver cannot be enabled.
Action Required	Restore factory settings; if the error persists, contact technical support,

E7 Power Board EEPROM Fault

Definition	Power Board EEPROM Fault
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 7
Panel Display	E7
Description	Power Board EEPROM access error. The driver cannot be enabled.
Action Required	Restore factory settings; if the error persists, contact technical support,

E9 Overvoltage

o	Bus Overvoltage
Definition	Overvoltage
Type	Fault
Active shutdown	No
SST Message #	FLT 9
Panel Display	E9
Description	The bus voltage exceeds the overvoltage threshold. This fault prevents Servo Driver from being enabled.
Action Required	Check if a regenerative resistor is required for the application.

E10 Power Board Overtemperature

Definition	Power Board Overtemperature
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 10
Panel Display	E10
Description	The NTC resistance sampling temperature exceeds Servo Driver overtemperature protection threshold. This fault prevents Servo Driver from being enabled.
Action Required	Check if the ambient temperature exceeds Servo Driver specifications. Otherwise, please contact technical support.

E11 Undervoltage

Definition	Undervoltage
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 11
Panel Display	E11
Description	The bus voltage is below the undervoltage threshold (depending on the undervoltage detection mode).
Action Required	Check if the main AC power supply is connected to Servo Driver and turned on. The undervoltage limit can be read using the UVTHRESH command.

E12 Not Configured

Definition	Not Configured
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 12
Panel Display	E12
Description	Driver configuration is required. Configuration (CONFIG) is needed after any specific parameter value has been modified. Even if the parameter values have not changed, configuration (CONFIG) must be performed after sending specific parameters to Servo Driver.
Action Required	Set driver parameters and/or perform configuration (CONFIG).

E13 Failed to write EEPROM parameters

E	Flashing
Definition	Failed to write EEPROM parameters
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 13
Panel Display	E13
Description	Failed to write EEPROM parameters. The driver cannot be enabled.
Action Required	Please contact technical support.

E14 Over-speed

Definition	Over-speed
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 14
Panel Display	E14
Description	The actual speed exceeds the speed limit, which is set by VLIM. This fault will disable Servo Drive.
Action Required	Check if the VLIM setting meets the application requirements. Use speed loop tuning to check if the speed overshoot is too large.

E16 Driver overload

Definition	Driver Overload
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 16
Panel Display	E16
Description	The driver overload current is below Servo Driver overload current fault threshold (IFOLDFTHRESH).
Action Required	Check the motor driver power. In actual applications, if the rated current of Servo Driver is too low (insufficient power), this fault will occur. Check if the encoder bias angle is correct. Check the IFOLDFTHRESH value.

E17 Motor Overload

Definition	Motor Overload
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 17
Panel Display	E17
Description	The motor overload current is below the motor overload current fault threshold (MIFOLDFTHRESH).
Action Required	Check Servo Driver's motor power calibration. In actual applications, if the rated motor current is too low (insufficient power), this fault will occur. Check the MIFOLDFTHRESH value.

E34 Encoder Communication Error

Definition	Encoder communication error
Type	Fault

Definition	Encoder communication error
Active shutdown	No
SST Message #	FLT 34
Panel Display	E34
Description	Encoder communication timeout; the encoder may be disconnected. This fault prevents Servo Driver from being enabled.
Action Required	Check if the feedback device is wired correctly. Check if the selected encoder type (MENCTYPEUSER) is correct.

E39 Integrated Power Module Overtemperature

Definition	Integrated power module overtemperature
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 39
Panel Display	E39
Description	The integrated power module (IPM) internal temperature exceeds the set threshold, triggering an over-temperature OT signal. This fault prevents Servo Driver from being enabled.
Action Required	Check if the ambient temperature exceeds Servo Driver specifications. Otherwise, please contact technical support.

E42 Tamagawa encoder initialization failed

Definition	Tamagawa encoder initialization failed
Type	Fault
Active shutdown	No
SST Message #	FLT 42
Panel Display	E42
Description	Tamagawa encoder initialization process failed. Possible scenarios include using MENCTYPEUSER to configure the encoder type beyond limits, not disabling the enable when changing the encoder type, and mismatched single-turn bit counts when changing the encoder type via FeedBackType. For PH3 motors: The encoder firmware does not support a PWM carrier (PWMFRQ) of 12kHz, the encoder baud rate switch fails, and the encoder lock command fails. This fault prevents Servo Driver from being enabled.
Action Required	Check if the encoder wiring is correct. For PH3 motors: Use ENCINFO to check the encoder firmware.

E43 Current Sensor Bias Abnormality

Definition	Current Sensor Bias Abnormality
Type	Fault
Active shutdown	No
SST Message #	FLT 43
Panel Display	E43
Description	The calculated current sensor bias exceeds the set threshold.
Action Required	Reset the fault. If the fault persists, Servo Driver may need repair. Contact technical support.

E49 Tamagawa Encoder Fault

Definition	Tamagawa Encoder Fault
Type	Fault
Active shutdown	No
SST Message #	FLT 49
Panel Display	E49
Description	Multiple faults exist in the Tamagawa encoder, including one or more of the following errors: overspeed, counting error, multi-turn error. This fault prevents Servo Driver from being enabled.
Action Required	Check the feedback wiring. Ensure the motor is not running at high speed during the encoder initialization process.

E51 Motor Power Line Phase Loss

Definition	Motor Power Line Phase Loss
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 51

Definition	Motor Power Line Phase Loss
Panel Display	E51
Description	Motor power line phase missing, where the current of one phase is always 0 and the current command exceeds a certain value.
Action Required	Check if the motor power line is correct.

E56 Absolute Multi-turn Encoder Battery Voltage Low

Definition	Absolute Multi-turn Encoder Battery Voltage Low
Type	Fault
Active shutdown	No
SST Message #	FLT 56
Panel Display	E56
Description	The voltage level of the absolute multi-turn encoder backup battery has dropped below 3.0V. This fault prevents Servo Driver from being enabled.
Action Required	Replace the encoder battery and then restart Servo Driver. If the battery is replaced while Servo Driver is on, the position information will be effectively saved. If the battery power is disconnected before replacing the battery, the multi-turn information must be reset using the MTURNRESET command after the battery power is restored.

E57 Emergency Stop

Definition	Emergency Stop
Type	Fault
Active shutdown	No
SST Message #	FLT 57
Panel Display	E57
Description	Emergency Stop Signal Triggered This fault will disable Servo Drive.
Action Required	Turn off the power and confirm safety.

E59 Stall Fault

Definition	Stall Fault
Type	Fault
Active shutdown	No
SST Message #	FLT 59
Panel Display	E59
Description	Motor Stall, when the motor speed is below the stall threshold and the actual current is greater than the motor rated current or greater than the stall current, and the duration reaches the stall time threshold (when 90% of the current limit value is less than Servo Driver's rated current, the stall current is Servo Driver's rated current; when 90% of the current limit value is greater than Servo Driver's rated current, the stall current is 90% of the current limit value) this fault will disable Servo Driver.
Action Required	Clear the stall condition and pay attention to avoiding the occurrence of stall conditions.

E65 Bus Communication Disconnected

Definition	Bus Communication Disconnected
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 65
Panel Display	E65
Description	The bus between the controller and the slave station is disconnected.
Action Required	Ensure that the EtherCAT host (controller) is properly connected to the slave via the network cable.

E67 Speed Error Exceeded

Definition	Speed Error Exceeded
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 67
Panel Display	E67
Description	The speed error (VE) has exceeded the speed error limit (VEMAX). When VEMAX is 0, speed error exceeding is not detected. This fault will disable Servo Drive.

Definition	Speed Error Exceeded
Action Required	Adjust Servo Driver tuning to improve speed tracking performance, or increase VEMAX to allow for greater speed error.

E70 Internal Error

Definition	Internal Error
Type	Fault
Active shutdown	Yes
SST Message #	FLT 70
Panel Display	E70
Description	Internal Error
Action Required	Please contact technical support.

E77 Motor Runaway

Definition	Motor Runaway
Type	Fault
Active shutdown	Yes
SST Message #	FLT 77
Panel Display	E77
Description	The algebraic signs of the actual current, acceleration, and speed do not match.
Action Required	Correct the MPHASE setting and improve/activate the phasefind process.

E78 Main Circuit Power Line Disconnected

Definition	Main Circuit Power Line Disconnected
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 78
Panel Display	E78
Description	Main Circuit Power Line Disconnected. This fault prevents Servo Driver from being enabled.
Action Required	Check the connections of the main circuit source. Ensure the supply is normal. Refer to the wiring diagram and relevant parameters.

E79 Cooling Fan Fault

Definition	Cooling fan failure
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 79
Panel Display	E79
Description	Cooling air duct/fan is blocked, or the fan is damaged. This fault prevents Servo Driver from being enabled.
Action Required	Check if the cooling duct/fan is blocked. If the duct is clear, contact technical support to check if the fan is damaged.

E82 SensAR Encoder Fault

Definition	SensAR Encoder Fault
Type	Fault
Active shutdown	No
SST Message #	FLT 82
Panel Display	E82
Description	The SensAR encoder has multiple faults, including one or more of the following errors: overspeed, counting error, multi-turn error. This fault prevents Servo Driver from being enabled.
Action Required	Check the feedback wiring. Ensure the motor is not running at high speed during the encoder initialization process.

E83 Regenerative Braking Resistor Overload

Definition	Regenerative Braking Resistor Overload
Type	Fault
Active shutdown	No
SST Message #	FLT 83
Panel Display	E83
Description	The regenerative braking resistor load exceeds its allowable power. Continuous overloading of the brake pipe or repeated overloading of the brake pipe. This fault prevents Servo Driver from being enabled.
Action Required	Please check if the resistance value of the regenerative resistor is appropriate.

E84 Encoder Communication CRC Error

Definition	Encoder Communication CRC Error
Type	Fault
Active shutdown	Yes
SST Message #	FLT 84
Panel Display	E84
Description	The encoder communication CRC error is caused by interference or abnormal conditions leading to inconsistency between the encoder request frame CF command and the response frame CF. This fault prevents Servo Driver from being enabled.
Action Required	Check if Servo Driver is grounded, and ensure that the encoder cable and power cables are routed separately.

E85 Electronic Nameplate (MTP) Read Failure

Definition	Electronic Nameplate Read Failure
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 85
Panel Display	E85
Description	Unable to read the motor model nameplate data. This fault will disable Servo Drive.
Action Required	Reconnect the feedback device. Ensure the motor model nameplate data is readable.

E86 Save and Power Cycle Required

Definition	Save and Power Cycle Required
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Definition	Save and Power Cycle Required
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 86
Panel Display	E86
Description	Parameter save and drive restart required.
Action Required	Save parameters, turn off, and then power on Servo Drive again.

E87 Position Error Exceeded

Definition	Position Error Exceeded
Type	Fault
Active shutdown	No
SST Message #	FLT 87
Panel Display	E87
Description	Position error (PE) has exceeded the position error limit (PEMAX). No position error check is performed when PEMAX is 0. This fault will disable Servo Drive.
Action Required	Adjust Servo Drive tuning to improve position tracking performance, or increase PEMAX to allow for greater position error.

E89 MCU Real-time Task Overload Error

Definition	MCU Real-time Task Overload Error
Type	Fault
SST Message #	FLT 89
Panel Display	E89
Description	The driver has detected that the CPU is approaching its computational limit.
Action Required	Please contact technical support.

E91 EtherCAT Data Packet Loss

Definition	EtherCAT Data Packet Loss
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 91
Panel Display	E91
Description	EtherCAT Data Packet Loss. When DC synchronization is enabled, EtherCAT is in OP state, and no SYNC0 event is received or the SM/SYNC0 queue is invalid. This fault will disable Servo Drive.
Action Required	Ensure that the EtherCAT host (controller) sends data packets within the specified time frame.

E92 EtherCAT State Not Operational

Definition	EtherCAT State Not Operational
Type	Fault

Definition	EtherCAT State Not Operational
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 92
Panel Display	E92
Description	The current state of the EtherCAT slave does not allow this operation.
Action Required	Ensure that the operations allowed in the slave state are performed.

E99 Sankyo Encoder Fault

Definition	Sankyo Encoder Fault
Type	Fault
Active shutdown	No
SST Message #	FLT 99
Panel Display	E99
Description	Multiple faults exist in the Sankyo encoder, including one or more of the following errors: overspeed, position error, multi-turn error. This fault prevents Servo Driver from being enabled.
Action Required	Check the feedback wiring. Ensure the motor is not running at high speed during the encoder initialization process.

E108 Motor name does not match MTP data

Definition	Motor name does not match MTP data
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 108
Panel Display	E108
Description	Motor name does not match MTP data. This fault will disable Servo Drive.
Action Required	Reconnect the feedback device. Ensure the motor model nameplate data is readable.

E109 Drive firmware mismatch

Definition	Drive firmware mismatch
Type	Fault
Active shutdown	No
SST Message #	FLT 109
Panel Display	E109
Description	Drive firmware does not match drive model This fault will disable Servo Drive.
Action Required	Check Servo Drive firmware version and drive model; BD3E drive must use BD3E firmware.

E118 Multi-turn encoder common fault

Definition	Multi-turn encoder common fault
Type	Fault
Active shutdown	No

Definition	Multi-turn encoder common fault
SST Message #	FLT 118
Panel Display	E118
Description	Absolute multi-turn encoder multi-turn information is not yet ready. This fault prevents Servo Driver from being enabled.
Action Required	Clear drive fault. Wait for the multi-turn information to be ready; the fault will clear automatically.

E124 Driver does not support motor

Definition	Driver does not support motor
Type	Fault
Active shutdown	No
SST Message #	FLT 124
Panel Display	E124
Description	Driver does not support motor, typically occurs with BD3E drive paired with optical encoder. This fault prevents Servo Driver from being enabled.
Action Required	Check Servo Driver model and motor encoder type, replace the motor.

E125 PWM carrier frequency setting error

Definition	PWM carrier frequency setting error
Type	Fault
Active shutdown	No
SST Message #	FLT 125
Panel Display	E125
Description	PWM carrier frequency (PWMFRQ) setting error. This fault prevents Servo Driver from being enabled.
Action Required	Check if PWMFRQ is set to 8/12/16 [kHz].

E146 Hardware overcurrent

Definition	Integrated power module (IPM) overcurrent
Type	Fault
Active shutdown	Yes
SST Message #	FLT 146
Panel Display	E146
Description	Hardware overcurrent, actual current exceeds IPM overcurrent threshold, triggering IPM overcurrent signal.
Action Required	Please contact technical support.

E147 Braking resistor value out of range

Definition	Braking resistor value out of range
Type	Fault
Active shutdown	Yes
SST Message #	FLT 147

Definition	Braking resistor value out of range
Panel Display	E147
Description	The braking resistor value entered by the user is less than the minimum required value or greater than the maximum required value.
Action Required	Replace the braking resistor with one that has an appropriate resistance value.

E148 Braking circuit fault

Definition	Braking circuit fault
Type	Fault
Active shutdown	Yes
SST Message #	FLT 148
Panel Display	E148
Description	The brake pipe opening signal does not match the brake pipe status signal.
Action Required	Check the brake pipe wiring for any short circuits or open circuits, and ensure the braking resistor is connected.

E151 Driver parameter initialization failed

Definition	Driver parameter initialization failed
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 151
Panel Display	E151
Description	Driver parameter configuration failed (this error will not occur if the power board EEPROM is normal).
Action Required	Restore factory settings; if the error persists, contact technical support,

E152 Motor parameter initialization failed

Definition	Motor parameter initialization failed
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 152
Panel Display	E152
Description	Motor parameter setting error (incorrect motor model setting when MTP is not used).
Action Required	Restore factory settings; if the error persists, contact technical support,

E153 Power Board EEPROM Checksum Failure

Definition	Power Board EEPROM Checksum Failure
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 153
Panel Display	E153
Description	Power Board EEPROM Checksum Error.

Definition	Power Board EEPROM Checksum Failure
Action Required	Reconfigure Servo Driver, or download the parameter set, and save the parameters. If the problem persists, contact technical support.

E154 EEPROM Version Error

Definition	EEPROM Version Error
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 154
Panel Display	E154
Description	EEPROM version does not match the firmware version.
Action Required	Restore factory settings; if the error persists, contact technical support,

E155 Current Sensor Precharge Abnormality

Definition	Current Sensor Precharge Abnormality
Type	Fault
Active shutdown	Yes
SST Message #	FLT 155
Panel Display	E155
Description	Current Sensor Precharge Abnormality
Action Required	Please contact technical support.

E156 Power-On Timeout

Definition	Power-On Timeout
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 156
Panel Display	E156
Description	After detecting IPM lower bridge short circuit fault and motor power line to ground short circuit fault, the relay has not engaged after more than 5 seconds.
Action Required	Please check the input circuit.

E157 Parameter EEPROM Fault

Definition	Parameter EEPROM Fault
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 157
Panel Display	E157

Definition	Parameter EEPROM Fault
Description	Failed to read EEPROM parameters.
Action Required	Restore factory settings; if the error persists, contact technical support,

E158 Control Board EEPROM Checksum Failure

Definition	Control Board EEPROM Checksum Failure
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 158
Panel Display	E158
Description	Control Board EEPROM Checksum Error.
Action Required	Reconfigure Servo Driver, or download the parameter set, and save the parameters. If the problem persists, contact technical support.

E159 Write Power Board EEPROM Failed

Definition	Failed to write to power board EEPROM
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 159
Panel Display	E159
Description	Write to Power Board EEPROM Failed.
Action Required	Restore factory settings; if the error persists, contact technical support,

E160 Write Control Board EEPROM Failed

Definition	Failed to write to control board EEPROM
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 160
Panel Display	E160
Description	Write to Control Board EEPROM Failed.
Action Required	Restore factory settings; if the error persists, contact technical support,

E161 Control Board and Drive Board Mismatch

Definition	Control Board and Drive Board Mismatch
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 161
Panel Display	E161
Description	Control Board and Power Board Mismatch (Power Board Model Does Not Match the One Stored in Control Board).

Definition	Control Board and Drive Board Mismatch
Action Required	Restore factory settings; if the error persists, contact technical support,

E162 Touch Probe No Signal

Definition	Touch Probe No Signal
Type	Fault
Active shutdown	Yes
SST Message #	FLT 162
Panel Display	E162
Description	Touch Probe Signal Enabled and Touch Probe Digital IO Not Configured.
Action Required	Need to Configure Touch Probe Digital IO.

E163 Electronic Gear Calculation Overflow

Definition	Electronic Gear Calculation Overflow
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 163
Panel Display	E163
Description	Electronic gear calculation data overflow.
Action Required	Set an effective electronic gear ratio.

E164 Electronic gear out of range

Definition	Electronic gear out of range
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 164
Panel Display	E164
Description	Electronic gear setting range exceeded.
Action Required	Set valid electronic gear ratio parameters.

E165 SensAR encoder initialization failed

Definition	SensAR encoder initialization failed
Type	Fault
Active shutdown	Not Applicable
SST Message #	FLT 165
Panel Display	E165

Definition	SensAR encoder initialization failed
Description	Encoder type not disabled when modifying, mismatch in single-turn bits when changing encoder type through FeedBackType.
Action Required	Check the feedback wiring. Ensure the motor is not running at high speed during the encoder initialization process.

E166 Integrated power module (IPM) lower bridge short circuit

Definition	Integrated power module (IPM) lower bridge short circuit
Type	Fault
Active shutdown	Yes
SST Message #	FLT 166
Panel Display	E166
Description	IPM lower bridge overcurrent detected during power-on self-test.
Action Required	Please contact technical support.

E167 three-phase (UVW) to ground short circuit

Definition	three-phase (UVW) to ground short circuit
Type	Fault
Active shutdown	Yes
SST Message #	FLT 167
Panel Display	E167
Description	Motor power line to ground short circuit fault.
Action Required	Inspect the wiring to avoid motor power line short circuits.

E168 Encoder multi-turn count overflow

Definition	Encoder multi-turn count overflow
Type	Fault
Active shutdown	Yes
SST Message #	FLT 168
Panel Display	E168
Description	Encoder multi-turn count overflow.
Action Required	Use the MTTURNRESET command to clear the multi-turn information, and it is recommended to reset the zero point.

E174 Return to Zero error

Definition	Return to Zero error
Type	Fault
Active shutdown	Yes
SST Message #	FLT 174
Panel Display	E174
Description	Return to Zero operation not completed
Action Required	Check the return to zero switch to clear the error and retry.

E175 Encoder power supply error

Definition	Encoder power supply error
Type	Fault
Active shutdown	Yes
SST Message #	FLT 175
Panel Display	E175
Description	The driver detects an encoder power supply error.
Action Required	Check the encoder cable and socket.

E176 PDO mapping has reached the maximum number

Definition	PDO mapping has reached the maximum number
Type	Fault
Active shutdown	Yes
SST Message #	FLT 176
Panel Display	E176
Description	The number of channels in PDO mapping is greater than 1 or the number of PDO objects is greater than 8.
Action Required	Reduce the number of PDO channels or PDO objects.

E177 Unsupported interpolation cycle

Definition	Unsupported interpolation cycle
Type	Fault
Active shutdown	Yes
SST Message #	FLT 177
Panel Display	E177
Description	The DC cycle or the time set via 0x60C2 is not supported.
Action Required	Change to an appropriate interpolation cycle.

E178 Collision detected

Definition	Collision detected
Type	Fault
Active shutdown	Yes
SST Message #	FLT 178
Panel Display	E178
Description	Collision detected by collision detection function.
Action Required	No action required.

E179 Torque output has reached the limit

Definition	Torque output has reached the limit
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.
SST Message #	FLT 179
Panel Display	E179
Description	Torque output has reached the user-set torque limit value. This fault prevents Servo Driver from being enabled.
Action Required	Check the system or torque limit.

E180 Position Notch Filter Overflow

Definition	Position Notch Filter Overflow
Type	Fault
Active shutdown	Yes
SST Message #	FLT 180
Panel Display	E180
Description	Position Notch Filter Calculation Overflow.
Action Required	Check Position Notch Filter Parameters.

E181 Main Circuit Power Phase Loss

Definition	Main circuit power phase missing
Type	Fault
Active shutdown	This fault can trigger the active shutdown function.

Definition	Main circuit power phase missing
SST Message #	FLT 181
Panel Display	E181
Description	One phase of the main circuit power is not connected. This fault prevents Servo Driver from being enabled.
Action Required	Check the connections of the main circuit source. Ensure the supply is normal. Refer to the wiring diagram and relevant parameters.

11.6 Warning, Error, and Fault Messages

The table below shows possible faults, warnings, and error codes that may be displayed when operating in terminal mode. All faults and many warnings are also displayed on Servo Drive's digital display. Specific conditions generate only interface warning messages.

11.6.1 Warning Messages

BD3E Drive warnings are reported in object 2011h.

Due to BD3E The warning is 96 bits, divided into three 32-bit segments.

Table 11- 17 Warning Codes and Messages

Exception Code	Description	5-Segment Display Code	Warning #Number
00000000 00000000 00000001h	STO Warning	A1	WRN 1
00000000 00000000 00000002h	Driver Overload	A2	WRN 2
00000000 00000000 00000004h	Motor Overload	A3	WRN 3
00000000 00000000 00000008h	Undervoltage	A4	WRN 4
00000000 00000000 00000010h	Power Module Overtemperature	A5	WRN 5
00000000 00000000 00004000h	Hardware Positive Limit Switch Triggered	A15	WRN 15
Exception Code	Description	5-Segment Display Code	Warning #Number
00000000 00000000 00008000h	Hardware Negative Limit Switch Triggered	A16	WRN 16
00000000 00000000 00010000h	Hardware Positive and Negative Limit Switches Triggered	A17	WRN 17
00000000 00000000 00020000h	Positive software limit triggered	A18	WRN 18
00000000 00000000 00040000h	Negative software limit triggered	A19	WRN 19
00000000 00000000 00080000h	Positive and negative software limits triggered	A20	WRN 20
00000000 00000000 00200000h	Encoder battery voltage low	A22	WRN 22
00000000 00000000 80000000h	Main circuit power phase missing	A32	WRN 32
00000000 00000002 00000000h	Braking resistor overload	A34	WRN 34
00000000 00000008 00000000h	MCU real-time load warning	A36	WRN 36
00000000 00000020 00000000h	IPM Module Overtemperature	A38	WRN 38
00000000 00008000 00000000h	Default Driver Configuration	A48	WRN 48
00000001 00000000 00000000h	Failed to restore default parameter settings	A65	WRN 65
00000002 00000000 00000000h	Failed to read EEPROM parameters	A66	WRN 66

00000004 00000000 00000000h	Failed to clear error history	A67	WRN 67
00000008 00000000 00000000h	Read-back EEPROM parameters out of range	A68	WRN 68
00000010 00000000 00000000h	Sync0 time does not match interpolation time	A69	WRN 69
00000040 00000000 00000000h	Failed to write to power board EEPROM	A71	WRN 71
00000080 00000000 00000000h	Failed to write to control board EEPROM	A72	WRN 72
00000400 00000000 00000000h	Collision detected	A75	WRN 75

11.6.2 Error Messages - Manufacturer Specific

BD3E drive error messages are reported in the ServoStudio 2 terminal interface.

Table 11- 18 Error number and message - manufacturer specific

Error number	#	Error message	Chinese interpretation
ERR	20	Unknown command	Unknown command
ERR	21	Unknown variable	Unknown variable
ERR	22	Checksum error	Checksum error
ERR	23	Drive active	Drive enabled
ERR	24	Drive inactive	Drive disabled
ERR	25	Value out of range	Data out of range
ERR	26	Value too much	Data too small
ERR	27	OPMODE invalid	Invalid OPMODE
ERR	28	Syntax error	Syntax error
ERR	29	Value too high	Data too large
ERR	36	Not programmable	Not programmable
ERR	37	Not Configured	Not Configured
ERR	38	N/A	N/A
ERR	42	Flash invalid	Invalid Flash
ERR	43	Recording active	Waveform recording in use
ERR	44	Recorded data not available	Waveform data unavailable
ERR	45	NVRAM empty	Non-volatile RAM empty
ERR	46	Value must be an even number	Data must be even
ERR	49	Value must be a multiple of 0.25	Data must be multiplied by 0.25
ERR	50	SAVE to flash failed	Failed to save Flash
ERR	51	Not available	Unavailable
ERR	56	Value must be divisible by 4	Data must be divided by 4
ERR	66	Password protected	Password protected
ERR	82	Functionality already defined	Function already defined
ERR	96	Variable is not recordable	Variables cannot record waveform
ERR	104	Motion pending	Unexecuted motion command exists
ERR	116	Fieldbus MODE(COMMODE=1) active	Bus mode (COMMODE 1) activated
ERR	210	VLIM out of range	Speed limit value out of range
ERR	270	Cannot be SET when MTPMODE>0	Cannot set when MTPMODE>0
ERR	300	Record data too much	Too many recorded data
ERR	380	Remote enable is on	Remote enable activated
ERR	400	Not supported parameter backup	Parameter backup not supported

11.6.3 Fault Messages

Table 11- 19 Fault code and display

Fault code	Description	5-Segment Display Code	Fault #number
0x5585	Parameter storage verification failed	E2	FLT 2
0x2214	Software Overcurrent	E3	FLT 3

Fault code	Description	5-Segment Display Code	Fault #number
0x3181	STO Fault	E4	FLT 4
0x5581	Control board EEPROM error	E6	FLT 6
0x5530	Power board EEPROM error	E7	FLT 7
0x3110	Overvoltage	E9	FLT 9
0x4310	Power Board Overtemperature	E10	FLT 10
0x3120	Undervoltage	E11	FLT 11
0x6381	Not Configured	E12	FLT 12
0x5586	Failed to write parameters to EEPROM	E13	FLT 13
0x8481	Motor overspeed	E14	FLT 14
0x2311	Driver Overload	E16	FLT 16
0x2310	Motor Overload	E17	FLT 17
0x7380	Encoder communication error	E34	FLT 34
0x4080	IPM overheating	E39	FLT 39
0x7382	Tamagawa initialization failed	E42	FLT 42
0x2380	Current Sensor Bias Abnormality	E43	FLT 43
0x7388	Tamagawa encoder error	E49	FLT 49
0x2381	Motor Phase Line Missing	E51	FLT 51
0x7385	Multi-turn Encoder Battery Voltage Low	E56	FLT 56
0x7091	Emergency Stop	E57	FLT 57
0x7121	Motor Stalled	E59	FLT 59
0x7580	Bus Communication Disconnected	E65	FLT 65
0x8482	Speed Error Exceeded	E67	FLT 67
0xFF01	Internal Error	E70	FLT 70
0x7198	Motor Runaway	E77	FLT 77
0x3183	Main circuit power phase missing	E78	FLT 78
0xFF05	Cooling fan failure	E79	FLT 79
0x738D	Encoder Error	E82	FLT 82
0x3199	Braking resistor overload	E83	FLT 83
0x7388	Encoder Communication CRC Error	E84	FLT 84
0xFF02	Failed to Read Motor Electronic Nameplate	E85	FLT 85
0xFF03	Save and Power Cycle Required	E86	FLT 86
0x8689	Position Error Too Large	E87	FLT 87
0xFF04	MCU Real-time Load Overload Error	E89	FLT 89
0x818D	EtherCAT Frame Lost	E91	FLT 91
0xF080	CAN/EtherCAT in Inoperable State	E92	FLT 92
0x7388	Sankyo Encoder Error	E99	FLT 99
0xFF14	Motor Mismatch	E108	FLT 108
0x3187	Multi-turn Encoder Error	E118	FLT 118
0x2214	Hardware Overcurrent	E146	FLT 146
0x6320	Brake Resistor Value Out of Range	E147	FLT 147
0x3199	Braking circuit fault	E148	FLT 148
0x6320	Driver parameter initialization failed	E151	FLT 151
0x6320	Motor parameter initialization failed	E152	FLT 152
0x5585	Power Board EEPROM Check Error	E153	FLT 153
0x5585	EEPROM Version Error	E154	FLT 154
0x2380	Current Sensor Precharge Abnormality	E155	FLT 155
0x6320	Main Power Supply Timeout	E156	FLT 156
0x5581	Parameter EEPROM Error	E157	FLT 157
0x5585	Control Board EEPROM Check Error	E158	FLT 158
0x5530	Failed to write to power board EEPROM	E159	FLT 159
0x5581	Failed to write to control board EEPROM	E160	FLT 160
0x5585	Control Board and Power Board Mismatch	E161	FLT 161
0x6320	Touch Probe Signal Not Configured	E162	FLT 162
0x6320	Electronic Gear Ratio Calculation Overflow	E163	FLT 163
0x6320	Electronic Gear Ratio Out of Range	E164	FLT 164
0x7382	SenseAR Initialization Failed	E165	FLT 165
0x2250	IPM Lower Arm Short Circuit	E166	FLT 166
0x2330	UVW to Ground Short Circuit	E167	FLT 167
0x7305	Encoder Multi-turn Counter Overflow	E168	FLT 168
0x6100	Return to Zero error	E174	FLT 174
0x7380	Encoder power supply error	E175	FLT 175
0x7580	PDO mapping has reached the maximum	E176	FLT 176

Fault code	Description	5-Segment Display Code	Fault #number
	number		
0x7580	Unsupported interpolation cycle	E177	FLT 177
0x7580	Collision detected	E178	FLT 178
0x7580	Torque output has reached the limit	E179	FLT 179
0x6320	Position Command Notch Compensation Overflow	E180	FLT 180
0xFF03	MTP Unsupported Encoder Type	E201	FLT 201
0xFF04	MTP Motor Parameters Damaged	E202	FLT 202
0xFF14	Encoder Communication CRC Error	E203	FLT 203
0xFF16	Tamagawa Encoder Overspeed Bit 0	E204	FLT 204
0xFF14	Tamagawa Encoder Count Overflow Bit 3	E205	FLT 205
0xFF14	Tamagawa Encoder Overheat Bit 4	E206	FLT 206
0xFF14	Tamagawa Encoder Multi-turn Abnormal Bit 5	E207	FLT 207

12. Accessories

12.1 Docking Connectors

Note: The power and motor connection connectors are provided with Servo Driver.

Table 12- 20 C4-I/O Connection Connector

Manufacturer	Name	Manufacturer Part Number	Servotronic Part Number
Antek	Docking Socket	HPCNS-20-S-BK-11-3-S1	11201707001735
Antek	Connector Housing	HPPCS02-20-S-BK-11-3	17419400001183

Table 12- 21 C5-Encoder Feedback Docking Connector

Manufacturer	Name	Manufacturer Part Number	Servotronic Part Number
Sanzhu	Welding Plug Connector	SC-06-4	12119400000273

Table 12- 22 P1-Power and Motor Docking Connector

Driver Model	Manufacturer	Name	Manufacturer Part Number	Servotronic Part Number
BD3E -1D62AEB BD3E -2D82AEB BD3E -5D52AEB	Sanzhu	Plug for Pluggable Terminal Blocks	SC-T3005008SB0XT-45	11201707001675
BD3E -7D62AEB BD3E -0122AEB BD3E -3D54DEB BD3E -5D44DEB BD3E -8D44DEB BD3E -0124DEB	Kosong	Plug for Pluggable Terminal Blocks	9EDGK-7.5-09P-13-1051Z(H)	11201707002135

12.2 Cables

Table 12- 23 C5-PM2 Motor Encoder Cable

Encoder Type	Connector Type	Length	Servotronic Part Number
Single-turn Magnetic Encoder	D、A	3 meters 5 meters 10 meters 15 meters 20 meters	CBL-FBPH21S301D0xx (Non-flexible) CBL-FBPH22S301D0xx (Flexible) CBL-FBPH21S301A0xx (Non-flexible) CBL-FBPH22S301A0xx (Flexible)
Multi-turn Magnetic Encoder	D、A	3 meters 5 meters 10 meters 15 meters 20 meters	CBL-FBPH21T203D0xx (Non-flexible) CBL-FBPH22T203D0xx (Flexible) CBL-FBPH21T203A0xx (Non-flexible) CBL-FBPH22T203A0xx (Flexible)

Note: Encoder Type

S3: Single-turn Absolute 20-bit Magnetic Encoder

T2: Multi-turn Absolute 20-bit Magnetic Encoder Connector Type

D: 300mm Cable with AMP Connector, Suitable for Flange Sizes: 04, 06, 08

A: MIL Connector (Aviation Plug), Suitable for Flange Sizes: 10, 13 Length

xx: 03/05/10/15/20, Representing 3/5/10/15/20 Meters Respectively;

Table 12- 24 P2–PM2 Motor Cable

Encoder Type	Connector Type	Length	Servotronics Part Number
Single-turn Magnetic Encoder	D、A	3 meters	CBL-FBPH21S301D0xx (Non-flexible)
		5 meters	CBL-FBPH22S301D0xx (Flexible)
		10 meters	CBL-FBPH21S301A0xx (Non-flexible)
		15 meters	CBL-FBPH22S301A0xx (Flexible)
		20 meters	
Multi-turn Magnetic Encoder	D、A	3 meters	CBL-FBPH21T203D0xx (Non-flexible)
		5 meters	CBL-FBPH22T203D0xx (Flexible)
		10 meters	CBL-FBPH21T203A0xx (Non-flexible)
		15 meters	CBL-FBPH22T203A0xx (Flexible)
		20 meters	

12.3 Line Filters

The following table lists the recommended line filter manufacturers and part numbers for BD3E .

Table 12- 25 BD3E Recommended Line Filters

Driver	Manufacturer Part Number
BD3E -1D62AEB BD3E -2D82AEB	LCR: 055M.80601.00
	LCR: 092.00623.00
	Schaffner: FN2070-6
BD3E -5D52AEB	LCR: 0923.01021.00
	LCR: 092.01023.00
	LCR: 055.81011.00
	Schaffner: FN2070-10
BD3E -3D54DEB BD3E -5D44DEB BD3E -8D44DEB BD3E -0124DEB	LCR: 096B.02001.00
	LCR: 097.01601.00
	Schaffner: FN3258-16-44

12.4 Regenerative Resistor

The resistance value (ohms) is defined by the BD3E servo drive, and the required power is defined by the application. Therefore, there are multiple regenerative resistor options for each drive.Ω

The recommended manufacturers and part numbers for regenerative resistors for use with BD3E are listed in the table below.

