SERVOTRONIX
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# BDHDE

# 伺服系统用户手册

## Servo System User Manual

## Revision History

| Document Revision Number | Date | Notes |
|---|---|---|
| 0.0.1 | November 2019 | BDHDE – initial release. |
| 0.0.2 | May 2020 | Updated some of the content |
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| 0.0.4 | July 2020 | Updated AP drive information and PH2-L motor information |
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## Contact Information

Servotronix Motion Control Ltd.
Address: Room 605, Unit B2, Kexing Science Park, Nanshan District, Shenzhen
Mobile: 400-111-8669
Website: www.servotronix.cn

## Technical Support

If you need assistance with the installation and configuration of the BDHDE drive, please contact Servotronix Technical Support at tech.support@servotronix.com
Mobile: 400-111-8669

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## Warranty

The Product Warranty statement can be found in the Terms and Conditions document on the Servotronix website: servotronix.com/terms-conditions.

## Unpacking

The package contains only one BDHDE drive and two power plugs included with the package.

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

Check to ensure that there is no visible damage to the BDHDE drive. If damage is detected, notify the carrier immediately.

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# 1 Introduction

## 1.1 BDHDE Product Overview

BDHDE is a high-performance servo drive optimized for light payload robotics and electronic assembly in 3C (computer, communication and consumer electronics) and semiconductor industries. BDHDE servo drive can be matched to servo motors from 50W to 2000W. The matching of drive and motor ensures that machine manufacture can achieve optimum motion control performance, machine operating efficiency and high output.

BDHDE servo bundle is suitable for applications using EtherCAT fieldbus (controlled by Servotronix softMC multi-axis controller or any third-party EtherCAT controller), and for PLC and motion control card with pulse command. USB communication supports plug-and-play commissioning via ServoStudio2 software; motor installation, application configuration and automatic adjustment guide simplify the commissioning process, while making it very easy for users to script programming and monitor servo system operating state;

The BDHDE servo bundle also includes PRHD2 high-performance brushless servo motor. PRHD2 series motors are designed to satisfy the requirements of advanced automation with low-speed torque fluctuation, low temperature rise, high torque density, and high overload capability etc.; the PRHD2 motor can be paired with sensAR 17-bit magnetic absolute encoders, Tamagawa 17-bit or 23-bit optical absolute encoders, and can support single-turn or multi-turn configurations. All motor encoder units (stored in the encoder EEPROM) have a set of motor parameters (motor electronic nameplate, i.e. MTP) built in. When the MTP is detected at drive start-up, the values of these parameters are loaded directly from the encoder memory to the drive memory, enabling automatic identification and matching of drive and motor without additional operation, ensuring a simple and reliable use process.

In the BDHDE servo assembly, the combination of drive, motor and encoder achieves the motion accuracy and smoothness required for precision manufacturing and assembly automation processes.

For a complete list of the BDHDE drive options, please refer to the *Ordering Information.*

## 1.2 Ordering Information

The ordering options shown below include the various drive and motor models currently available from the BDHDE Servo Assembly product line. To inquire about product availability, please contact Servotronix.

### 1.2.1 BDHDE Ordering Information

**Table 1-1. BDHDE Ordering Information**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **BDHDE** | **–** | **003** | **2A** | **EB** | **–** | **000** |
| | **BDHDE Series Servo Motors** | | | | | | | | | |
| | Rated Value | | | | | | | | | |
| | AC 220V | | | | | | | | | |
| | Duration [A rms] | Max. [A rms] | | | | | | | | |
| **003** | 2.8 | 8.4 | | | | | | | | |
| **006** | 6.0 | 18.0 | | | | | | | | |
| **010** | 10 | 30 | | | | | | | | |
| **013** | 13 | 28 | | | | | | | | |
| | **Input Power Supply** | | | | | | | | | |
| **2A** | •Single-phase 220V AC, -10% ~ +10%, 50/60 Hz | | | | | | | | | |
| | **Communication Interface** | | | | | | | | | |
| **EB** | EtherCAT, USB | | | | | | | | | |
| **AP** | Position pulse, RS485, USB | | | | | | | | | |
| **EC** | EtherCAT, Position pulse, RS232, USB | | | | | | | | | |
| | **Special Options** | | | | | | | | | |
| **[Blank]** | Standards | | | | | | | | | |

### 1.2.2 PRHD2 Ordering Information

**Table 1-2. PRHD2 Ordering information**

| | | PH2 | – | M | 04 | A | 2 | 30 | 0 | 5 | S3 | 0 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRHD2 Series Servo Motors | | | | | | | | | | | | |
| | **Inertia** | | | | | | | | | | | | |
| **L** | Low Inertia | | | | | | | | | | | | |
| **M** | Medium Inertia | | | | | | | | | | | | |
| | **Flange Size** | | | | | | | | | | | | |
| **04** | 40 mm | | | | | | | | | | | | |
| **06** | 60 mm | | | | | | | | | | | | |
| **08** | 80 mm | | | | | | | | | | | | |
| **10** | 100 mm | | | | | | | | | | | | |
| **13** | 130 mm | | | | | | | | | | | | |
| | **Electromagnetic Solutions** | | | | | | | | | | | | |
| **A** | A Type | | | | | | | | | | | | |
| **B** | | | | | | | | | | | | | |
| **C** | | | | | | | | | | | | | |
| | **Input Voltage** | | | | | | | | | | | | |
| **2** | 230 VAC | | | | | | | | | | | | |
| | **Rated Speed** | | | | | | | | | | | | |
| **15** | 1500 rpm | | | | | | | | | | | | |
| **30** | 3000 rpm | | | | | | | | | | | | |
| | **Shaft & Oil Seal** | | | | | | | | | | | | |
| **2** | With key | | | | | | | | | | | | |
| **3** | With key and oil seal | | | | | | | | | | | | |
| | **Degree of Protection** | | | | | | | | | | | | |
| **5** | IP65 | | | | | | | | | | | | |
| | **Feedback Type** | | | | | | | | | | | | |
| **S3** | SensAR Single-turn Absolute Encoder 20-bit | | | | | | | | | | | | |
| **M3** | SensAR Multi-turn Absolute Encoder 20-bit | | | | | | | | | | | | |
| **T1** | Tamagawa Single-turn Absolute Encoder 17-bit | | | | | | | | | | | | |
| **T4** | Tamagawa Multi-turn Absolute Encoder 23-bit | | | | | | | | | | | | |
| | **Holding Brake** | | | | | | | | | | | | |
| **0** | No Holding Brake | | | | | | | | | | | | |
| **1** | With Holding Brake | | | | | | | | | | | | |
| | **Connector** | | | | | | | | | | | | |
| **D** | Amp Plug-in Connection | | | | | | | | | | | | |
| **A** | Aviation Plug | | | | | | | | | | | | |

## 1.3 Servo System Matching Table

### 1.3.1 PRHD2-BDHDE Matching Table

**Table 1-3. PRHD2-BDHDE Low Inertia Series Matching Table**

| Motor | Rated Power [W] | Rated Torque [Nm] | Peak Torque [Nm] | Rated Speed [rpm] | Inertia | Drive |
|---|---|---|---|---|---|---|
| PH2-L04A230 | 50 | 0.16 | 0.56 | 3000 | Low | BDHDE-0032A |
| PH2-L04B230 | 100 | 0.32 | 1.12 | 3000 | Low | BDHDE-0032A |
| PH2-L06A230 | 200 | 0.64 | 2.24 | 3000 | Low | BDHDE-0032A |
| PH2-L06B230 | 400 | 1.23 | 3.35 | 3000 | Low | BDHDE-0032A |
| PH2-L08A230 | 750 | 2.39 | 8.36 | 3000 | Low | BDHDE-0062A |
| PH2-L10A230 | 1000 | 3.18 | 8.38 | 3000 | Low | BDHDE-0062A |

**Table 1-4. PRHD2-BDHDE Medium Inertia Series Matching Table**

| Motor | Rated Power [ W] | Rated Torque [Nm] | Peak Torque [Nm] | Rated Speed [rpm] | Inertia | Drive |
|---|---|---|---|---|---|---|
| PH2-M04A230 | 50 | 0.16 | 0.56 | 3000 | Medium | BDHDE-0032A |
| PH2-M04B230 | 100 | 0.32 | 1.12 | 3000 | Medium | BDHDE-0032A |
| PH2-M06A230 | 200 | 0.64 | 2.24 | 3000 | Medium | BDHDE-0032A |
| PH2-M06B230 | 400 | 1.27 | 3.67 | 3000 | Medium | BDHDE-0032A |
| PH2-M08A230 | 750 | 2.39 | 8.36 | 3000 | Medium | BDHDE-0062A |
| PH2-M13A215 | 1000 | 6.37 | 19.10 | 1500 | Medium | BDHDE-0062A |
| PH2-M13C220 | 1100 | 5.39 | 16.17 | 2000 | Medium | BDHDE-0102A |
| PH2-M13B215 | 1500 | 9.55 | 28.65 | 1500 | Medium | BDHDE-0102A |
| PH2-M13B220 | 2000 | 9.55 | 28.65 | 2000 | Medium | BDHDE-0132A |
| PH2-M13D220 | 1750 | 8.34 | 25.02 | 2000 | Medium | BDHDE-0132A |

## 1.4 BDHDE Product Label

Different models may look exactly the same. See the product label on the backplate of the drive for model numbers and specifications.

**Table 1-5. BDHDE Product Label Code**

| Items | Description |
|---|---|
| **Model** | Catalog number (Ordering information) |
| **S/N** | Product serial number.<br>1st digit = manufacturer code<br>2nd and 3rd digits = year code<br>4th digit = month code<br>Last 7 digits = serial code |
| **Ref** | Manufacturer part number |
| **Rev** | Part number revision. 2 digits. |

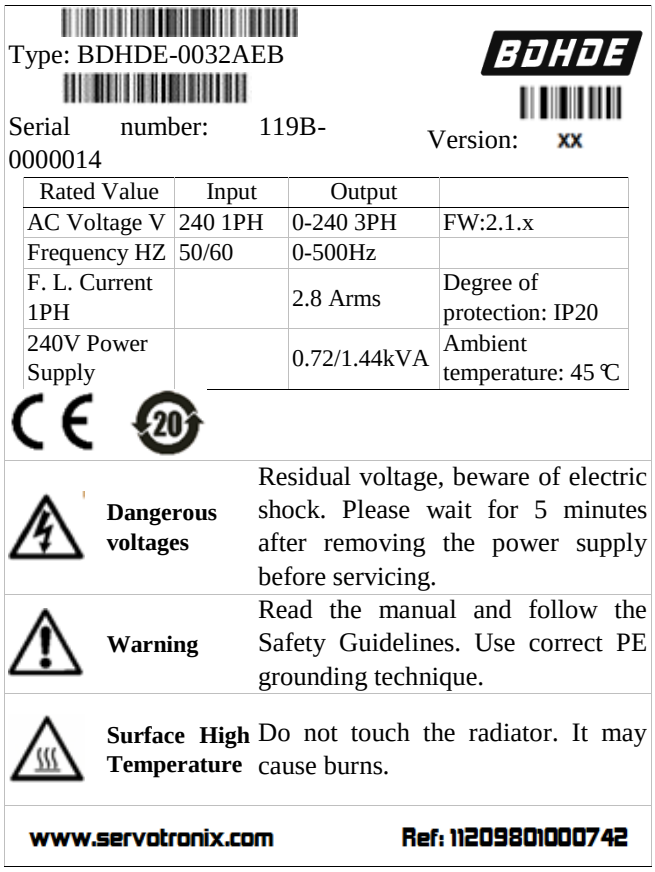



**Figure 1-1. BDHDE Product Label - Sample**

## 1.5 BDHDE File Package

The file package of the servo drive contains the following manuals.

- **BDHDE User Manual: Hardware setup, operation and tuning.**
  For use by personnel qualified for transportation, assembly, consignment and maintenance of the drive.
- **Reference Manual**: Graphical User Interface (GUI) supplied with the BDHDE for configuring, operating and tuning the drive.
- **VarCom Reference Manual:** parameters and commands used to configure, operate and tune the drive.
- **EtherCAT reference manual**: implementation of the CANopen over EtherCAT(CoE) protocol in the drive.

# 2 Safety and Standards

## 2.1 Safety Symbols

Safety symbols indicate a high risk of personal injury or equipment damage if prescribed precautions and safe operating practices are not followed.

The following safety warning signs are used on the drive and in the documentation.

**Table 2-1. Safety Warning Signs**

| Signs | Meaning | Description | ISO 7000/ IEC 60417 |
|---|---|---|---|
|  | Warning | Prompts the need for caution when operating the equipment.<br>Also prompts the operator to be aware of the current situation or the operator needs to take action to avoid undesirable consequences. | 0434 |
|  | Dangerous voltages | Prompts potential dangerous voltage. | 5036 |
|  | Protective grounding | Indicates any terminal used to connect the outer conductor to provide motor protection in the event of a fault, or to protect the grounding electrode terminal. | 5019 |
|  | Warning, hot surface | Prompts the marked object is hot and should be touched with care. | 5041 |

## 2.2 Safety Guidelines

BDHDE servo drive is in use as a component within the machine's electronic control system. The machine manufacturer and/or integrator must ensure the safety of personnel and the integrity of the machine system.

The machine manufacturer and/or integrator must take into account the intended use of the drive when conducting a risk assessment and implement appropriate safety measures based on the results of such assessment.

The BDHDE drive must be used in accordance with all applicable safety specifications and orders and all technical specifications and requirements.



The BDHDE drive has hazardous voltages when in use and must be properly grounded.



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



The owner and the operator of the machine are responsible to ensure that personnel are not allowed to enter the hazardous area while the machine is energized (unless equipped with an appropriate functional safety mechanism).

Only qualified personnel should perform installation, operation, servicing and maintenance procedures. These qualified personnel must have sufficient technical training and enough knowledge to be able to anticipate and identify potential hazards that may arise when using the product, modifying settings, and operating the mechanical, electrical, and electronic components of the machine system.

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

### 2.2.1 Installation Safety

**Notes** Improper handling of BDHDE can result in personal injury and/or equipment damage.



When connecting BDHDE to other control equipment, ensure the following two basic guidelines are followed to prevent damage to the drive:

- BDHDE must be safely grounded by the grounding wire of AC main power supply.
- Any motion controller, PLC or PC connected to BDHDE must have the same ground wire as the one connected to the BDHDE.

- Please review all relevant product literature before installing or commissioning BDHDE .
- Install in strict accordance with product specifications and installation instructions.
- All system components must be grounded. Electrical safety is provided by a low resistance ground connection (level 1 protection defined by EN/IEC 618005-1 standard). The motor should be connected to a protective ground wire through a separate grounding conductor rated not less than the motor wire.
- As part of the machine design, the machine manufacturer must prepare a machine hazard analysis and take appropriate measures to ensure that accidental activities do not cause bodily injury and/or equipment damage.
- The drive meets the requirements of IP20(IEC 60529 standard); Therefore, the machine manufacturer must choose a suitable enclosure. The enclosure must at least meet the requirements of IP54(IEC 60529 standard), be made of metal or material of 5VA flammability class with no openings at the bottom.
- The leakage current of protective grounding wire is greater than 3.5mA; therefore, in order to meet IEC61800-5-1 standard, double PE connection can be adopted (one is grounded via the main power grounding wire, and the other is connected with the grounded equipment base through the cooling fin), or a connecting copper cable with cross-sectional area greater than $10mm^2$ can be used. Use drive mounting screws and PE connecting screws to meet this requirement.
- Do not use yellow-green wire for connections other than for protective grounding.
- The power cable should be rated at least 600V, 75℃.
- The motor and cable must be properly installed so as to avoid short circuits to ground. Please use earth leakage circuit breaker to improve system safety.

### 2.2.2 Operational Safety

**Notes** The machine manufacturer is responsible for equipment safety implementation, testing and certification. The machine manual must clearly describe operating and maintenance conditions and safety precautions.

- Operate all equipment in strict accordance with product specifications and installation instructions.
- The equipment manufacturer must provide power disconnect devices in accordance with local regulations.
- During operation, all protective covers and cabinet doors remain closed.
- During operation, components of this equipment can be charged or high-temperature. The BDHDE cooling fins can reach 85 ℃, and the control and power cables can carry high voltage even when the motor is not rotating.
- Motion axes subjected to suspended or unbalanced loads must be provided with additional mechanical safety blocks (such as motor brakes) to prevent uncontrolled fall due to the load. If the load is not properly protected, it may cause serious injury.

### 2.2.3 Maintenance Safety

**Notes** Improper handling of BDHDE may cause injury and/or equipment damage.

- Please review all relevant product literature before carrying out maintenance on BDHDE (or the machine it drives).
- Implement maintenance procedures in strict accordance with product maintenance requirements and instructions.
- To avoid electric arc, physical injury and electrical contact damage, do not disconnect or connect the product when it is energized.
- After the equipment is powered off, wait at least 5 minutes before touching or disconnecting normally charged components (such as capacitors, switch contacts and screw connections).
- Before touching the equipment, measure electrical contacts with an electric meter to ensure that the DC voltage is lower than 30 V before handling the component.

## 2.3 Material Safety Data

BDHDE is marked in accordance with the SJ/T 11364 standard, which applies to electronic and electrical products sold in the People's Republic of China.

The data of harmful substances in the table below conforms to China RoHS 2.0: Administrative Measures for the Restriction of Hazardous Substances in Electric Appliances and Electronic Products; released January 21, 2016.




BDHDE contains certain hazardous substances and can be used safely for 20 years, after which it should enter the recycling system.