Table 12- 26 BD3E Recommended Regenerative Resistors

Driver	Power (W)	Resistance Value	Manufacturer Part Number
BD3E -1D62AEB BD3E -2D82AEB BD3E -5D52AEB	150	40Ω	Lifoo: RXLG-150W-40RJ
	300		Lifoo: RXLG-300W-40RJ
	600		Lifoo: RXLG-600W-40RJ
	1000		Lifoo: RXLG-1000W-40RJ
	2000		Lifoo: RXLG-2000W-40RJ
BD3E -3D54DEB BD3E -5D44DEB	150	100Ω	LaiFu: RXLG-150W-100RJ
	300		LaiFu: RXLG-300W-100RJ
	600		LaiFu: RXLG-600W-100RJ
	1000		LaiFu: RXLG-1000W-100RJ
	2000		LaiFu: RXLG-2000W-100RJ
BD3E -8D44DEB BD3E -0124DEB	150	50Ω	LaiFu: RXLG-150W-50RJ
	300		LaiFu: RXLG-300W-50RJ
	600		LaiFu: RXLG-600W-50RJ
	1000		LaiFu: RXLG-1000W-50RJ
	2000		LaiFu: RXLG-2000W-50RJ

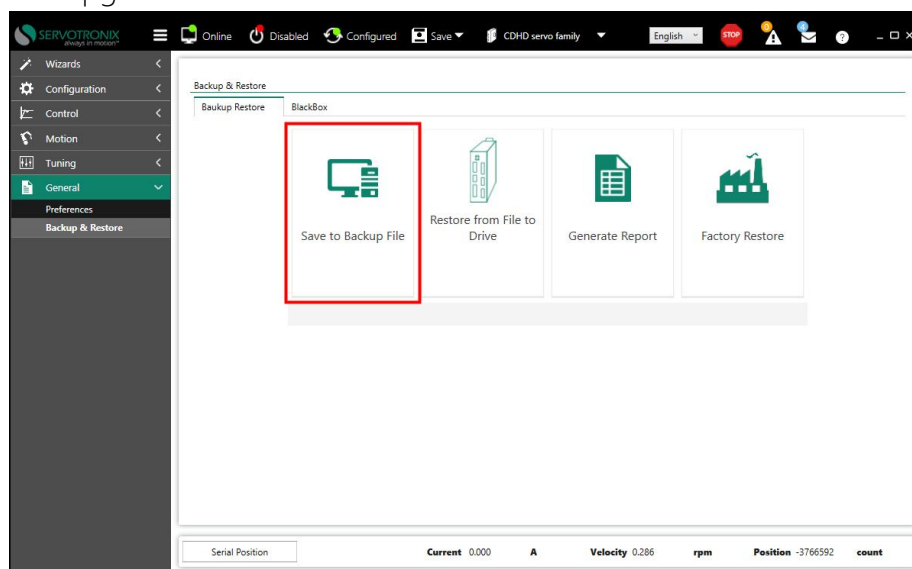
13. Application Guidelines

13.1 Firmware Upgrade

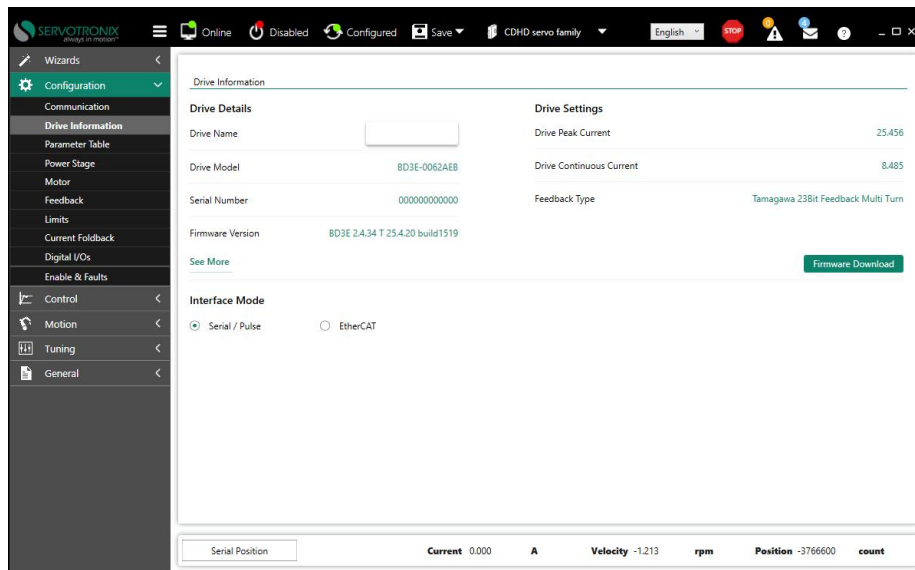
This application guide describes the method for upgrading the MCU firmware of the BD3E drive and the troubleshooting steps if issues arise during the process. During the MCU firmware update, the LED displays a rapidly flashing 'LOAD⁻' or 'LOAD₋'.

13.1.1 Firmware Upgrade

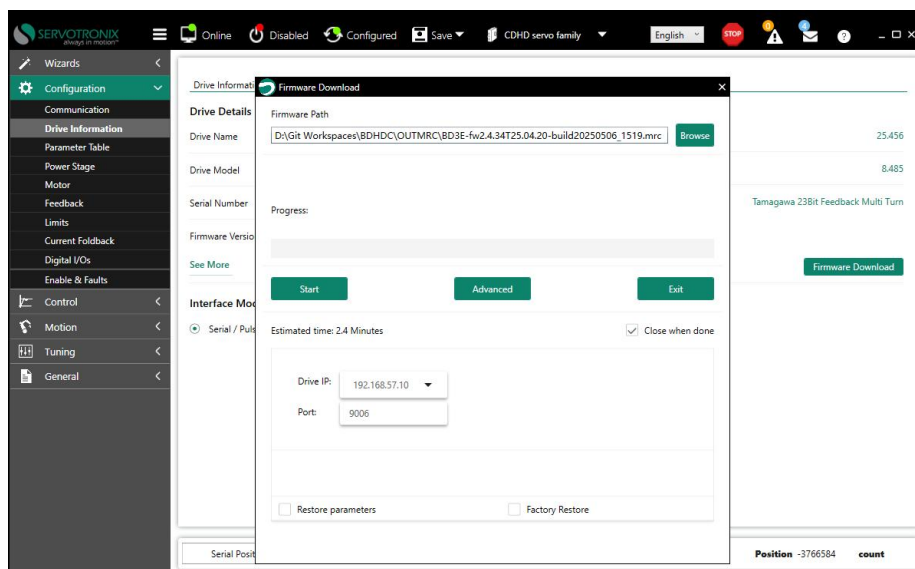
1) Open ServoStudio 2 software to back up parameters. This step is not mandatory, but it is recommended to back up Servo Driver parameters to an .ssv file before each MCU firmware upgrade.



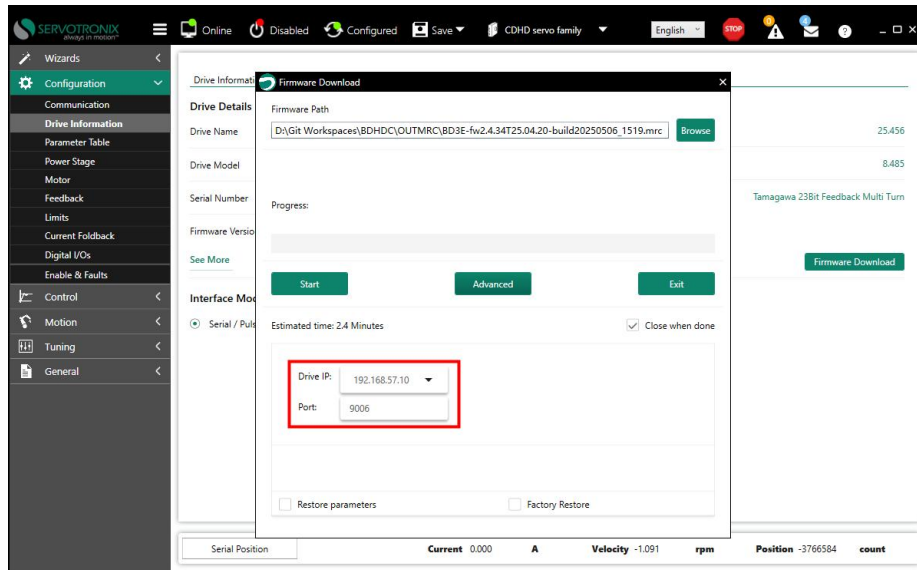
2) Enter the firmware download interface.



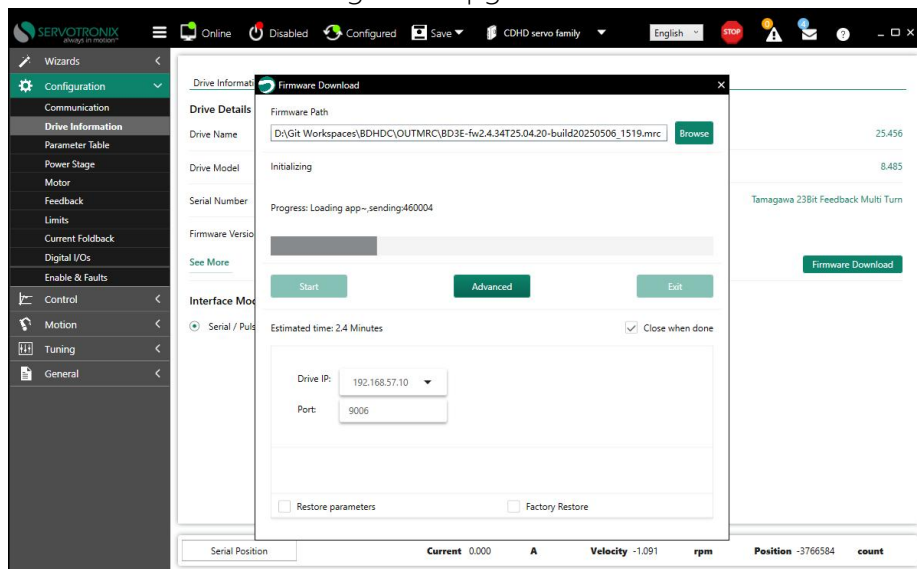
3) Select the firmware with the .mrc suffix.



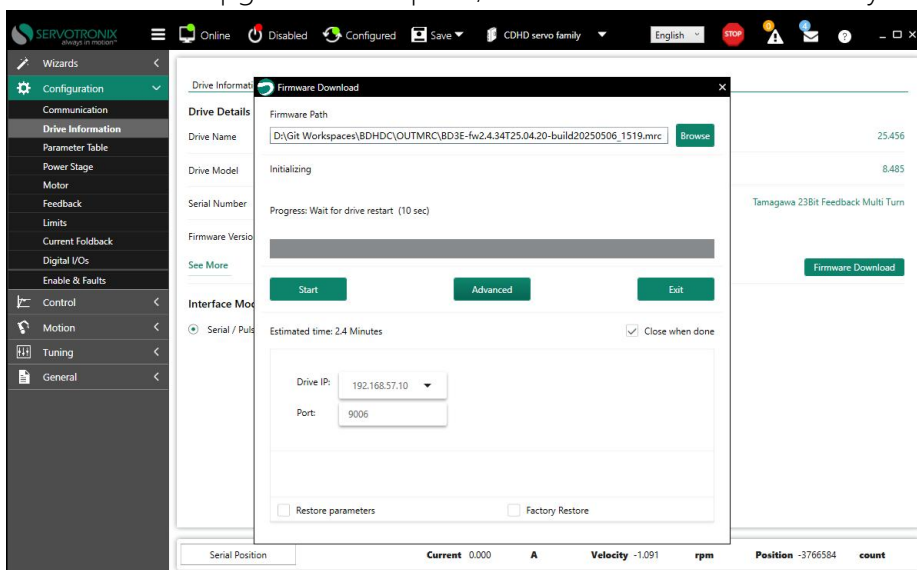
4) For offline upgrades, expand the “Advanced” options and select the IP address and port of the BD3E drive to be upgraded.



5) Click the “Start” button to begin the upgrade.



6) After the firmware upgrade is complete, Servo Drive will automatically restart.



7) Restore factory settings.

Switch to the terminal page and enter

```
-->factoryrestore 1234
```

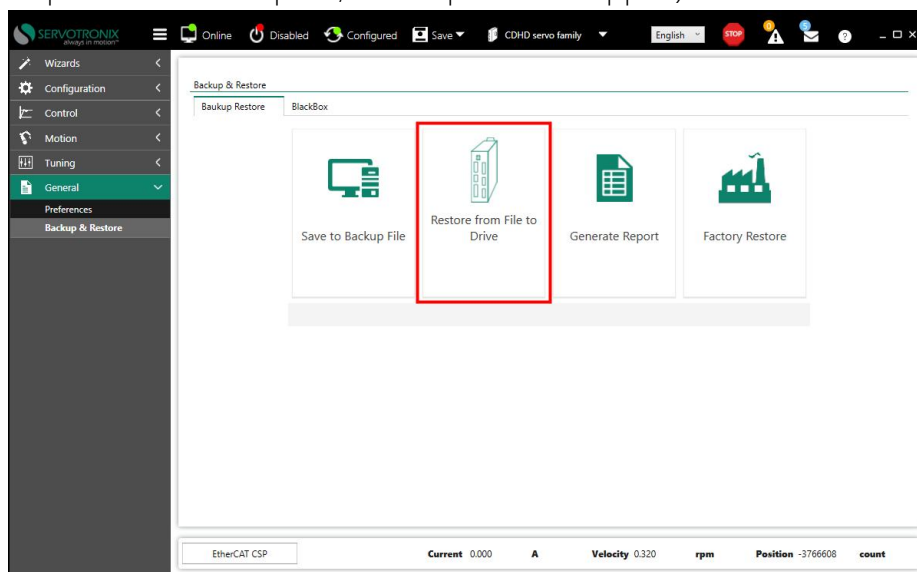
Parameter recover success

```
-->save
```

save

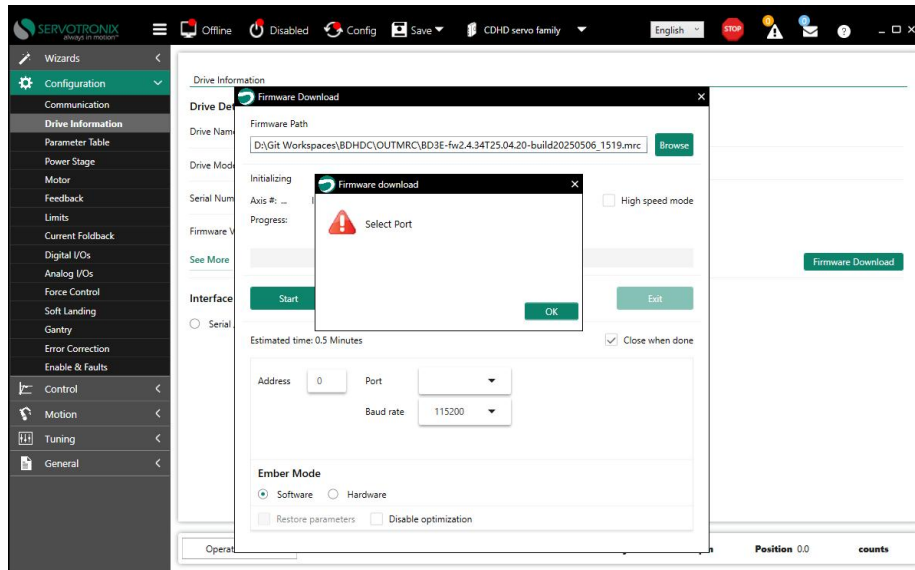
```
-->restart
```

8) Import the parameter backup file, save it to Servo Drive, and then power it back on (if there is no parameter backup file, this step can be skipped).



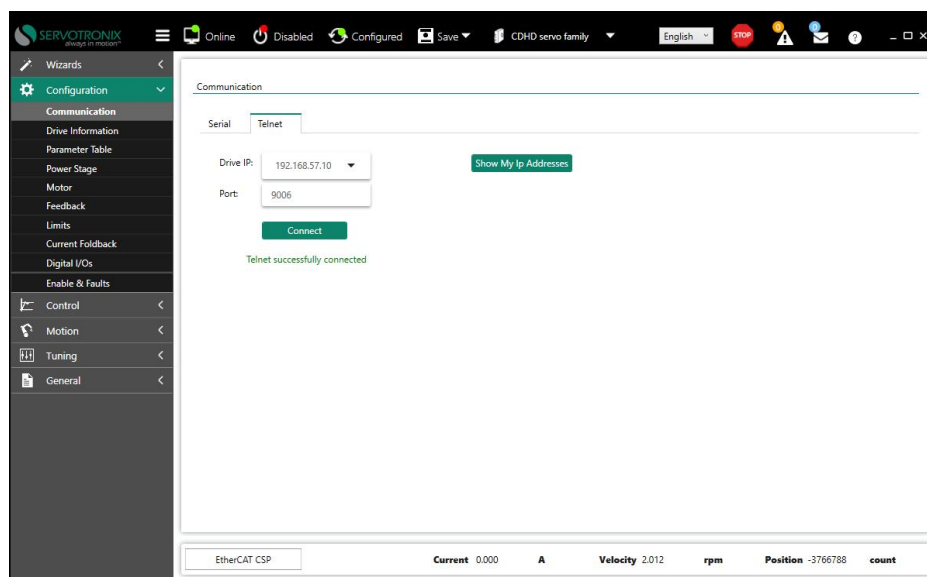
13.1.2 Possible Issues and Solutions

1) A prompt indicates that you need to select firmware in .i00 format; firmware in .mrc format cannot be selected.

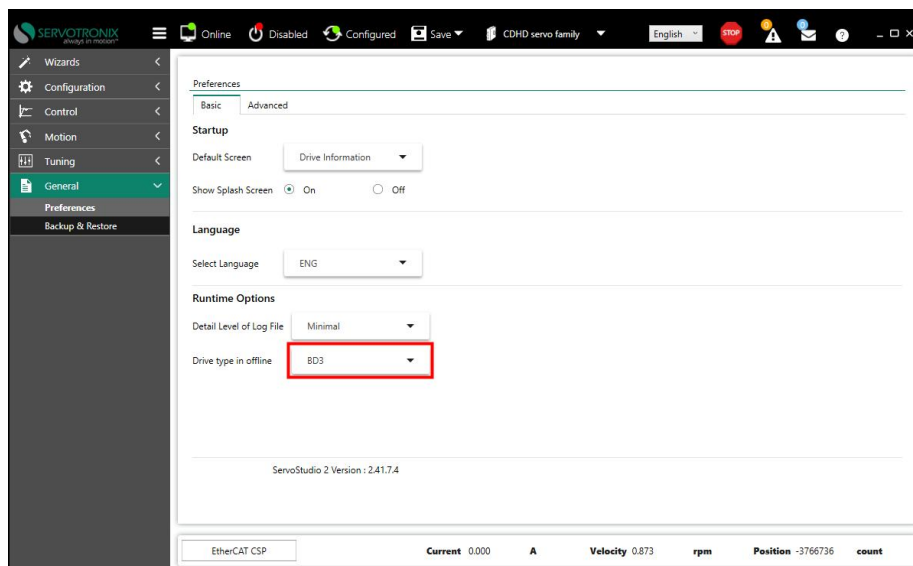


Solution:

This issue occurs because ServoStudio 2 software has not communicated with Servo Drive after being opened. Communication with Servo Drive must be established before proceeding with the upgrade.



If Servo Driver can no longer communicate normally and Servo Driver scrolls to display the IP address or shows 'LOAD-' flashing, after changing the setting in ServoStudio 2 software "General" -> "Preferences" -> "Driver Type When Offline" to BD3, you can proceed with the normal upgrade.

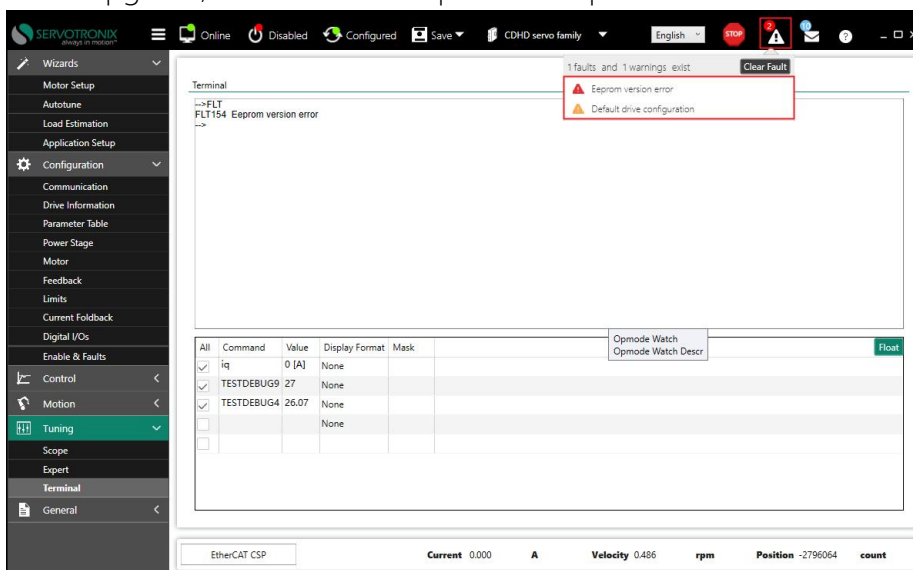


2) The upgrade process gets stuck at: nack error or other errors

Solution:

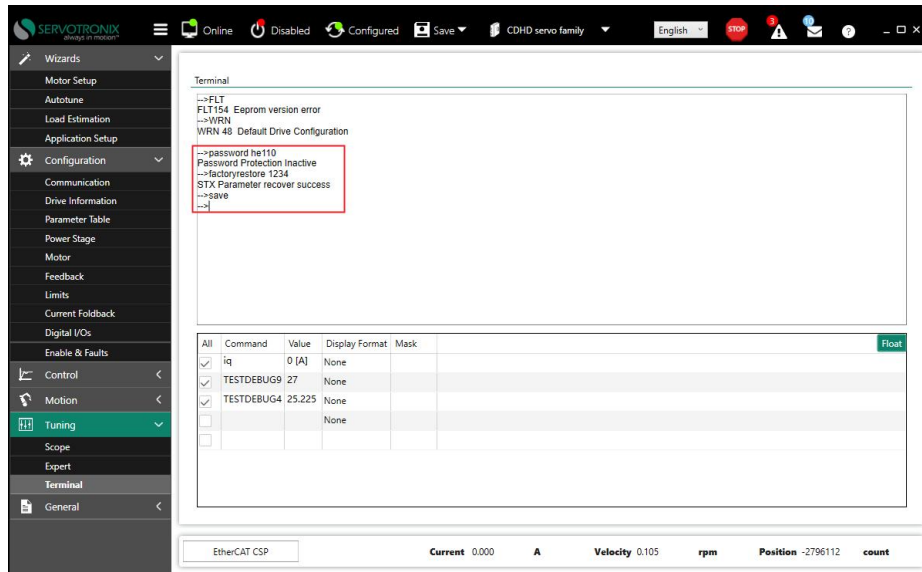
Click the 'Start' button again to retry the upgrade without any additional operations. If multiple retries still fail, power cycle Servo Driver.

3) After the upgrade, ServoStudio 2 reports an Eeprom version error.

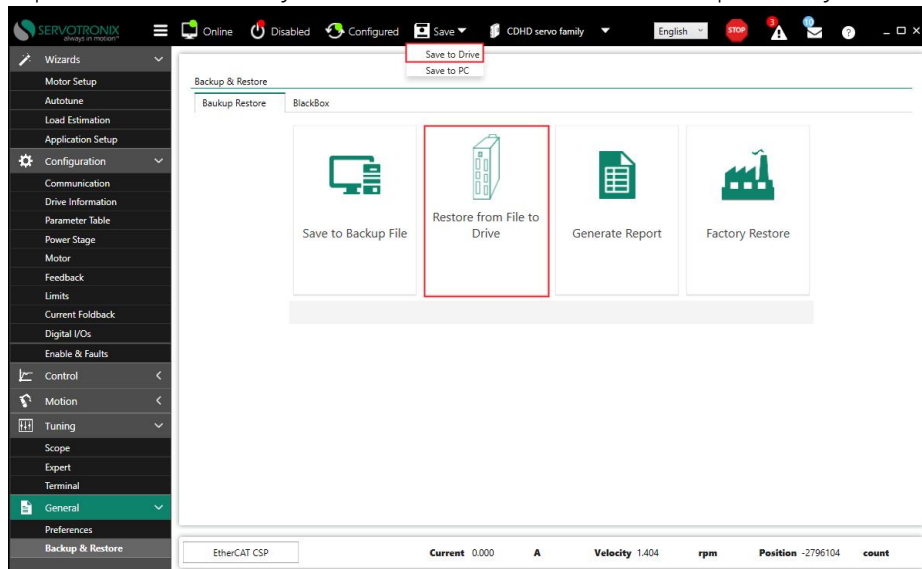


Solution:

After the firmware upgrade, the firmware version changes, causing the EEPROM parameters to be mismatched with the firmware. Perform a factory reset operation in the terminal interface, then power on again. If ServoStudio 2 cannot connect and reports an error, check Servo Driver panel parameters P0001 IP address, P0002 port number, P0003 subnet mask, P0004 gateway, and ensure they match before attempting to connect again.



If you need to restore Servo Driver parameters from a backup, import the parameters through the parameter recovery interface, save them, and then power cycle Servo Driver.



5) If clicking the firmware upgrade button does not bring up the upgrade dialog and the software becomes unresponsive, click has no reaction.

Solution:

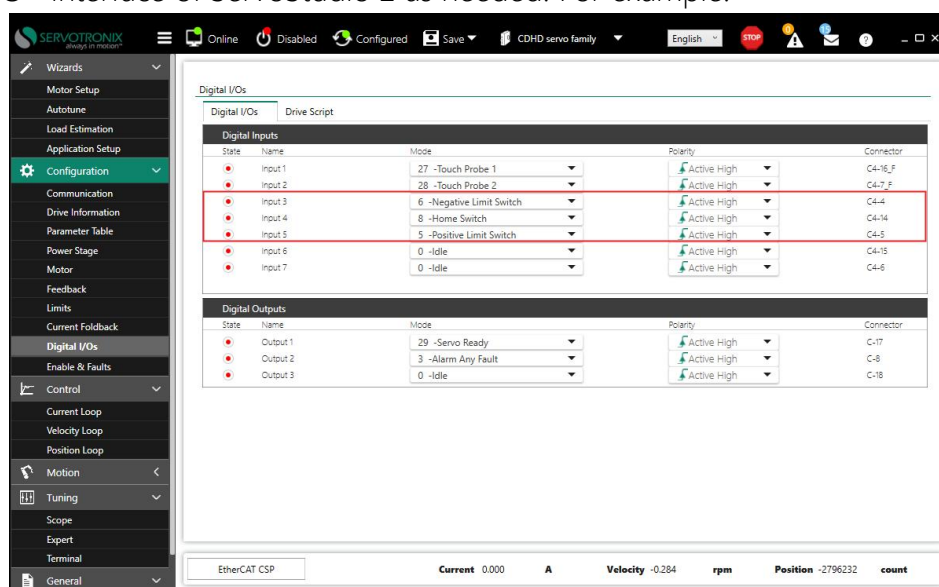
ServoStudio 2 has an upgrade protection mechanism; clicking the firmware download button will automatically send a disable command. However, in EtherCAT mode, ServoStudio 2 does not have the permission to disable, so if the EtherCAT master station does not send a disable command at this time, ServoStudio 2 cannot bring up the firmware download interface, and the software cannot be operated. In this case, the

EtherCAT master station needs to send a disable command, after which ServoStudio 2 will automatically bring up the firmware upgrade interface.

13.2 Return to Zero Function

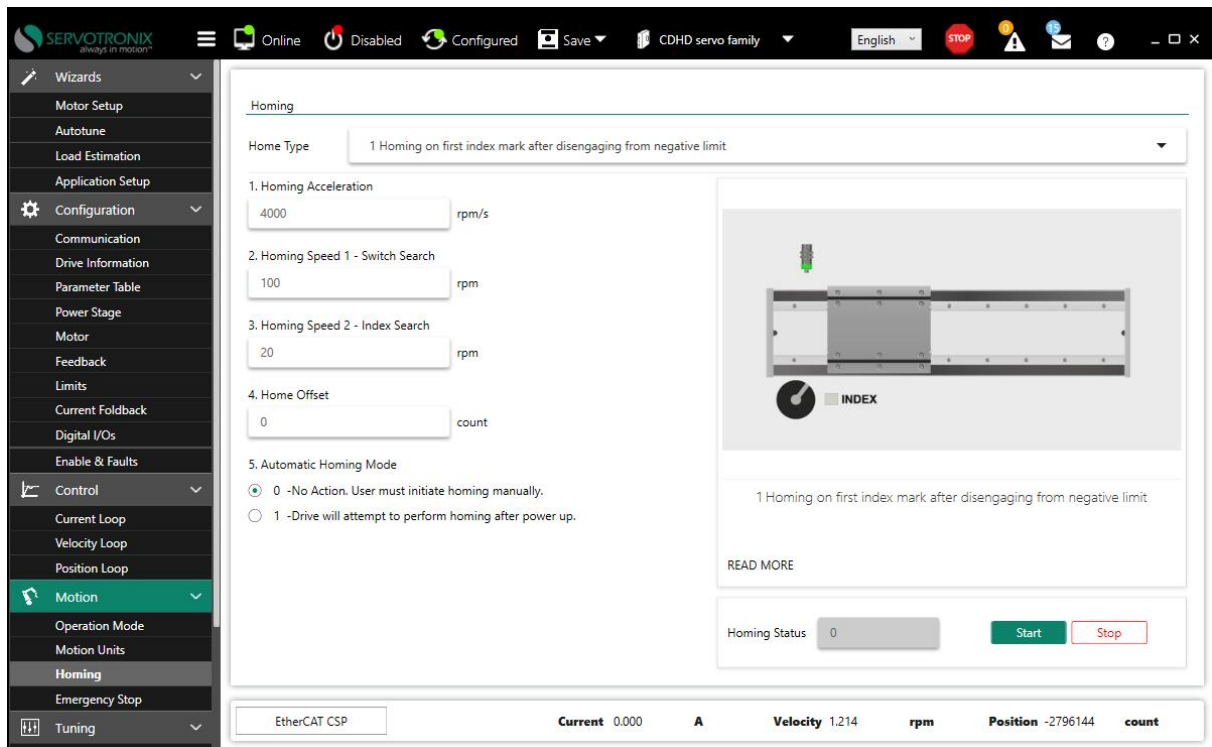
This application note describes how to perform the Return to Zero function and assumes that you are familiar with the use of ServoStudio 2 software.

Before returning to zero, allocate the home switch "Home Switch", positive limit switch "Positive Limit Switch", or negative limit switch "Negative Limit Switch" through the "Digital I/O" interface of ServoStudio 2 as needed. For example:

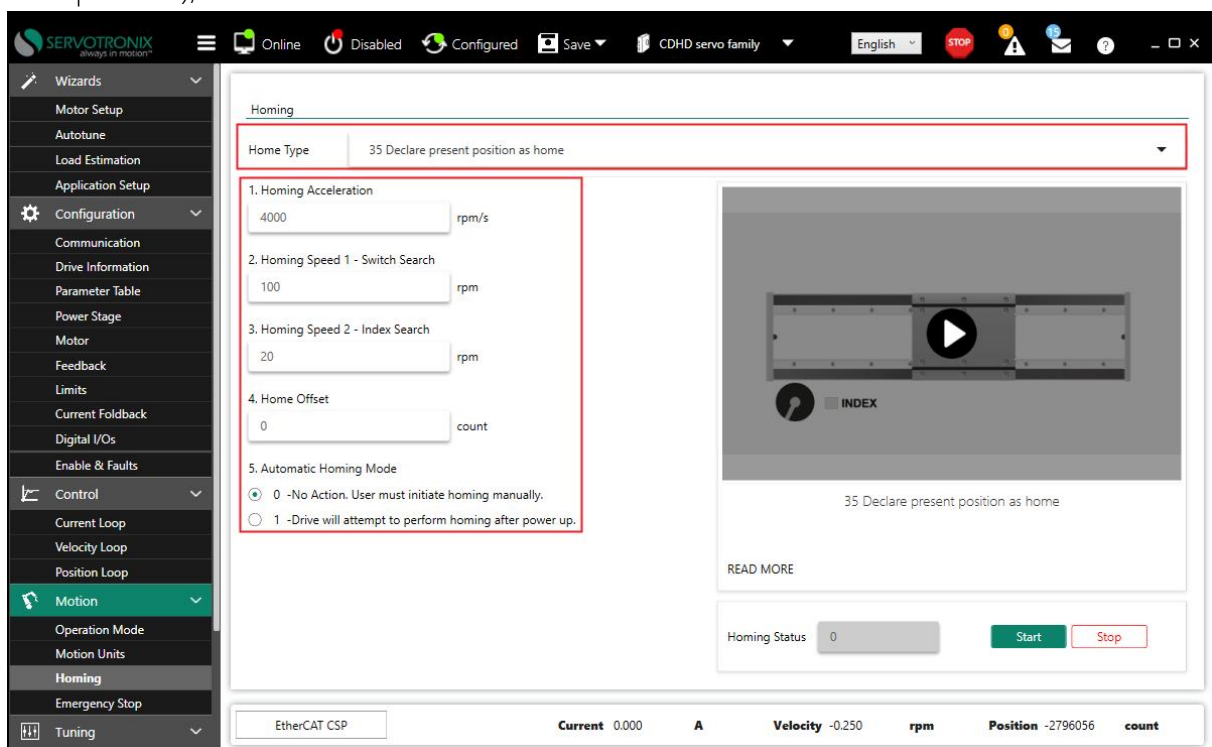


13.2.1 Steps to Execute in ServoStudio 2 Interface

- 1) Open ServoStudio 2 software and enter the "Return to Zero" interface.



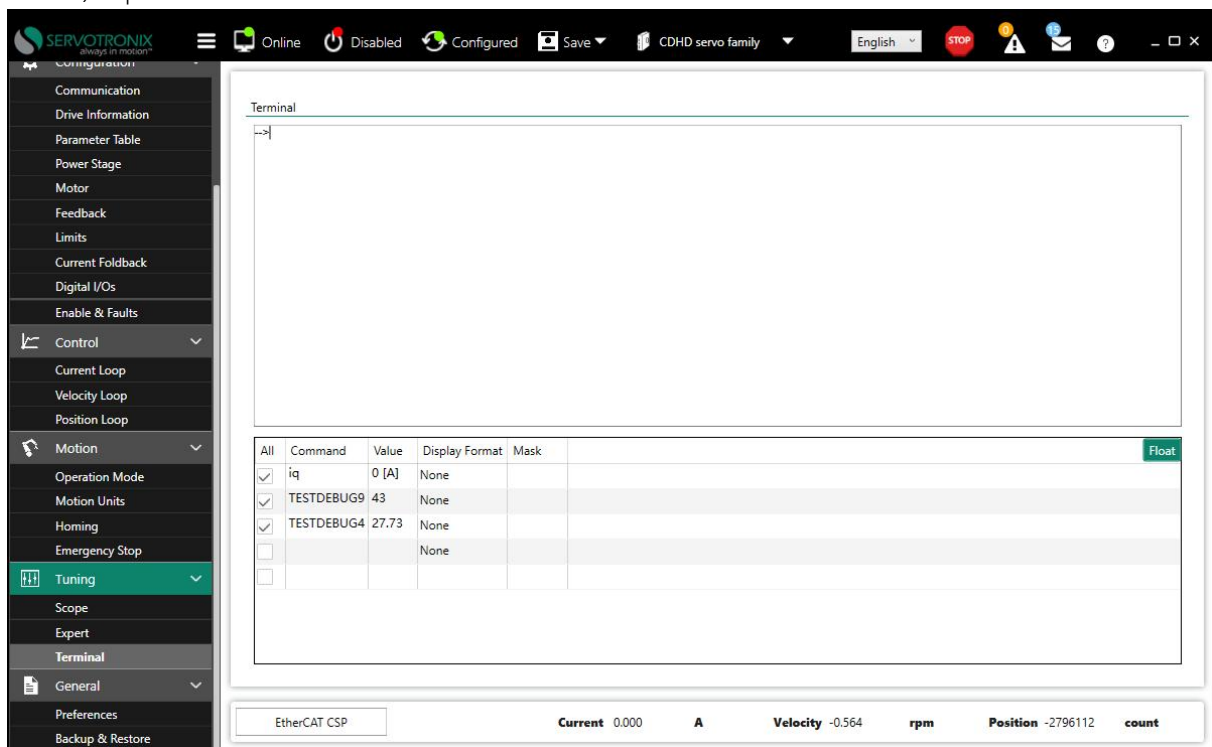
2) Select the “Return to Zero Type”, set the Homing return to zero acceleration, first return to zero speed (for finding the switch), second return to zero speed (for finding the zero position), and return to zero offset.



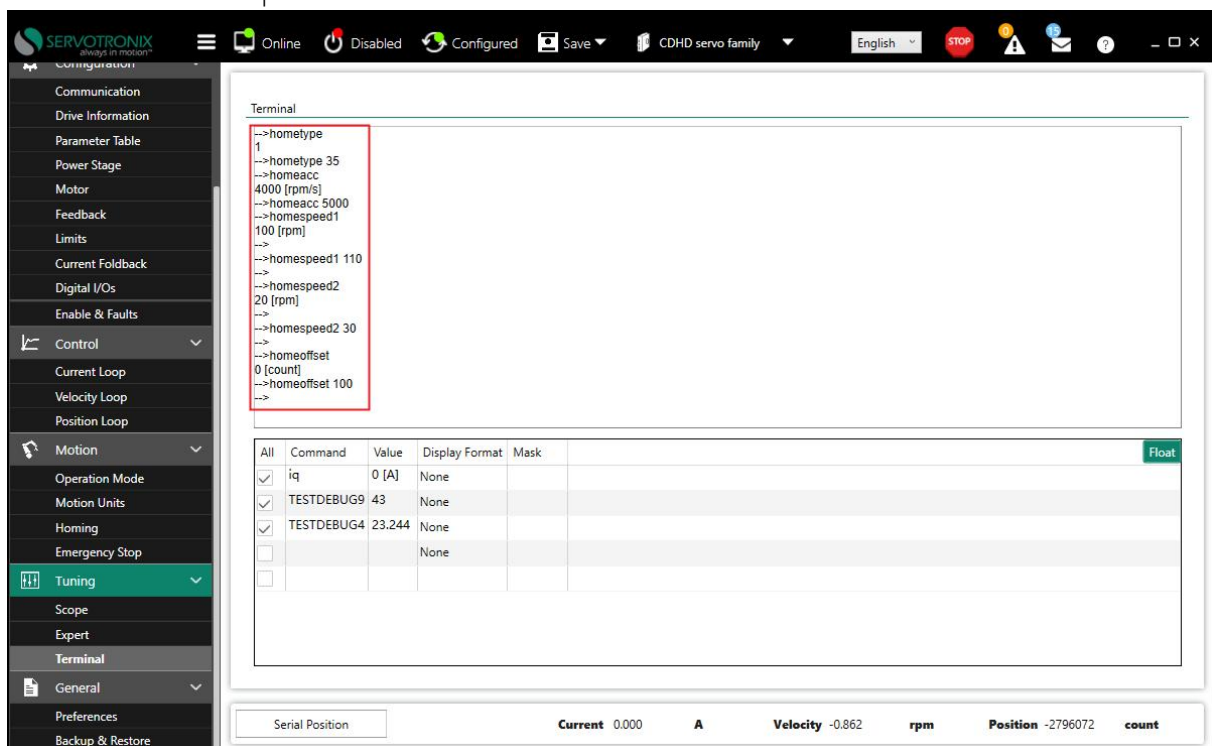
3) Click “Start” to return to zero.