**Table 2-2. Hazardous Substances**

| Component Name | Lead (Pb) | Mercury (Hg) | Cadmium (Cd) | Hexavalent Chromium (Cr VI)) | Polybrominated Biphenyls (PBB) | Polybrominated Diphenyl Ethers (PBDE) |
|---|---|---|---|---|---|---|
| Metal parts | X | O | O | O | O | O |
| Plastic parts | O | O | O | O | O | O |
| Electronic parts | 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 hazardous substance in all homogeneous materials of this part is lower than the limit specified in GB/T 26572.<br>X indicates that the content of the hazardous substance in at least one kind of homogeneous material of the part exceeds the limit specified in GB/T 26572. | | | | | | |

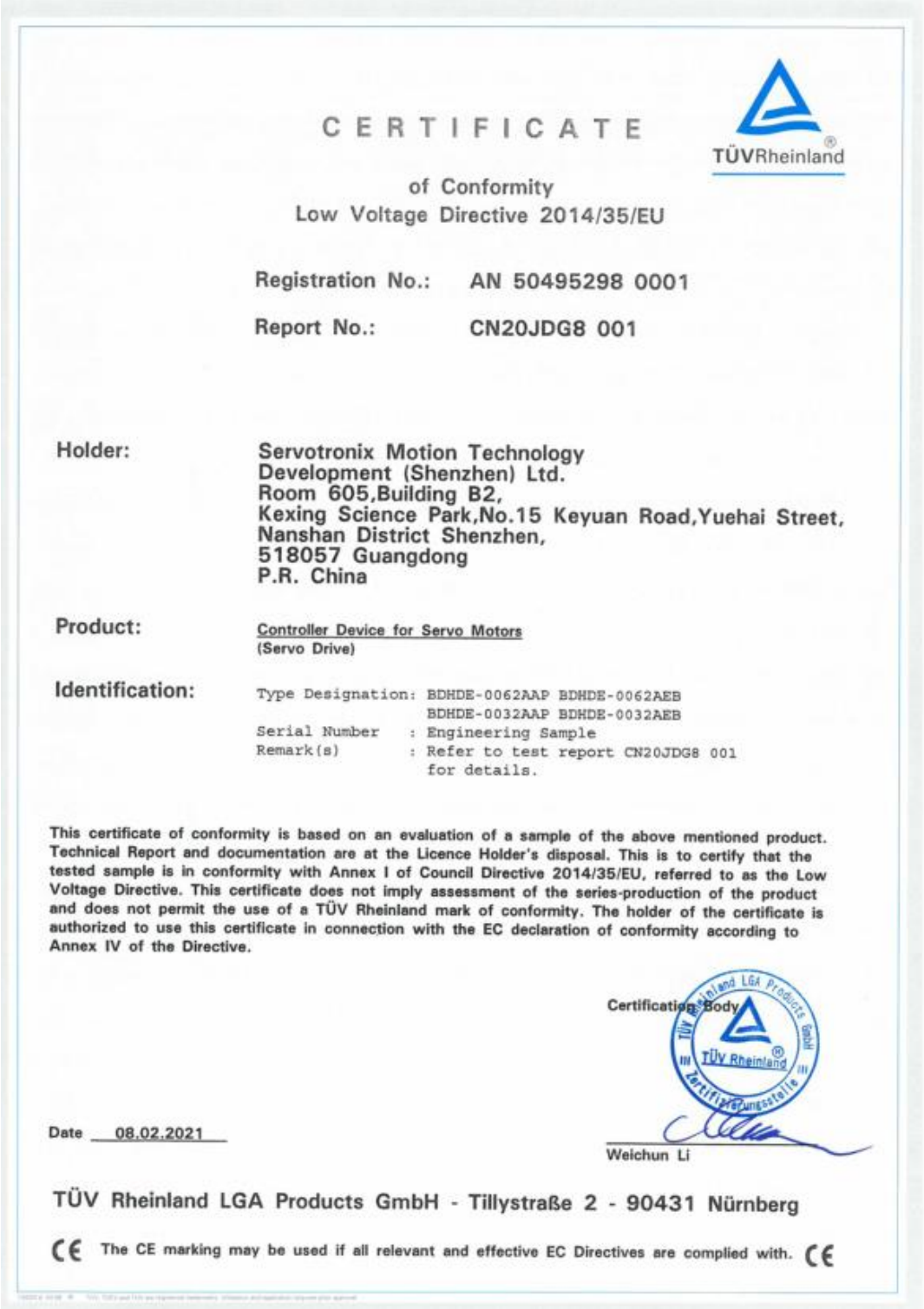
## 2.4 Standards Compliance

BDHDE-003/BDHDE-006 have been tested and certified according to the following standards.

**Table 2-3. Standards Compliance**

| Standards | Directive/Description | Certification Mark |
|---|---|---|
| **IEC 61800-5-1** | **Low Voltage Directive 2014/35/EU**<br>Adjustable speed electrical power drive systems | CE |
| **IEC 61800-3** | **Electromagnetic Compatibility (EMC) Directive 2014/30/EU**<br>Adjustable speed electrical power drive systems | CE |
| **EN 50581** | **European Regulation 2011/65/EU RoHS (Restriction of Hazardous Substances)**<br>Declare compliance with the technical documentation required to meet the substance restriction. | CE |
| **SJ/T 11364** | **Hazardous substance restriction marks for electronic and electrical products (China RoHS 2.0)**<br>Hazardous substances in electronic and electrical products; environmentally friendly service life and recyclability. | 20 |
| IEC International Electrotechnical Commission<br>EN European Standards (European Specifications)<br>EU European Parliament and Council of the European Union | | |

## 2.5 Certificates of Compliance



CERTIFICATE

TÜVRheinland

of Conformity
Low Voltage Directive 2014/35/EU

Registration No.: AN 50495298 0001

Report No.: CN20JDG8 001

Holder: Servotronix Motion Technology Development (Shenzhen) Ltd.
Room 605,Building B2,
Kexing Science Park,No.15 Keyuan Road,Yuehai Street,
Nanshan District Shenzhen,
518057 Guangdong
P.R. China

Product: Controller Device for Servo Motors
(Servo Drive)

Identification:
Type Designation: BDHDE-0062AAP BDHDE-0062AEB
BDHDE-0032AAP BDHDE-0032AEB
Serial Number : Engineering Sample
Remark(s) : Refer to test report CN20JDG8 001 for details.

This certificate of conformity is based on an evaluation of a sample of the above mentioned product. Technical Report and documentation are at the Licence Holder's disposal. This is to certify that the tested sample is in conformity with Annex I of Council Directive 2014/35/EU, referred to as the Low Voltage Directive. This certificate does not imply assessment of the series-production of the product and does not permit the use of a TÜV Rheinland mark of conformity. The holder of the certificate is authorized to use this certificate in connection with the EC declaration of conformity according to Annex IV of the Directive.

Certification Body

Date 08.02.2021

Weichun Li

TÜV Rheinland LGA Products GmbH - Tillystraße 2 - 90431 Nürnberg

CE The CE marking may be used if all relevant and effective EC Directives are complied with. CE



# CERTIFICATE

of Conformity
EC Council Directive 2014/30/EU
Electromagnetic Compatibility

TÜVRheinland

Registration No.: AE 50490573 0001

Report No.: CN20TO2F 001

Holder: Servotronix Motion Technology Development (Shenzhen) Ltd.
Room 605,Building B2,
Kexing Science Park,No.15 Keyuan Road,Yuehai Street,
Nanshan District Shenzhen,
518057 Guangdong
P.R. China

Product: Controller Device for Servo Motors
(Servo Drive)

Identification: BDHDE-0032AEB BDHDE-0032AAP
BDHDE-0062AEB BDHDE-0062AAP
(SERVOTRONIX) (BDHDE)

Serial No.: n.a.
Remark: Refer to test report CN20TO2F 001 for details.

Tested acc. to: EN IEC 61800-3:2018

This certificate of conformity is based on an evaluation of a sample of the above mentioned product. Technical Report and documentation are at the Licence Holder's disposal. This is to certify that the tested sample is in conformity with all provisions of Annex I of Council Directive 2014/30/EU. This certificate does not imply assessment of the production of the product and does not permit the use of a TÜV Rheinland mark of conformity. The holder of the certificate is authorized to use this certificate in connection with the EC declaration of conformity according to the a.m. Directive.

Certification Body

Date 29.12.2020

XinHua Lu

TÜV Rheinland LGA Products GmbH - Tillystraße 2 - 90431 Nürnberg

CE The CE marking may only be used if all relevant and effective EC Directives are complied with. CE

# 3 BDHDE Drive Specifications

## 3.1 External Dimensions

BDHDE-003/ BDHDE-006 model drives have the same external dimensions, as shown in the figure below:

**Notes** The BDHDE-003 series models have no fan.

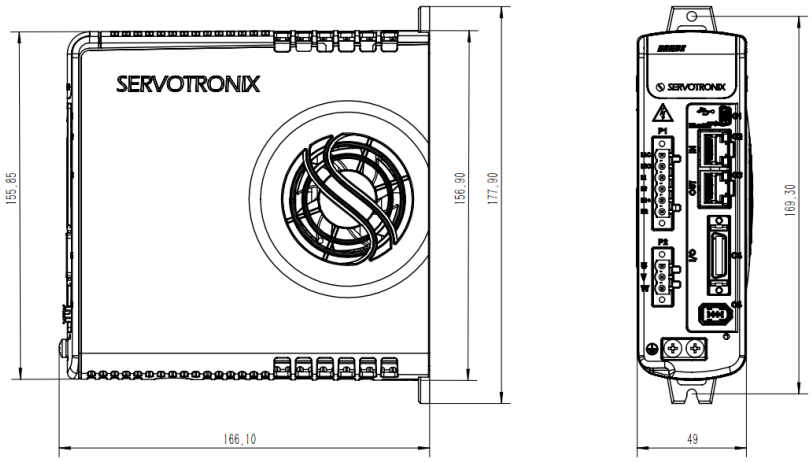



Figure 3-1 BDHDE-010/ BDHDE-013 model drives have the same external dimensions, as shown in the figure below:

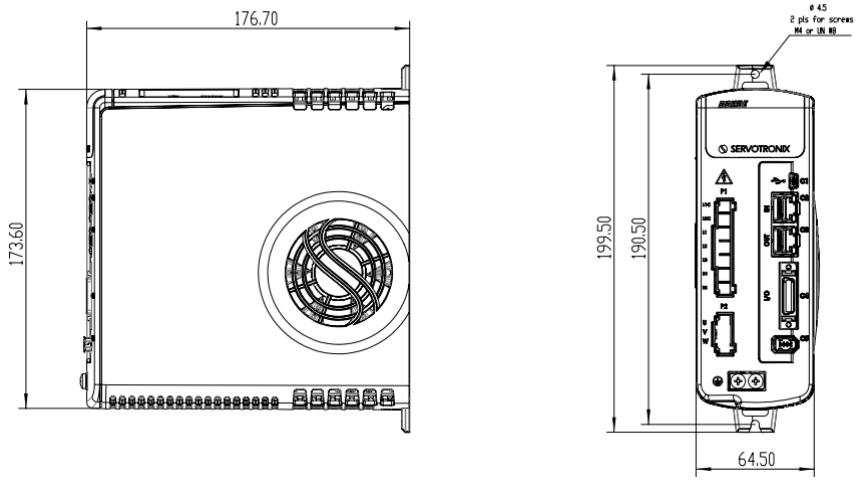



Figure 3-2 BDHDE-010/BDHDE-013 Dimensions(mm)

## 3.2 Mechanical and Electrical Specifications

**Table 3-1. Mechanical and Electrical Specifications**

| Specifications | BDHDE-003 | BDHDE-006 | BDHDE-010 | BDHDE-013 |
|---|---|---|---|---|
| Rated Value | | | | |

| Specifications | | BDHDE-003 | BDHDE-006 | BDHDE-010 | BDHDE-013 |
|---|---|---|---|---|---|
| Power Circuit Input L1, L2 | Rated Voltage(L-N)±10% | 220 | 220 | 220 | 220 |
| | Line Frequency(Hz) | 50/60 | 50/60 | 50/60 | 50/60 |
| | AC Voltage 220V | 1 Phase | 1 Phase | 1 Phase | 1 Phase |
| | Continuous Current (Single-phase A rms) | 5.2 | 9 | 14 | 10 |
| | Wire fuse (FRN-R, LPN, or equivalent) (A) | 6 | 10 | 18 | 15 |
| | Withstanding Voltage (Primary Side to PE) | AC 1500V (DC 2121V) | AC 1500V (DC 2121V) | AC 1500V (DC 2121V) | AC 1500V (DC 2121V) |
| Control Circuit Input L1C, L2C | AC Voltage 220v ± 10% | 1 Phase | 1 Phase | 1 Phase | 1 Phase |
| Input Fuse (Time Delay) | AC Voltage 220V(A) | 0.5 | 0.5 | 0.5 | 0.5 |
| Drive Output | Continuous Output Current (A rms) | 2.8 | 6 | 10 | 13 |
| | Continuous Output Current (A peak) | 3.96 | 8.48 | 14.14 | 18.38 |
| | Peak Output Current (A rms) 2 sec | 8.4 | 18 | 30 | 28 |
| | Peak Output Current (A peak) 2 sec | 11.88 | 25.45 | 42.42 | 39.59 |
| | kVA, AC Voltage 220V | 0.72 | 1.44 | 3.5 | 4.2 |
| | PWM Frequency (kHz) | 8 | 8 | 8 | 8 |
| | Max. Surge Start Current (A) | 7 | 7 | 19.1 | 19.1 |
| **Hardware** | | | | | |
| Unit Weight | kg | 0.875 | 1.10 | 1.35 | 1.35 |
| 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) (Over 3m) | 24–28 | 24–28 | 24－28 | 24－28 |
| | Main Circuit Motor Line (AWG) | 18 | 16 | 13 | 12 |

| Specifications | | BDHDE-003 | BDHDE-006 | BDHDE-010 | BDHDE-013 |
|---|---|---|---|---|---|
| | Main circuit AC Input (AWG) | 18 | 16 | 12 | 12 |
| Spacing Specifications | Installation Method | Book type | Book type | Book type | Book type |
| | Left and Right(mm) | 10 | 10 | 10 | 10 |
| | Top/Bottom(mm) | 50 | 50 | 50 | 50 |
| Voltage Protection | Undervoltage Protection Value(DC Voltage) | 180(Customizable) | 180(Customizable) | 180(Customizable) | 180(Customizable) |
| | Overvoltage Protection Value(DC Voltage) | 400 | 400 | 400 | 400 |
| Fan | Fan Start Conditions | None | Constant speed after power up | Constant speed after power up | Constant speed after power up |
| External Regeneration Resistors (B1+, B2) | Minimum Resistance(Ω) | 40 | 40 | 10 | 10 |
| | Maximum Current(A) | 10 | 10 | 40 | 40 |
| | Maximum Continuous Power(W) | 280 | 280 | 1400 | 1400 |
| | Internal DC Bus Capacity(μF) | 780 | 1110 | 2040 | 2040 |
| | Regenerative Brake Circuit Shutdown Voltage | 360 | 360 | 360 | 360 |
| | Regenerative Brake Circuit Start Voltage | 380 | 380 | 380 | 380 |

## 3.3 Control Specifications

**Table 3-2. Control Specifications**

| Characteristics | | Specifications |
|---|---|---|
| Motor | Type | Surface-mounted three-phase permanent magnet synchronous AC servo motor |
| | Motor Phase | Automatic configuration of motor phase, encoder direction |
| Operation Mode | Control Mode | Current (torque) control, speed control, position control, control mode switching |
| Current (Torque) Control | Performance | Update rate 31.25/62.5 μs (32/16 KHz), output waveform sine wave |
| | Step Response Time | Current feedback following time, 187.5μs |
| | Control Method | DQ, PI, feedforward |
| | Reference Command | USB, EtherCAT |
| | Parameter Tuning Method | Automatic setting of current control loop parameters |
| Speed Control | Performance | Update rate 125μs(8 kHz) |
| | Control Method | PDFF |
| | Filter | First-order low-pass filter, notch filter, load disturbance observer, speed observer |
| | Reference Command | USB, EtherCAT, segment speed command |
| | Parameter Tuning Method | Rigidity table, automatic parameter tuning (load inertia ratio identification), manual parameter setting, load adjustment-free function |
| Position Control | Performance | Update rate 125μs(8 kHz) |
| | Control Method | P+feedforward |
| | Reference Command | USB, EtherCAT, pulse input, segment instruction |
| | Parameter Tuning Method | Rigidity table, manual parameter setting, load adjustment-free function |
| Brake | Method | Dynamic brake, motor regenerative brake. |
| Display | User Interface | 1-bit 7-segment LED display |
| GUI | User Interface | ServerStudio2 application based on Windows |
| | Function | Setting connection, drive information, power information, motor, feedback, I/O selection/configuration, action setting/tuning, fault history/display, setup wizard, expert view, etc. |
| Electronic Gearing Ratio | Scope | 1:1000 ~ 8000:1 |
| SECURITY CONTROL* | STO | SAFE TORQUE OFF |
| Motion Unit | Position | Count (User Unit) |
| | Speed | rpm |
| | Acceleration/Deceleration | rpm/s |

*Some features are only available in some models, please refer to ordering information

## 3.4 Protective Functions and Environmental Specifications

**Table 3-3. Protective Functions and Environmental Specifications**

| Characteristics | Specifications |
|---|---|
| Protective Function | Including but not limited to: low/overvoltage, overcurrent, drive and motor overheating, motor foldback, drive foldback, feedback loss, unconfiguration and circuit failure. |
| Compliance | IEC 61800-5-1: Low Voltage Directive 2014/35/EU.<br>Adjustable Speed Electrical Power Drive Systems |
| | IEC 61800-3: Electromagnetic Compatibility(EMC) Directive 2014/30/EU.<br>Adjustable Speed Electrical Power Drive Systems |
| | EN 50581: supports the basic requirements of EU RoHS directive 2011/65/EU.<br>*The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment*. |
| Environment | Ambient temperature: working temperature 0-45 ℃, storage temperature -20 ~ 70 ℃ |
| | Humidity: 10-90% (no condensation) |
| | Altitude: BDHDE is used at altitudes below 1000 meters above sea level in accordance with the spacing requirements of IEC 61800-5-1 standard. |
| | Vibration: 1.0g |
| Operating Conditions | Degree of protection: IP20<br>Pollution level: IEC 60664-1 standard Level 2<br>Do not use in locations with: corrosive or flammable gases, water, oil or chemicals, dust (including iron powder) and salt |

## 3.5 Communication Specifications

**Table 3-4. Communication Specifications**

| Characteristics | Specifications |
|---|---|
| EtherCAT* | CiA 301 application layer and CiA 402 device configuration file for drive and motion control |
| | Communication period: over 250μs |
| USB | Based on ASCII, ServoStudio2, hyper terminal |
| | Baud rate: compliant with USB2.0 specification(12Mbps) |
| | Maximum cable length: 3m |
| RS485* | Based on ASCII, ServoStudio2, hyper terminal |
| | Baud rate: 115200 bit/s |