13.2.2 Steps to Execute ServoStudio 2 Terminal Commands

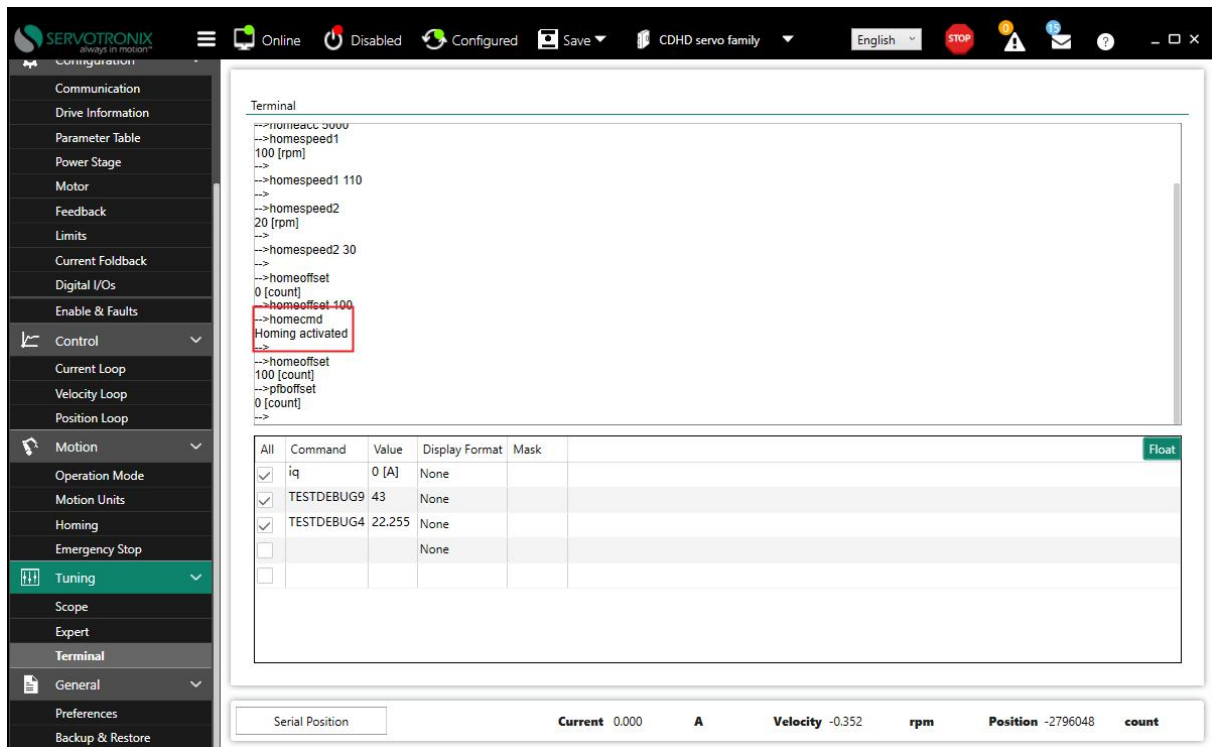
1) Open ServoStudio 2 software and enter the "Terminal" interface.



2) In the 'terminal', use the command 'hometype' to select the return-to-zero method, and use the commands 'homeacc', 'homespeed1', 'homespeed2', and 'homeoffset' to set the return-to-zero parameters.



3) After enabling the servo, enter the command 'homecmd' in the 'terminal' to perform the return-to-zero operation.



13.2.3 Parameter Description

Explanation of Return-to-Zero Types:

1) Index Return-to-Zero: HOMETYPE 1-14, 33, 34.

Use HOMESPEED1 before detecting the limit switch, zero position switch, or hard stop. Once an appropriate sequence time has occurred (e.g., reversing direction upon limit switch detection), the axis moves at HOMESPEED2 to detect the index pulse (or equivalent signal on an absolute encoder).

2) Positive and Negative Edge Return-to-Zero: HOMETYPE 17-30.

Zeroing occurs on the falling edge of the positive/negative limit switch or the upper/lower edge of the zero return switch.

3) Set the current position as the zero return position: HOMETYPE 35.

Set the current position as the zero position.

The zero return parameters are defined as follows:

VarCom	Description
HOMEACC	Acceleration and deceleration values during the return to zero process.
HOMEOFFSET	Set the 'Zero' position offset (count).

VarCom	Description
HOMEOFSTMOVE	Defines whether the axis moves during the zero return process. When HOMEOFSTMOVE=1, the value of PFB is 0 after zero return. If HOMETYPE=35, HOMEOFSTMOVE is ignored.
HOMESPEED1	The initial speed used during the zero return process while searching for limit switches, zero switches, and hard stops.
HOMESPEED2	The speed used during the search for the zero return trigger (which may be an index pulse, limit switch transition, zero switch transition, or other source as defined by HOMETYPE).
HOMETYPE	Defines the type of homing process to be executed.
HOMECMD	1 Start the zero return process; 0 Stop the Return to Zero process
HOMESTATE	Display the current status of the system return to zero. HOMESTATE 0 Return to Zero not started HOMESTATE 1 Return to Zero in progress HOMESTATE 19 Return to Zero completed HOMESTATE 20 Return to Zero error
HOMINGERRCODE	Display the type of return to zero error.
HOMINGRUNTIMEMAX	Define the maximum runtime for return to zero; if the return to zero operation exceeds this value, a return to zero error is reported.

When a return to zero error occurs, the specific type of return to zero error can be viewed using the command "HOMINGERRCODE". The explanations are as follows:

HOMINGERRCODE	Description
0	No error
1	When the interface mode is Serial/Pulse, if the return to zero has not ended and the return to zero is stopped, this error is reported.
2	When the interface mode is Serial/Pulse, if the return to zero has not ended and the enable is turned off, this error is reported.
3	If the actual runtime of the return to zero exceeds the value of HOMINGRUNTIMEMAX (unit: ms), this error is reported. Note: When HOMINGRUNTIMEMAX=0, the runtime for returning to zero is not limited, and this error will not be reported.
4	This error is reported when starting with a target speed of 0. Note: For homing types 1~14, 17~32, if HomingSpeed1 or HomingSpeed2 is set to 0, this error is reported. For homing types 33~34, if HomingSpeed2 is set to 0, this error is reported. For homing type 35, if both speeds are set to 0, this error is not reported.
5	DI has not been assigned the required home position switch and limit switch for the homing type. For example, homing type 1 requires a negative limit switch; if DI is not configured with a negative limit switch, this error will be reported. If DI is not configured with a positive limit switch and a home position switch, this error will not be reported.
6	This error is reported when the positive limit switch, negative limit switch, and home position switch are all active simultaneously.
7	When both the positive limit switch and the negative limit switch are active, this error is reported.
8	When both the zero position switch and the positive limit switch are active, this error is reported.
9	When both the zero position switch and the negative limit switch are active, this error is reported.

HOMINGERRCODE	Description
10	Limit switch installation error. This return-to-zero type does not require a certain limit switch, but during actual operation, that limit switch is in an active state. For example: Return-to-zero type 1 does not require the positive limit switch; if the positive limit switch is active during the return-to-zero process, this error is reported.
12	In the return-to-zero type that reverses through the positive limit switch, if the falling edge of the positive limit switch is detected during the deceleration phase after the rising edge of the positive limit switch, a penetration will occur, and this error is reported. It is recommended to reduce the return-to-zero speed or increase the return-to-zero acceleration.
13	In the return-to-zero type that reverses through the negative limit switch, if the falling edge of the negative limit switch is detected during the deceleration process when the rising edge is detected, a penetration error will be reported. It is recommended to reduce the return-to-zero speed or increase the return-to-zero acceleration.
14	In the return-to-zero type that reverses through the return-to-zero switch, if the falling edge of the return-to-zero switch is detected during the deceleration process when the rising edge is detected, a penetration error will be reported. It is recommended to reduce the return-to-zero speed or increase the return-to-zero acceleration.

13.3 Collision Detection Application

This application note describes how to perform the collision detection function and assumes that you are familiar with the use of ServoStudio 2 software.

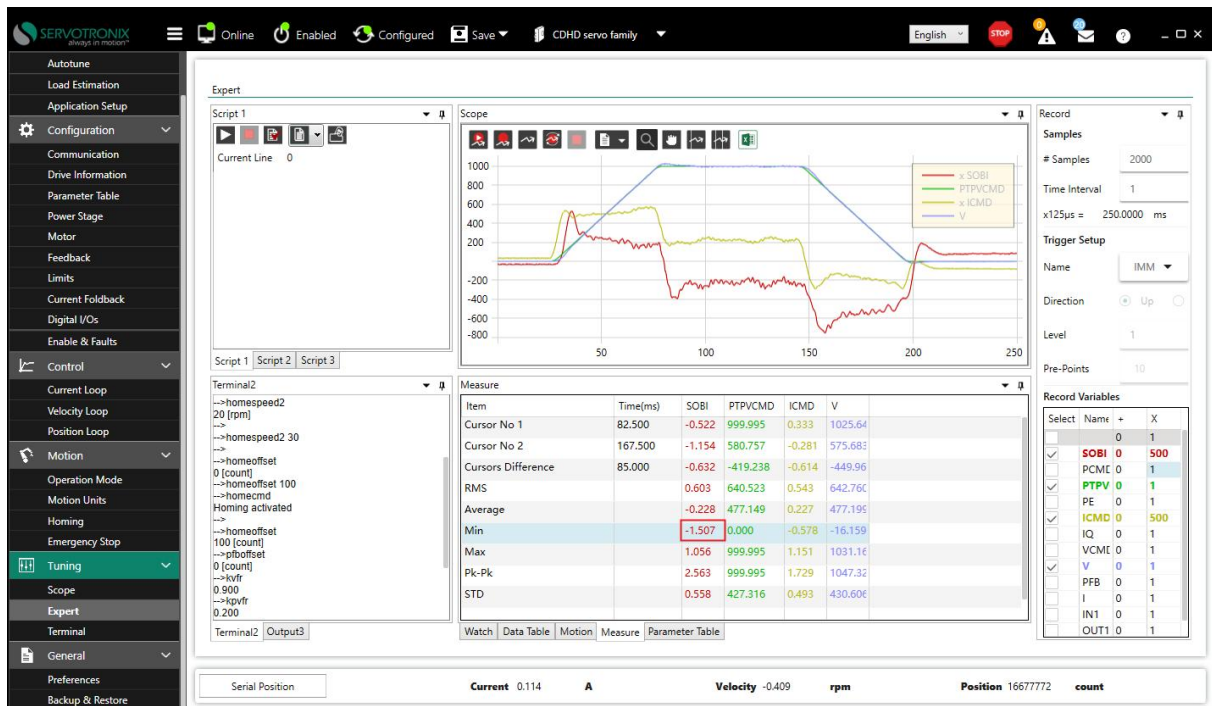
Please familiarize yourself with the relevant content before testing:

Collision detection is only available under position control. When switching to other loops, be sure to set COLDETTYPE to 0.

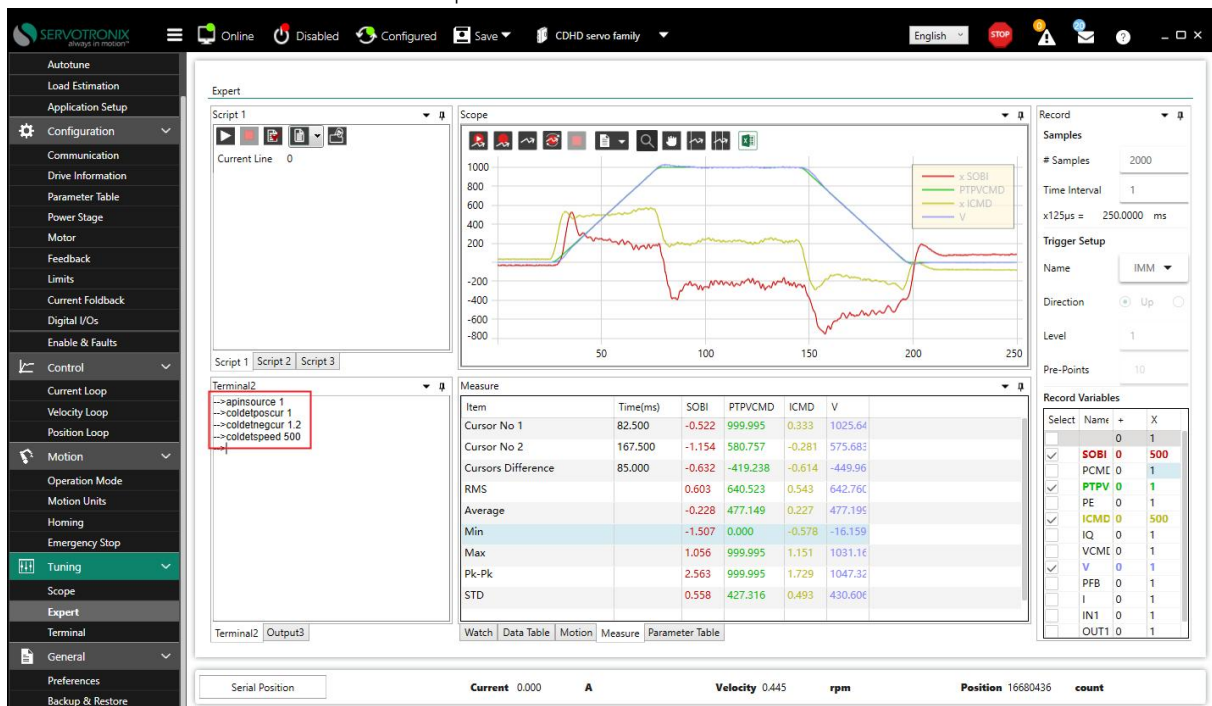
Collision detection requires appropriate parameter settings, which are related to operating speed and load conditions. Therefore, determine the motion trajectory parameters first, then set the collision detection parameters.

13.3.1 Usage Steps

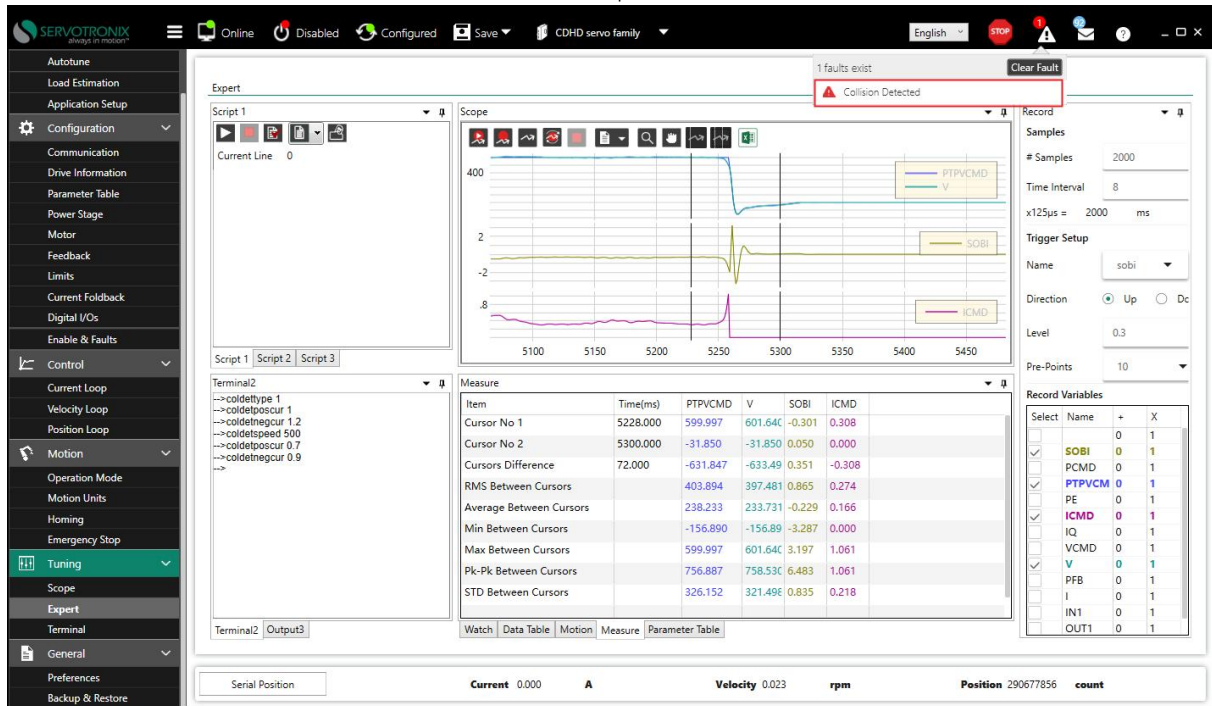
1) Open ServoStudio 2 software and enter the 'Expert' interface. After determining the motion trajectory, use the oscilloscope to observe the variable SOBI. Run forward and reverse multiple times, and record the maximum absolute value of SOBI as a reference for setting the collision detection parameters. If the results are unsatisfactory, you can switch the collision detection current source COLDETCURTYPE and re-determine the collision detection parameter conditions.



2) In the 'Terminal', use the command 'COLDETTTYPE' to select the collision detection method, use the commands 'COLDETPOSCUR' and 'COLDETNEGCUR' to set the collision current thresholds, use the command 'COLDETSPEED' to set the detection speed threshold, use the commands 'COLDETPOSHOLDCUR' and 'COLDETNEGHCUR' to set the post-collision holding current values, and use the commands 'COLDETPOSPFB' and 'COLDETNEGPF' to set the start positions for collision detection.



3) Using COLDETTYPE 1 as an example for negative direction collision, after enabling the servo, run the motor in the negative direction under the Motion tab. When it hits an obstacle, a 'Collision Detected' error will be reported, and the motor will lose enablement.



13.3.2 Parameter Description

1) The collision detection parameter definitions are as follows:

VarCom	Description
COLDETTYPE	Collision detection type. 0: No detection. 1: When the speed meets the velocity threshold, the motor rotates forward and backward, and the absolute value of the load current is greater than the COLDETPOSCUR set value, Servo Driver reports a "Collision Detected" error, and Servo Driver loses enablement. 2: When the speed meets the velocity threshold, the motor rotates forward, the load current is greater than the COLDETPOSCUR set value, the motor rotates backward, and the load current is less than the COLDETNEGCUR set value, Servo Driver reports a "Collision Detected" error, and Servo Driver loses enablement. 3: When the speed meets the velocity threshold, the motor rotates forward and backward, and the load current is greater than the COLDETPOSCUR set value, Servo Driver reports a "Collision Detected" warning, and Servo Driver output current maintains the COLDETHOLDPOSCUR set value. 4: When the speed meets the speed threshold, the motor rotates forward, and the load current exceeds the COLDETPOSCUR set value, Servo Driver reports a "Collision Detected" warning, and Servo Driver output current maintains the COLDETHOLDPOSCUR set value; when the motor rotates backward, and the load current is less than the COLDETNEGCUR set value, Servo Driver reports a "Collision Detected" warning, and Servo Driver output current maintains the COLDETHOLDNEGCUR set value. 7: The motor rotates forward, and when the load current exceeds the COLDETPOSCUR set value, and the current position feedback is greater than COLDETPOSPFB, Servo Driver reports a "Collision Detected" warning, and Servo Driver output current maintains the COLDETHOLDPOSCUR set value. After the motor rotates backward, the warning is cleared. Motor reverses, when the load current is less than (-COLDETPOSCUR) set value, and the current position feedback is less than COLDETPOSPFB, Servo Driver reports a 'Collision Detected' warning, and Servo Driver output current maintains the COLDETHOLDPOSCUR set value. The warning is cleared after the

VarCom	Description
	motor rotates forward. 8: Motor rotates forward, when the load current is greater than the COLDETPOSCUR set value, and the current position feedback is greater than COLDETPOSPFB, Servo Driver reports a 'Collision Detected' warning, and Servo Driver output current maintains the COLDETHOLDPOSCUR set value. The warning is cleared after the motor reverses. Motor reverses, when the load current is less than (-COLDETNEGCUR) set value, and the current position feedback is less than COLDETNEGPF, Servo Driver reports a 'Collision Detected' warning, and Servo Driver output current maintains the COLDETHOLDNEGCUR set value. The warning is cleared after the motor rotates forward. 9: Motor rotates forward, when the load current exceeds the COLDETPOSCUR set value, and the current position feedback is greater than COLDETPOSPFB, Servo Driver reports a "Collision Detected" error and Servo Driver loses enablement. Motor rotates backward, when the load current is less than (-COLDETPOSCUR) set value, and the current position feedback is less than COLDETNEGPF, Servo Driver reports a "Collision Detected" error and Servo Driver loses enablement. 10: Motor rotates forward, when the load current exceeds the COLDETPOSCUR set value, and the current position feedback is greater than COLDETPOSPFB, Servo Driver reports a "Collision Detected" error and Servo Driver loses enablement. Motor rotates backward, when the load current is less than (-COLDETNEGCUR) set value, and the current position feedback is less than COLDETNEGPF, Servo Driver reports a "Collision Detected" error and Servo Driver loses enablement.
COLDETCURTYPE	Collision Detection Current Source Detection 0: Load current estimated by the speed observer (default) 1: Load current estimated by the disturbance observer 2: Command current 3: Load current output by the force model
COLDETPOSCUR	Positive direction collision detection current threshold (A). Range 0~300.
COLDETNEGCUR	Negative direction collision detection current threshold (A). Range 0~300.
COLDETSPEED	Collision detection speed threshold (rpm). When this value is 0, collision detection is performed at any speed; when this value is not 0, collision detection is only performed when the absolute speed is less than this value.
COLDETPOSHOLDCUR	Positive direction collision maintenance current (A). Range 0~300.
COLDETNEGHOLDCUR	Maintain current after negative direction collision (A). Range 0~300.
COLDETPOSPFB	Positive direction collision detection start position (count).
COLDETNEGPF	Negative direction collision detection start position (count).
COLDETJCOEF	Inertia adjustment coefficient
COLDETJLPF	Use for collision detection current source selection 3
COLDETKCOEFF	Collision detection current filter coefficient
COLDETKOFFSET	Collision detection current fine-tuning coefficient
COLDETKOFFSET	Collision detection current fine-tuning bias

2) Other notes:

SOBI: Observed load current (A). Used as a basis for determining whether a collision has occurred; this value is affected by motion trajectory parameters and load during the constant speed segment.

13.3.3 Possible Issues and Solutions

1) False alarms

False alarms in collision detection may occur when parameters are set improperly. Since the motor needs to overcome friction and load forces during operation, SOBI itself has a certain range. Setting the collision current threshold higher than the maximum SOBI

value during normal motor operation can prevent false alarms; alternatively, setting COLDETSPEED to a value less than the cruising speed can also prevent false alarms.

The load current threshold and speed detection threshold need to balance the allowable collision current of the workpiece and the stress that can be accepted after a collision; careful testing is required.

13.4 Multi-segment Collision Detection Application

This application note describes how to perform multi-segment collision detection functions and assumes that you are familiar with the use of ServoStudio 2 software.

Please familiarize yourself with the relevant content before testing:

Multi-segment collision detection is only available under position control; when switching to other loops, it is essential to set COLDETTYPE to 0.

To perform multi-segment collision detection, appropriate parameters must be set, which are related to the operating speed and load conditions. Therefore, it is necessary to first determine the motion trajectory parameters before setting the multi-segment collision detection parameters.

13.4.1 Usage Steps

- 1) Open the ServoStudio 2 software and enter the 'Expert' interface.
- 2) Calibration Method
 - (1) Prepare the force gauge;
 - (2) Set Servo Driver to position mode, return the motor to the origin, set the current position as the origin, i.e., write 0 to ethercat address 0x236B or set COLDETHOME 0 in ServoStudio2, Servo Driver writes the current position feedback PFB value into COLDETOFFSET;
 - (3) Set the collision detection type to 11 (or 12), COLDETTYPE 11 (12);
 - (4) Disable collision detection enable, COLDETDIS 1;
 - (5) Enable Servo Driver.

(6) Place the force gauge at the first calibration position, move the motor down until it contacts the force gauge;

(7) Make minor adjustments to the position, monitor the current SOBI and position COLDETPFB in Servostudio2, until the force gauge reaches the target force value, record the current SOBI value I1 and the position COLDETPFB value P1;

(8) Write P1 and I1 to Servo Driver, COLDETCALB 1 P1 I1;

(9) Place the force gauge at the second position;

(10) Repeat steps 6 - 8, up to 5 points can be calibrated.

(11) Save parameters, calibration ends.

(12) Enable collision detection, COLDETDIS 0, activate the collision detection function.

3) Usage Method

(1) Switch Servo Driver to CSP mode.

(2) Return the motor to the origin, give a zero signal, i.e., write 0 to EtherCAT address 0x236B.

(3) The master station controls movement to the ready position.

(4) The master station controls downward movement; when the target position is reached, the multi-segment position collision detection conditions are met, and collision detection is activated.

(5) The main station controls the upstream to the ready position.

13.4.2 Parameter Description

1) The collision detection parameter definitions are as follows:

VarCom	Description
COLDETTYPE	Collision detection type. 0~10: Refer to Section 13.4.2 for collision detection application parameter descriptions 11: Set the inter-segment detection current threshold and position threshold for up to 5 points. The motor rotates forward, and when the position feedback reaches the position threshold, if the feedback current exceeds the inter-segment current threshold, Servo Driver reports a 'Collision Detected' warning, and Servo Driver's output current maintains the inter-segment detection current setting. After the motor reverses, the warning is cleared. The motor rotates backward, and when the position feedback reaches the position threshold, if the feedback current is less than the inter-segment current threshold, Servo Driver reports a 'Collision Detected' warning, and Servo Driver's output current maintains the inter-segment detection current setting. After the motor rotates forward, the warning is cleared. 12: Set the inter-segment detection current threshold and position threshold for up to 5 points. When the motor rotates forward, if the position feedback reaches the position threshold and the feedback current exceeds the inter-segment current threshold, Servo Driver reports a 'Collision

VarCom	Description
	Detected' error and disables Servo Drive. When the motor rotates backward, if the position feedback reaches the position threshold and the feedback current exceeds the inter-segment current threshold, Servo Driver reports a 'Collision Detected' error and disables Servo Drive.
COLDETCURTYPE	Collision Detection Current Source Detection 0: Load current estimated by the speed observer (default) 1: Load current estimated by the disturbance observer 2: Command current 3: Load current output by the force model
COLDETCALIB	Multi-Segment Position Collision Detection Configuration Read COLDETCALIB <point> Write COLDETCALIB <point> <detect distance> <limit current> Parameter Range point: 1 to 5 detect distance: -2^{63} to $2^{63}-1$, relative to the origin limit current: -300~300 (A)
COLDETOFFSET	Multi-segment Collision Detection Return to Origin Offset (count) Read COLDETOFFSET Write COLDETOFFSET <value>
COLDETPFB	Position Relative to Collision Detection Origin (count), in Encoder Units Read COLDETPFB
MULTICOLDETCUR	Multi-segment Collision Detection Current (user unit) Range: -3000~3000 EtherCat: 0x236C, sub-index 1, sub-index 2, sub-index 3, sub-index 4, sub-index 5
COLDEDIS	Disable Multi-segment Collision Detection Mode, this parameter is not saved to internal storage, defaults to 0 after power-on Read COLDETDIS Write COLDETDIS <value> Range: 0~1
COLDETHOME	Set Multi-segment Collision Detection Mode Return to Origin Offset Read COLDETHOME Write COLDETHOME <value> Range: 0~1 EtherCat: 0x236B, sub-index 0
COLDETJCOEF	Inertia adjustment coefficient Use for collision detection current source selection 3
COLDETJLPF	Collision detection current filter coefficient Use for collision detection current source selection 3
COLDETKCOEFF	Collision detection current fine-tuning coefficient
COLDETKOFFSET	Collision detection current fine-tuning bias

2) Other notes:

SOBI: Observed load current (A). Used as a basis for determining whether a collision has occurred; this value is affected by motion trajectory parameters and load during the constant speed segment.

13.4.3 Precautions

- 1) Position thresholds must be entered in the order of actual motor movement;
- 2) After power-on, COLDETDIS defaults to 0 (collision detection enable is on by default), and is only temporarily disabled during calibration.

13.5 Low-frequency Vibration Suppression

Note: The availability of this function may vary depending on Servo Driver model and firmware version. For detailed information, please contact technical support.

This application note describes how to use the low-frequency vibration suppression function to suppress low-frequency jitter, assuming that you are familiar with the use of ServoStudio 2 software.

13.5.1 Usage Steps

- Disable the low-frequency vibration suppression function, INSHAPEREN 0;
- Sample the variable PE;
- Calculate the low-frequency vibration frequency and damping;
- Disable Servo Driver;
- Set ANTIVIBTYPE to 0 or 1;
- Set the frequency INSHAPERFREQ and damping INSHAPERDAMP;
- Enable low-frequency vibration suppression function INSHAPEREN 1.

or

- Disable the low-frequency vibration suppression function, INSHAPEREN 0;
- Turn on INSHAPERIDENT 1 or LFOIEN 1;
- The motor reciprocates for several cycles;
- If INSHAPERIDENT is 1, then enable lower and upper, the low-frequency suppression function will automatically turn on, and frequency and damping will be set automatically;

● If LFOIEN is 1, manually write LFOIFREQ into INSHAPERFREQ and LFOIDAMP into INSHAPERDAMP;

- Manually enable the low-frequency vibration suppression function INSHAPEREN 1.

or

- Disable the low-frequency vibration suppression function, PNOTCHMODE 0;
- Sample PE;
- Calculate the low-frequency vibration frequency;

- Disable Servo Driver;
- Set ANTIVIBTYPE to 2;
- Set the low-frequency vibration frequency PNOTCHCENTER;
- Set the low-frequency vibration bandwidth PNOTCHBW;
- Set the low-frequency vibration suppression depth PNOTCHDEP;
- Enable the low-frequency vibration suppression function, PNOTCHMODE 1.

VarCom	Description
ANTIVIBTYPE	Low-frequency vibration suppression type: 0: Single-pulse input shaper; 1: Two-pulse input shaper; 2: Position command notch filter.
INSHAPEREN	Low-frequency vibration suppression function enable, valid only for ANTIVIBTYPE 0 and 1.
INSHAPERFREQ	Low-frequency vibration suppression frequency (Hz), valid only for ANTIVIBTYPE 0 and 1.
INSHAPERDAMP	Low-frequency vibration suppression damping, valid only for ANTIVIBTYPE 0 and 1.
INSHAPERIDENT	Low-frequency scanning enable, after identifying frequency LFOIFREQ and damping LFOIDAMP, re-enable will automatically activate the rectifier.
LFOIEN	Low-frequency scanning enable, after identifying frequency LFOIFREQ and damping LFOIDAMP, the rectifier needs to be manually activated.
LDOIFREQ	Frequency results identified by low-frequency scanning.
LFOIDAMP	Damping results identified by low-frequency scanning.
PNOTCHMODE	Position command notch filter 1 enable, valid only for ANTIVIBTYPE 2.
PNOTCHBW	Position command notch filter 1 bandwidth, valid only for ANTIVIBTYPE 2.
PNOTCHCENTER	Position command notch filter 1 center frequency (Hz), valid only for ANTIVIBTYPE 2.
PNOTCHDEP	Position command notch filter 1 depth, valid only for ANTIVIBTYPE 2.
PNOTCH2MODE	Position Command Notch Filter 2 Enable, Only Valid for ANTIVIBTYPE 2.
PNOTCH2BW	Position Command Notch Filter 2 Bandwidth, Only Valid for ANTIVIBTYPE 2.
PNOTCH2CENTER	Position Command Notch Filter 2 Center Frequency (Hz), Only Valid for ANTIVIBTYPE 2.
PNOTCH2DEP	Position Command Notch Filter 2 Depth, Only Valid for ANTIVIBTYPE 2.
PNOTCH3MODE	Position Command Notch Filter 3 Enable, Only Valid for ANTIVIBTYPE 2.
PNOTCH3BW	Position Command Notch Filter 3 Bandwidth, Only Valid for ANTIVIBTYPE 2.
PNOTCH3CENTER	Position Command Notch Filter 3 Center Frequency (Hz), Only Valid for ANTIVIBTYPE 2.
PNOTCH3DEP	Position Command Notch Filter 3 Depth, Only Valid for ANTIVIBTYPE 2.

13.6 Speed Disturbance Observer

13.6.1 Overview

The speed disturbance observer function can effectively suppress sustained vibrations around 100Hz to 1000Hz that occur when increasing the control gain. After automatically detecting or manually setting the vibration frequency, the vibration can be eliminated by adjusting the damping gain. This function can be automatically set through self-tuning; please only set it when further fine-tuning is required.

After executing this function, if you need to improve the response characteristics, you can further increase the gain using the rigidity table. After increasing the gain, be aware

that vibrations may occur. The vibration frequencies that can be detected using this function range from 100Hz to 1000Hz. When the vibration frequency is outside this range, use a notch filter. Appropriately increasing the speed disturbance observer gain ATYPEDAMPGAIN1 can enhance the vibration suppression effect, but excessive gain can increase the vibration. During debugging, gradually increase the gain in 10% increments.

13.6.2 Related Parameters

The speed disturbance observer can increase control gain, but it may cause vibrations at higher frequencies than the controlled vibration due to the mechanical structure. In this case, multiple vibrations can be controlled by adjusting the speed disturbance observer damping gain 2 ATYPEDAMPGAIN2.

VarCom	Range	Units	Default Value	Effective Method
ATYPEDAMPGAIN1	0~1000	%	0	Immediate
Speed Disturbance Observer Damping Gain 1				
ATYPEDAMPGAIN2	0~1000	%	0	Immediate
Speed Disturbance Observer Damping Gain 2				
ATYPEEN	0~1	/	0	Immediate
Speed Disturbance Observer Enable 0: Disable Speed Disturbance Observer 1: Enable Speed Disturbance Observer				
ATYPEFREQ	0~2000	Hz	100	Immediate
Speed Disturbance Observer Frequency				
ATYPELPFCMP	-10~10	ms	0	Immediate
Speed Disturbance Observer Low-pass Filter Time Parameter Compensation				
ATYPEHPF1CMP	-10~10	ms	0	Immediate
Speed Disturbance Observer First High-pass Filter Time Parameter Compensation				
ATYPEHPF2FREQ	1~5000	Hz	2000	Immediate
Speed Disturbance Observer Second High-pass Filter Frequency				
ATYPEJGAIN	1~1000	%	100	Immediate
Speed Disturbance Observer Gain Compensation				

13.6.3 Precautions

- The response may change significantly before and after executing this function. For safety reasons, please perform this function under conditions where an emergency stop can be made at any time.
- Before executing the speed disturbance observer function, correctly set the inertia ratio (Pn103). If the inertia ratio is set incorrectly, normal control will not be possible, and vibrations may occur.

13.7 Notch Filter

A notch filter can be used to eliminate high-frequency oscillations that may occur in systems with flexible connections between the motor and load, for example:

- Ball Screw Linear Guide with Coupling
- Belt Drive
- Harmonic Drive

Oscillation typically occurs in the first step of tuning (adjusting gain), which is completed by checking the oscillation frequency and setting the notch accordingly.

During tuning, a notch filter can be used at any time to suppress oscillations with a fixed frequency greater than 200 Hz.

The system has 2 sets of notch filters connected in series on the speed controller output channel; the first set is in manual mode, with the following parameter variables:

- NOTCHMODE configured to 1, enabling the first set of notch filters
- NOTCHCENTER, the center frequency of the first set of notch filters
- NOTCHBW, Notch Width of the First Group of Notch Filters
- NOTCHDEP, Notch Depth of the First Group of Notch Filters

The second group can be set to manual or automatic, with the corresponding parameter variables as follows:

- NOTCH2MODE configured to 1, enabling the second group of notch filters
- NOTCH2CENTER, center frequency of the second group of notch filters
- NOTCH2BW, notch width of the second group of notch filters
- NOTCH2DEP, notch depth of the second group of notch filters

- ANFEN configured to 1, enabling automatic search for the center frequency and automatic setting of parameters for the second group of notch filters

Note, the NOTCH2MODE of the second group of notch filters must be set to 1 before ANFEN can be set to 1, and when ANFEN=1, NOTCH2CENTER cannot be manually set; when ANFEN=0, NOTCH2CENTER can be manually set.

The notch parameters of the second group of notch filters can be copied to the first group of notch filters via a command:

- NOTCHDUMP, the command does not follow any parameters, which achieves the batch copying of the second group of notch filter parameters to the first group of notch filters, while the parameters of the second group of notch filters are reset to their default values to re-perform automatic detection and suppression of new resonant frequencies.

The third group is in manual mode, with the corresponding parameter variables as follows:

- NOTCH3MODE set to 1, enabling the third group of notch filters
- NOTCH3CENTER, the center frequency of the third group of notch filters
- NOTCH3BW, the notch width of the third group of notch filters
- NOTCH3DEP, the notch depth of the third group of notch filters

The fourth group is set to manual mode, with the corresponding parameter variables as follows:

- NOTCH4MODE configured to 1, enabling the notch filter for the fourth group
- NOTCH4CENTER, center frequency of the notch filter for the fourth group
- NOTCH4BW, bandwidth of the notch filter for the fourth group
- NOTCH4DEP, depth of the notch filter for the fourth group

13.8 Friction Compensation

13.8.1 Overview

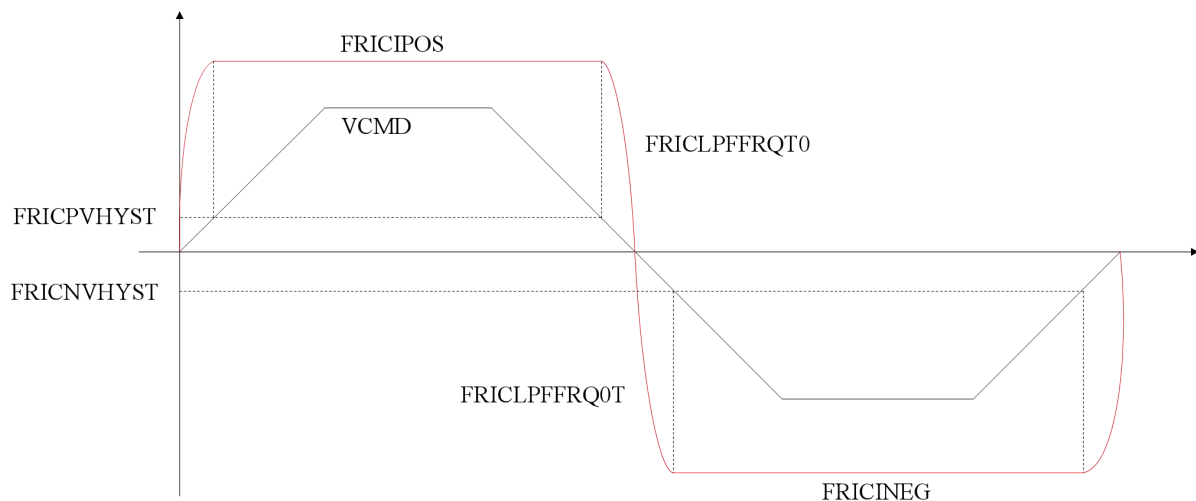
This function is used to reduce the impact of friction in mechanical transmission on operational performance, providing different positive and negative compensation values based on the direction of operation. This function is only effective in position mode.