*Some features are only available in some models, please refer to *ordering information*

## 3.6 I/O Specifications

**Table 3-5. I/O Specifications**

| Characteristics | | Specifications | | |
|---|---|---|---|---|
| | | AP | EB | |
| Position Pulse Input* | Signal Electrical Interface | RS-422 Line Receiver | | |
| | Signal Format | Pulse/direction, CW/CCW, AB orthogonal | | |
| | Maximum Frequency | 4 MHz | | |
| Equivalent Encoder Output* | Signal Electrical Interface | RS-422 line transmitter | | |
| | Signal Format | AB orthogonal and differential Index | | |
| | Maximum Frequency | 4 MHz | | |
| High Speed Digital Inputs | Number of Channels | 2 | 2 | 2 |
| | Signal Format | Optical isolation<br>Configurable as single-ended pulse input<br>NPN or PNP connection<br>Active level configurable | Optical isolation<br>Configurable as Touch Probe<br>NPN or PNP connection<br>Active level configurable | Optical isolation<br>Configurable as Touch Probe<br>NPN or PNP connection<br>Active level configurable |
| | Voltage Class | | 24V(IEC 61131) | |

| Characteristics | | Specifications | | | |
|---|---|---|---|---|---|
| | | AP | EB | | |
| | Maximum Input Current | | 12.5 mA | | |
| | Transmission Delay Time | | 1 μs | | |
| | Maximum Frequency | | 200kHz | 1MHz | 1MHz |
| Normal digital input | Number of Channels | | 6 | 3 | 5 |
| | Signal Format | | Optical isolation<br>Functional configurable<br>NPN or PNP connection configurable<br>Active level configurable | | Optical isolation<br>Functional configurable<br>NPN or PNP connection configurable<br>Active level configurable |
| | Voltage Class | | 24V(IEC 61131) | | |
| | Maximum Input Current | | 6 mA | | |
| | Transmission Delay Time | | 1 ms | | |
| | Maximum Frequency | | 1 kHz | | |
| Normal Digital Outputs | Number of Channels | | 5 | 3 | 4 |
| | Signal Format | | Optical isolation<br>Functional configurable<br>NPN or PNP connection configurable<br>Active level configurable | | Optical isolation<br>Functional configurable<br>NPN or PNP connection configurable<br>Active level configurable |
| | Voltage Class | | 24V(IEC 61131) | | |
| | Maximum Output Current | | 50 mA | | |
| | Short Circuit Protection | | No | Yes | Yes |
| | Transmission Delay Time | | 1 ms | | |

*Some features are only available in some models, please refer to ordering information

## 3.7 Motor Feedback Specifications

**Table 3-6. Motor Feedback Specifications**

| Characteristics | | Specifications |
|---|---|---|
| Power Supply | Drive supply voltage | DC voltage 5V |
| | Maximum current from drive to encoder | 200mA @ 5V |
| Cable | Maximum length | 20m |
| Serial Synchronous Interface (SSI) Encoder | Signal | Differential data and clock for synchronous encoder<br>Data for asynchronous encoder only |
| | Protocol | sensAR, Tamagawa |

**Table 3-7. SensAR Encoder Specifications**

| | SensAR Single-turn | SensAR Multi-turn |
|---|---|---|
| **Main Encoder Specifications** | | |
| Single-turn Resolution | 20 bit | 20 bit |
| Multi-turn Counting | | 16 bit |
| Accuracy | ±0.016 ° | ±0.016 ° |
| Repetition Accuracy | ±0.015 ° | ±0.015 ° |
| Maximum Speed | 12,000 rpm | |
| Maximum Angular Acceleration | 100,000 rad/s2 | |
| Data Storage EEPROM | 2040 bytes | |
| **Ambient Conditions** | | |
| Working Temperature Range | -20 ℃ to 120 ℃ | -20 ℃ to 120 ℃ |
| Storage Temperature Range | -30 ℃ to 120 ℃ | -30 ℃ to 120 ℃ |
| Humidity | 90% RH | 90% RH |
| Vibration Resistance (EN60068-2-6) | 30G(10–2000 Hz) | 30G(10–2000 Hz) |
| Shock Resistance (EN60068-2-27) | 200G (6 ms) | 200G(6 ms) |
| **Mechanical Specifications** | | |
| Allowing Shaft Movement (Installation) | Axial ±0.7mm<br>radial ±0.1mm | Axial ±0.7mm radial ±0.1mm |
| **Electrical Specifications** | | |
| Service Life | 786,401 hours/90 years | 786,401 hours/90 years |
| Power Up Standby Time | 1500 ms | 1500 ms |

**Table 3-8. Tamagawa Encoder Specifications**

| | Tamagawa<br>Single-turn 17-bit | Tamagawa<br>Multi-turn 23-big |
|---|---|---|
| **Main Encoder Specifications** | | |
| Single-turn Resolution | 17bit | 23 bit |
| Multi-turn Counting | | 16 bit |
| Accuracy | ±0.016 ° | ±0.016 ° |
| Repetition Accuracy | ±0.022 ° | ±0.022 ° |
| Maximum Speed | 6000 rpm | 6000 rpm |
| Maximum Angular Acceleration | 80,000 rad/s2 | 80,000 rad/s2 |
| Data Storage EEPROM | 80 bytes | 80 bytes |
| **Ambient Conditions** | | |
| Working Temperature Range | -10 ℃ to 85 ℃ | -10 ℃ to 85 ℃ |
| Storage Temperature Range | -20 ℃ to 90 ℃ | -20 ℃ to 90 ℃ |
| Humidity | 90% RH | 90% RH |
| Vibration Resistance (EN60068-2-6) | 10G(58–2000 Hz) | 10G(58–2000 Hz) |
| Shock Resistance (EN60068-2-27) | 200G (11ms) | 200G(11ms) |
| **Mechanical Specifications** | | |
| Allowing Shaft Movement (Installation) | Axial ±0.1mm<br>Radial ±0.05mm | Axial ±0.1mm<br>Radial ±0.05mm |
| **Electrical Specifications** | | |
| Service Life | 24,000 hours | 24,000 hours |
| Power Up Standby Time | 1000 ms | 1000 ms |

# 4 PRHD2 Motor Specifications

## 4.1 General Specifications

**Table 4-1. PRHD2 Motor-General Specifications**

| Characteristics | Specifications |
|---|---|
| Rated Operation System | S1 (continuous) |
| Insulation Grade | F |
| Enclosure | Fully enclosed self-cooling |
| Degree of Protection | IP65 |
| Ambient Temperature | -10 ℃ ~ + 40 ℃ |
| Relative Humidity | 20% ~ 80% |
| Number of Poles | 10 |
| Certification | CE/UL |

## 4.2 PRHD2 MotorR40

### 4.2.1 PRHD2 Low Inertia Motor R40 -Specifications

**Table 4-2. PRHD2 Low Inertia Motor R40 - Specifications**

| | | | PH2-L04A230 | PH2-L04B230 |
|---|---|---|---|---|
| Rated Torque | Tn | Nm | 0.16 | 0.32 |
| Peak Torque | Tmax | Nm | 0.56 | 1.12 |
| Rated Speed | ωn | $min^{-1}$ | 3000 | 3000 |
| Maximum Speed | ωmax | $min^{-1}$ | 6000 | 6000 |
| Rated Power | Pn | kW | 0.05 | 0.10 |
| Rated Current | In | $A_{rms}$ | 0.9 | 0.85 |
| Maximum Current | Imax | $A_{rms}$ | 3.3 | 2.90 |
| Rated Winding Voltage | Un | $V_{AC}$ | 220 | 220 |
| Maximum Winding Voltage | Umax | $V_{DC}$ | 340 | 340 |
| Maximum Ground Voltage | | $V_{AC}$ | 240 | 240 |
| Counter Electromotive Force Constant | Keu-v | $V_{rms}/k_{rpm}$ | 11.9 | 26.1 |
| Torque Coefficient | Kt | N m/$A_{rms}$ | 0.18 | 0.39 |
| Winding Resistance | R20 u-v | Ohm | 13.50 | 24.50 |
| Winding Inductance | Lu-v | mH | 12.90 | 26.70 |
| Rotor Inertia without Brake | Jm | ×10-4 kg ṁ$^2$ | 0.02 | 0.035 |
| Rotor Inertia with Brake | Jm | ×10-4 kg ṁ$^2$ | 0.027 | 0.042 |
| No-brake Mass | m | kg | 0.46 | 0.59 |

| | | | PH2-L04A230 | PH2-L04B230 |
|---|---|---|---|---|
| Brake Mass | m | kg | 0.66 | 0.79 |
| Thermal Time Constant | | $min^{-1}$ | 7 | 9 |
| Maximum Radial Shaft Load | | N | 78 | 78 |
| Maximum Axial Shaft Load | | N | 54 | 54 |

### 4.2.2 PRHD2 Low Inertia Motor R40 - Torque and Speed Curve

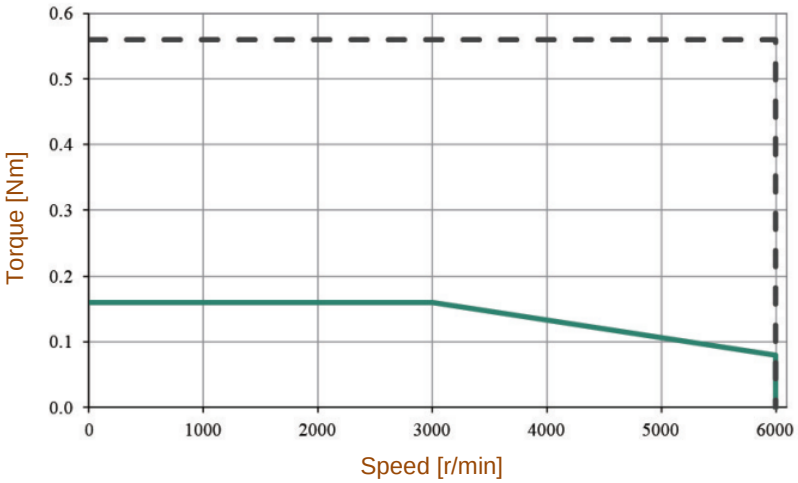



**Figure 4-1 Torque and Speed Curve - PH2-L04A230**

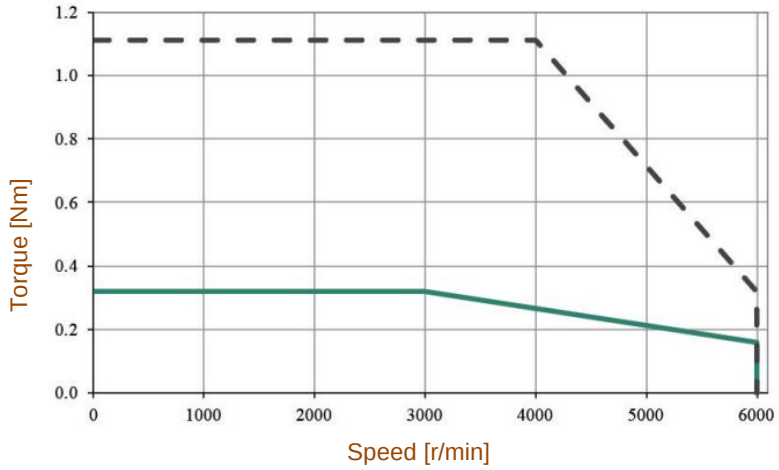



**Figure4-2. Torque and Speed Curve - PH2-L04B230**

### 4.2.3 PRHD2 Low Inertia Motor R40-Dimension Drawing

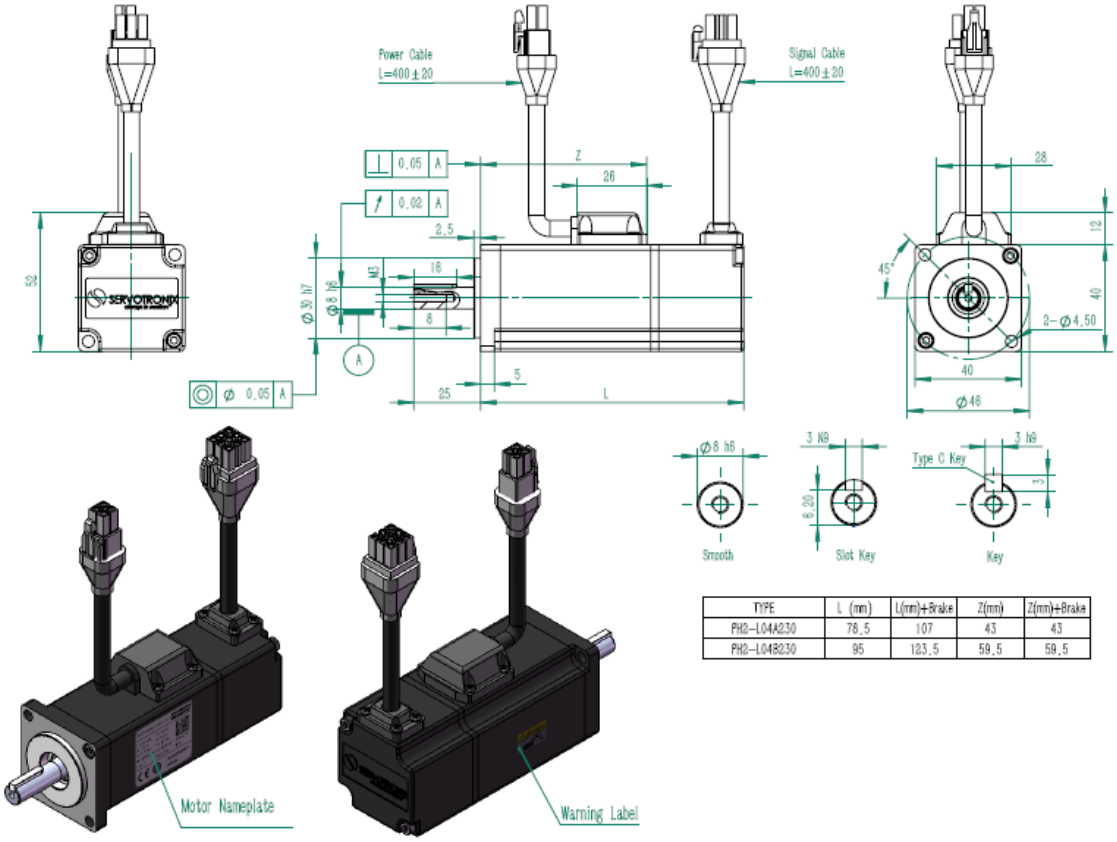



**Figure 4-3. Dimension Drawing - PH2-L04A230/PH2-L04B230**

### 4.2.4 PRHD2 Medium Inertia Motor R40 - Specifications

**Table 4-3. PRHD2 Medium Inertia Motor R40 - Specifications**

| | | | PH2-M04A230 | PH2-M04B230 |
|---|---|---|---|---|
| Rated Torque | Tn | Nm | 0.16 | 0.32 |
| Peak Torque | Tmax | Nm | 0.56 | 1.12 |
| Rated Speed | ωn | $min^{-1}$ | 3000 | 3000 |
| Maximum Speed | ωmax | $min^{-1}$ | 6000 | 6000 |
| Rated Power | Pn | kW | 0.05 | 0.10 |
| Rated Current | In | $A_{rms}$ | 0.45 | 0.90 |
| Maximum Current | Imax | $A_{rms}$ | 1.60 | 3.10 |
| Rated Winding Voltage | Un | $V_{AC}$ | 220 | 220 |
| Maximum Winding Voltage | Umax | $V_{DC}$ | 340 | 340 |
| Maximum Ground Voltage | | $V_{AC}$ | 240 | 240 |
| Counter Electromotive Force Constant | Keu-v | $V_{rms}/k_{rpm}$ | 23.7 | 23.7 |
| Torque Coefficient | Kt | N m/$A_{rms}$ | 0.39 | 0.39 |
| Winding Resistance | R20 u-v | Ohm | 44.00 | 17.50 |

| | | | PH2-M04A230 | PH2-M04B230 |
|---|---|---|---|---|
| Winding Inductance | Lu-v | mH | 21.75 | 9.55 |
| Rotor Inertia without Brake | Jm | ×10-4 kg ṁ$^2$ | 0.041 | 0.075 |
| Rotor Inertia with Brake | Jm | ×10-4 kg ṁ$^2$ | 0.048 | 0.082 |
| No-brake Mass | m | kg | 0.45 | 0.55 |
| Brake Mass | m | kg | 0.65 | 0.75 |
| Thermal Time Constant | | min$^{-1}$ | 7 | 9 |
| Maximum Radial Shaft Load | | N | 78 | 78 |
| Maximum Axial Shaft Load | | N | 54 | 54 |