When the speed is below the speed threshold, it is considered to be in a state of static friction; once exceeded, it transitions to dynamic friction. The direction of positive and negative compensation is determined by the actual position command direction, typically applying positive compensation for positive direction and negative compensation for negative direction.

13.8.2 Related Parameters

VarCom	Range	Units	Default Value	Effective Method
FRICIPOS	-100~100	A	0	Immediate
Positive Friction Compensation Current				
FRICINEG	-100~100	A	0	Immediate
Negative Friction Compensation Current				
FRICPVHYST	-1000~1000	rpm	0	Immediate
Positive Friction Compensation Hysteresis Speed				
FRICNVHYST	-1000~1000	rpm	0	Immediate
Negative Friction Compensation Hysteresis Speed				
FRICLPFFRQT0	0~8000	Hz	0	Immediate
Friction Compensation Torque to Dead Zone Low-pass Filter Frequency				
FRICLPFFRQT	0~8000	Hz	0	Immediate
Friction Compensation Dead Zone to Torque Low-pass Filter Frequency				

Hysteresis speed is used to control the switching of positive and negative friction compensation torques. When the command speed is higher than the positive hysteresis speed or lower than the negative hysteresis speed, the output friction torque is generated; when the command speed is between the positive and negative hysteresis speeds, it is in the dead zone, and the output friction torque is zero. To reduce position errors caused by sudden changes in friction torque, low-pass filtering is applied to the friction torque when entering and exiting the dead zone, as shown in the figure below.



13.8.3 Precautions

The magnitude of the friction compensation current can be set by monitoring the current during the constant speed segment of the trapezoidal trajectory.

For setting the filter frequency, the exit dead zone filter frequency should typically be set higher, while the entry dead zone filter frequency should be set lower.

13.9 Model Tracking

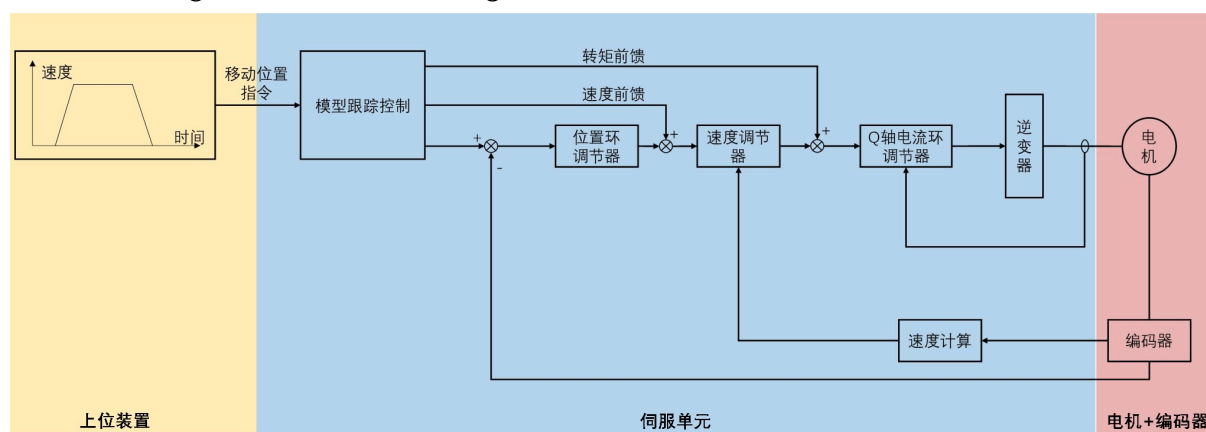
13.9.1 Overview

Using model tracking control can improve the responsiveness of the servo system and reduce positioning time. Model tracking control can only be used with position control. The parameters used for model tracking can be automatically set together with the servo gain parameters through the auto-tuning function.

If any of the following situations occur, please manually adjust the model tracking parameters.

- Dissatisfaction with the results of the auto-tuning
- Compared to self-adjustment results, higher responsiveness enhancement is required.
- Customers need to set the servo gain or model tracking control parameters themselves.

The block diagram of model tracking control is shown below:



- Example of manual adjustment steps:

An example of the adjustment steps when using model tracking control is shown below.

Steps	Content
1	Adjusting Servo Gain: • Please set the correct inertia ratio (LMJR) as much as possible. • Adjust the current filter time parameter ICMDLPF to prevent vibration. • Within the range where the mechanism does not vibrate, increase the speed loop gain (KVBW) as much as possible while reducing the speed loop integral time parameter (KVTI).

Steps	Content
	When performing position control, increase the position loop gain (KPP) as much as possible within the range where mechanical vibration does not occur.
2	For rigid loads, set MFCTYPE to 1. For flexible loads, set MFCTYPE to 3, and then set the parameter MFCWANTHZ according to the vibration frequency of the position deviation (PE0) after reaching the target.
3	Increase the model tracking speed loop gain (MFCKVBW) as much as possible within the range where mechanical vibration does not occur.
4	Under the condition that the overshoot of the position deviation (PE0) meets the requirements, increase the model tracking speed and current feedforward coefficients (MFCVFFGAIN, MFCIFFGAIN) as much as possible.

13.9.2 Related Parameters

VarCom	Range	Units	Default Value	Effective Method
MFCTYPE	0~3		0	Immediate
Model Tracking Mode Switch 0: Disable model tracking, 1: Rigid model tracking; 3: Flexible model tracking				
MFCKVBW	1~3000	Hz	50	Immediate
Model tracking speed gain, increasing the model tracking control gain improves responsiveness and shortens positioning time.				
MFCIFFGAIN	0~200	%	90	Immediate
Model tracking torque feedforward, decreasing the set value slows down the response but reduces overshoot.				
MFCVFFGAIN	0~200	%	90	Immediate
Model tracking speed feedforward, decreasing the set value slows down the response but reduces overshoot.				
MFCWANTHZ	0~1000	Hz	0	Immediate
Flexible vibration suppression frequency, effective when MFCTYPE is set to 3.				

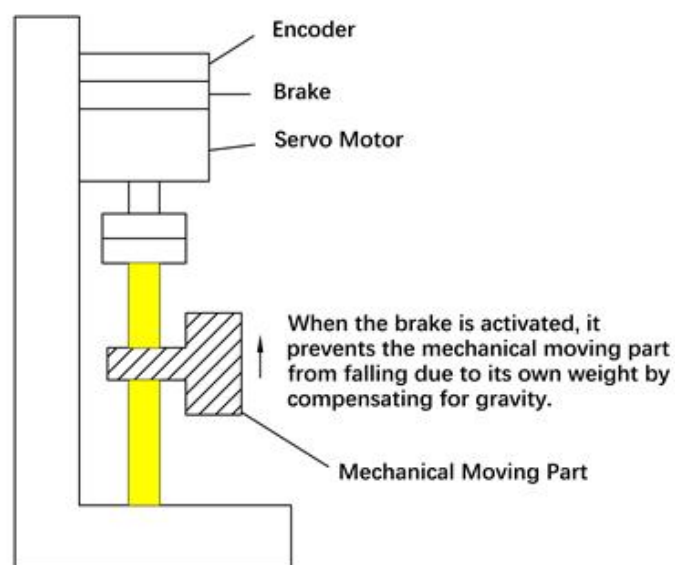
13.9.3 Precautions

Please set the correct inertia value; a significant deviation from the actual value will cause motor vibration.

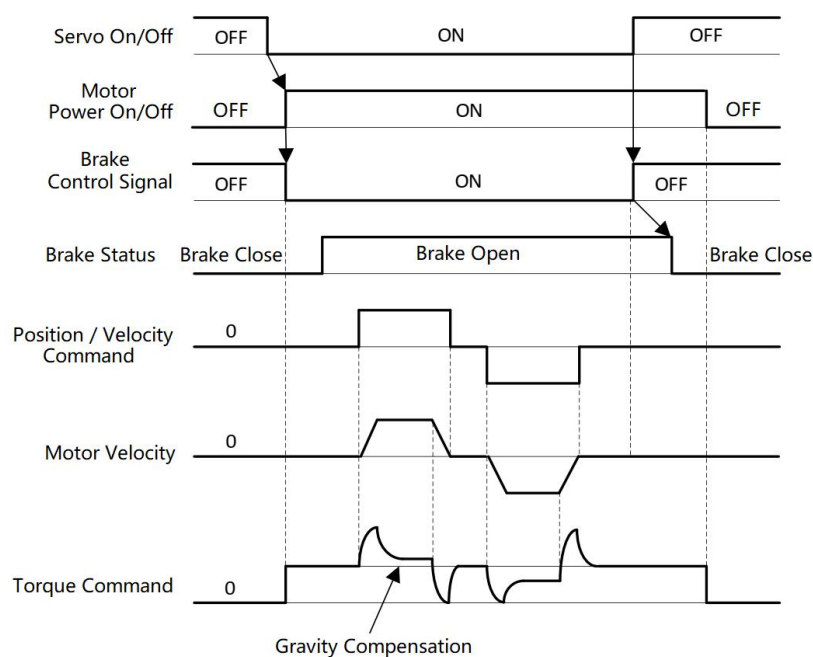
13.10 Gravity Compensation Function

13.10.1 Overview

The gravity compensation function prevents moving mechanical parts from falling due to their own weight when the brake is released in vertical axis applications of servo motors.



The timing diagram for the lifting and lowering actions of the moving parts is shown below.



13.10.2 Related Parameters

VarCom	Range	Units	Default Value	Effective Method
IGRAV	-100~100	A	0	Immediate
Gravity Compensation Current Value				
IGRAVCOEF	0~1		0	Stop
Gravity Compensation Mode				
0: Manually set the gravity compensation current value IGRAV, 1: Automatically set the gravity compensation current value IGRAV				
IGRAVCOEF	0~1000		100	Immediate

VarCom	Range	Units	Default Value	Effective Method
Gravity Compensation Coefficient				
Used to adjust the sensitivity of automatic gravity compensation				
IGRAVMODE	0~1		0	Stop
Gravity Compensation Current Value Decrease Mode				
0: The gravity compensation current value remains unchanged after gravity compensation is disabled				
1: After gravity compensation is disabled, the gravity compensation current value will decrease to 0 according to the IGRAVDECTIME ramp				
IGRAVDECTIME	1~10000	ms	500	Stop
Gravity Compensation Current Value Decrease Time				
When the gravity compensation current value decrease mode IGRAVMODE is enabled, after gravity compensation is disabled, the gravity compensation current value will decrease to 0 according to the IGRAVDECTIME ramp				

13.10.3 Precautions

Steps for Operating Gravity Compensation Function

1. Select the gravity compensation mode IGRAVAUTO, manually set (0) or automatically set (1).
2. If the gravity compensation mode is manually set (IGRAVAUTO = 0), set IGRAV to the current command value ICMD when the motor stops under the servo ON state. If the gravity compensation mode is automatically set (IGRAVAUTO = 1), set an appropriate gravity compensation coefficient IGRAVCOEF to ensure that the drop of the moving mechanical parts due to their own weight meets the requirements after the brake is released.
3. Set the gravity compensation current decrement mode IGRAVMODE and the gravity compensation current decrement time according to application needs.

14. Communication

Through EtherNET communication connection, the BD3E digital driver can communicate with the host (terminal, PC, or high-end controller).

When the host and BD3E communicate via Ethernet, a series of commands and variables (referred to as VarCom) are used to configure, control, and monitor Servo Driver.

The communication interface can be a graphical software interface, such as ServoStudio 2, or a user-designed application, or a basic terminal.

14.1 Variables and Commands

Communication for BD3E is achieved through VarCom. VarCom is a proprietary command string and variable set that configures, controls, and monitors Servo Driver.

- Commands instruct Servo Driver to perform actions.
- Read-only variables are calculated or set by Servo Driver to monitor the machine's operational status.

- To read a specific variable, enter <CR> after the name. The driver will return the variable value.

- Read/write variables, used for configuring and monitoring Servo Driver.
- VarCom is case-insensitive.

To set a variable, enter the variable name (VarCom mnemonic), a space (or =), the variable value, and then <CR> (Enter key).

14.2 Information Format

The information format is the structure used by BD3E to process ASCII encoded information. Information sent from the host to Servo Driver is used to send commands, set variables, or query Servo Driver. Information from Servo Driver to the host contains query responses.

The information format has two main elements: **information unit** and **information termination**, as shown in the figure below.

The checksum function is optional.

Note: The start has no practical meaning; it simply indicates that Servo Driver is waiting for the host to send information.

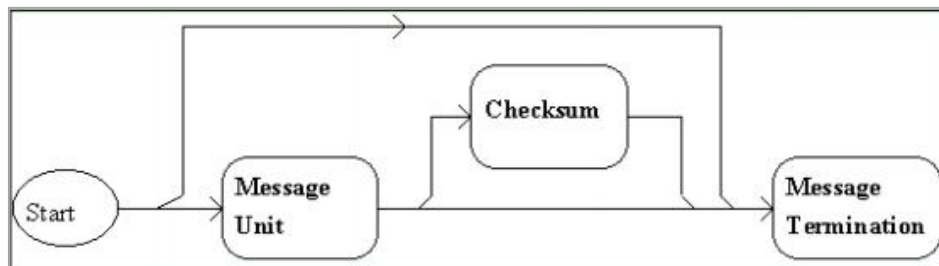


Figure 14- 8

14.2.1 Information Unit

An information unit is a segment of information transmitted over a communication link. The basic information unit is shown in the figure below.

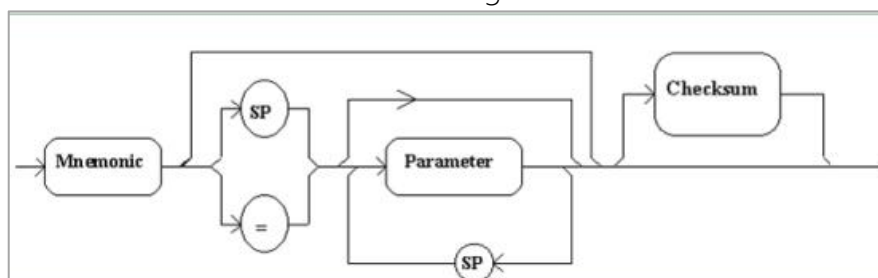


Figure 14- 9

An information unit includes a header (VarCom mnemonic), with or without parameters. The header defines the context for the parameters that follow. Information from Servo Driver to the host generally does not have a header.

When using a header, parameters are separated from the mnemonic by spaces or assignment operators. Parameters must be separated by spaces.

In an information format, BD3E can only receive one information unit.

14.2.2 Information Termination

Information termination refers to the end of the transmission of information.

Information transmitted by the host is terminated with a carriage return (CR) – ASCII character 0DH.



Figure 14- 10

Information transmitted by Servo Driver is terminated with a carriage return/line feed (CR/LF) combination – ASCII characters 0DH/0AH.

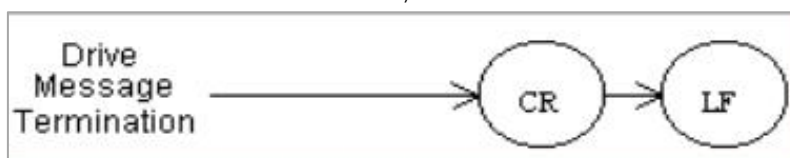


Figure 14- 11

The driver can also accept information termination without any additional information.

14.2.3 Units

In messages or commands, units are indicated in square brackets []. For example:

- Message to Servo Driver: mpoles
- Message from Servo Driver: 4 [poles]

When information from the host includes units, Servo Driver ignores the unit information.

14.3 BD3E Protocol Example

The following examples illustrate the protocol commands between BD3E and the host.

14.3.1 Issuing Commands or Variables

Example 1 – Command

EN (Enable driver), user inputs EN, then presses Enter

Terminal displays:

```
-->EN
```

```
-->
```

Example 2 – Command/Variable – Multi-line Return

Due to a large amount of data output to the screen, such commands generally have a longer delay.

DUMP (Returns driver parameter values), user inputs DUMP, press Enter

Terminal displays:

```
-->DUMP
```

```
-->var1 val1
```

```
-->var2 val2
```

```
-->varn valn
```

Example 3 – Command/Variable – Returns multiple values

Moveabs (Absolute position operation Read target position, plan speed) User inputs Moveabs, press Enter

Terminal displays:

```
-->Moveabs
```

```
0[count] 0[rpm]
```

```
-->
```

Example 4 – Read a variable value

MPOLES (Value is 2 for single-pole motor), user inputs MPOLES, press Enter

Terminal displays:

```
-->MPOLES
```

```
2 [poles]
```

```
-->
```

Example 5 – Define a variable value

ACC (Accelerate with value 50000), user inputs ACC 5000, press Enter

Terminal displays:

```
-->ACC 50000
```

-->

15. Application Cases

15.1 Usage Instructions for BD3E Series Servos with SERVOTRONIX SC301 EtherCAT Controller

The BD3E series servo can be connected to the SC301 EtherCAT controller master station for single-axis or multi-axis coordinated control. The controller is based on CODESYS, and a series of settings need to be made before use. The following uses the configuration of single-axis motion of the BD3E servo as an example.

15.1.1 Preparation

(1) Install CODESYS software.

It is recommended to install CODESYS software version V3.5 SP4 or higher.

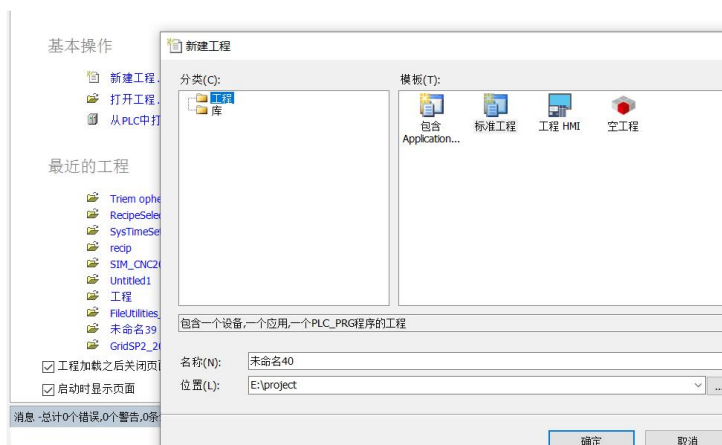
(2) Complete the configuration of servo parameters.

Set the servo bus parameters and motor parameters, and ensure the motor test run is successful.

15.1.2 Software Engineering Configuration

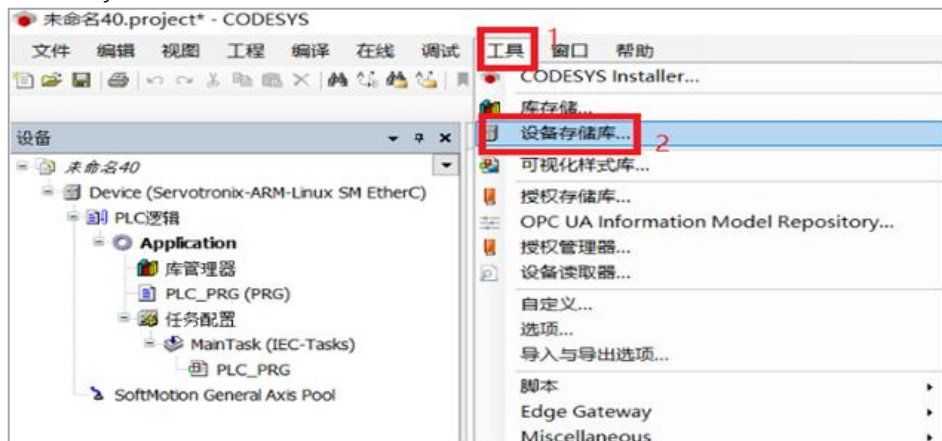
1) First, install the equipment.

Open the CODESYS software, as shown in the figure below, and install the device description files for the master and slave stations from the tool device library:→

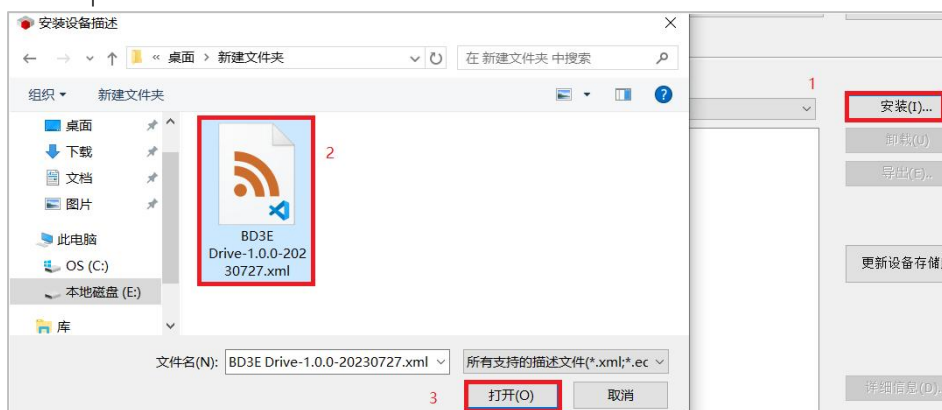


Create a new standard project.

device library:



Click Install, then find the location of the device description files, select all the master and slave station description files, note that you need to choose all supported description files, and then open them.

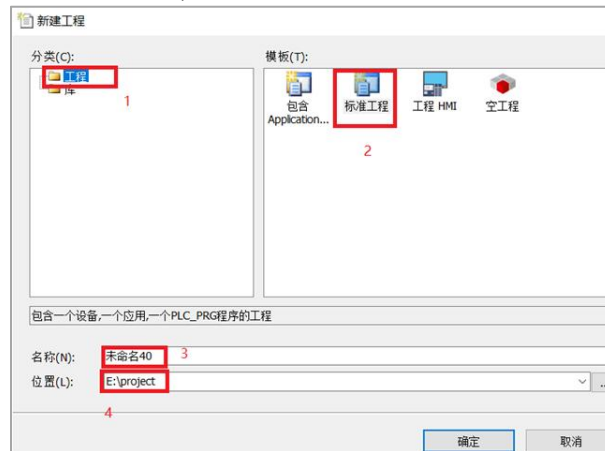


When the device installation is successful, the following display information will appear; click Close to finish.

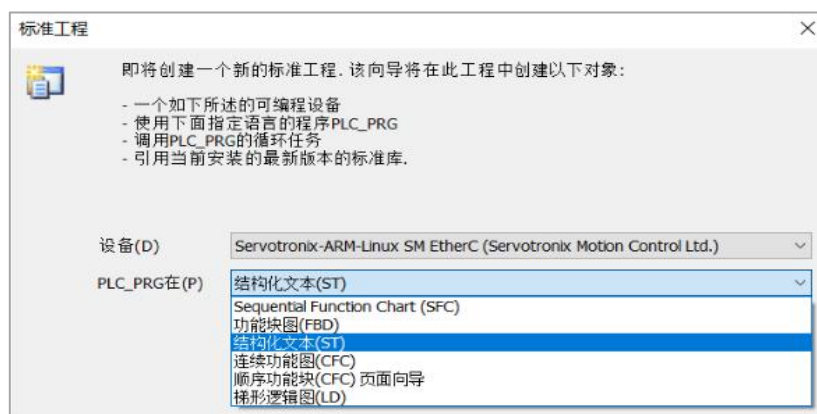


2) Configure the master station and slave stations

Open the CODESYS software, File, New Project, in Project select Standard project, then choose the project name and path.

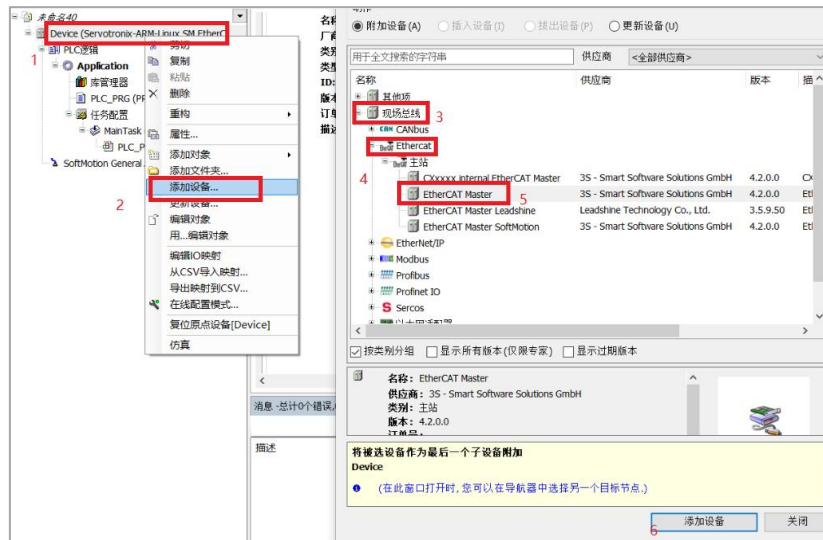


In the project wizard, select the device and programming language: for the device, select the master station Servotronix-ARM-Linux SM EtherC that was installed earlier. The programming language can be chosen based on personal preference, such as Ladder Diagram (LD), Function Block Diagram (FBD), Continuous Function Chart (CFC), Structured Text (ST), etc., which are IEC61131-3 programming languages.



This example uses the ST language.

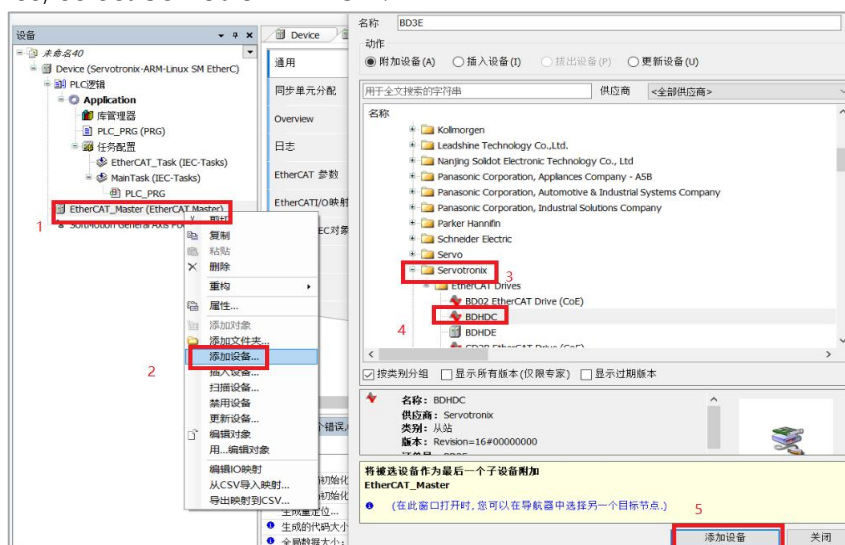
Adding the master station: Right-click on Device, Add Device, then select Fieldbus, EtherCAT Master, EtherCAT Master. → → →



Double-click the added EtherCAT_Master, and in the EtherCAT NIC settings, change the network name to eth2.

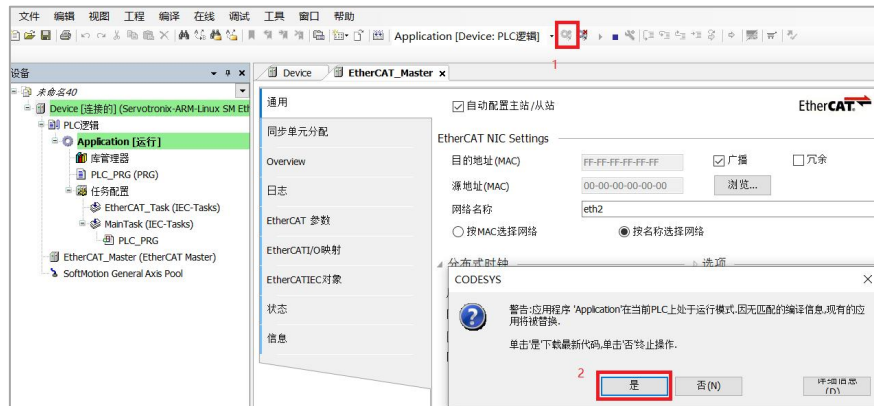


Add device, select Servotronic BD3E .

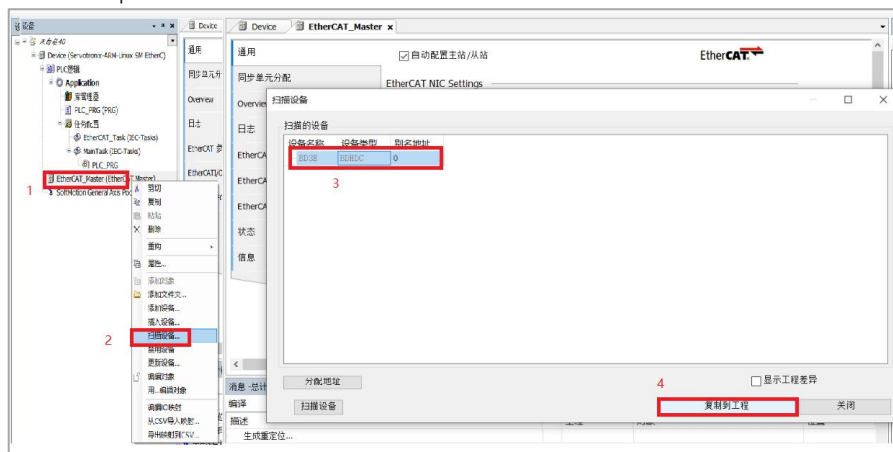


Method two: Download configuration, scan slave stations.

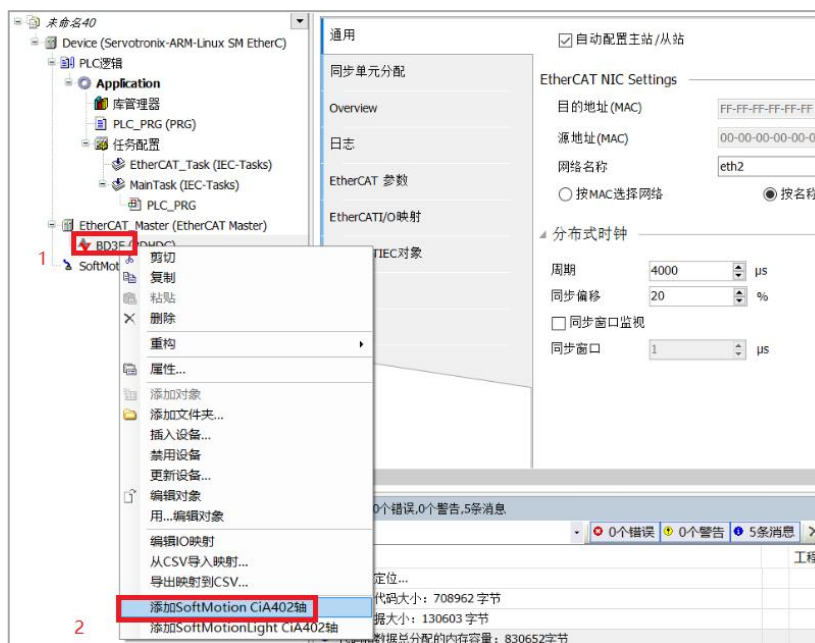
Click login, download the master station configuration, and it is complete when it shows download finished.



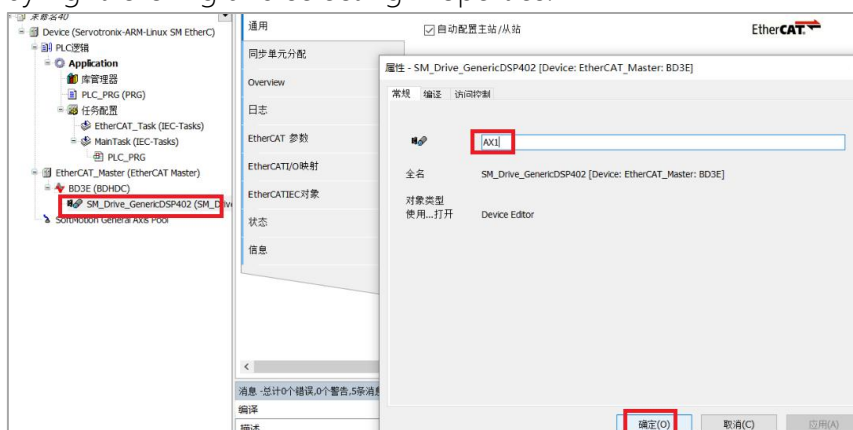
Log out at this point, and scan the devices.



Add motion control axes to the slave station: Right-click to add a SoftMotion CiA402 axis on the slave station. →



The default axis name is quite long; you can change the axis name to a simpler name (letters only) by right-clicking and selecting Properties.



Slave station axis settings: Double-click to add a SoftMotion axis, and you can configure the axis. The following is the basic setup interface.

Rotary axis; Limited

2: Software maximum and minimum positions for axis movement (soft limits).

3: Axis tracking error settings.



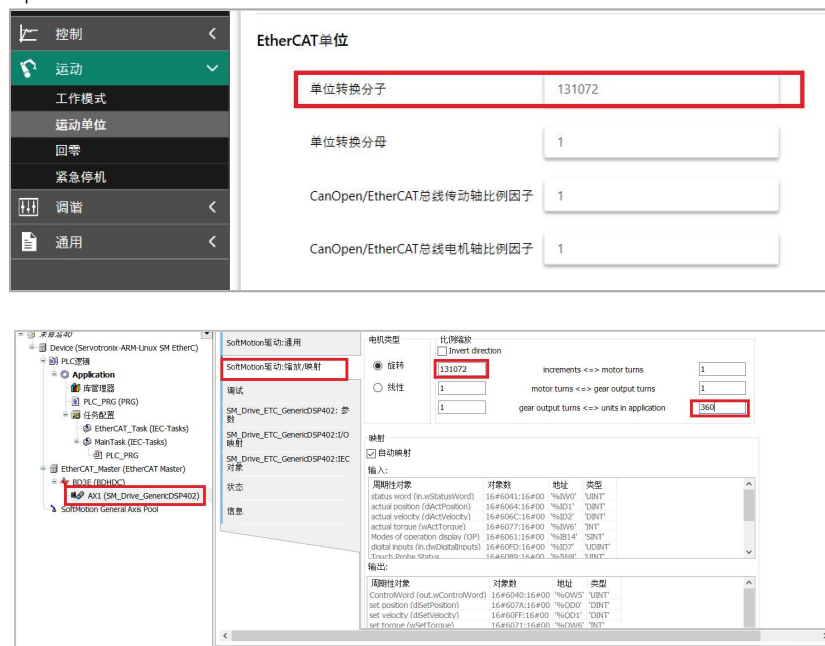
Axis electronic gear settings:

As shown in the figure below:

Incremental motor rotation: This corresponds to the encoder resolution of the motor, i.e., the number of pulses per revolution of the motor. ⇔

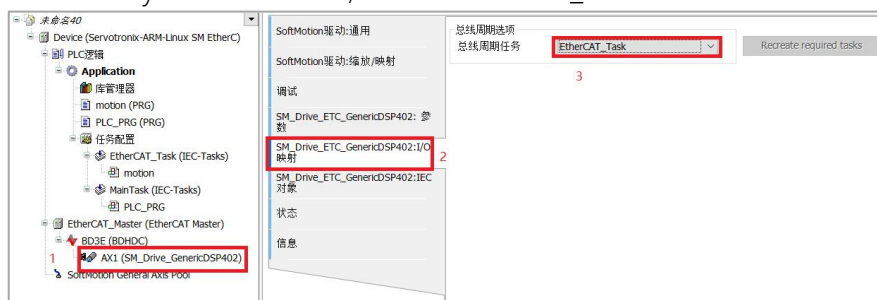
Motor gear output rotation: This corresponds to the gear ratio. ⇔

Reducer output rotation application unit: This corresponds to the position unit in the program, i.e., the position value in the program corresponding to one revolution of the mechanical output end. ⇔



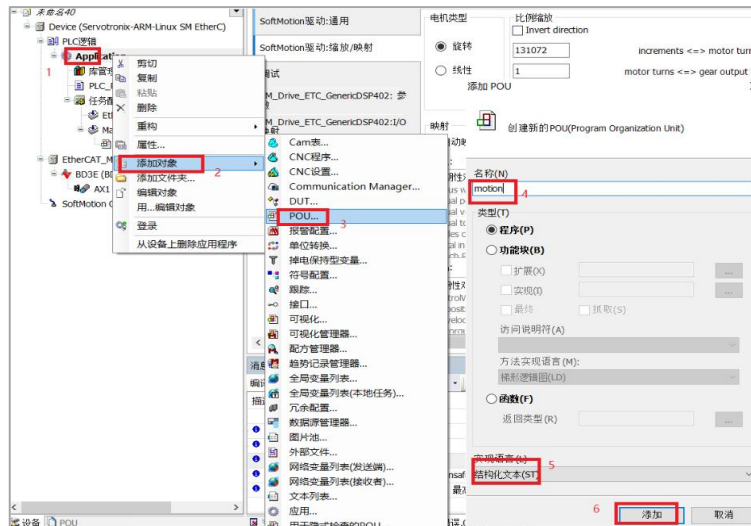
The number of pulses per revolution set in the controller must be consistent with the setting in the servo.

Set the bus task cycle for the axis, select EtherCAT_Task.



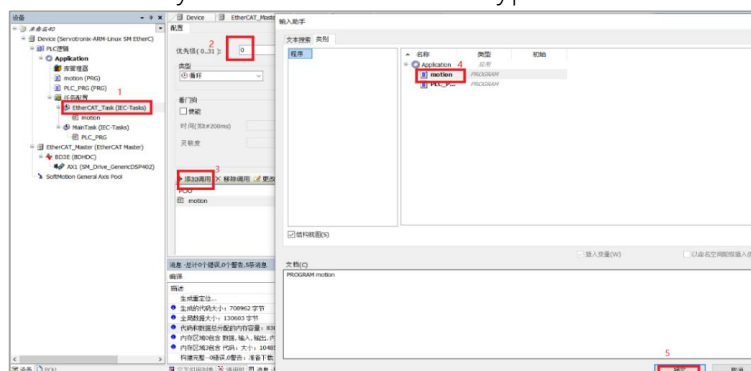
3) Write a single-axis motion program.

Program Organization Unit. In the dialog box, modify the added program name, programming language, etc., and then confirm. As shown in the figure below:



Add the motion program to EtherCAT_Task and set the bus priority to the highest.