### 4.2.5 PRHD2 Medium Inertia Motor R40 - Torque and Speed Curve

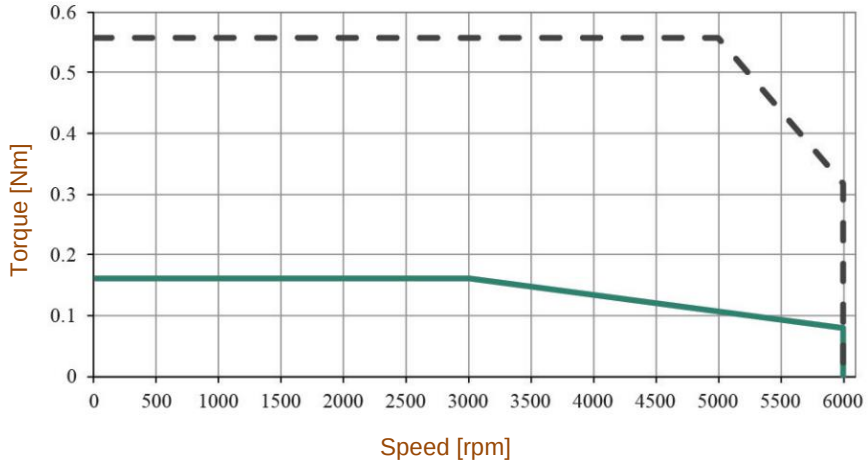



**Figure 4-4 Torque and Speed- PH2 - M04A230**

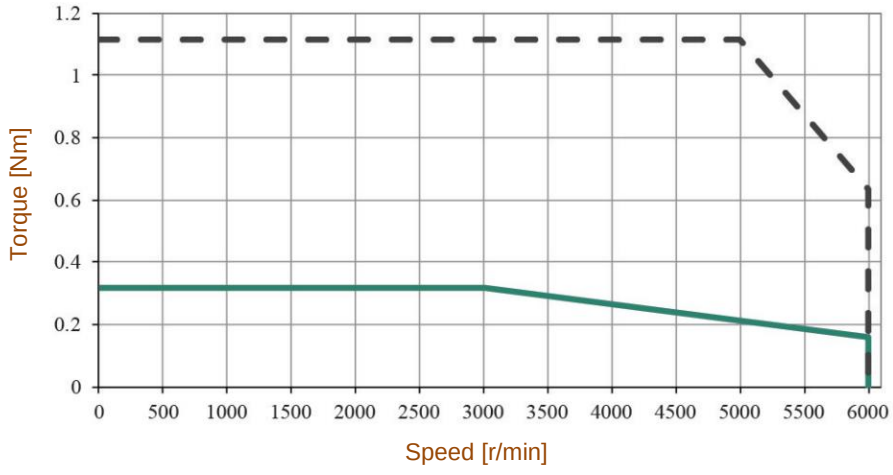
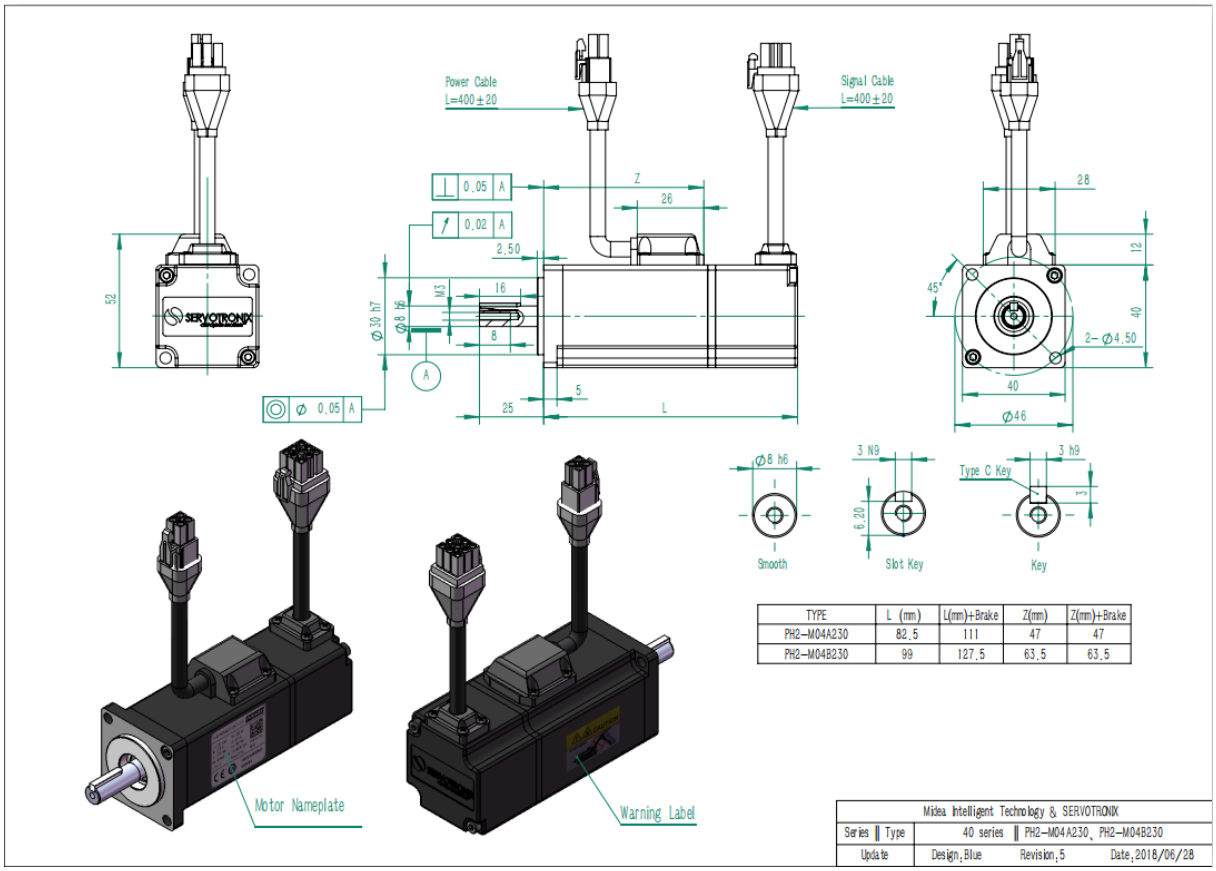



**Figure 4-5 Torque and Speed - PH2 - M04B230**

### 4.2.6 PRHD2 Medium Inertia Motor R40 - Dimension Drawing




| TYPE | L (mm) | L(mm)+Brake | Z(mm) | Z(mm)+Brake |
|---|---|---|---|---|
| PH2-M04A230 | 82.5 | 111 | 47 | 47 |
| PH2-M04B230 | 99 | 127.5 | 63.5 | 63.5 |

**Figure 4-6. Dimension Drawing - PH2 - M04A230 / PH2 - M04B230**

## 4.3 PRHD2 Motor R60

### 4.3.1 PRHD2 Low Inertia Motor R60 - Specifications

**Table 4-4. PRHD2 Low Inertia Motor R60 - Specification**

| | | | PH2-L06A230 | PH2-L06B230 |
|---|---|---|---|---|
| Rated Torque | Tn | Nm | 0.64 | 1.23 |
| Peak Torque | Tmax | Nm | 2.24 | 3.35 |
| Rated Speed | ωn | min-1 | 3000 | 3000 |
| Maximum Speed | ωmax | min-1 | 6000 | 6000 |
| Rated Power | Pn | kW | 0.2 | 0.4 |
| Rated Current | In | Arms | 1.5 | 2.8 |
| Maximum Current | Imax | Arms | 5.7 | 8.4 |
| Rated Winding Voltage | Un | VAC | 220 | 220 |
| Maximum Winding Voltage | Umax | VDC | 340 | 340 |
| Maximum Ground Voltage | | VAC | 240 | 240 |
| Counter Electromotive Force Constant | Keu-v | Vrms/krpm | 27.5 | 28 |
| Torque Coefficient | Kt | N m/Arms | 0.454 | 0.46 |

| | | | PH2-L06A230 | PH2-L06B230 |
|---|---|---|---|---|
| Winding Resistance | R20 u-v | Ohm | 6.82 | 2.79 |
| Winding Inductance | Lu-v | mH | 16 | 8.2 |
| Rotor Inertia without Brake | Jm | ×10-4 kg·m2 | 0.14 | 0.23 |
| Rotor Inertia with Brake | Jm | ×10-4 kg·m2 | 0.147 | 0.236 |
| No-brake Mass | m | kg | 1.1 | 1.5 |
| Brake Mass | m | kg | 1.7 | 2.1 |
| Thermal Time Constant | | min-1 | 10 | 12 |
| Maximum Radial Shaft Load | | N | 245 | 245 |
| Maximum Axial Shaft Load | | N | 75 | 75 |