Task settings are as shown in the figure below. Task priority 0 is the highest, and 31 is the lowest. Please select the cyclic mode for the task type.



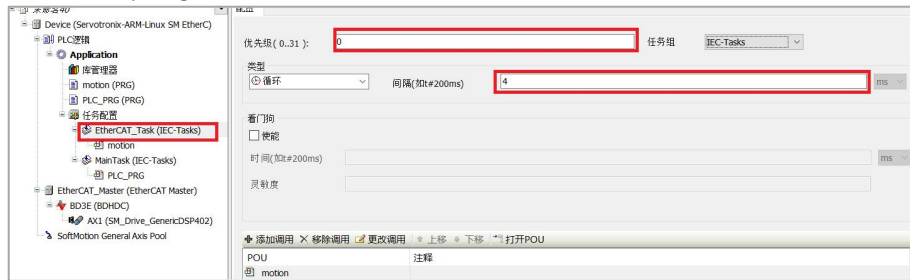
After the program is added, you can add program control code according to the requirements:

```

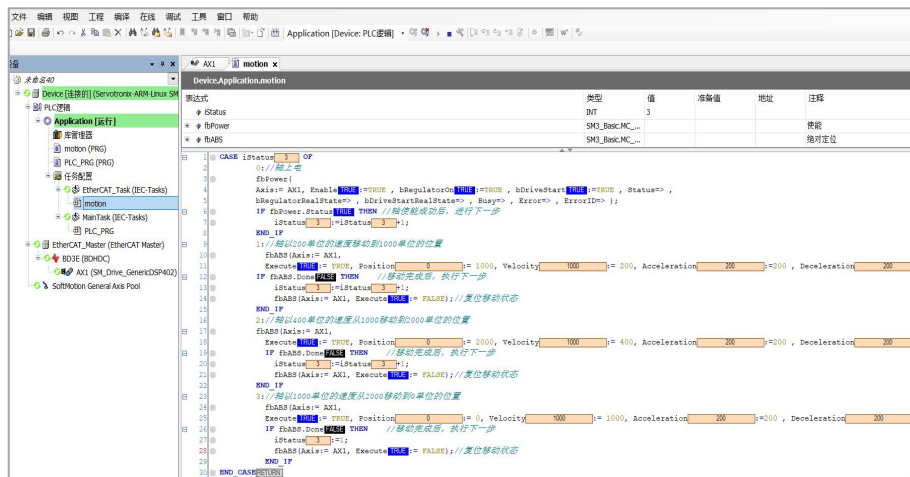
1 PROGRAM motion
2 VAR
3   iStatus:INT:=0;
4   fbPower:SM3_Basic_MC_Power; //使能
5   fbABS:SM3_Basic_MC_MoveAbsolute; //绝对定位
6 END_VAR
7
8 CASE iStatus OF
9   0://轴上电
10    fbPower(
11      Axis:= AX1, Enable:=TRUE, bRegulatorOn:=TRUE, bDriveStart:=TRUE, Status=>,
12      bRegulatorRealState=>, bDriveStartRealState=>, Busy=>, Error=>, ErrorID=> );
13    IF fbPower.Status THEN //使能成功后, 进行下一步
14      iStatus:=iStatus+1;
15    END_IF
16    1://轴以200单位的速度移动到1000单位的位置
17    fbABS(Axis:= AX1,
18      Execute:= TRUE, Position:= 1000, Velocity:= 200, Acceleration:=200, Deceleration:= 200);
19    IF fbABS.Done THEN //移动完成后, 执行下一步
20      iStatus:=iStatus+1;
21      fbABS(Axis:= AX1, Execute:= FALSE); //复位移动状态
22    END_IF
23    2://轴以400单位的速度从1000移动到2000单位的位置
24    fbABS(Axis:= AX1,
25      Execute:= TRUE, Position:= 2000, Velocity:= 400, Acceleration:=200, Deceleration:= 200);
26    IF fbABS.Done THEN //移动完成后, 执行下一步
27      iStatus:=iStatus+1;
28      fbABS(Axis:= AX1, Execute:= FALSE); //复位移动状态
29    END_IF
30    3://轴以1000单位的速度从2000移动到0单位的位置
31    fbABS(Axis:= AX1,
32      Execute:= TRUE, Position:= 0, Velocity:= 1000, Acceleration:=200, Deceleration:= 200);
33    IF fbABS.Done THEN //移动完成后, 执行下一步
34      iStatus:=iStatus+1;
35      fbABS(Axis:= AX1, Execute:= FALSE); //复位移动状态
36    END_IF
37  END_CASE
38 END_PROGRAM
  
```

4) Task Configuration

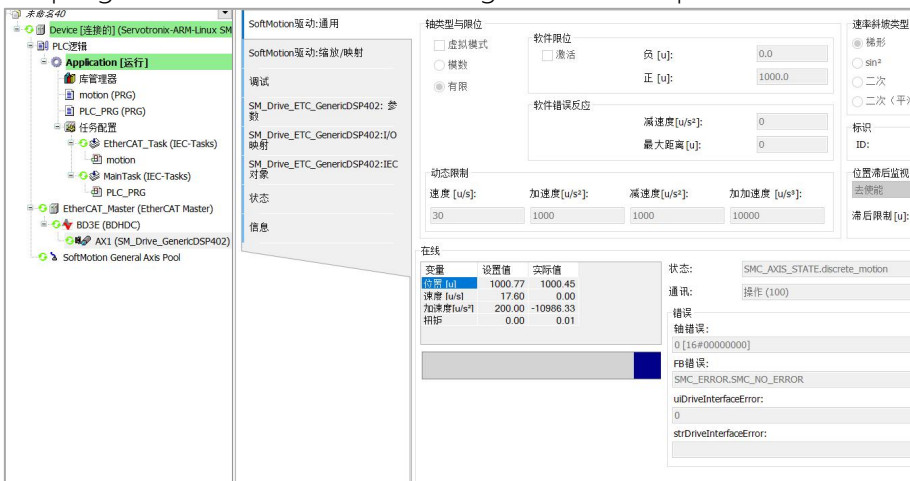
As shown in the figure below: Set the priority to 0 (highest), bus cycle time to 4ms, and run the motion program under this task.



5) Test Run



After the program runs, observe the changes in the axis position.



15.2 Usage Instructions for BD3E Series Servos with STEP EtherCAT Controller

The BD3E series servo can be connected to the EtherCAT controller master station of STEP for single-axis or multi-axis coordinated control. The controller is based on CODESYS,

and a series of settings need to be performed before use. The following uses the configuration of single-axis motion of the BD3E servo as an example.

15.2.1 Preparation

(1) Install CODESYS software.

It is recommended to install CODESYS software version V3.5 SP4 or higher.

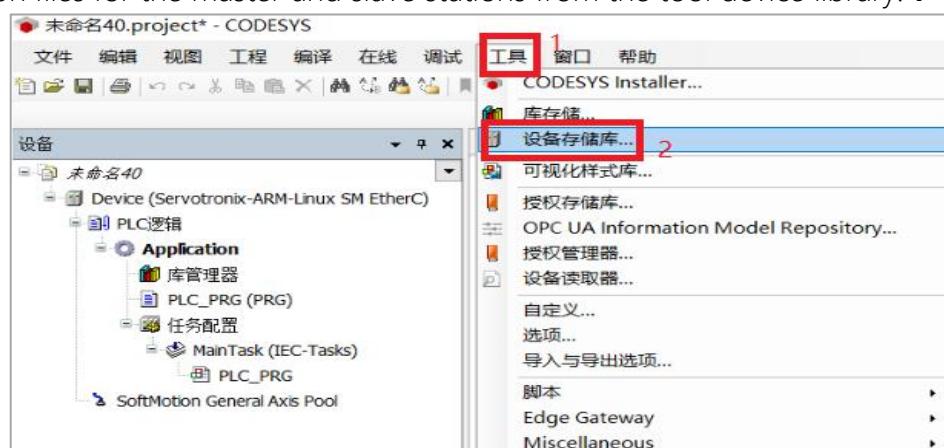
(2) Complete the configuration of servo parameters.

Set the servo bus parameters and motor parameters, and ensure the motor test run is successful.

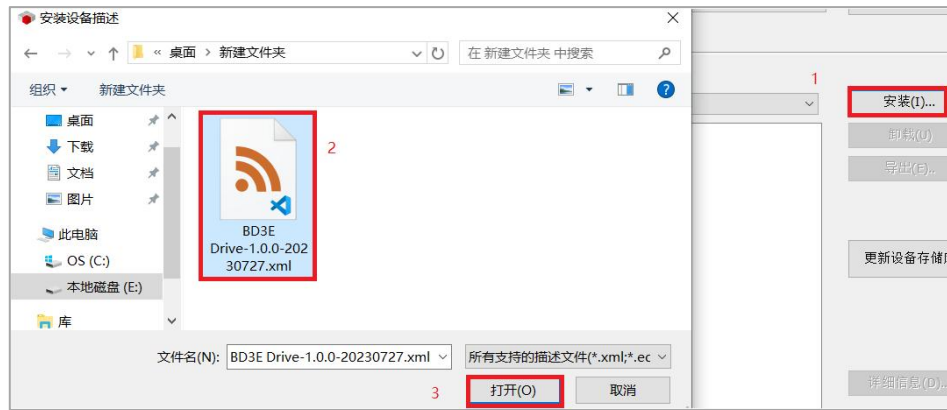
15.2.2 Software Engineering Configuration

1) First, install the equipment.

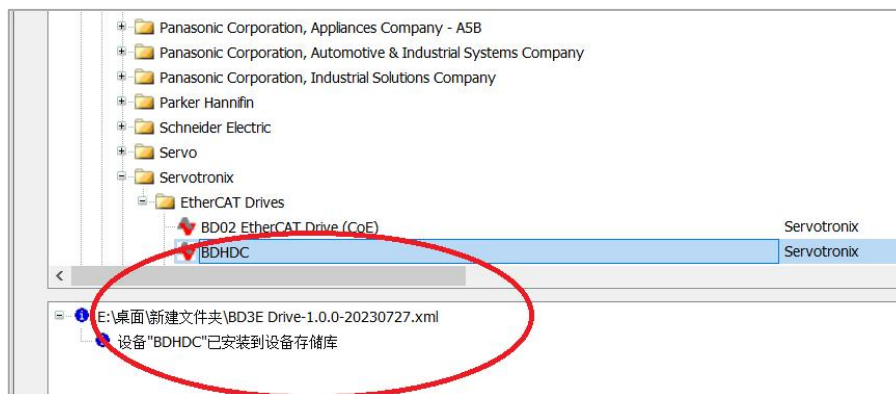
Open the CODESYS software, as shown in the figure below, and install the device description files for the master and slave stations from the tool device library:→



Click Install, then find the location of the device description files, select all the master and slave station description files, note that you need to choose all supported description files, and then open them.

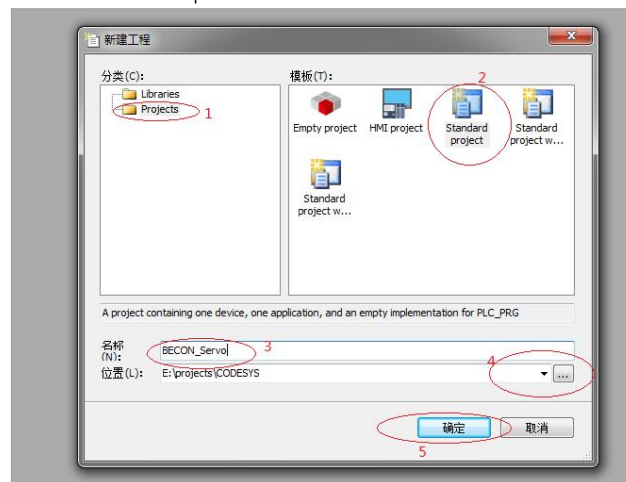


When the device installation is successful, the following display information will appear; click Close to finish.



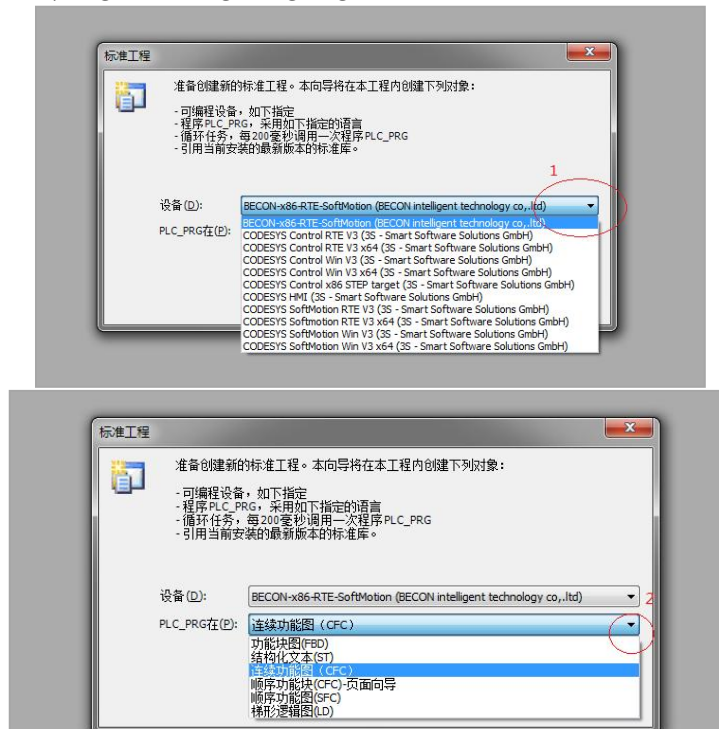
2) Configure the master station and slave stations

Open the CODESYS software, File, New Project, in Project select Standard project, then choose the project name and path.

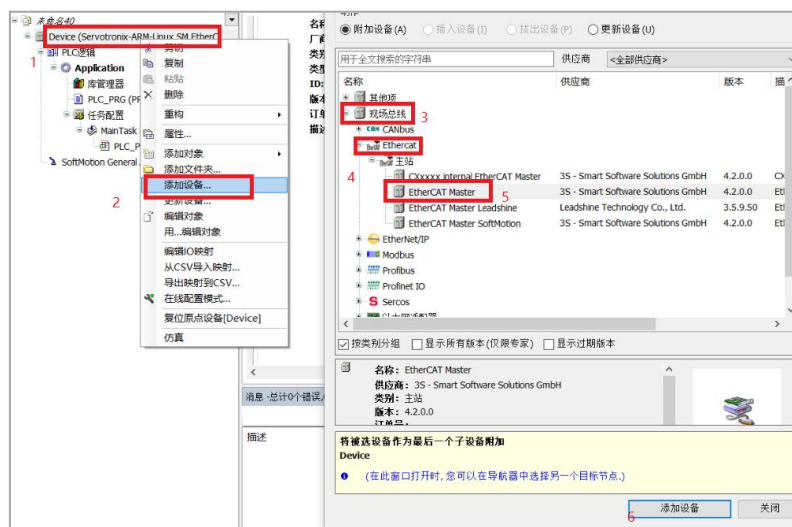


In the engineering wizard, select the device and programming language: choose the master station CODESYS Control x86 STEP target installed earlier. The programming language can be selected according to personal preference, such as Ladder Diagram (LD),

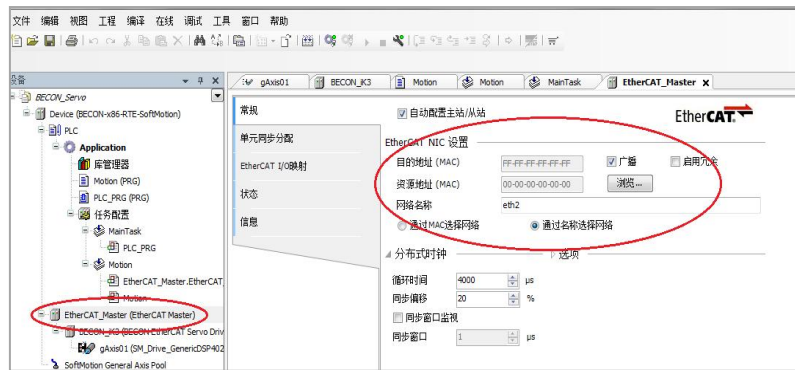
Function Block Diagram (FBD), Continuous Function Chart (CFC), Structured Text (ST), etc., which are IEC61131-3 programming languages.



Adding the master station: Right-click on Device and add a device, then select Fieldbus Industrial Ethernet EtherCAT Master. → →

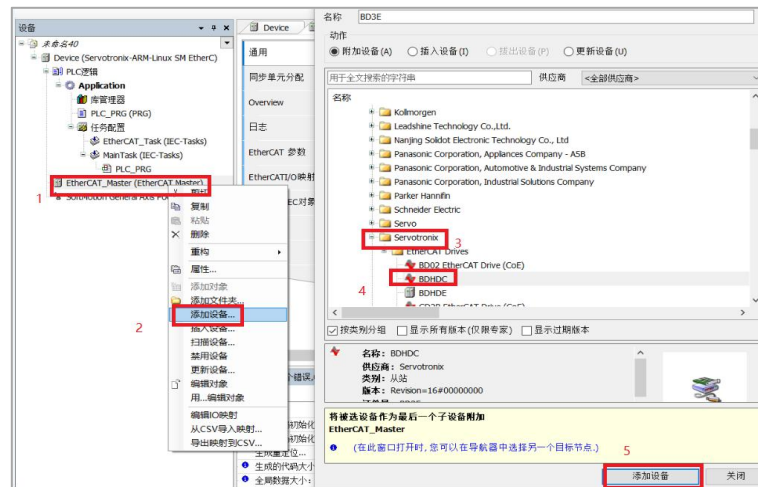


Double-click the added EtherCAT _Master and change the network name to eth2 in the EtherCAT NIC settings.



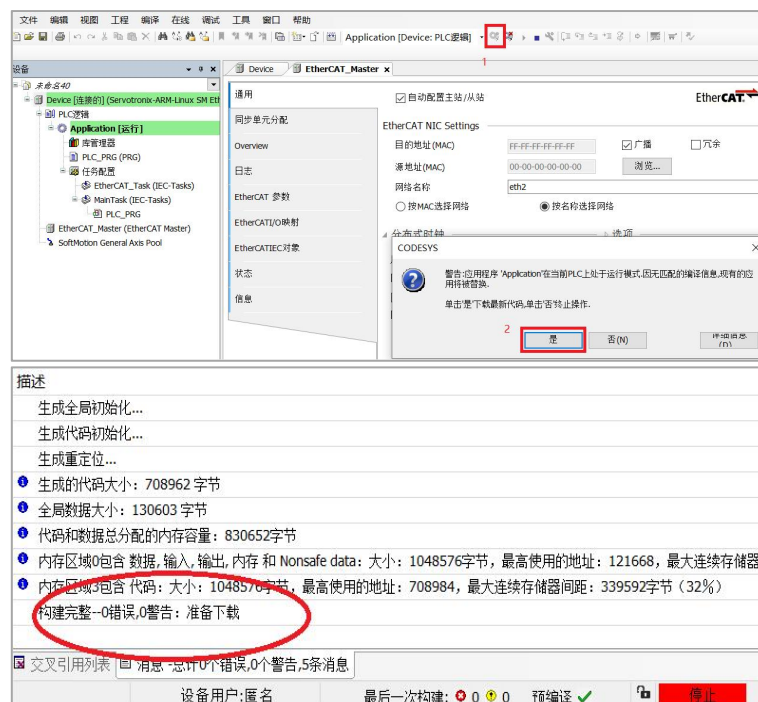
Add slave

Add device, and select Servotronic BD3E .



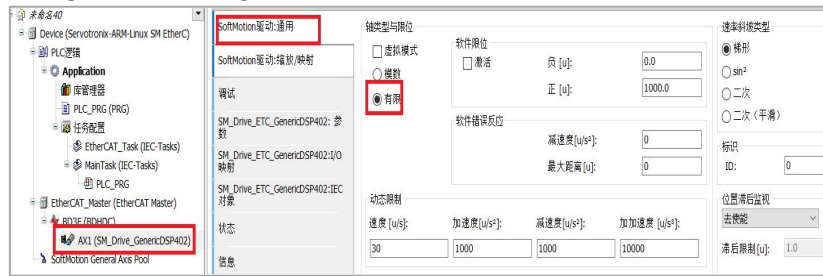
Method two: Download configuration, scan slave stations.

Click login, download the master station configuration, and it is complete when it shows download finished.



2: Software maximum and minimum positions for axis movement (soft limits).

3: Axis tracking error settings.



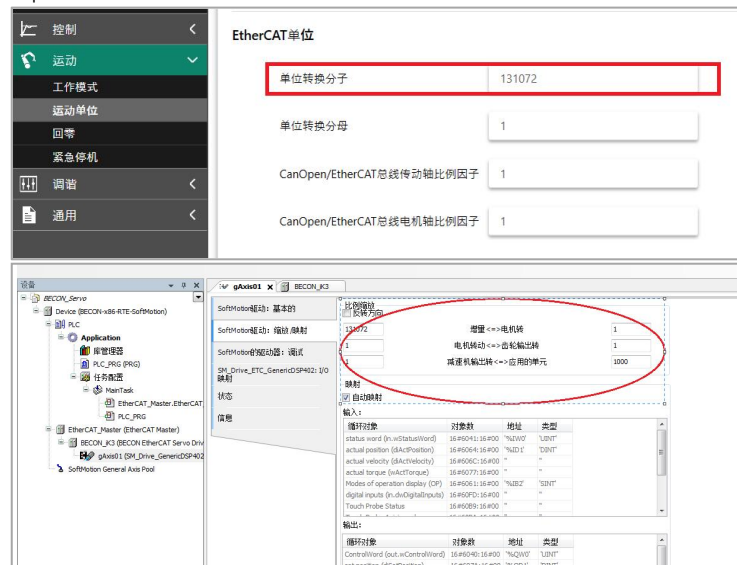
Axis electronic gear settings:

As shown in the figure below:

Incremental motor rotation: This corresponds to the motor encoder resolution, i.e., how many pulses the motor generates per revolution. ⇔

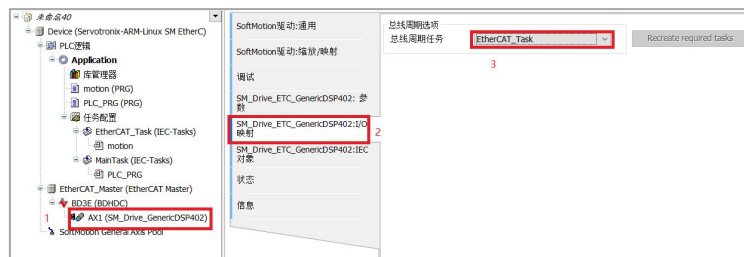
Motor rotation to gear output rotation: This corresponds to the gear ratio. ⇔

Unit applied to the reducer output rotation: This corresponds to the position unit in the program, i.e., the position value in the program corresponding to one revolution of the mechanical output end. ⇔



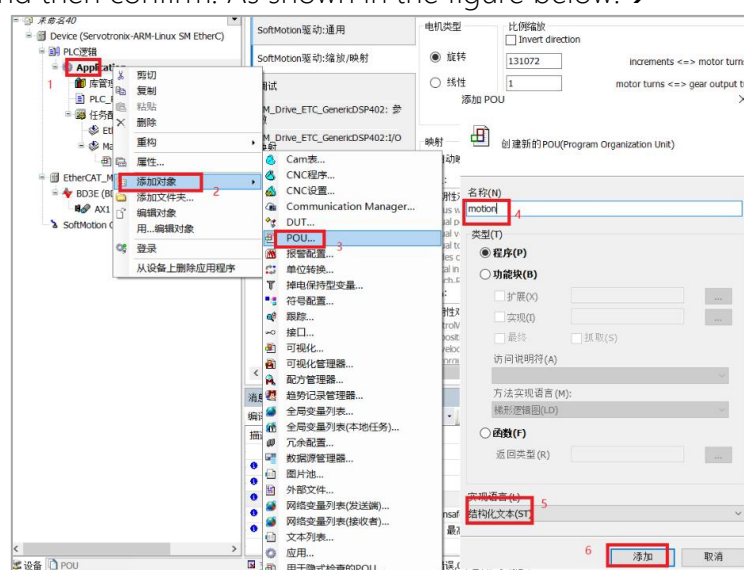
The number of pulses per revolution set in the controller must be consistent with the setting in the servo.

Set the bus task cycle for the axis, and select EtherCAT_T



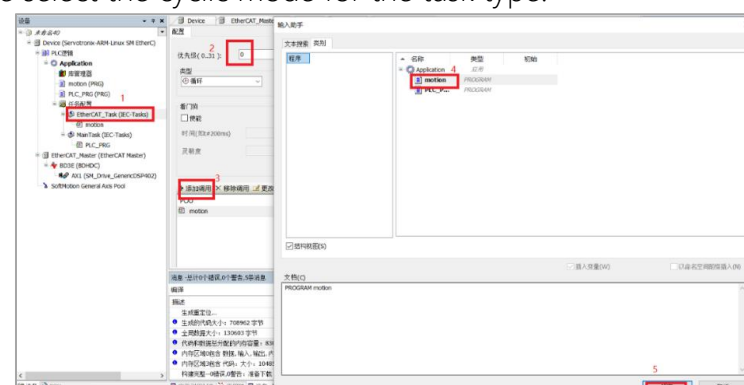
3) Write a single-axis motion program.

After configuring the master and slave stations, you can proceed with writing the axis motion control program. Right-click on Application and select Add Object Program Organization Unit. In the dialog box, modify the added program name, programming language, etc., and then confirm. As shown in the figure below:→



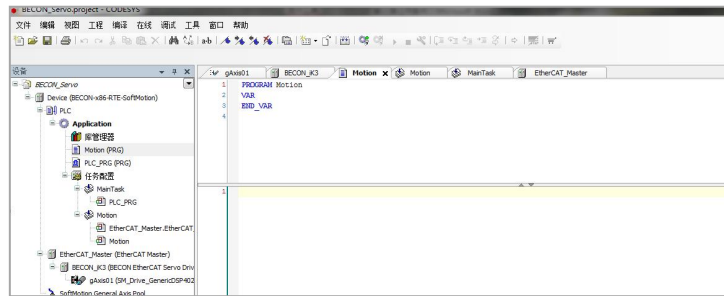
Add the motion program to EtherCAT_Task and set the bus priority to the highest.

Task settings are as shown in the figure below. Task priority 0 is the highest, and 31 is the lowest. Please select the cyclic mode for the task type.

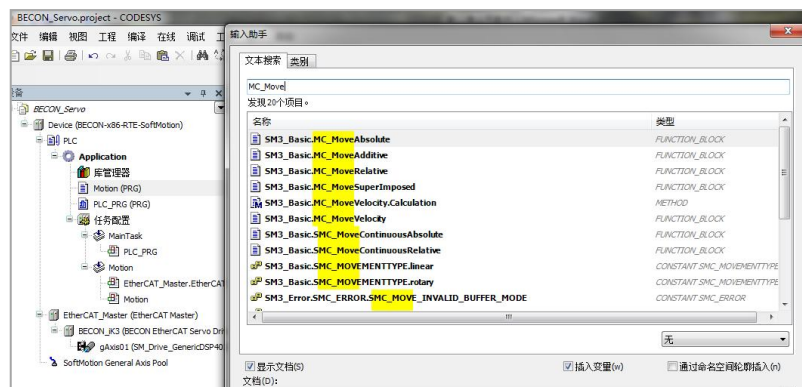


After the program is added, you can add program control code according to the requirements:

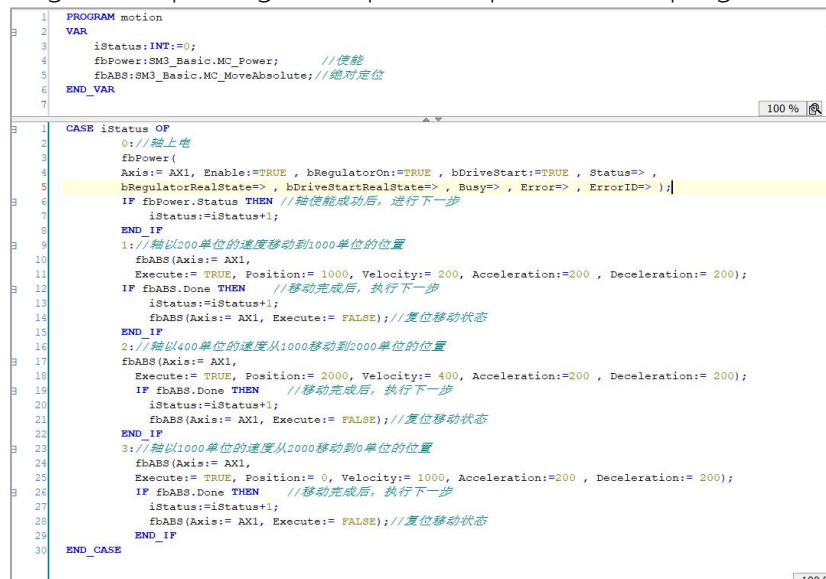
After the program is added, you can add program control code according to the requirements:



You can right-click in the blank area of the program editing box and select Input Assistant to search for the required function blocks. All IEC6113-3 PLCopen Part 1, Part 2, and Part 4 instructions can be searched.



The following is a simple single-axis point-to-point control program:

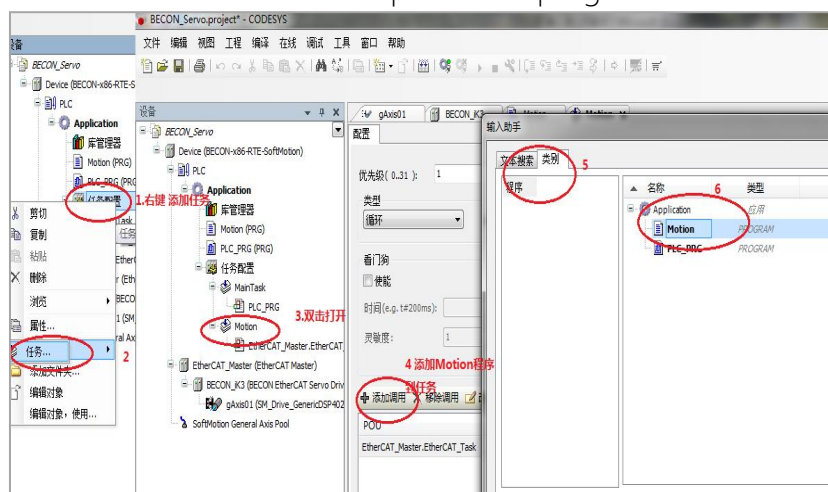


4) Program Task Configuration

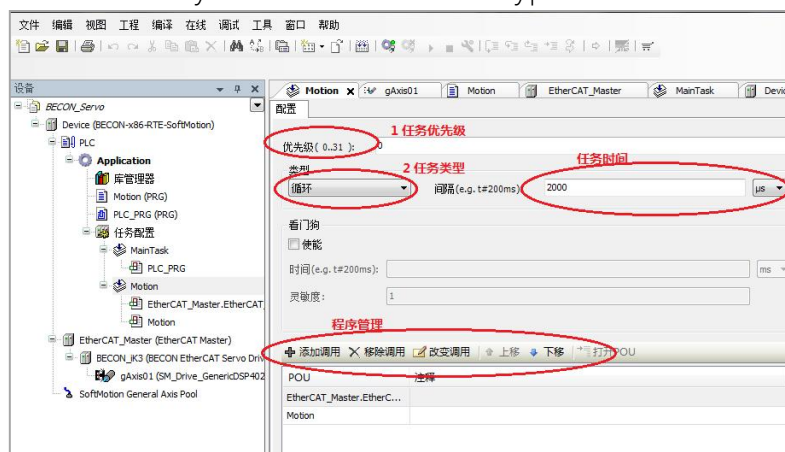
After completing the program writing, you can allocate tasks to the program. The general configuration method is as shown in the figure below:

Right-click on Task Configuration and select Add Task. In the dialog box, name the task.→

Double-click the added task to set it up and add programs.

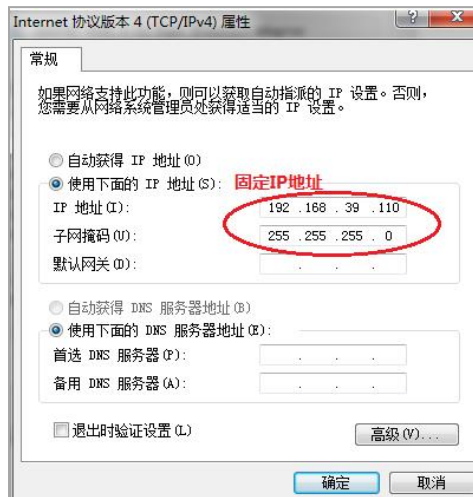


Task settings are as shown in the figure below. Task priority 0 is the highest, and 31 is the lowest. Please select the cyclic mode for the task type.

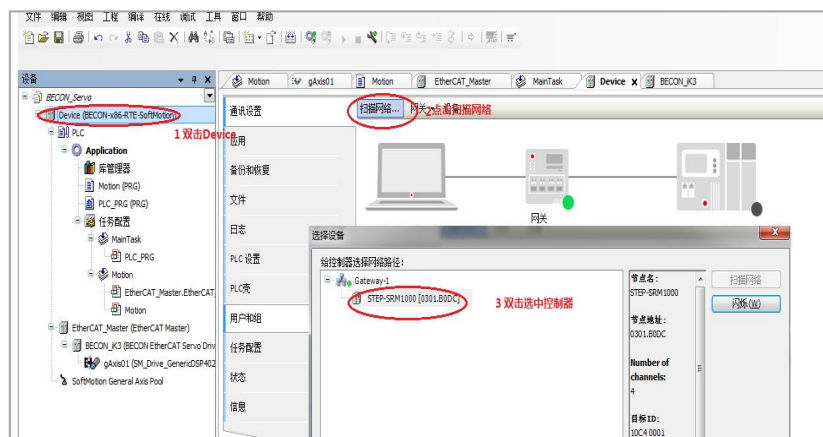


5) Controller Connection and Project Download

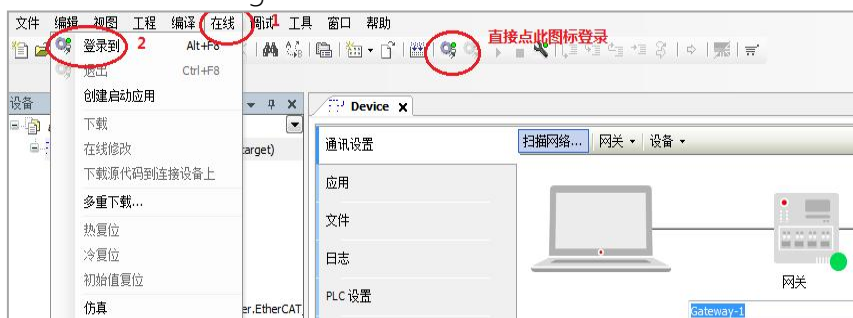
After the project creation is completed, you can connect the controller to download the project file to the controller. First, connect the controller's debugging network port to the PC's network port using an Ethernet cable, and set the IP address of the PC's network port to the 192.168.39.xxx subnet as shown in the figure below.



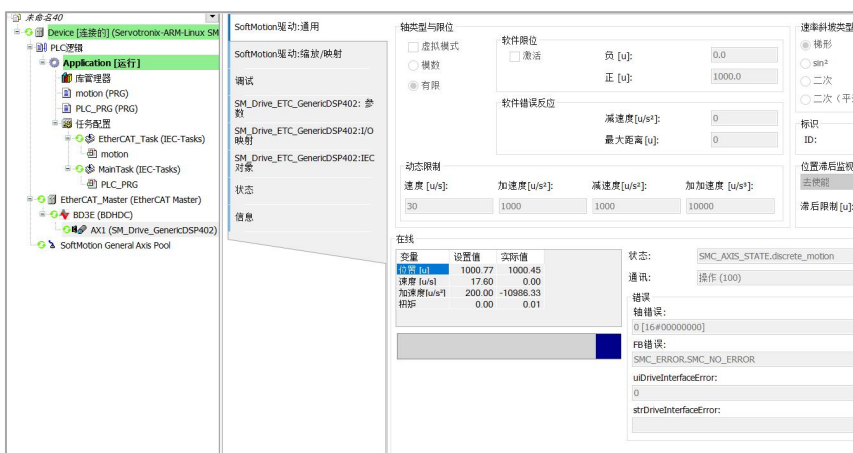
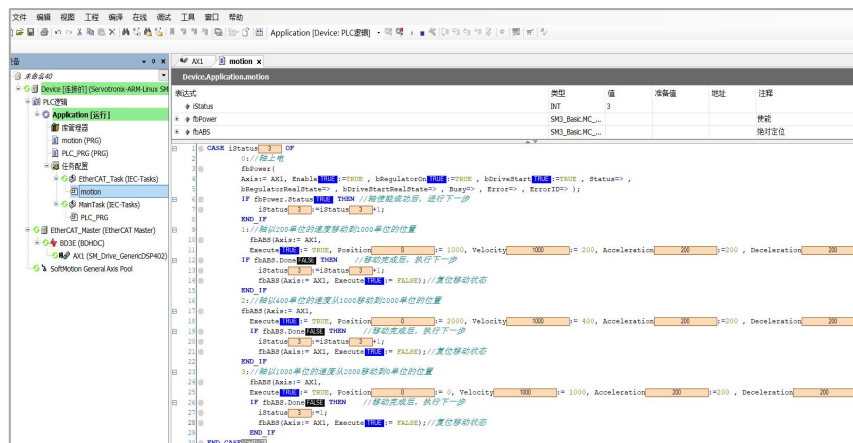
Then, you can proceed to connect the controller: Double-click Device, in the Communication Settings interface, select Scan Network, and double-click on the scanned controller. →→



After successfully connecting to the controller, you can download the project. Select Online Login to automatically compile and download the project, or you can directly click the icon on the toolbar in the figure below. →



6) Test Run



15.3 BD3E Series Servo Operation Guide with Beckhoff TwinCAT3

All Beckhoff master stations can also control the iK3 series servos. Below, we will use the latest TwinCAT3 software from Beckhoff as an example to detail the method for configuring the iK3 series servos with the Beckhoff controller.

15.3.1 Preparation

1) Install TwinCAT3 software.

Beckhoff's TwinCAT3 software is integrated into Microsoft Visual Studio, and TwinCAT3 software supports installation on versions of VS2010 and above.

Before installing TwinCAT3 software, please install Visual Studio software first.

2) Configuration of servo parameters, etc.

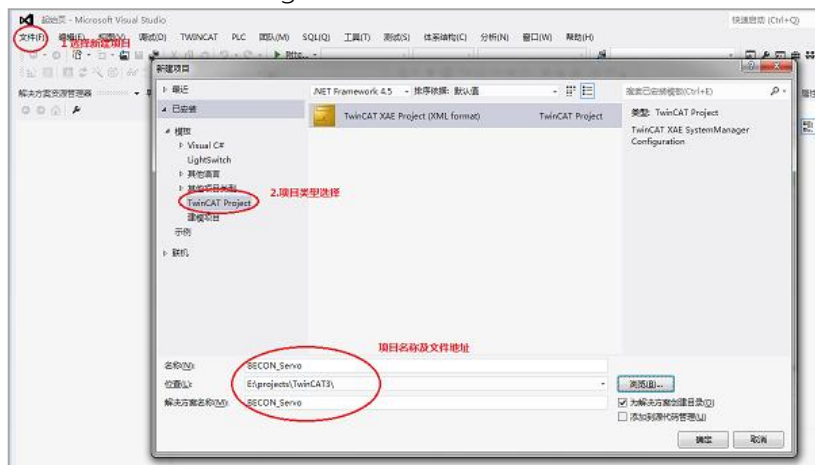
Set the servo bus parameters and motor parameters, and ensure the motor self-learning is successful.

15.3.2 Software Engineering Configuration

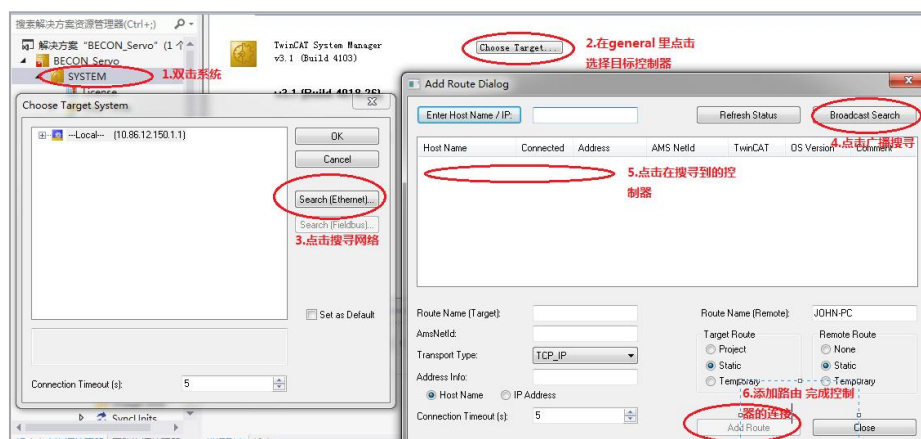
The following uses Visual Studio 2013 as an example to explain the configuration and usage method of BD3E series servos with Beckhoff.

1. Create a new project and add a servo axis

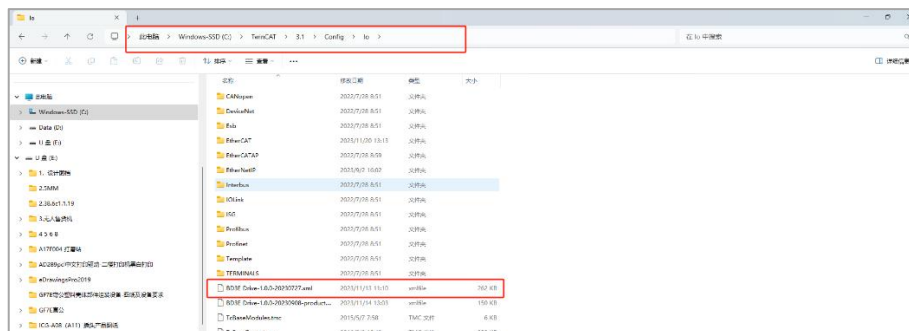
1) After the program is installed, open Visual Studio to create a new project, select TwinCAT Project, as shown in the figure below.



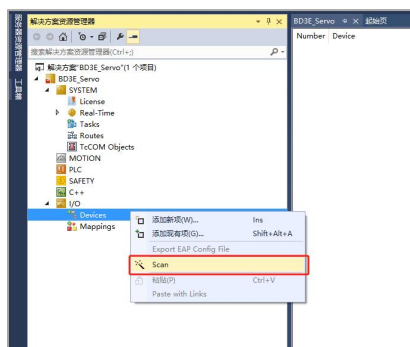
2) After creating the new project, you can connect to the target controller. As shown in the figure below, double-click SYSTEM under the project, in the General interface, select Choose Target, in the dialog box, select Search Ethernet Broadcast Search, click on the detected controller, and connect to the target controller through adding a route (Add Route).→



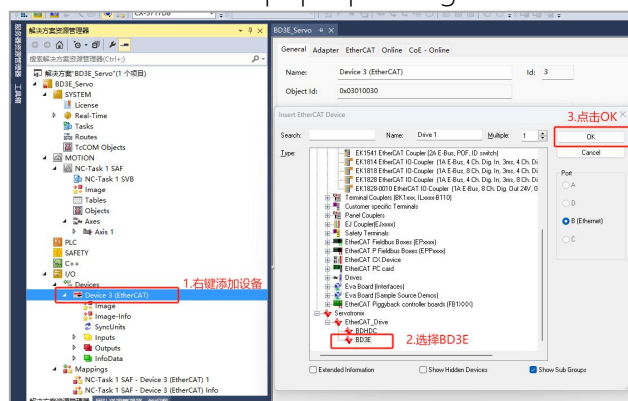
3) Add the BD3E XML file to the specified location.



4) After connecting to the target controller, you can manually add EtherCAT master stations and servo slave stations, or you can directly add them through scanning. As shown in the figure below, right-click on Device under I/O and select Add New Item to manually add, or use Scan to automatically detect and add the servo drives connected to the controller.

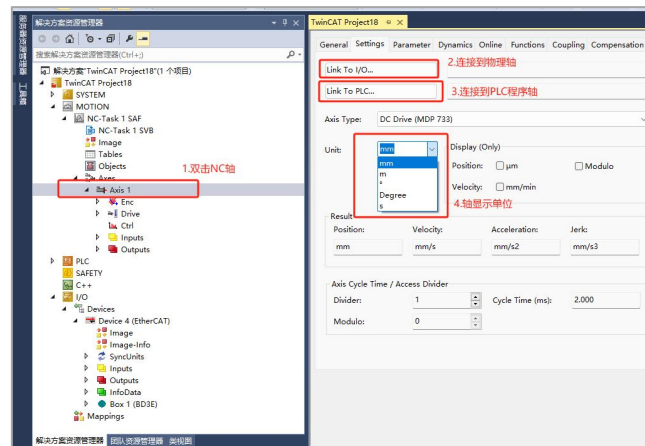


5) Manually add servo slave stations to the added EtherCAT master station, and automatically connect the NC axis in the pop-up dialog box.



2. Basic Settings for NC Axis

Select an axis in the NC axes of Motion for basic settings, as shown in the figure below.



- 1) Link To I/O: Select BOX 1 (BD3E)
 - 2) Link To PLC: Select the axis in the PLC program
 - 3) Axis Type: Select CANopen DS402 axis
 - 4) Unit: Select the required display unit
- #### 4. NC Axis Parameter Settings

Speed Settings

General	Settings	Parameter	Dynamics	Online	Functions	Coupling	Compensation
		Parameter	Value	Type	Unit		
		Velocities:					
		Reference Velocity	18000.0	F	Degree/s		
		Maximum Velocity	16000.0	F	Degree/s		
		Manual Velocity (Fast)	600.0	F	Degree/s		
		Manual Velocity (Slow)	300.0	F	Degree/s		
		Calibration Velocity (towards plc cam)	1200.0	F	Degree/s		
		Calibration Velocity (off plc cam)	300.0	F	Degree/s		
		Jog Increment (Forward)	5.0	F	Degree		
		Jog Increment (Backward)	5.0	F	Degree		

NC Axis Speed Settings

- 1) Reference Velocity: Reference speed, corresponding to the maximum allowable rotational speed of the axis
- 2) Maximum Velocity: Set the maximum speed of the axis during operation
- 3) Manual Velocity (Fast): Set the fast speed for manual jogging of the axis
- 4) Manual Velocity (Slow): Set the slow speed for manual jogging of the axis
- 5) Calibration Velocity (towards PLC cam): Speed for axis reference point search (return to zero switch)
- 6) Calibration Velocity (away from PLC cam): Speed for moving away from the return to zero switch
- 7) Jog Increments (Forward): Forward jog increment for the axis

8) Jog Increment (Backward): Backward jog increment for the axis

Acceleration and Deceleration Settings

General	Settings	Parameter	Dynamics	Online	Functions	Coupling	Compensation
		Parameter	Value	Type	Unit		
+		Velocities:					
-		Dynamics:					
		Acceleration	9000.0	F	Degree/s2		
		Deceleration	8000.0	F	Degree/s2		
		Jerk	2250.0	F	Degree/s3		
		Fast Axis Stop Signal Type (optional)	'OFF (defa...	E			
		Fast Acceleration (optional)	0.0	F	Degree/s2		
		Fast Deceleration (optional)	0.0	F	Degree/s2		
		Fast Jerk (optional)	0.0	F	Degree/s3		

- 1) Acceleration: Axis operation acceleration
- 2) Deceleration: Axis operation deceleration
- 3) Jerk: Rate of change of acceleration

Operation Status Monitoring

General	Settings	Parameter	Dynamics	Online	Functions	Coupling	Compensation
		Parameter	Value	Type	Unit		
+		Dynamics:					
+		Limit Switches:					
-		Monitoring:					
		Position Lag Monitoring	FALSE	B			
		Maximum Position Lag Value	20.0	F	Degree		
		Maximum Position Lag Filter Time	0.02	F	s		
		Position Range Monitoring	TRUE	B			
		Position Range Window	5.0	F	Degree		
		Target Position Monitoring	TRUE	B			
		Target Position Window	2.0	F	Degree		
		Target Position Monitoring Time	0.02	F	s		
		In-Target Alarm	FALSE	B			
		In-Target Timeout	5.0	F	s		
		Motion Monitoring	FALSE	B			
		Motion Monitoring Window	0.1	F	Degree		
		Motion Monitoring Time	0.5	F	s		

- 1) Position Lag Monitoring: Axis following error monitoring. Set this option to FALSE during debugging.

5. Axis Encoder Settings

Double-click Enc under Axis1 to set up the encoder.

General	NC-Encoder	Parameter	Time Compensation	Online
		Parameter	Value	Type Unit
+		Encoder Evaluation:		
		Invert Encoder Counting Direction	FALSE	B
		Scaling Factor	0.00274658203125	F Degree/INC
		Position Bias	0.0	F Degree
		Modulo Factor (e.g. 360.0°)	360.0	F Degree
		Tolerance Window for Modulo Start	0.0	F Degree
		Encoder Mask (maximum encoder value)	0xFFFFFFFF	D
		Encoder Sub Mask (absolute range maximum value)	0x00001FFF	D
		Reference System	'INCREMENTAL'	E

- 1) Scaling Factor: Encoder scaling factor. Set the actual physical parameter corresponding to the number of motor shaft encoder pulses.

Setting Method:

(a) Determine the encoder pulse value for one revolution of the motor, a 17-bit motor encoder provides 131072 incremental pulses per revolution.

(b) Determine the physical parameter for one revolution of the motor, when using degrees as the unit, one revolution of the motor corresponds to 360 degrees.

then the scaling factor value is set to $360/131072 = 0.00274658203125$

2) Encoder Mask(maximum encoder value):

The corresponding encoder can feedback the maximum position value, which is set as follows:

$$GM_{max} = 2^{Singleturn\ Bits + Multiturn\ Bits} - 1$$

That is, the position value corresponding to the combination of single-turn and multi-turn bits of the encoder. The default setting is the maximum value of a 32-bit position.

3) Encoder Sub Mask (absolute range maximum value)

Corresponding to the maximum single-turn feedback value of the encoder:

$$GM_{ST} = 2^{Singleturn\ Bits} - 1$$

6. Position Loop Control Parameter Settings

Double-click on Drive under Axis1 to set the controller parameters.

When the servo operates in velocity mode (0x6060=9), the TwinCAT host must set the corresponding Kp and feedforward parameters.

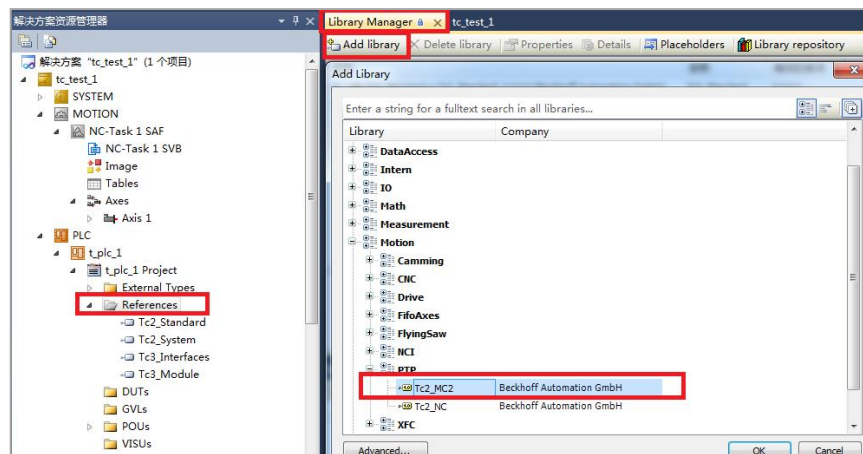
General NC-Controller Parameter Online				
	Parameter	V...	Ty...	Unit
+	Monitoring:			
-	Position Control Loop:			
	Position control: Proportional Factor Kv	1.0	F	Degree/s/Degree
	Feedforward Velocity: Pre-Control Weighting [0.0 ... 1.0]	1.0	F	

7. PLC Motion Control Function

TwinCAT integrates the PLCopen motion control library, and by calling the relevant functions of the motion control library, it can achieve motion control for single-axis and multi-axis systems.

The main steps for controlling axis operation via PLC (the PLC programming part of TwinCAT3 and TwinCAT2 is basically the same):

1) Add the PLC motion control library



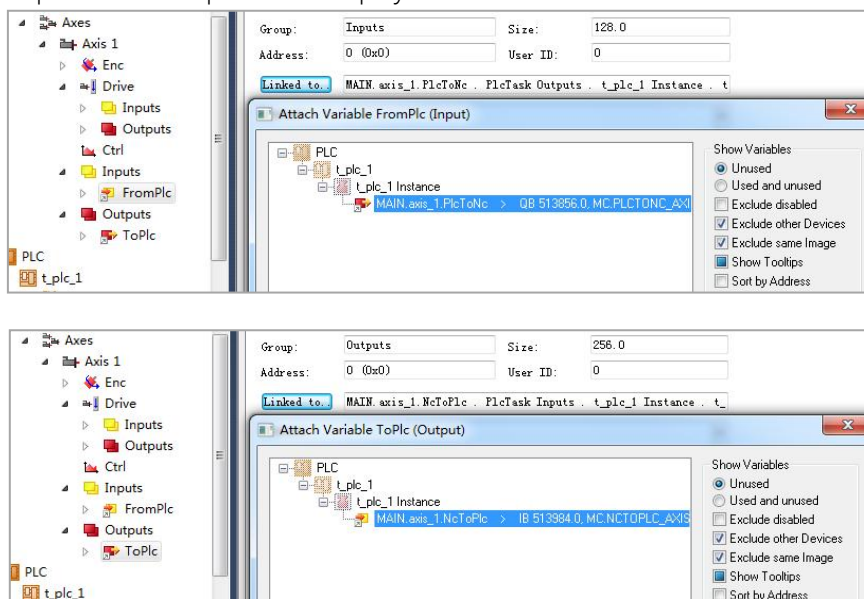
2) Define a reference axis type:

axis_1 : AXIS_REF;

Here, AXIS_REF is the axis type parameter defined by the PLC motion control library, and all function blocks of the motion control library must reference this type parameter.

3) Associate the physical axis

Establish the association between the inputs and outputs of the axis defined by the PLC and the inputs and outputs of the physical axis:

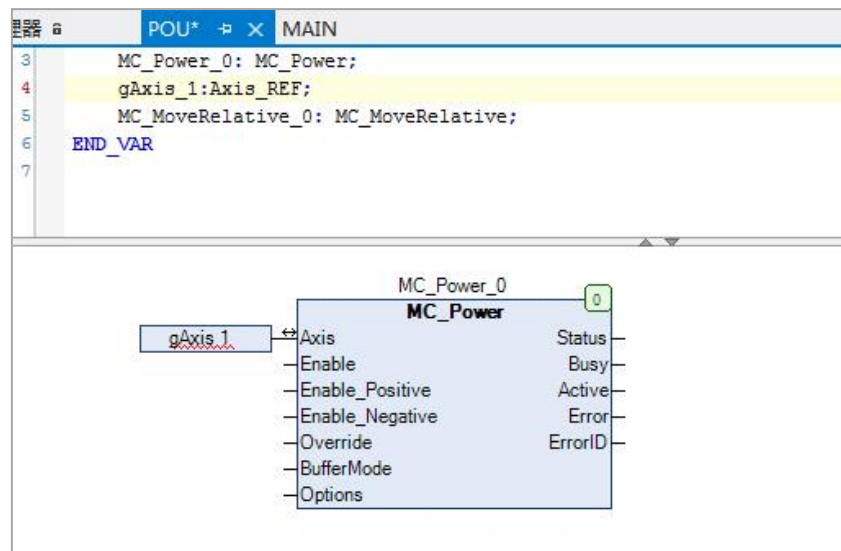


4) Enable the axis

First, define an instance of the axis enable function block:

MC_Power_0: MC_Power;

Call the axis enable function block using CFC language:



After calling, the enable status of the axis can be monitored in real-time through the NC Online interface.

5) Axis Point-to-Point Motion Execution

After enabling the axis, you can call the relevant motion control function blocks to perform axis movement operations.

The relevant motion control function blocks are listed as follows:

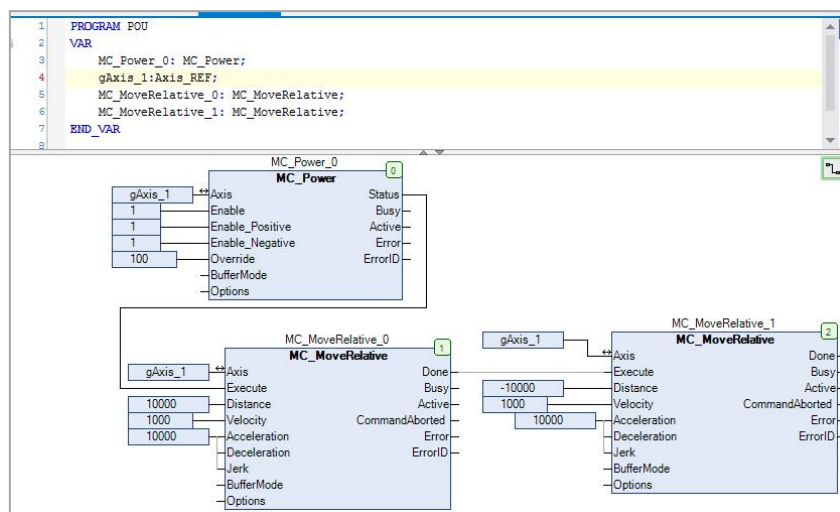
PLCopen Motion Control Library Function Blocks	
Function Block	Function Description
MC_Home	Axis Return to Zero
MC_Jog	Axis Jogging Operation
MC_Halt	Run Pause
MC_Stop	Run Stop
MC_MoveAbsolute	Run to Absolute Position
MC_MoveAdditive	Axis Additional Movement
MC_MoveRelative	Axis Relative Movement
MV_MoveVelocity	Run at Specified Speed

For example, to move the iK3 servo axis to a certain position, you can call it as follows:

First, declare an instance of the motion function block:

```
MC_MoveRelative_0: MC_MoveRelative;
```

Then call this function block:



15.4 BD3E Series Servo Operation Method with Omron Controller

15.4.1 Preparation

1) Install Sysmac Studio software

It is recommended to install version V1.10 or later. Sysmac Studio versions V1.03 and earlier cannot recognize third-party servos. Sysmac Studio patch version V1.09, V1.10, and later versions no longer verify whether the manufacturer ID in the XML matches the one in the program, allowing compatibility with all BD3E series XML files.

2) Import the device description file

Use the device description file "BD3E Drive-1.0.0-20230908-product.xml" or a later version. Place the file in the following path:

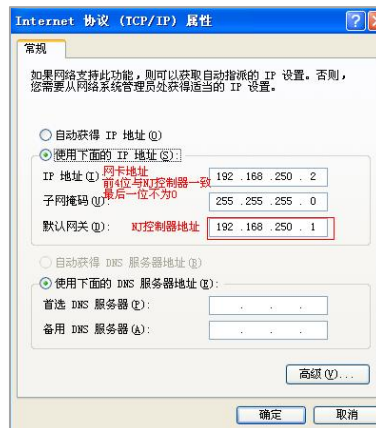
OMRON\SysmacStudio\IODeviceProfiles\EsiFiles\UserEsiFiles.

When placing the XML file in this path for the first time, you need to restart the Sysmac Studio software.

3) Set the network connection properties of your computer

If the computer is connected directly to the NJ controller via USB, skip this step;

If the computer is connected directly to the NJ controller via Ethernet, set the TCP/IP properties of the computer as shown in the figure below:



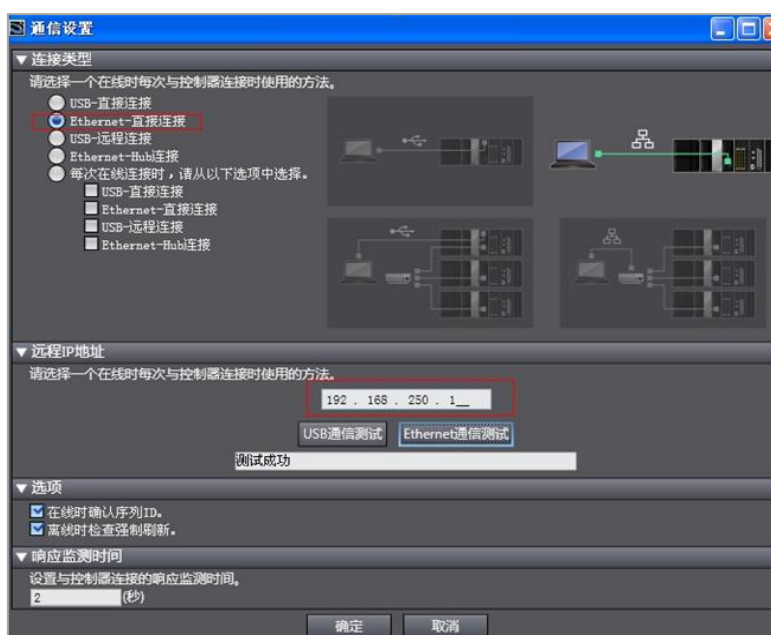
15.4.2 Omron NX Software Configuration

1) Create a New Project



Device: Operate according to the actual software version used; it is recommended to use version 1.09 or higher.

2) Communication Settings



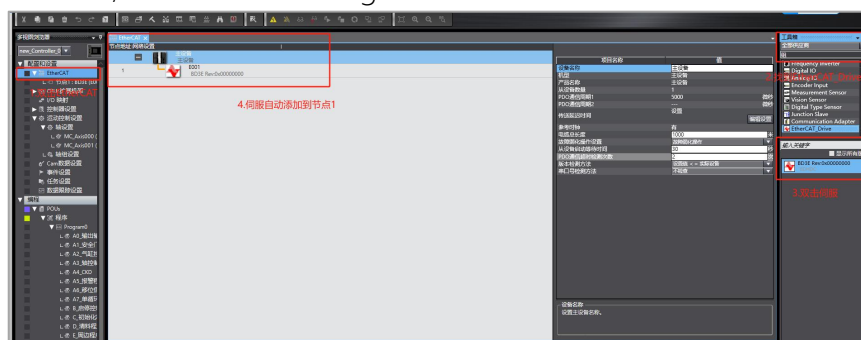
Enter the main interface, go to Controller → Communication Settings to select the connection method for the controller. If selecting USB connection, simply confirm; if selecting Ethernet-Direct Connection, an Ethernet communication test is required: change the remote IP to 192.168.250.1, then click on Ethernet Communication Test to ensure the test is successful.

3) Add Device

The BD3E series EtherCAT servo can be added directly through offline manual addition, or by connecting to Servo Driver for online scanning and addition. The following explains both methods of adding devices.

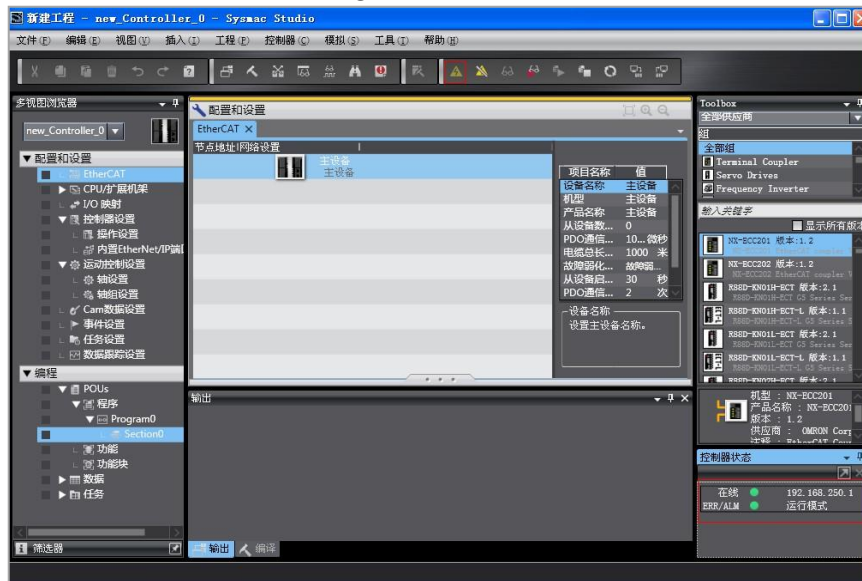
Offline Device Addition:

For configuration and settings, double-click EtherCAT, find BD3E in the toolbox, select the servo, and add it, as shown in the figure below.

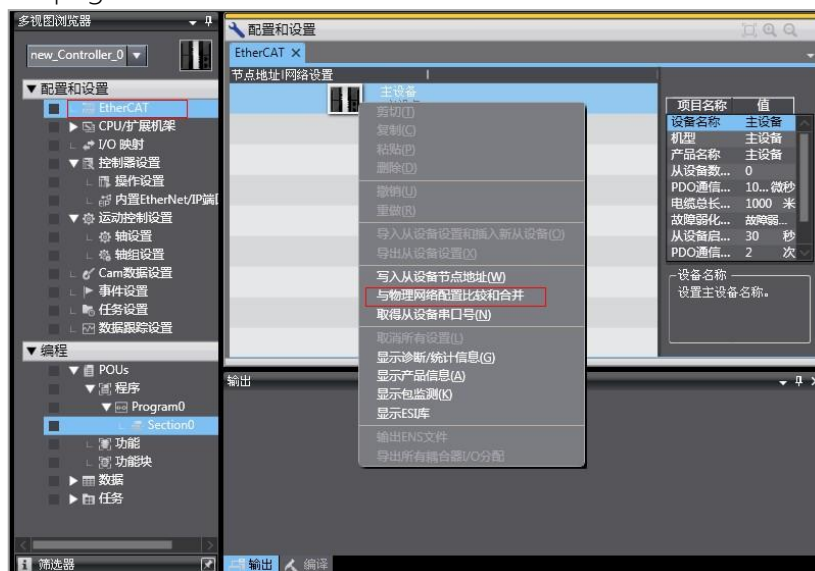


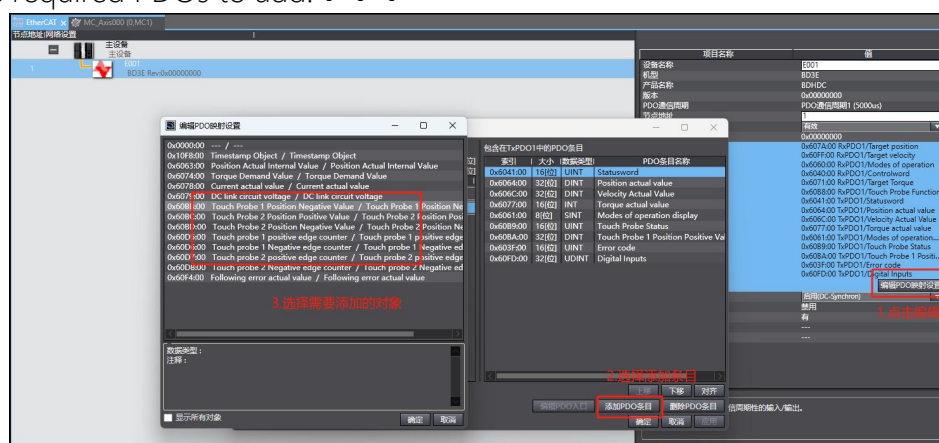
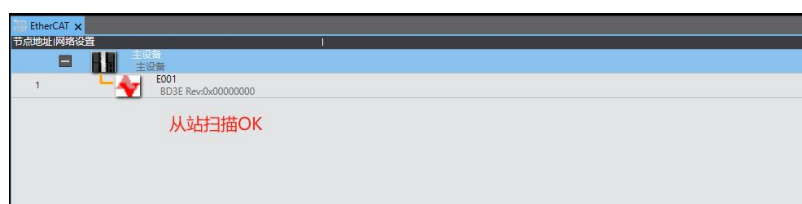
Add Device Online:

Switch the controller to the "Online, Running" mode. The online status of the controller can be seen at the bottom right corner.



Right-click on "Configuration and Settings" → "EtherCAT" → "Master Device", and select "Compare and Merge with Physical Network Configuration". The controller will automatically scan all slave stations in the network (stations with an address of 0 will cause an error). After scanning, click "Apply Physical Network Configuration" in the pop-up window to complete the addition of the slave stations. The added slave stations can be seen on the main page.





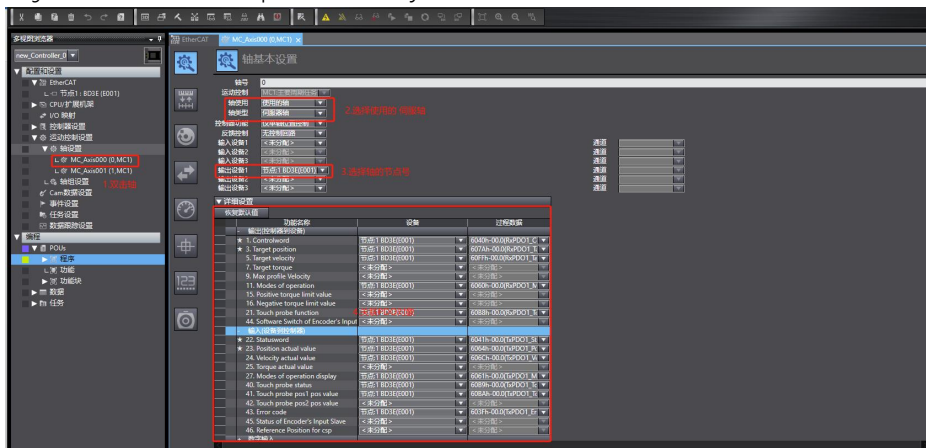
In 'Motion Control Settings' → 'Axis Settings', right-click and add 'Axis Settings' as shown in the figure below.



Click on 'MC_Axis000' to rename (Chinese characters are also supported).

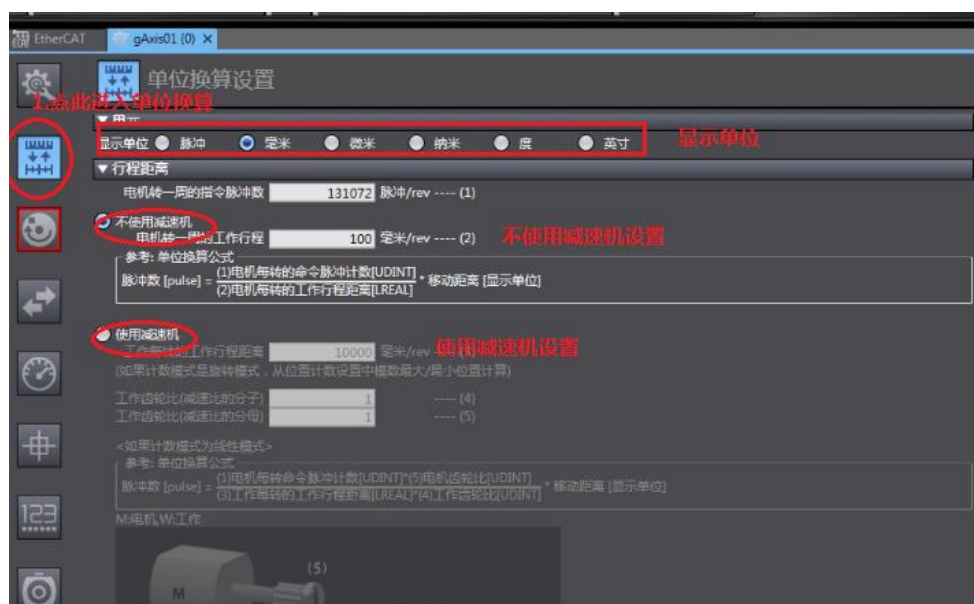
Basic Axis Settings:

In the Basic Axis Settings interface, first change the axis to the servo axis being used, and select the node number of the axis in Output Device 1. Then, in the detailed settings, associate the PDO objects with the input and output items. Note that the node number and PDO objects must correspond strictly; otherwise, an error will occur.

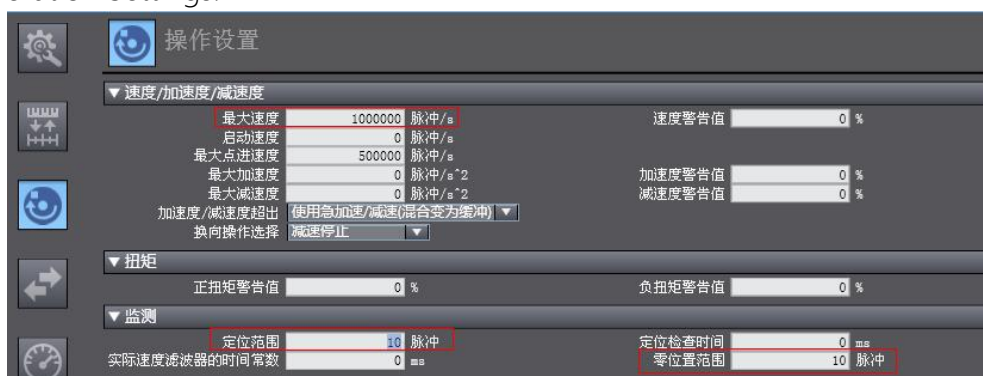


Unit Conversion Settings:

Set the 'Number of Command Pulses per Motor Revolution' based on the actual motor resolution (for example, for a 20-bit motor, set it to 1,048,576 pulses per revolution). This setting must be correct. The working travel for one motor revolution can remain at the default value. This is similar to performing electronic gear conversion on the host computer, so there is no need to set the conversion ratio inside the servo.



Operation Settings:



Speed / Acceleration / Deceleration: Set the maximum speed of the load according to actual conditions (if the converted motor speed exceeds 6000rpm, the upper-level software will display a red box indicating an incorrect parameter setting); an acceleration or deceleration of 0 indicates that the motion profile will be planned with the maximum acceleration or deceleration (if there are no special customer requirements, this does not need to be set).

Torque: A warning value of 0 indicates no warning (if there are no special customer requirements, this does not need to be set).

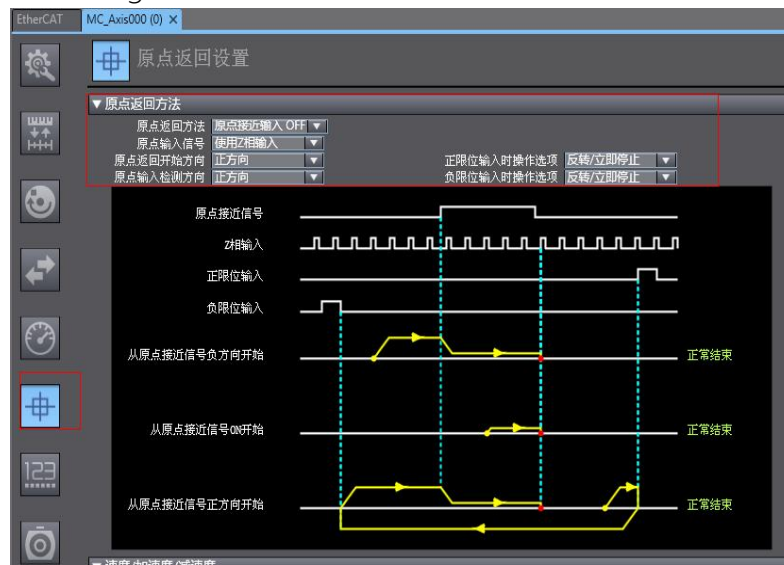
Monitoring: The positioning range and zero position range must be set according to the actual motor and mechanical conditions; setting them too small will result in the inability to complete positioning or returning to zero.

Limit Setting:



The software limit function can be used, which becomes effective after the origin return is performed using the host computer;

Origin Return Setting:



Setting the method of returning to the origin requires special attention, as it involves the coordination between the servo and the host computer functions. Please refer to the table below for settings.

NJ Software Description	Servo Corresponding Function
Home Signal	Home Switch
External Home Input	Probe Input 1
Z-Signal Input	Motor Encoder Z-Signal
Positive Limit Input	POT
Negative Limit Input	NOT

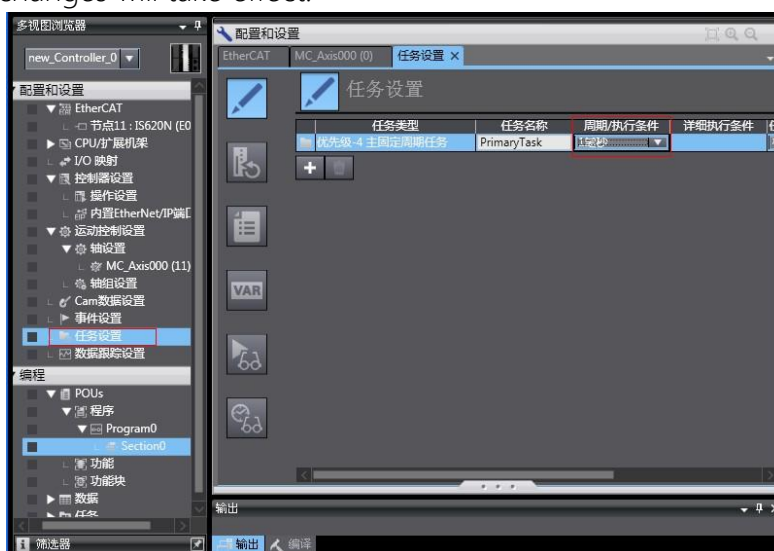
Note:

- 1 Choose either the Z signal or external home input; they cannot be used simultaneously.
- 2 Set the speed and acceleration for the origin return based on the actual mechanical setup.

3 Omron provides two homing function blocks: MC_Home and MC_HomeWithParameter. The parameters for MC_Home are set in the figure above, while the parameters for MC_HomeWithParameter are set within the function block. Both include 10 homing modes (for detailed information, please refer to the Omron NJ Motion Control User Manual).

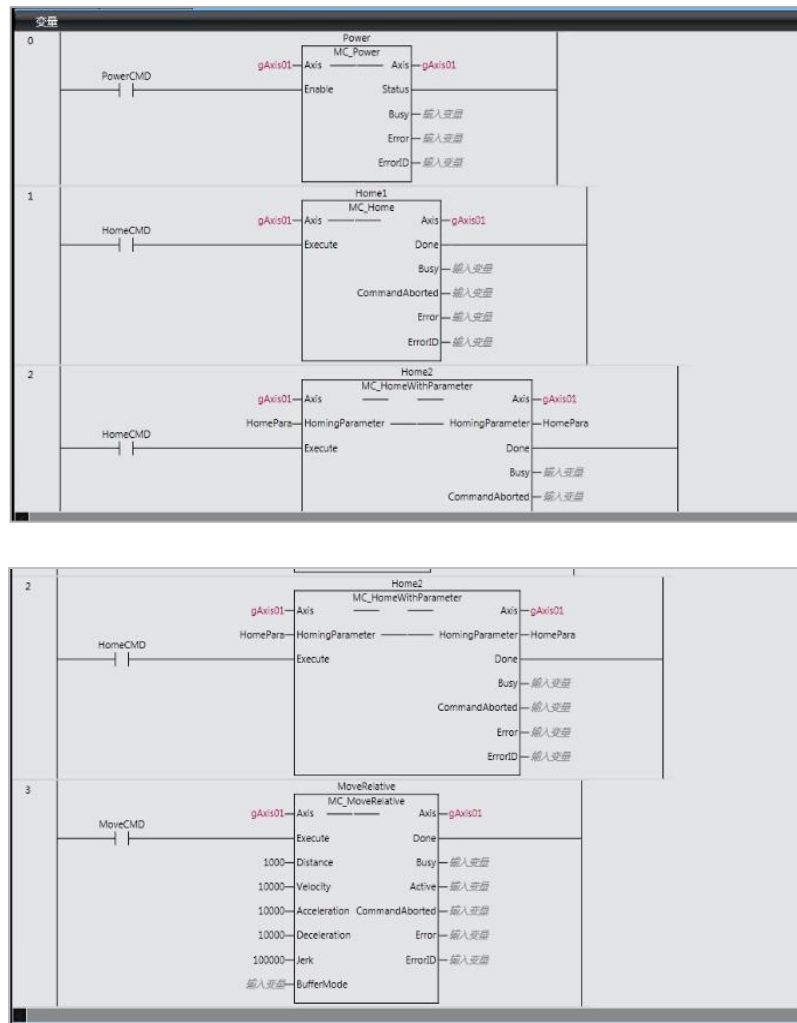
DC Clock Setting:

The default clock is 1ms. In offline mode, you can change the synchronization clock (the period of the main fixed cycle task) in the "Task Settings". In NJ, it is named "PDO Communication Cycle". After making changes, power cycle the device, switch to online mode, and the changes will take effect.



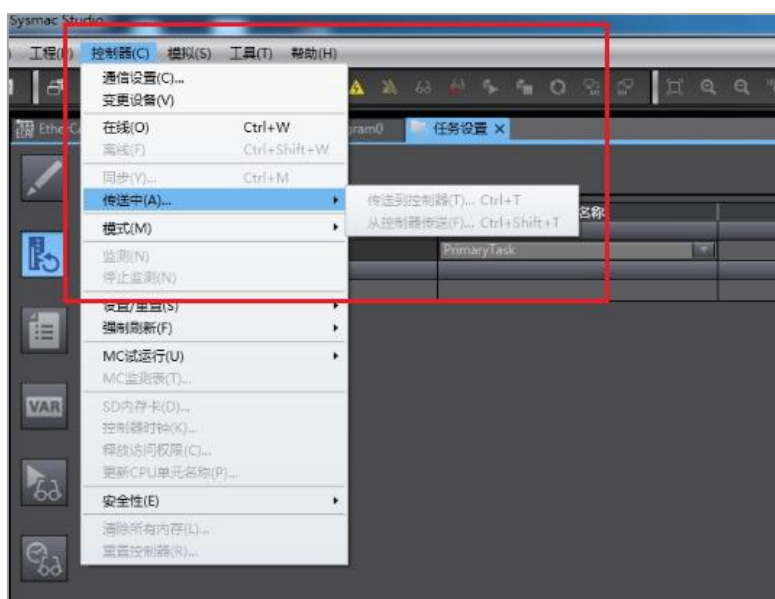
5) Program Control

After configuration is complete, the servo can be controlled via PLC program as shown in the figure below. Users can choose ladder diagram (LD) or structured text (ST) for programming.



6) Online Operation

After all settings and programming are completed, switch to online mode and execute the download to the controller.  Use the synchronization function  to compare the differences between the current program and the program in the controller, then decide whether to download to the controller or upload from the controller.  ", or it can remain unchanged. (The operation can also be performed by clicking in the menu bar Controller.)



15.5 Method for Using BD3E Series Servos with H5U Controller

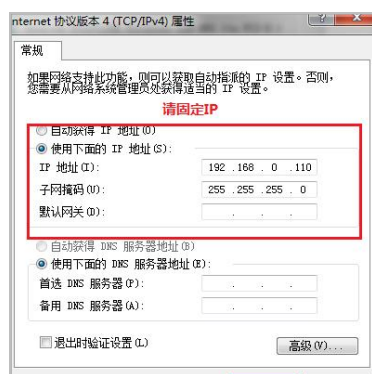
15.5.1 Preparation

1) Install H5U Controller Software

The H5U controller programming software AutoShop can be downloaded from the Inovance website.

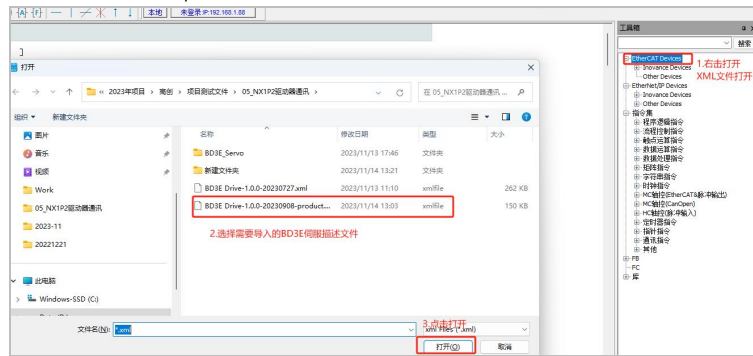
2) Change Local Connection IP Address

The H5U controller can communicate with a PC via USB, PCI, or Ethernet port. In this example, we use the Ethernet port, so you need to change the local connection IP address to the 192.168.0.xx subnet.

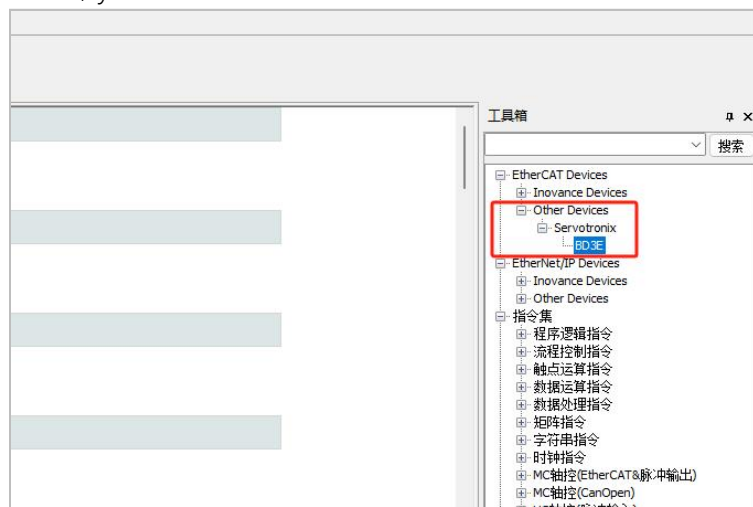


15.5.2 Software Configuration

1) Install the device description file for the BD3E series servos as shown below:

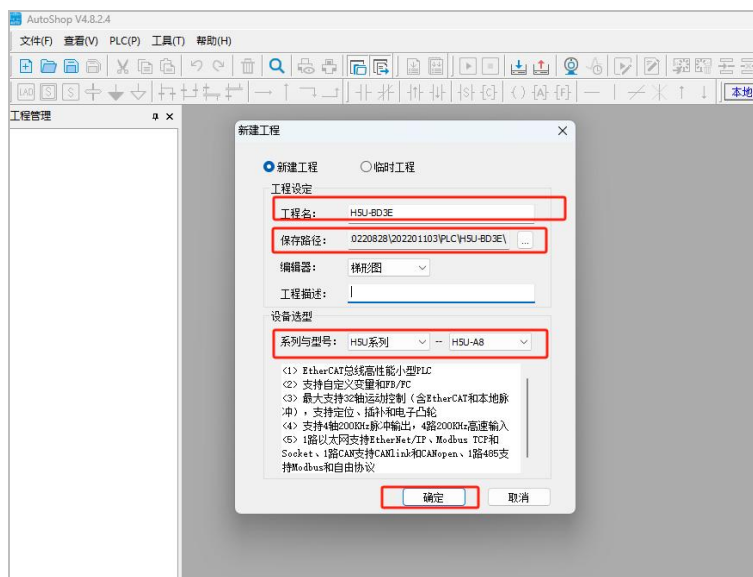


After successful installation, a prompt will appear to restart the software. After restarting the software, you will see that the file has been installed successfully.

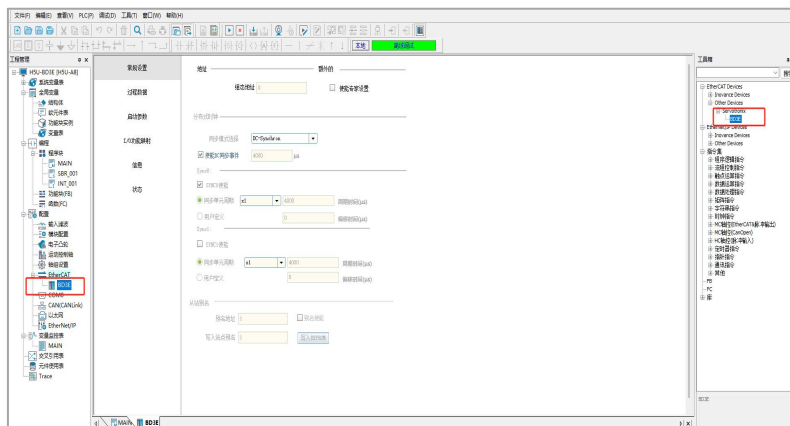


2) Configure the master station and slave stations

Open the AutoShop software, File, New Project, set the project name, save path, and select the H5U series device model.



Add a slave station: Method one, select BD3E from the toolbox on the right side of the software, and double-click to add.



Method two: Download configuration, automatically scan for slave stations.



Add motion control axis: Right-click to add an axis. →



3) Parameter Configuration

Switch the controller to offline mode, and perform PDO mapping settings and axis parameter settings.

PDO Mapping Settings

The BD3E series servo motors are configured by default with three sets of PDO parameters: Control Word (6040h), Status Word (6041h); Mode of Operation (6060h), Mode of Operation Display (6061h); Target Position (607Ah), Position Actual Value (6064h). If additional PDO parameters need to be mapped, they can be added manually:



Unit Conversion Settings:

Set the 'Number of Command Pulses per Motor Revolution' based on the actual motor resolution (for example, for a 20-bit motor, set it to 1,048,576 pulses per revolution). This setting must be correct. The working travel for one motor revolution can remain at the default value. This is similar to performing electronic gear conversion on the host computer, so there is no need to set the conversion ratio inside the servo.



Mode/Parameter Settings:

基本设置	模式选择:
单位换算设置	编码器模式: ☒ 增量模式 ☐ 绝对模式
模式/参数设置	模式设置: ☒ 线性模式 ☐ 旋转模式
原点返回设置	软件限位: ☐ 使能
在线调试	负向限制值: 0.00 Unit 正向限制值: 1000.00 Unit
	软件出排响应: 限位减速速度: 1000.00 Unit/s ² 轴减速速度: 10000.00 Unit/s ²
	阈值设置: 跟随误差阈值: 100.00 Unit 速度到达阈值: 5.00 Unit/s
	轴速度设置: 最大速度: 1000.00 Unit/s 最大加速度: 30000.00 Unit/s ²
	Jog最大速度: 500.00 Unit/s
	扭矩设置: 正扭矩最大值: 3000 0.1% 负扭矩最大值: 3000 0.1%
	选项: ☐ 碰限位后不进ErrorStop状态
	硬件限位逻辑: 硬件正限位: 正逻辑 硬件负限位: 正逻辑

Encoder Mode: Confirm the type based on the motor model; Mode Setting: Determine based on the application environment;

Other parameters should be set according to actual usage, and can be run using default values.

4) Task Cycle Time Setting:

The default clock is 4ms; in offline mode, the cycle time can be changed in the "General Settings".

工程管理	常规设置	分布式时钟	选项
	2.选择常规设置	循环时间: 4000 ms	☒ 自动重启从站
	状态	同步偏移: 50 %	3.设置循环时间, 默认4ms
		别名模式	选项
		☐ 别名使能	

1.双击EtherCAT

5) Program Control

网络7 网络主站	网络从站
轴号: Enable MC_Power Status: 伺服ON_L Busy: Error: ErrorID:	轴号: Enable MC_Reset Reset: 伺服点动ON_M Busy: 伺服点动ON_M CommandAborted: Error: ErrorID:

16. Appendix

16.1 Monitoring Display Overview D

	VarCom	Range	Units	Default Value
d0001	SYSST	0 to 9	--	0
	System Status			
d0002	APPST	0 to 7	--	1
	Current state of the applied state machine			
d0003	PCMD	-4294967296 to 4294967295	count	0
	Low bit of position command			
d0004	PCMD	-4294967296 to 4294967295	count	0
	High bit of position command			
d0005	PFB	-4294967296 to 4294967295	count	0
	Low bit of position feedback			
d0006	PFB	-4294967296 to 4294967295	count	0
	High bit of position feedback			
d0007	PE	-4294967296 to 4294967295	count	0
	Low bit of position error			
d0008	PE	-4294967296 to 4294967295	count	0
	High bit of position error			
d0009	V	-10000 to 10000	rpm	0
	Speed			
d0010	VCMD	-10000 to 10000	rpm	0
	Speed Command			
d0011	ICMD	-100 to 100	A	0
	Current Command			
d0012	IDCMD	-100 to 100	A	0
	D-axis Current Command			
d0013	IQ	-100 to 100	A	0
	Q-axis Current			
d0014	ID	-100 to 100	A	0
	D-axis Current			
d0015	I	-100 to 100	A	0
	Motor Current			

	VarCom	Range	Units	Default Value
d0016	VBUSREADOUT	0 to 850	V	0
	Bus Voltage Value			
d0017	ELECTANGLE	0 to 65535	0-65535	0
	Electrical Angle			
d0018	MFB	0 to 4294967295	count	0
	Motor Position Feedback Low 32 Bits			
d0019	MFB	0 to 4294967295	count	0
	Motor Position Feedback High 32 Bits			
d0020	ENCMULTITURN	-4294967296 to 4294967295	rev	0
	Encoder Multi-turn Value Low 32 Bits			
d0021	ENCMULTITURN	-4294967296 to 4294967295	rev	0
	Encoder Multi-turn Value High 32 Bits			
d0022	ENC SINGLETURN	-2147483648 to 2147483647	count	0
	Encoder Single-turn Value			
d0023	ENC SINGLETURN2	-2147483648 to 2147483647	count	0
	Encoder Single-turn Value 2			
d0024	MECHANGLE	0 to 65535	65536/rev	0
	Motor Mechanical Angle			
d0025	HWPEXT	-2147483648 to 2147483647	count	0
	Pulse Count Accumulated Value			
d0026	IN	1 to 5	--	0
	Input Status			
d0027	OUT	0 to 3	--	0
	Output Status			
d0028	MENCCRCVALUE	0 to 65535	--	0
	Motor Encoder CRC Count, Including Incremental and Absolute Encoders			
d0029	SYSLOADNUM	0 to 6	--	0
	System Overload Flag			
d0030	COLDCTCURACT	-100 to 100	--	0

	VarCom	Range	Units	Default Value
	Collision Current Value			
d0031	COLDETI	-100 to 100	A	0
	Collision Detection Current Value			
	For Collision Detection 11			
d0032	COLDETJLPFOUT	-1000000 to 1000000	rad/s^2	0
	Collision Low-pass Filter Output			
d0033	COLDETPFB	-2147483648 to 2147483647	count	0
	Collision Detection Position Value For Collision Detection 11			
d0034	STOST	0 to 1	--	0
	Safe Torque Off Status			
d0035	MENCTIMEOUTVALUE	0 to 65535	--	0
	Encoder Communication Timeout Error Count			
d0036	MFOLD	0 to 1	--	0
	Motor Overload Status			
d0037	MFOLDR	0 to 1000000	s	0
	Motor Overload Recovery Time			
d0038	MIFOLD	0 to 300000	A	0
	Motor Overload Current			
d0039	MFOLD	0 to 1	--	0
	Motor Overload Status 1: Normal 0: Abnormal			
d0040	IMAX	0 to 100000	A	11879
	Driver Current Limit			
d0041	VMAX	10 to 9000	rpm	6000
	Maximum Speed			
d0042	GEARTOTALMAX	1 to 10000000	--	8000000
	Maximum Value of Electronic Gear Ratio Product			
d0043	HOMINGERRCODE	0 to 14	--	0
	Return to Zero Fault Code			

16.2 Auxiliary Function Overview C

Command Code	Function
C0001	Display driver software information
C0002	Error Log
C0003	Panel Servo Enable
C0004	Load Inertia Estimation
C0005	Speed JOG
C0006	CONFIG
C0007	Alarm record cleared
C0008	Absolute Encoder Initialization
C0009	Restore Factory Settings
C0010	Soft reboot
C0011	Servo parameter auto-tuning
C0012	Save to driver
C0100	Panel password

16.3 Parameter Overview P

16.3.1 P0 Basic Functions

	VarCom	Range	Units	Default Value	Effective Method
P0001	NETLOCALIP	0.0.0.0 to 255.255.255.255	--	192.168.57.10	Stop
	Ethernet IP Address, for communication with the host computer				
P0002	NETTCPPORT	1 to 65535	--	9006	Stop
	Ethernet Port Number				
P0003	NETMASK	0.0.0.0 to 255.255.255.255	--	255.255.255.0	Stop
	Ethernet Subnet Mask				
P0004	NETGATEWAY	0.0.0.0 to 255.255.255.255	--	192.168.57.1	Stop
	Ethernet Default Gateway				
P0005	UPGRADE	0 to 10	--	0	Stop
	Jump to Bootloader				
P0101	COMMODE	0 to 1	--	1	Stop
	Communication Mode 0: Ethernet Communication 1: EtherCAT Bus Communication				
P0102	OPMODE	0 to 8	--	8	Stop

	VarCom	Range	Units	Default Value	Effective Method
	Driver Operation Mode 0: Serial Speed 2: Serial Current 7: Serial Voltage 8: Serial Position				
P0103	STOMODE	0 to 3	--	1	Immediate
	STO Alarm Mode 0: Disable STO Alarm Function 1: Alarm in Unenabled State, Fault in Enabled State 2: Always Alarm 3: Always Fault				
P0104	STORECOVERMODE	0 to 1	--	0	Immediate
	STO Recovery Mode 0: Do Not Recover 1: Clear Alarm When STO is Connected				
P0201	PNUM	1 to 4294967295	--	131072	Stop
	The feed constant is the position movement for any motor motion, calculated as follows: $\text{Feed} = \text{Feed} \div \text{Shaft Rotations}$ PNUM defines the numerator (feed) of the ratio. Used to scale the motor's rotational speed (for rotary motors) or the motor's pitch (for linear motors), based on the motor type (MOTORTYPE).				
P0202	PDEN	1 to 4294967295	--	1	Stop
	The feed constant is the position movement for any motor motion, calculated as follows: $\text{Feed} = \text{Feed} \div \text{Shaft Rotations}$ PDEN defines the denominator (number of revolutions) of the rate. Used to scale the motor's rotational speed (for rotary motors) or the motor's pitch (for linear motors), based on the motor type (MOTORTYPE).				
P0203	FBGDS	1 to 4294967295	--	1	Stop
	EtherCAT gear ratio factor for Servo Drive shaft (object 6091h subindex 2).				
P0204	FBGMS	1 to 4294967295	--	1	Stop
	EtherCAT gear ratio factor for the motor shaft speed (object 6091h subindex 1).				
P0205	GEARIN	-2147483648 to 2147483647	--	1	Stop
	Electronic gear numerator				
P0206	GEAROUT	-2147483648 to 2147483647	--	1	Stop
	Electronic gear denominator				
P0301	DISMODE	0 to 5	--	0	Immediate
	Disabling Servo Driver results from a disable command issued by the motion controller or Servo Driver's response to a fault condition. When Servo Driver is disabled, the DISMODE function can be used in certain situations (see the note below) to quickly stop the motor before the motor power is turned off, reducing the coasting distance of the motor. DISMODE includes two mechanisms: *Active shutdown stops the motor by controlling deceleration to zero, then disabling Servo Driver. Active shutdown cannot be used when Servo Driver is operating in OPMODE2 or OPMODE3 mode. *Dynamic braking stops the motor by creating a three-phase short circuit in the motor after Servo Driver is disabled, so it can still be used even if feedback is lost. 0: Active shutdown off, dynamic braking off.				

	VarCom	Range	Units	Default Value	Effective Method
	1: Active shutdown off; dynamic braking only on fault. 2: Active shutdown off; dynamic braking on any disable. 3: Active shutdown on fault; no dynamic braking. 4: Active shutdown on fault; dynamic braking only on fault. 5: Active Shutdown Fault; Dynamic braking is disabled at any time.				
P0302	DECSTOP	0 to 1000000	rpm/s	100000	Immediate
	Deceleration value for active shutdown or emergency stop.				
P0303	DISSPEED	0 to 200	rpm	10	Immediate
	Get/Set the speed threshold below which the motor is considered stopped, and the Active Disable timer starts counting down to disable. The motor speed must remain below this threshold for at least 50 milliseconds for the motor to be considered stopped. The Active Shutdown function uses DECSTOP to reduce the motor speed to zero. DISSPEED is compared with the actual motor speed; when the absolute speed is below the threshold for 50ms, the ActiveDisable timer (DISTIME) begins timing. Once the timer expires, Servo Driver will be disabled.				
P0304	DISTIME	0 to 6500	ms	10	Immediate
	Get/Set the continuous time the motor must remain below DISSPEED before the active shutdown function of Servo Driver is disabled. This delay is typically set to accommodate the brake engagement time. The DISTIME counter only starts counting after the motor speed has been below DISSPEED for at least 50 milliseconds.				
P0305	DECSTOPTIME	0 to 6500	ms	200	Immediate
	Control deceleration time				
P0306	DISTOTALTIME	0 to 6500	ms	200	Immediate
	Active shutdown maximum deceleration time				
P0307	OUTBRAKEENGAGETIME	0 to 10000	ms	500	Immediate
	Brake closing time				
P0308	OUTBRAKERELEASETIME	0 to 10000	ms	500	Immediate
	Brake release time				
P0309	OUTBRAKESAFESPD	0 to 3000	rpm	100	Immediate
	Brake closing safety speed				
P0401	REGENPOW	-1 to 32767	W	35	Stop
	The power of the regenerative braking resistor, in watts. If the system does not have a regenerative braking resistor, use REGENPOW-1.				
P0402	REGENRES	-1 to 32767	Ohm	-1	Stop
	The resistance of the regenerative braking resistor, in ohms. If the system does not have a regenerative braking resistor, use REGENRE-1.				
P0501	POSLIMMODE	0 to 7	--	6	Stop

	VarCom	Range	Units	Default Value	Effective Method
	Define whether to apply software position limits and/or transient position limits and/or return to zero limits. 0: Transient hard limit enabled, soft limit disabled 1: Transient hard limit enabled, soft limit enabled 6: Transient hard limit disabled, soft limit disabled 7: Transient hard limit disabled, soft limit enabled Other values: Reserved When the transient hard limit is enabled, the hard limit signal must disappear and the motion must be in the opposite direction for the limit state to be cleared. When the transient limit is disabled, the limit state is immediately cleared when the hard limit signal disappears.				
P0502	POSLIMNEG	-4294967296 to 4294967295	count	0	Stop
	Minimum position of software limits. (Lower 32 bits)				
P0503	POSLIMNEG2	-4294967296 to 4294967295	count	0	
	Minimum position of software limits. (Upper 32 bits)				
P0504	POSLIMPOS	-4294967296 to 4294967295	count	0xFFFFFFFF	Stop
	Software-limited maximum position. (Lower 32 bits)				
P0505	POSLIMPOS2	-4294967296 to 4294967295	count	0	
	Software-limited maximum position. (Upper 32 bits)				
P0506	POSLIMRECTHRESH	0 to 4294967295	count	10	Immediate
	Position limit status exit threshold				
P0507	VLIMIT	0 to 9000	rpm	3000	Immediate
	When Servo Driver operates in OPMODE2, this setting is used for user-defined speed limits in the application. This setting prevents the motor from reaching excessive speeds when operating in serial current mode.				
P0508	ILIM	0 to 100	A	11.879	Immediate
	Get/Set the application current limit, allowing users to limit the peak current of Servo Driver. This variable limits the current command received from the user (using the T command in OPMODE2) or the command issued by the control loop (in OPMODE0, 1, 3, and 4). ILIM is an independent variable, not dependent on hardware parameters or any other variables. ILIM is similar to VLIM (used in OPMODE0 and 1) and can be used to protect sensitive load devices.				
P0509	VLIM	10 to 9000	rpm	6000	Stop
	User Speed Limit				
P0510	OCTHRESH	100 to 100000	A	100000	Stop
	Overcurrent Protection Threshold				

16.3.2 P1 Gain Adjustment

	VarCom	Range	Units	Default Value	Effective Method
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	VarCom	Range	Units	Default Value	Effective Method
P1101	LMJR	0 to 600000	--	1000	Immediate
	Load Inertia Ratio (%)				
P1102	RIGID	0 to 31	--	13	Immediate
	Rigidity Level				
P1201	KPBW	0 to 3000	Hz	48	Immediate
	Position Loop Gain				
P1202	KVBW	0 to 3000	Hz	27	Immediate
	Velocity Loop Gain				
P1203	KVTI	0 to 2000000	ms	21000	Immediate
	Speed Loop Integral Time Constant				
P1204	ICMDLPF	0 to 4000	Hz	200	Immediate
	Torque Command Filter Time				
P1205	KPP	0 to 3000000	--	48000	Immediate
	Position Loop Proportional Gain				
P1301	GSRIGID	0 to 31	--	13	Immediate
	Second Set of Gain Stiffness Level (Gain Switching)				
P1302	GSKPP	0 to 3000	--	48	Immediate
	Second Set of Position Loop Gain (Gain Switching)				
P1303	GSKVP	0 to 1000000	--	0.008	Immediate
	Second Set of Speed Loop Gain (Gain Switching)				
P1304	GSKVI	0 to 200000	--	0.005	Immediate
	Second Set of Speed Loop Integral Time Constant (Gain Switching)				
P1305	GSICMDLPF	0 to 4000	Hz	200	Immediate
	Second Set of Torque Command Filter Time (Gain Switching)				
P1401	GSEN	0 to 1	--	0	Stop
	Gain Switching Switch 0: Disabled 1: Enabled				
P1402	GSMODE	0 to 10	--	0	Stop
	Gain Switching Mode				
P1403	GSDELAY	0 to 10000	ms	2	Immediate
	Gain Switching Wait Time				
P1404	GSLPFEN	0 to 1	--	0	Immediate
	Torque Command Filter and Speed Feedback Filter Switching Enable (Gain Switching) 0: Disabled 1: Enabled				
P1405	GSTIME	0 to 1000	ms	100	Immediate
	Position Loop Gain Switching Time				
P1406	GSLEVEL	0 to 4294967295	--	0	Immediate
	Gain Switching Level Threshold				

	VarCom	Range	Units	Default Value	Effective Method
P1407	GSHYST	0 to 4294967295	--	0	Immediate
	Hysteresis of Gain Switching Level Threshold				
P1408	GSPCMDTHRESH	0 to 2147483647	count	2	Immediate
	Position Command Threshold for Gain Switching				
P1501	FEEDFORWARDTYPE	1 to 4	--	2	Stop
	Torque Feedforward Source Selection				
P1502	KPEFRC	-20000 to 20000	--	0	Immediate
	Position Deviation Torque Feedforward Gain				
P1503	KPEFRCLPF	100 to 8000	Hz	1000	Immediate
	Filter Time Constant for Position Deviation Torque Feedforward				
P1504	KPVFR	0 to 1	--	1	Immediate
	Velocity Feedforward Gain of Position Loop				
P1505	KPVFRLPF	100 to 8000	Hz	1000	Immediate
	Filter Time Constant for Velocity Feedforward of Position Loop				
P1506	KPAFRVMODE	0 to 2	--	2	Immediate
	Mode Selection for Acceleration/Deceleration Feedforward of Position Loop				
P1507	KPAFRVVEL	0 to 10000	rpm	0	Immediate
	Speed Judgment Threshold for Acceleration/Deceleration Feedforward of Position Loop				
P1508	KPAFRV	-200 to 200	--	0	Immediate
	Deceleration Feedforward Gain of Position Loop				
P1509	KPAFRVLPF	100 to 8000	Hz	1000	Immediate
	Filter Time Constant for Deceleration Feedforward of Position Loop				
P1510	KPAFRC	0 to 2	--	0	Immediate
	Acceleration Torque Feedforward Gain of Position Loop				
P1511	KPAFRCLPF	100 to 8000	Hz	1000	Immediate
	Position Loop Deceleration Torque Feedforward Filter Time Constant				
P1512	KVFR	0 to 1.2	--	1	Immediate
	Pseudo-Differential Feedforward Control Coefficient				
P1513	KVFRC	0 to 2	--	0	Immediate
	Position Loop Torque Feedforward Gain				
P1514	KVFRLPF	100 to 8000	HZ	1000	Immediate
	Position Loop Torque Feedforward Filter Time Constant				
P1515	PCMDFWPHASEK	0 to 10000	0.0001	0	Immediate
	Position Loop Phase Compensation Gain				
P1516	PCMDFWLPFBD	-1 to 3000	Hz	500	Immediate
	Position Loop Phase Compensation Filter Time Constant				

16.3.3 P3 Auxiliary Control

	VarCom	Range	Units	Default Value	Effective Method
P3001	MOVESMOOTHAVG	0 to 128	ms	4	Stop
	Smoothing Filter Time Constant				
P3002	MOVESMOOTHMODE	0 to 2	--	2	Stop
	Smoothing Filter Type 0: Disable Smoothing Filter 1: Reserved 2: Refers to Moving Average Filter				
P3101	ANTIVIBTYPE	0 to 2	--	0	Stop
	Low-Frequency Vibration Suppression Type 0: Single-Pulse Input Shaping 1: Two-Pulse Input Shaping 2: Position Command Notch				
P3102	INSHAPEREN	0 to 1	--	0	Stop
	Input Shaping Enable 0: Disabled 1: Enabled				
P3103	INSHAPERFREQ	2 to 300	Hz	300	Stop
	Input Shaping Frequency				
P3104	PNOTCHMODE	0 to 1	--	0	Stop
	Position Command Notch Filter 1 Enable 0: Disabled 1: Enabled				
P3105	PNOTCHCENTER	1 to 300	Hz	300	Stop
	Position Command Notch Filter 1 Frequency Value				
P3106	PNOTCHBW	1 to 600	Hz	600	Stop
	Position Command Notch Filter 1 Width				
P3107	PNOTCHDEP	0 to 100	%	0	Stop
	Position Command Notch Filter 1 Depth				
P3108	PNOTCH2MODE	0 to 1	--	0	Stop
	Position Command Notch Filter 2 Enable 0: Disabled 1: Enabled				
P3109	PNOTCH2CENTER	1 to 300	Hz	300	Stop
	Position Command Notch Filter 2 Frequency Value				
P3110	PNOTCH2BW	1 to 600	Hz	600	Stop
	Position Command Notch Filter 2 Width				
P3111	PNOTCH2DEP	0 to 100	%	0	Stop
	Position Command Notch Filter 2 Depth				

	VarCom	Range	Units	Default Value	Effective Method
P3112	PNOTCH3MODE	0 to 1	--	0	Stop
	Position Command Notch Filter 3 Enable 0: Disabled 1: Enabled				
P3113	PNOTCH3CENTER	1 to 300	Hz	300	Stop
	Position Command Notch Filter 3 Frequency Value				
P3114	PNOTCH3BW	1 to 600	Hz	600	Stop
	Position Command Notch Filter 3 Width				
P3115	PNOTCH3DEP	0 to 100	%	0	Stop
	Position Command Notch Filter 3 Depth				
P3116	LFOIFGTRATIO	0 to 100	%	90	Immediate
	Input Shaping Self-Tuning Forgetting Factor				
P3117	LFOILPFBD	0 to 2000	Hz	800	Immediate
	Position Deviation Low-Pass Filter Bandwidth				
P3118	LFOIOSCN	1 to 3	--	2	Immediate
	Input Shaping Adaptive Detection Data Periods				
P3119	LFOITRIG	0 to 2	--	0	Immediate
	Input Shaping Adaptive Identification Method Selection 0: Single deceleration stop action completion identification; 1: Two deceleration stop actions completion identification; 2: For testing use, continuous observation;				
P3120	LFOIZSPDRPM	0 to 200	rpm	5	Immediate
	Input Shaping Adaptive Zero Speed Detection Threshold				
P3121	INSHAPERIDENT	0 to 1	--	0	Immediate
	Input Shaping Adaptive Enable				
P3122	LFOIEN	0 to 1	--	0	Immediate
	Input Shaping Adaptive Identification Enable				
P3301	ANFEN	0 to 1	--	0	Immediate
	Adaptive Notch Enable 0: Disabled 1: Enabled				
P3302	ANFMETHOD	0 to 2	--	1	Immediate
	Set Adaptive Notch Filter Mode				
P3303	ANFFREQMIN	2 to 2000	--	300	Immediate
	Adaptive Notch Filter Minimum Frequency Determination				
P3304	ANFMAGTHRESH	0 to 1	--	0.12	Immediate
	Adaptive Notch Filter Vibration Judgment Threshold Coefficient				
P3305	NOTCHMODE	0 to 1	--	1	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Torque Command Notch Filter 1 Enable 0: Disabled 1: Enabled				
P3306	NOTCHCENTER	50 to 4000	Hz	4000	Immediate
	Torque Command Notch Filter 1 Center Frequency				
P3307	NOTCHCENTERLOW	0 to 15	--	0	Immediate
	Torque Command Notch Filter Low Frequency Flag bit0: Notch Filter 1 bit1: Notch Filter 2 bit2: Notch Filter 3 bit3: Notch Filter 4				
P3308	NOTCHBW	20 to 500	Hz	300	Immediate
	Torque Command Notch Filter 1 Width				
P3309	NOTCHDEP	0 to 100	%	15	Immediate
	Torque Command Notch Filter 1 Depth				
P3310	NOTCH2MODE	0 to 1	--	1	Immediate
	Torque Command Notch Filter 2 Enable 0: Disabled 1: Enabled				
P3311	NOTCH2CENTER	50 to 4000	Hz	4000	Immediate
	Torque Command Notch Filter 2 Center Frequency				
P3312	NOTCH2BW	20 to 500	Hz	300	Immediate
	Torque Command Notch Filter 2 Width				
P3313	NOTCH2DEP	0 to 100	%	15	Immediate
	Torque Command Notch Filter 2 Depth				
P3314	NOTCH3MODE	0 to 1	--	1	Immediate
	Torque Command Notch Filter 3 Enable 0: Disabled 1: Enabled				
P3315	NOTCH3CENTER	50 to 4000	Hz	4000	Immediate
	Torque Command Notch Filter 3 Center Frequency				
P3316	NOTCH3BW	20 to 500	Hz	80	Immediate
	Torque Command Notch Filter 3 Width				
P3317	NOTCH3DEP	0 to 100	%	40	Immediate
	Torque Command Notch Filter 3 Depth				
P3318	NOTCH4MODE	0 to 1	--	1	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Torque Command Notch Filter 4 Enable 0: Disabled 1: Enabled				
P3319	NOTCH4CENTER	50 to 4000	Hz	4000	Immediate
	Torque Command Notch Filter 4 Center Frequency				
P3320	NOTCH4BW	20 to 500	Hz	80	Immediate
	Torque Command Notch Filter 4 Bandwidth				
P3321	NOTCH4DEP	0 to 100	%	40	Immediate
	Torque Command Notch Filter 4 Depth				
P3401	VELFILTMODE	0 to 3	--	1	Stop
	Speed Feedback Type Selection 0: No Filtering; 1: First-Order Low-Pass Filter; 2: Speed Observer; 3: First-Order Low-Pass Filter During Motion, Observer During Stop				
P3402	VELFILTRQ	1 to 3500	Hz	800	Immediate
	First-Order Low-Pass Filter Cutoff Frequency for Speed Feedback				
P3403	SOBVBKTYPE	0 to 1	--	1	Immediate
	Speed Observer Output Speed Type 0: Type 1 1: Type 2				
P3405	SOBBW	2 to 6000	Hz	100	Immediate
	Speed Observer Bandwidth				
P3406	SOBTGAIN	-2 to 2	--	0	Immediate
	Speed Observer Disturbance Torque Compensation Gain				
P3407	SOBJCOMPCOEF	0 to 20	--	1	Immediate
	Speed Observer Inertia Compensation Coefficient				
P3408	SOBTINTC	0 to 1000	ms	0	Immediate
	Speed Observer Input Torque Low-pass Filter Time				
P3409	SOBTOUTTC	0 to 1000	ms	0.5	Immediate
	Speed Observer Output Torque Low-pass Filter Time				
P3501	DOB2LMJR	0 to 30	--	0	Immediate
	DOB Module Inertia Ratio				
P3502	DOB2GAIN	0 to 200	%	0	Immediate
	DOB Module Gain				
P3503	DOB2FREQ	0 to 8000	Hz	1000	Immediate
	DOB Module Low-pass Filter Cutoff Frequency				
P3504	FRICPVHYST	-1000 to 1000	rpm	0	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Friction Compensation Positive Speed Hysteresis				
P3505	FRICNVHYST	-1000 to 1000	rpm	0	Immediate
	Friction Compensation Negative Speed Hysteresis				
P3506	FRICIPOS	-100 to 100	A	0	Immediate
	Friction Compensation Positive Friction Force Set Value				
P3507	FRICINEG	-100 to 100	A	0	Immediate
	Friction Compensation Negative Friction Force Set Value				
P3601	PHASEPCSPD0ANG	-9000 to 9000	deg	0	Immediate
	Speed Phase Compensation 0 Angle				
P3602	PHASEPCSPD0EN	0 to 1	--	0	Immediate
	Speed Phase Compensation 0 Enable 0: Disabled 1: Enabled				
P3603	PHASEPCSPD0FREQ	-9000 to 9000	Hz	0	Immediate
	Speed Phase Compensation 0 Frequency				
P3604	PHASEPCSPD1ANG	-9000 to 9000	deg	0	Immediate
	Speed Phase Compensation 1 Angle				
P3605	PHASEPCSPD1EN	0 to 1	--	0	Immediate
	Speed Phase Compensation 1 Enable 0: Disabled 1: Enabled				
P3606	PHASEPCSPD1FREQ	-9000 to 9000	Hz	0	Immediate
	Speed Phase Compensation 1 Frequency				
P3607	PHASEPCSPD2ANG	-9000 to 9000	deg	0	Immediate
	Speed Phase Compensation 2 Angle				
P3608	PHASEPCSPD2EN	0 to 1	--	0	Immediate
	Speed Phase Compensation 2 Enable 0: Disabled 1: Enabled				
P3609	PHASEPCSPD2FREQ	-9000 to 9000	Hz	0	Immediate
	Speed Phase Compensation 2 Frequency				
P3610	PHASEPCSPD3ANG	-9000 to 9000	deg	0	Immediate
	Speed Phase Compensation 3 Angle				
P3611	PHASEPCSPD3EN	0 to 1	--	0	Immediate
	Speed Phase Compensation 3 Enable 0: Disabled 1: Enabled				
P3612	PHASEPCSPD3FREQ	-9000 to 9000	Hz	0	Immediate
	Speed Phase Compensation 3 Frequency				
P3613	PHASEPCTRQ0ANG	-9000 to 9000	deg	0	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Torque Phase Compensation 0 Angle				
P3614	PHASEPCTRQ0EN	0 to 1	--	0	Immediate
	Torque Phase Compensation 0 Enable 0: Disabled 1: Enabled				
P3615	PHASEPCTRQ0FREQ	-9000 to 9000	Hz	0	Immediate
	Torque Phase Compensation 0 Frequency				
P3616	PHASEPCTRQ1ANG	-9000 to 9000	deg	0	Immediate
	Torque Phase Compensation 1 Angle				
P3617	PHASEPCTRQ1EN	0 to 1	--	0	Immediate
	Torque Phase Compensation 1 Enable 0: Disabled 1: Enabled				
P3618	PHASEPCTRQ1FREQ	-9000 to 9000	Hz	0	Immediate
	Torque Phase Compensation 1 Frequency				
P3619	PHASEPCTRQ2ANG	-9000 to 9000	deg	0	Immediate
	Torque Phase Compensation 2 Angle				
P3620	PHASEPCTRQ2EN	0 to 1	--	0	Immediate
	Torque Phase Compensation 2 Enable 0: Disabled 1: Enabled				
P3621	PHASEPCTRQ2FREQ	-9000 to 9000	Hz	0	Immediate
	Torque Phase Compensation 2 Frequency				
P3622	PHASEPCTRQ3ANG	-9000 to 9000	deg	0	Immediate
	Torque Phase Compensation 3 Angle				
P3623	PHASEPCTRQ3EN	0 to 1	--	0	Immediate
	Torque Phase Compensation 3 Enable 0: Disabled 1: Enabled				
P3624	PHASEPCTRQ3FREQ	-9000 to 9000	Hz	0	Immediate
	Torque Phase Compensation 3 Frequency				
P3701	IGRAVCOEF	0 to 1000	--	1	Immediate
	Gravity Compensation Coefficient				
P3702	IGRAVDETIME	1 to 10000	ms	500	Stop
	Gravity Compensation Fade Time				
P3703	IGRAV	-100000 to 100000	A	0	Immediate
	Gravity Compensation				

16.3.4 P4 Motion Control

	VarCom	Range	Units	Default Value	Effective Method
P4001	PEMAX	-4294967296 to 4294967295	count	65536	Stop
	Position Deviation Over Alarm Threshold.				
P4002	PEMAX2	-4294967296 to 4294967295	count	0	Stop
	Maximum Position Error Value Without Fault.				
P4003	PEMAXTIME	0 to 1000	ms	1	Stop
	Maximum Redundant Time for Position Tracking Error.				
P4004	PEINPOS	0 to 4294967295	count	100	Immediate
	Get/Set the tolerance error for the 'Positioning Complete' status. The motor is considered stable when PE remains below PEINPOS for the time defined by PEINPOSTIME.				
P4005	PEINPOSTIME	0 to 1000	ms	1	Immediate
	PEINPOSTIME sets the duration for which INPOS=1 at the end of a motion command ("Command planning is complete, driver is in position").				
P4006	PFBOFFSET	-4294967296 to 4294967295	count	0	Immediate
	Get/Set a feedback offset that is added to the internal accumulated position counter to provide the PFB value. Only integer values can be entered when using count units.				
P4007	PFBOFFSET2	-4294967296 to 4294967295	count	0	Immediate
	Get/Set a position feedback offset that is added to the internal accumulated position counter to provide the PFB value. Only integer values can be entered when using count units.				
P4008	DITHERFRQ	0 to 3500	Hz	0	Immediate
	Object Dictionary 0x606C Speed Feedback Frequency				
P4009	DITHERMODE	0 to 2	--	0	Immediate
	Object Dictionary 0x606C Mode				
P4010	DITHERTHRESH	0 to 200	count	1	Immediate
	Object Dictionary 0x606C Speed Feedback Encoder Threshold				
P4101	ACC	0 to 1000000	rpm/s	1000	Immediate
	Get/Set the acceleration value for commands J(Jog) and STEP. In velocity mode, ACC serves as the acceleration limit for the velocity command (VCMD).				
P4102	DEC	0 to 1000000	rpm/s	1000	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Get/Set the deceleration value of Servo Driver.				
P4103	ZCLAMPMODE	0 to 2	--	0	Immediate
	Set zero-speed clamp mode				
P4104	ZCLAMPVEL	1 to 3000	rpm	50	Immediate
	Set zero-speed clamp speed threshold				
P4105	VEMAX	0 to 6000	rpm	0	Stop
	Speed deviation alarm threshold				
P4106	VETIME	0 to 3000	ms	100	Immediate
	Get/Set speed error time window				
P4107	VELTHRESH	0 to 3000	rpm	10	Immediate
	Speed range for reaching the command speed.				
P4108	VELTHRESHTIME	0 to 1000	ms	5	Immediate
	Hold time for reaching the command speed.				
P4109	VELWINDOW	0 to 3000	rpm	50	Immediate
	Speed reach window				
P4110	VELWINDOWTIME	0 to 1000	ms	5	Immediate
	Speed reach window time				
P4111	JOGSPD1	0 to 6000	rpm	100	Immediate
	Jog speed setpoint				
P4112	MACC	0 to 1000000	rpm/s	1000	Immediate
	Get/Set the acceleration value based on the feedback device on the motor. MACC reflects the ACC value to maintain the correct value of motor feedback or load feedback.				
P4113	MDEC	0 to 1000000	rpm/s	1000	Immediate
	Get/Set the deceleration value based on the feedback device on the motor. MDEC reflects the DEC value to maintain the correct value of motor feedback or load feedback.				
P4114	MAXACC	0 to 1000000	rpm/s	1000000	Immediate
	Get/Set maximum acceleration. MAXACC limits the maximum acceleration from EtherCAT. Effective when COMMODE=1.				

	VarCom	Range	Units	Default Value	Effective Method
P4115	MAXDEC	0 to 1000000	rpm/s	1000000	Immediate
	Get/Set maximum deceleration. MAXDEC limits the maximum deceleration from EtherCAT.				

16.3.5 P5 Special Functions

	VarCom	Range	Units	Default Value	Effective Method
P5001	LOADESTMOTION	0 to 3	--	0	Immediate
	Operating mode for offline inertia identification. 0: Motor rotates forward first, then reverses; 1: Motor rotates backward first, then forward; 2: Motor rotates forward only; 3: Motor rotates backward only.				
P5002	LOADESTMAXVEL	30 to 10000	rpm	800	Immediate
	Maximum operating speed during offline inertia identification process				
P5003	LOADESTACC	5000 to 60000	rpm/s	20000	Immediate
	Acceleration value for offline inertia identification				
P5004	LOADESTDIST	0.25 to 3	rev	2	Immediate
	Operating distance for offline inertia identification				
P5005	LOADESTLOAD	0 to 10	--	0	Immediate
	Initial inertia multiplier for offline inertia identification, unit: 1 corresponds to 5 times initial inertia				
P5006	LMJR	0 to 600000	--	1000	Immediate
	Inertia ratio				
P5101	HOMETYPE	0 to 35	--	1	Stop
	Return to zero mode. Return to zero types 1~14, 17~31, and 33~35 are defined by CiA402.				
P5102	HOMEACC	0 to 1000000	rpm/s	4000	Stop
	Return to Zero acceleration.				
P5103	HOMESPEED1	0 to 6000	rpm	100	Stop
	First Return to Zero speed.				
P5104	HOMESPEED2	0 to 6000	rpm	20	Stop
	Second Return to Zero speed.				
P5105	HOMEOFFSET	-2147483648 to 2147483647	count	0	Stop
	Return to Zero offset.				
P5106	HOMEOFSTMOVE	0 to 1	--	0	Stop
	Return to Zero offset effective mode, invalid when HOMETYPE=35. 0: After Return to Zero completion, the motor stops at the current position, PFB value is HOMEOFFSET. 1: After Return to Zero completion, the motor moves to the HOMEOFFSET position, PFB value is 0.				
P5107	HOMEDONE	0 to 1	--	0	Immediate
	Return to Zero completion flag, indicating whether Servo Driver has performed a Return to Zero operation. This flag will be cleared when encoder-related faults occur.				

	VarCom	Range	Units	Default Value	Effective Method
P5108	HOMEPTEN	0 to 1	--	1	Stop
	Positive/Negative/Return to Zero limit switch overrun detection during Return to Zero. 0: Disabled 1: Enabled				
P5109	HOMEERRCHKMODE	0 to 1	--	1	Immediate
	Indicates whether to ignore the positive/negative/return to zero limit switches not required in the current mode during Return to Zero. 0: If an unused switch is triggered, the return to zero fails; 1: Ignore unused switches.				
P5201	COLDETTYPE	0 to 12	--	0	Immediate
	Collision Detection Mode: 0: Off. 1: If the actual speed is less than COLDETSPEED and the collision detection current is greater than COLDETPOSCUR, a collision fault is triggered. 2: If the actual speed is less than COLDETSPEED and the collision detection current is greater than COLDETPOSCUR during positive movement or greater than COLDETNEGCUR during negative movement, a collision fault is triggered. 3: If the actual speed is less than COLDETSPEED and the collision detection current is greater than COLDETPOSCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETPOSHOLDCUR. 4: When the actual speed is less than COLDETSPEED and positive motion collision detection current is greater than COLDETPOSCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETPOSHOLDCUR. When the negative motion collision detection current is greater than COLDETNEGCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETNEGHOLDCUR. 5~6: Reserved 7: When the actual position of positive motion is greater than COLDETPOSPFB, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETPOSCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETPOSHOLDCUR. When the actual position during negative motion is less than COLDETNEGPF, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETPOSCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETPOSHOLDCUR. 8: When the actual position during positive motion is greater than COLDETPOSPFB, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETPOSCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETPOSHOLDCUR; When the actual position during negative motion is less than COLDETNEGPF, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETNEGCUR, a collision warning is triggered, and the maximum output current is maintained at COLDETNEGHOLDCUR. 9: When the actual position during positive motion exceeds COLDETPOSPFB, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETPOSCUR, a collision fault is triggered. When the actual position during negative motion is less than COLDETNEGPF, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETPOSCUR, a collision fault is triggered. 10: When the actual position during positive motion exceeds COLDETPOSPFB, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETPOSCUR, a collision fault is triggered; When the actual position during negative motion is less than COLDETNEGPF, the actual speed is less than COLDETSPEED, and the collision detection current is greater than COLDETNEGCUR, a collision fault is triggered. 11: Multi-segment position collision detection, each segment can be individually set for position and current, but the positions must meet ascending or descending order. When the position is within any segment range and the current exceeds the corresponding threshold value, a collision warning is triggered, and the maximum output current is maintained at this threshold value. 12: Multi-segment position collision detection, each segment can be individually set for position and current, but the positions must meet ascending or descending order. When the position is within any segment range and the current exceeds the corresponding threshold value, a collision fault is triggered. In modes 1~10, when COLDETSPEED is set to 0, speed conditions are not detected.				
At 0, speed is not detected. For P5202	COLDETSPEED	0 to 6000	rpm	0	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Speed threshold for enabling collision detection Setting 0 indicates always detecting collisions				
P5203	COLDETPOSCUR	0 to 300	A	0	Immediate
	Forward collision detection current threshold Used in collision modes 1, 2, 3, 4, 7, 8				
P5204	COLDETPOSHOLDCUR	0 to 300	A	0	Immediate
	Forward collision detection holding current Used in collision modes 3, 4, 7, 8				
P5205	COLDETPOSPFB	-4294967296 to 4294967295	count	0	Immediate
	Low 32 bits of forward collision detection position threshold Used in collision modes 7, 8				
P5206	COLDETPOSPFB	0x8000000000000000 to 0x7FFFFFFFFFFFFFFF	count	0	Immediate
	High 32 bits of forward collision detection position threshold Used in collision modes 7, 8				
P5207	COLDETNEGCUR	0 to 300	A	0	Immediate
	Reverse collision detection current threshold Used in collision modes 2, 4, 8				
P5208	COLDETNEGOLDCUR	0 to 300	A	0	Immediate
	Reverse collision detection holding current Used in Collision Mode 4, 8				
P5209	COLDETNEGPF	-4294967296 to 4294967295	count	0	Immediate
	Negative Collision Detection Position Threshold Low 32 Bits Used in Collision Mode 8				
P5210	COLDETNEGPF	-4294967296 to 4294967295	count	0	Immediate
	Negative Collision Detection Position Threshold High 32 Bits Used in Collision Mode 8				
P5211	COLDETCOE	0 to 100	--	1	Immediate
	Collision Detection Command Pressure Adjustment Coefficient Used in Collision Detection Mode 11				
P5212	COLDETCURTYPE	0 to 3	--	0	Immediate
	Collision Detection Current Source 0: Load Current Estimated by Speed Observer 1: Load current estimated by the disturbance observer 2: Command current 3: Load current output by the force model				
P5213	COLDETJCOE	0 to 100	--	1	Immediate
	Inertia adjustment coefficient Use for collision detection current source selection 3				

	VarCom	Range	Units	Default Value	Effective Method
P5214	COLDJETLPF	0 to 4000	Hz	4000	Immediate
	Collision detection current filter coefficient				
P5215	COLDETKCOEF	-1000000000 to 1000000000	1/10^9	0	Immediate
	Collision detection current fine-tuning coefficient Use for collision detection current source selection 3				
P5216	COLDETKOFFSET	-100 to 100	A	0	Immediate
	Collision detection current fine-tuning bias				
P5217	COLDETHOME	0 to 1	--	0	Immediate
	Collision Detection Return to Zero Enable Used in Collision Detection Mode 11				
P5301	MULTIPOSTYPE	0 to 1	--	0	Immediate
	Multi-Segment Position Type 0: Incremental Position 1: Absolute Position				
P5302	MULTIPOSCMD1	-2147483648 to 2147483647	count	0	Immediate
	Position Command for the First Segment of Multi-Segment Position Function				
P5303	MULTIPOSVEL1	0 to 9000	rpm	0	Immediate
	Planned Speed for Running the First Segment of Multi-Segment Position Function				
P5304	MULTISPCMD1	-9000 to 9000	rpm	0	Immediate
	Speed Command for the First Segment of Multi-Segment Speed Function				
P5305	MULTIPOSCMD2	-2147483648 to 2147483647	count	0	Immediate
	Position Command for the Second Segment of Multi-Segment Position Function				
P5306	MULTIPOSVEL2	0 to 9000	rpm	0	Immediate
	The planned speed for the second segment position of the multi-segment position function				
P5307	MULTISPCMD2	-9000 to 9000	rpm	0	Immediate
	The second segment speed command of the multi-segment speed function				
P5308	MULTIPOSCMD3	-2147483648 to 2147483647	count	0	Immediate
	The third segment position command of the multi-segment position function				
P5309	MULTIPOSVEL3	0 to 9000	rpm	0	Immediate
	The planned speed for the third segment position of the multi-segment position function				
P5310	MULTISPCMD3	-9000 to 9000	rpm	0	Immediate
	The third segment speed command of the multi-segment speed function				
P5311	MULTIPOSCMD4	-2147483648 to 2147483647	count	0	Immediate
	The fourth segment position command of the multi-segment position function				
P5312	MULTIPOSVEL4	0 to 9000	rpm	0	Immediate
	The planned speed for the fourth segment position of the multi-segment position function				
P5313	MULTISPCMD4	-9000 to 9000	rpm	0	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	The fourth segment speed command of the multi-segment speed function				
P5401	ROBGSTARGETRIGID	-1 to 31	--	-1	Immediate
	First Gain Stiffness If ROBGVELMIN < PTPVCMD < ROBGVELMAX, KPP/KVP/KVI will switch to ROBGSTARGETRIGID2; If ROBGVELMIN < PTPVCMD < ROBGVELMAX, ROBGSACC < PTPACMD and the duration is greater than ROBGSSTABLETIME, KPP/KVP/KVI will switch to ROBGSTARGETRIGID. The gain switching time depends on ROBGSSLOPTIME.				
P5402	ROBGSTARGETRIGID2	-1 to 31	--	-1	Immediate
	Second Gain Rigidity If ROBGVELMIN < PTPVCMD < ROBGVELMAX, KPP/KVP/KVI will switch to ROBGSTARGETRIGID2; If ROBGVELMIN < PTPVCMD, PTPVCMD > ROBGVELMAX, ROBGSACC < PTPACMD and the duration is greater than ROBGSSTABLETIME, KPP/KVP/KVI will switch to ROBGSTARGETRIGID. The gain switching time depends on ROBGSSLOPTIME.				
P5403	ROBGVELMAX	0 to 9000	rpm	400	Immediate
	Gain Switching Maximum Speed Threshold				
P5404	ROBGVELMIN	0 to 9000	rpm	300	Immediate
	Gain Switching Minimum Speed Threshold				
P5405	ROBGSACC	0.001 to 1000000	rpm/s	100	Immediate
	Gain Switching Acceleration Threshold				
P5406	ROBGEN	0 to 1	--	0	Immediate
	Gain Switching Enable 0: Disabled 1: Enabled				
P5407	ROBGSSLOPTIME	0 to 10000	ms	100	Immediate
	Gain Switching Window Time				
P5408	ROBGSSTABLETIME	0 to 10000	ms	0	Immediate
	Gain Switching Stability Time Threshold				

16.3.6 P6 I/O Allocation

	VarCom	Range	Units	Default Value	Effective Method
P6001	INMODE	to 64	--	27	Immediate
	Define the function mode of Digital Input 1. 0: Idle; 1: Remote Enable; 2: Clear Fault; 4: Emergency Stop; 5: Positive Limit Switch;				

	VarCom	Range	Units	Default Value	Effective Method
	6: Negative Limit Switch; 8: Return to Zero Switch; 19: Zero Speed Clamp; 24: Gain Switching; 26: Return to Zero Command; 27: Probe 1; 28: Probe 2; 38: Jog the motor in the positive direction at speed JOGSPD1; 39: Jog the motor in the negative direction at speed JOGSPD1;				
P6002	INMODE	0 to 64	--	28	Immediate
	Define the function mode of Digital Input 2. Same as P6001.				
P6003	INMODE	0 to 64	--	6	Immediate
	Define the function mode of Digital Input 3. 0: Idle; 1: Remote Enable; 2: Clear Fault; 4: Emergency Stop; 5: Positive Limit Switch; 6: Negative Limit Switch; 8: Return to Zero Switch; 19: Zero Speed Clamp; 24: Gain Switching; 26: Return to Zero Command; 27: Probe 1; 28: Probe 2; 38: Jog the motor in the positive direction at speed JOGSPD1; 39: Jog the motor in the negative direction at speed JOGSPD1; 42: Stored Position Command Selection Bit 1; 43: Stored Position Command Selection Bit 2; 44: Stored Position Command Enable				
P6004	INMODE	0 to 64	--	8	Immediate
	Define the function mode of Digital Input 4. Same as P6003.				
P6005	INMODE	0 to 64	--	5	Immediate
	Define Digital Input 5 Function Mode. Same as P6003.				
P6006	INMODE	0 to 64	--	0	Immediate
	Define Digital Input 6 Function Mode. Same as P6003.				
P6007	INMODE	0 to 64	--	0	Immediate
	Define Digital Input 7 Function Mode. Same as P6003.				
P6008	ININV	0 to 65535	--	Not applicable	Immediate
	Invert Digital Input 1 Polarity 0: Inversion Invalid 1: Polarity Inverted Note: When the input function setting INMODE is set to 30, ININV1 must be set to 0 to ensure that unexpected activity does not occur due to line faults. It is not recommended to invert this input logic; any consequences of inversion will be the responsibility of the user.				
P6009	ININV	0 to 1	--	0	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Invert Digital Input 2 Polarity Same as P6008				
P6010	ININV	0 to 1	--	0	Immediate
	Invert Digital Input 3 Polarity Same as P6008				
P6011	ININV	0 to 1	--	0	Immediate
	Invert Digital Input 4 Polarity Same as P6008				
P6012	ININV	0 to 1	--	0	Immediate
	Invert Digital Input 5 Polarity Same as P6008				
P6013	ININV	0 to 1	--	0	Immediate
	Invert Digital Input 6 Polarity Same as P6008				
P6014	ININV	0 to 1	--	0	Immediate
	Invert Digital Input 7 Polarity Same as P6008				
P6015	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 1 Filter Time				
P6016	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 2 Filter Time				
P6017	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 3 Filter Time				
P6018	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 4 Filter Time				
P6019	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 5 Filter Time				
P6020	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 6 Filter Time				
P6021	INFLTTIME	0 to 32	ms	1	Immediate
	Digital Input 7 Filter Time				
P6022	OUTMODE	0 to 32	--	29	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Define Digital Output 1 Function Mode. 0: Idle; 1: Driver Enabled; 2: Brake Release Signal; 3: Fault Present; 4: Position Reached; 5: Stop; 6: Overload; 13: Low Battery Voltage Fault; 14: Warning Present; 15: Fault or Disabled Enable; 16: Low Battery Voltage Warning or Fault; 17: Phase Search Successful; 18: Overcurrent Fault; 19: Overvoltage Fault; 20: Undervoltage Fault; 23: Return to Zero Complete; 24: Encoder Analog Zero Point; 26: Speed Reached; 29: Servo Ready; 30: Collision Detected; 31: Torque Limit Reached.				
P6023	OUTMODE	0 to 32	--	3	Immediate
	Define Digital Output 2 Function Mode. Same as P6022.				
P6024	OUTMODE	0 to 32	--	2	Immediate
	Define Digital Output 3 Function Mode. Same as P6022.				
P6025	OUTINV	0 to 255	--	0	Immediate
	Switch Digital Output 1 Polarity. Same as P6008.				
P6026	OUTINV	0 to 1	--	0	Immediate
	Switch Digital Output 2 Polarity. Same as P6008.				
P6027	OUTINV	0 to 1	--	0	Immediate
	Switch Digital Output 3 Polarity. Same as P6008.				

16.3.7 P7 Drive Settings

	VarCom	Range	Units	Default Value	Effective Method
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	VarCom	Range	Units	Default Value	Effective Method
P7001	DRIVETYPE	0 to 7	--	1	Stop
	Driver Model, Mainly Used to Distinguish Driver Power Levels. 0: 200W; 1: 400W; 3: 750W; 4: 1000W; 5: 1500W; 6: 2000W; 7: 3000W。				
P7101	UVTHRESH	90 to 400	V	180	Stop
	Get/Set the Level Used to Detect Undervoltage State.				
P7102	UVMODE	0 to 3	--	3	Stop
	Define How the Driver Responds to Undervoltage. 0: If Servo Driver is disabled or enabled, lock the fault immediately. 1: Issue a warning when Servo Driver is enabled. Ignore whether Servo Driver is disabled. 2: Issue a warning of the problem if Servo Driver is enabled, then wait for UVTIME before locking the fault. Ignore whether Servo Driver is disabled. 3: Issue a warning of the problem if Servo Driver is disabled. If Servo Driver is enabled, lock the fault immediately.				
P7103	UVRECOVER	0 to 1	--	0	Stop
	Define how Servo Driver recovers from an undervoltage fault. 0: After the undervoltage condition clears, recover by switching Servo Driver from the disabled state to the enabled state. 1: Automatically recover after the undervoltage condition clears.				
P7104	UVTIME	0 to 10000	ms	40	Stop
	Get/Set the amount of time an undervoltage warning is displayed before latching in UVMODE2. In UVMODE3, the time starts when Servo Driver is enabled.				
P7105	RELAYOFFVOLT	0 to 400000	V	170000	Stop
	Soft Start Relay Release Voltage				
P7106	RELAYONVOLT	0 to 400000	V	230000	Stop
	Soft Start Relay Close Voltage				
P7201	LINELOSSTYPE	0 to 2	--	1	Immediate
	Define the type of fault for the disconnection of the AC power line on the bus. Only programmable with hardware support 0: No Detection 1: Single Phase Detection 2: Three-Phase Detection				
P7202	LINELOSSMODE	0 to 2	--	0	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Monitor the characteristics of the bus power supply and define how Servo Driver will respond if a phase loss is detected 0: Always Report Fault 1: Report Fault When Driver is Enabled, Report Warning When Disabled 2: Always Report Warning				
P7203	LINELOSSRECOVER	0 to 1	--	0	Immediate
	Defines how Servo Driver recovers from a fault of disconnection from the bus AC power supply. 0: No automatic recovery 1: Automatic recovery (no CLEARFAULTS required)				
P7302	KCBW	0 to 5000	Hz	3000	Immediate
	Current loop bandwidth				
P7303	KCP	0 to 1000	--	8.613	Immediate
	Current loop proportional coefficient				
P7304	KCI	0 to 70	--	0.104	Immediate
	Current loop integral coefficient				
P7305	KCTICOF	0 to 1	--	1	Immediate
	Current loop integral compensation coefficient				
P7306	KCA	0 to 100	--	0.02	Immediate
	Current loop anti-saturation coefficient				
P7307	KCBEMF	0 to 1	--	0.7	Immediate
	Feedforward BEMF compensation ratio for current control				
P7308	KCGLOBALGAIN	0.3 to 2	--	1	Immediate
	Global gain for current loop parameters				
P7309	PAEN	0 to 1	--	1	Immediate
	Weak magnetic control switch				
P7310	PAF	0.6 to 1.0	--	0.9	Immediate
	Weak magnetic depth coefficient				

16.3.8 P8 Motor Settings

	VarCom	Range	Units	Default Value	Effective Method
P8101	OVELTHRESH	1 to 11000	rpm	7500	Immediate
	Overspeed threshold				
P8102	OVELTIME	1 to 1000	ms	1	Immediate
	Overspeed judgment time				
P8201	COMMERRMODE	0 to 1	--	1	Immediate

	VarCom	Range	Units	Default Value	Effective Method
	Flywheel fault detection mode. 0: The driver reports a flywheel fault when it detects a flywheel state and the continuous time exceeds the set time threshold; 1: When Servo Driver detects that the runaway condition has occurred and the runaway movement position exceeds the set position threshold, it reports a runaway fault.				
P8202	COMMERRITHRESH	0 to 1	0.001	0.05	Immediate
	Runaway Fault Current Coefficient				
P8203	COMMERRPTHRESH	0 to 100	rev	0.5	Immediate
	Runaway Fault Position Threshold. Effective when COMMERRMODE=1.				
P8204	COMMERRTTHRESH	0 to 3000	ms	20	Immediate
	Runaway Fault Time Threshold. Effective when COMMERRMODE=0.				
P8205	COMMERRVTHRESH	0 to 3000	rpm	60	Immediate
	Runaway Fault Speed Deviation				
P8301	MFOLDDIS	0 to 1	--	0	Stop
	Motor Overload Enable 0: Enable 1: Disable				
P8302	MFOLDF	1 to 1.5	--	1	Stop
	Motor Overload Recovery Time				
P8303	MFOLDD	0 to 2400	s	3	Stop
	Motor Overload Delay. This is the time from when the motor current exceeds the motor rated current (MICONTE) until the motor enters the overload state (MFOLD=1). MFOLDD is the worst-case time, i.e., when Servo Driver reaches peak current. As the current decreases, the overload time will extend. If MTP is used, MFOLDD is read from the encoder MTP.				
P8304	MFOLDT	0 to 1200	s	3	Stop
	Motor Overload Time Constant. After the servo enters the motor overload state, MFOLDT defines the time for the current to decrease to the rated current. If MTP is used, MFOLDT is read from the encoder MTP.				
P8305	MIFOLDTHRESH	0 to 300	A	0	Immediate
	Motor Overload Fault Threshold				
P8306	MIFOLDWTHRESH	0 to 300	A	0	Immediate
	Motor Overload Warning Threshold				
P8401	STALLI	-1 to 100	A	-1	Stop
	Motor Stall Current Threshold. If STALLI > 0, stalling occurs when [I > STALLI] and [V < STALLVEL]. If STALLI < 0, stalling occurs when [I > MICONTE] or [I > Istall] and [V < STALLVEL]. Istall is the greater of 0.9 * ILIM and DICONTE. When the stall time exceeds STALLTIME, a stall alarm is issued. When a stall alarm occurs, Servo Driver's digital display shows alarm number E59.				
P8402	STALLTIME	0 to 10000	ms	1000	Stop
	Stall Time Threshold.				
P8403	STALLVEL	0 to 500	rpm	60	Stop
	Stall Speed Threshold.				
P8501	MICONTE	0 to 150	A	3.959	Stop
	Motor Rated Current. After modifying MICONTE, the CONFIG command needs to be executed. If using MTP, MICONTE is read from the encoder MTP.				
P8502	MIPEAK	0.1 to 300	A	11.879	Stop
	Motor Peak Current. After modifying MIPEAK, the CONFIG command needs to be executed. If using MTP, MIPEAK is read from the encoder MTP.				
P8503	MJ	0 to 2000000	kg*m ² *10 ⁻⁴	0.49	Stop
	Motor Rotor Inertia. The motor rotor inertia MJ and the load inertia ratio LMJR determine the total inertia. After				

	VarCom	Range	Units	Default Value	Effective Method
	modifying MJ, the CONFIG command needs to be executed. If using MTP, MJ is read from the encoder MTP.				
P8504	MKE	0 to 500	V/krpm	29.86	Stop
	Motor Back EMF Coefficient. If using MTP, MKE is read from the encoder MTP.				
P8505	MKT	0.001 to 30	Nm/A	0.321	Stop
	Motor Torque Coefficient. The ratio of motor torque to Q-axis current. If using MTP, MKT is read from the encoder MTP.				
P8506	ML	0 to 1000	mh	9.2	Stop
	Motor winding inductance. After modifying ML, the CONFIG command needs to be executed. If using MTP, ML is read from the encoder MTP.				
P8507	MMAXT	0 to 100	Nm	3.82	Stop
	Maximum motor torque. If using MTP, MMAXT is read from the encoder MTP.				
P8508	MPHASE	0 to 359	degree	0	Stop
	Phase difference between the encoder position and the motor zero electrical angle. Modifying MPHASE changes the phase difference between the internal compensation encoder position and the motor zero electrical angle without affecting the encoder position feedback. If using MTP, MPHASE is read from the encoder MTP.				
P8509	MPOLES	2 to 20	pole pairs	5	Stop
	Number of motor poles. This value represents the number of magnetic poles of the motor (not pole pairs). After modifying MPOLES, the CONFIG command needs to be executed. If using MTP, MPOLES is read from the encoder MTP.				
P8510	MPOWER	0 to 2000	W	400	Stop
	Motor rated power. If using MTP, MPOWER is read from the encoder MTP.				
P8511	MR	0 to 75	Ohm	4.25	Stop
	Motor resistance. After modifying MR, the CONFIG command needs to be executed. If using MTP, MR is read from the encoder MTP.				
P8512	MRATEDSPEED	0 to 6000	rpm	3000	Stop
	Motor rated speed. If using MTP, MRATEDSPEED is read from the encoder MTP.				
P8513	MRATEDT	0 to 100	Nm	1.273	Stop
	Motor rated torque. If using MTP, MRATEDT is read from the encoder MTP.				
P8514	MSPEED	0 to 9000	rpm	6000	Stop
	Motor maximum speed. After modifying MSPEED, the CONFIG command needs to be executed.				
P8515	MVOLT	0 to 400	V	220	Stop
	Motor rated voltage. If using MTP, MVOLT is read from the encoder MTP.				
P8601	MTPMODE	0 to 4	--	4	Immediate
	MTPMODE determines whether motor and encoder parameters come from the electronic motor nameplate (MTP). The driver does not have motor parameters by default; after power-on, the motor and encoder parameters from the electronic motor nameplate are read into Servo Driver's RAM from the encoder memory. If MTPMODE≠0, motor parameters cannot be modified by the user. 0: Do not use electronic motor nameplate 3: SensAR encoder 4: Tamagawa protocol encoder				
P8602	MENCRES	1 to 2000000000	LPR	32768	Stop
	Encoder resolution (lines per revolution)				
P8603	ENCMULTITURNENDLESS	0 to 1	--	0	Stop
	Infinite rotation mode. When enabled, multi-turn encoder motors can rotate infinitely in both directions, and multi-turn information will not be lost even when exceeding the multi-turn limit. Note: When enabled, Servo Driver automatically stores multi-turn information to EEPROM. If Servo Driver loses power while the motor is rotating, storage may fail, resulting in an FLT2 alarm. 0: Disabled 1: Enabled				

	VarCom	Range	Units	Default Value	Effective Method
P8604	IGNOREBATTFLT	0 to 1	--	0	Stop
	IGNOREBATTFLT determines whether Servo Driver responds to encoder battery voltage warnings or alarms. When IGNOREBATTFLT=1, it allows multi-turn encoders to operate as single-turn encoders without a battery.				
P8605	DIR	0 to 3	--	0	Stop
	Motor Rotation Direction				
P8606	ENCFLTCLRMODE	0 to 1	--	1	Immediate
	Encoder Timeout and CRC Reset Mode.				
P8607	IENCRESOFFSET	-10000000 to 10000000	count	0	Stop
	Encoder Line Deviation Value				
P8608	MENCERRTHRESH	0x0101 to 0xFFFF	--	0x0505	Stop
	Encoder Error Threshold. The high 8 bits represent the encoder CRC error threshold, and the low 8 bits represent the encoder timeout threshold.				
P8609	ENCMULTITURNMODE	0 to 1	--	0	Stop
	Multi-turn Acquisition Mode of Encoder. 0: After encoder communication loss, calculated from single-turn information 1: Read only from the encoder				
P8610	ENCMULTITURNOFFSET	0 to 65535	rev	32768	Stop
	Used to define the range for multi-turn overflow. Multi-turn overflow occurs when the number of turns of the multi-turn encoder exceeds (-ENCMULTITURNOFFSET) to (65535-ENCMULTITURNOFFSET).				
P8611	ENCMULTITURNTHRESH	2 to 10	rev	2	Immediate
	Multi-turn Fault Threshold.				
P8612	ENCMULTITURNTIME	0 to 1000	125us	0	Immediate
	Multi-turn Fault Time.				

16.3.9 P9 Communication Configuration

	VarCom	Range	Units	Default Value	Effective Method
P9001	ADDR	0 to 65535	--	0	Stop
	Driver Communication Address For EB version, it is the slave address of EtherCAT				
P9002	ECEEMODE	0 to 1	--	0	Immediate
	EtherCAT EEPROM read mode (reserved)				
P9003	ECML	0 to 1	--	1	Stop
	EtherCAT master loop operation cycle				
P9004	ECCOMPMODE	0 to 1	--	1	Stop
	EtherCAT compensation mode 0: EtherCAT lost frame compensation off 1: EtherCAT lost frame compensation on				
P9005	ECCRMODE	0 to 1	--	0	Stop
	EtherCAT cyclic redundancy mode (reserved)				
P9006	FBITIDX	-5 to -2	--	-3	Stop

	Interpolation time index				
P9007	FBITPRD	1 to 250	--	1	Stop
	Interpolation time				
P9008	BIT12THRESH	0 to 100	--	0	Immediate
	Threshold of 0x6041 in standard pole configuration (PP)				



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