### 4.3.2 PRHD2 Low Inertia Motor R60 - Torque and Speed Curve

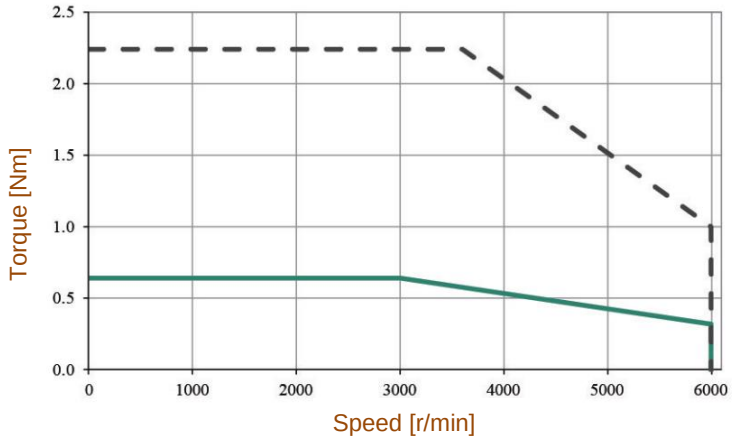



**Figure 4-7. Torque and Speed Curve - PH2 - L06A230**

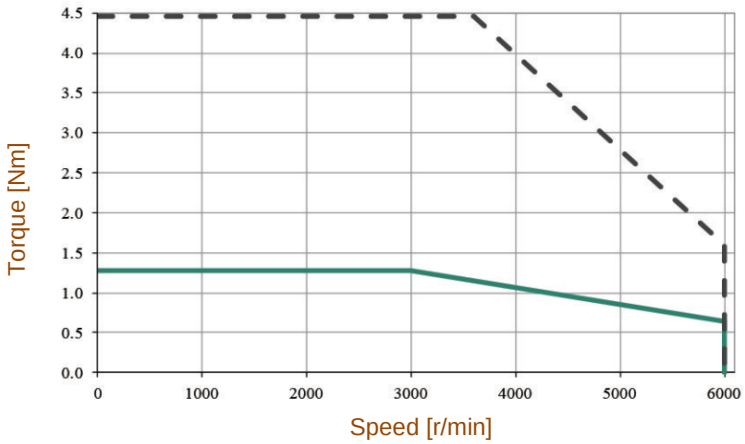
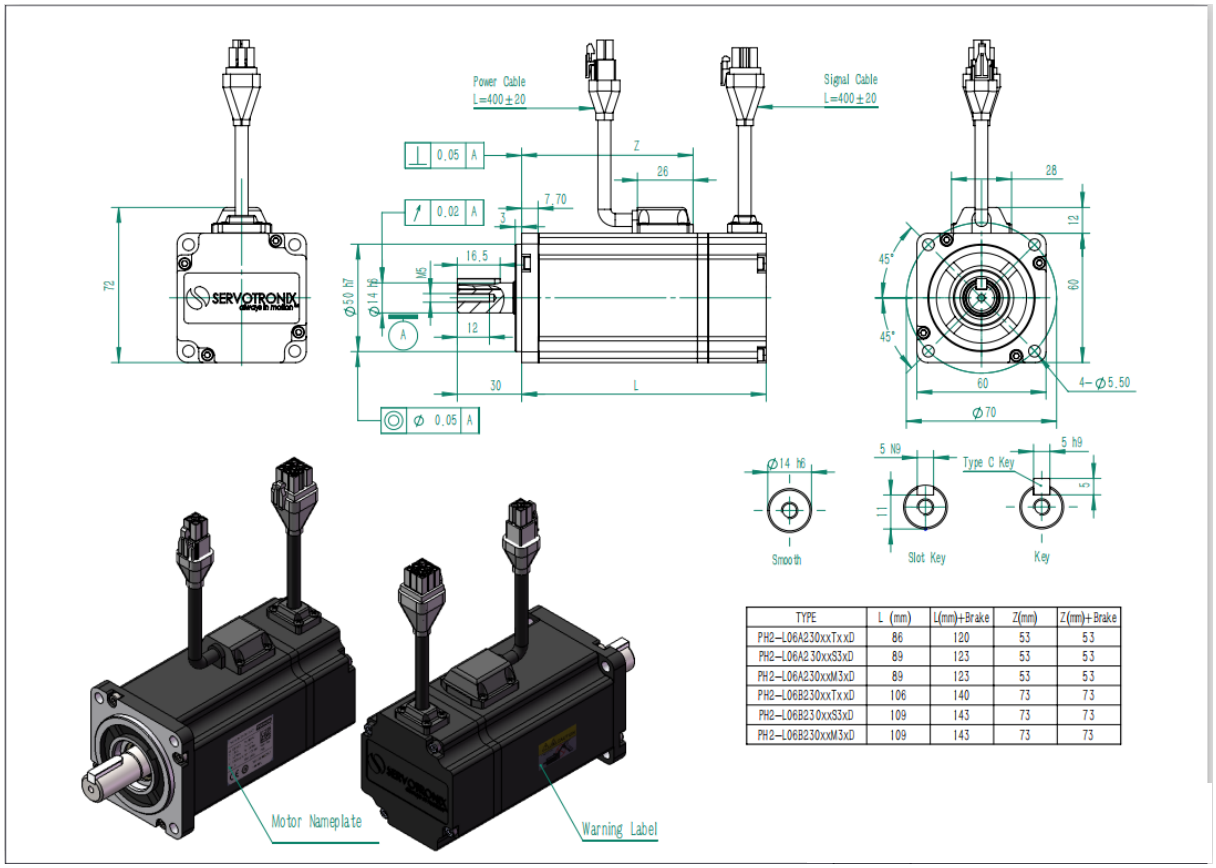



**Figure 4-8. Torque and Speed Curve - PH2 - L06B230**

### 4.3.3 PRHD2 Low Inertia Motor R60 - Dimension Drawing




| TYPE | L (mm) | L(mm)+Brake | Z(mm) | Z(mm)+Brake |
|---|---|---|---|---|
| PH2-L06A230xxTxxD | 86 | 120 | 53 | 53 |
| PH2-L06A230xxS3xD | 89 | 123 | 53 | 53 |
| PH2-L06A230xxM3xD | 89 | 123 | 53 | 53 |
| PH2-L06B230xxTxxD | 106 | 140 | 73 | 73 |
| PH2-L06B230xxS3xD | 109 | 143 | 73 | 73 |
| PH2-L06B230xxM3xD | 109 | 143 | 73 | 73 |

**Figure 4-9. Dimension Drawing - PH2 - L06A230 / PH2 - L06B230**

### 4.3.4 PRHD2 Medium Inertia Motor R60 - Specifications

**Table 4-5. PRHD2 Medium Inertia Motor R60 - Specifications**

| | | | PH2-M06A230 | PH2-M06B230 |
|---|---|---|---|---|
| Rated Torque | Tn | Nm | 0.64 | 1.27 |
| Peak Torque | Tmax | Nm | 2.24 | 3.67 |
| Rated Speed | ωn | min-1 | 3000 | 3000 |
| Maximum Speed | ωmax | min-1 | 6000 | 6000 |
| Rated Power | Pn | kW | 0.2 | 0.4 |
| Rated Current | In | Arms | 1.7 | 2.8 |
| Maximum Current | Imax | Arms | 6.1 | 8.4 |
| Rated Winding Voltage | Un | VAC | 220 | 220 |
| Maximum Winding Voltage | Umax | VDC | 340 | 340 |
| Maximum Ground Voltage | | VAC | 240 | 240 |
| Counter Electromotive Force Constant | Keu-v | Vrms/krpm | 25 | 29.86 |
| Torque Coefficient | Kt | N m/Arms | 0.38 | 0.49 |
| Winding Resistance | R20 u-v | Ohm | 4.25 | 2.62 |
| Winding Inductance | Lu-v | mH | 9.2 | 6.2 |

| | | | PH2-M06A230 | PH2-M06B230 |
|---|---|---|---|---|
| Rotor Inertia without Brake | Jm | ×10-4 kg ṁ2 | 0.27 | 0.49 |
| Rotor Inertia with Brake | Jm | ×10-4 kg ṁ2 | 0.29 | 0.51 |
| No-brake Mass | m | kg | 1.1 | 1.6 |
| Brake Mass | m | kg | 1.5 | 2.1 |
| Thermal Time Constant | | min-1 | 8 | 10 |
| Maximum Radial Shaft Load | | N | 245 | 245 |
| Maximum Axial Shaft Load | | N | 75 | 75 |

### 4.3.5 PRHD2 Medium Inertia Motor R60 - Torque and Speed Curve

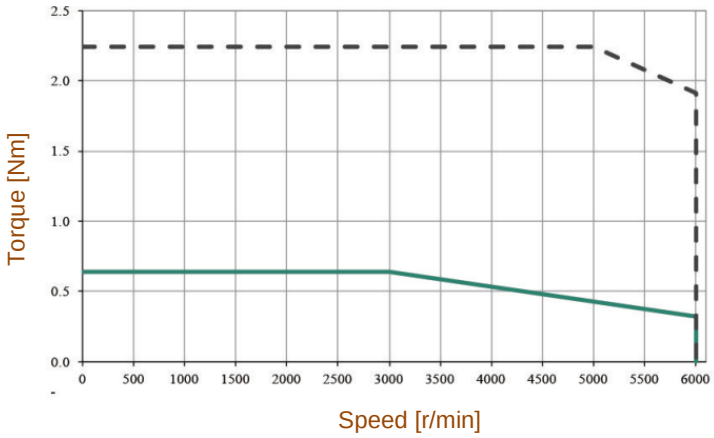



**Figure 4-10. -1 Torque and Speed Curve - PH2 - M06A230**

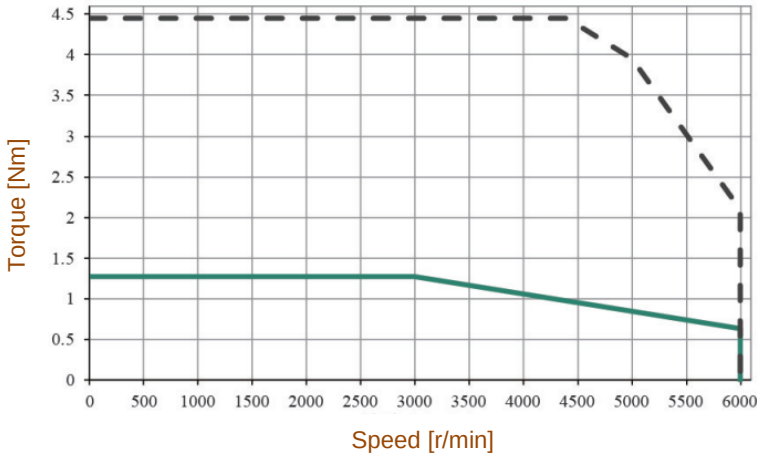
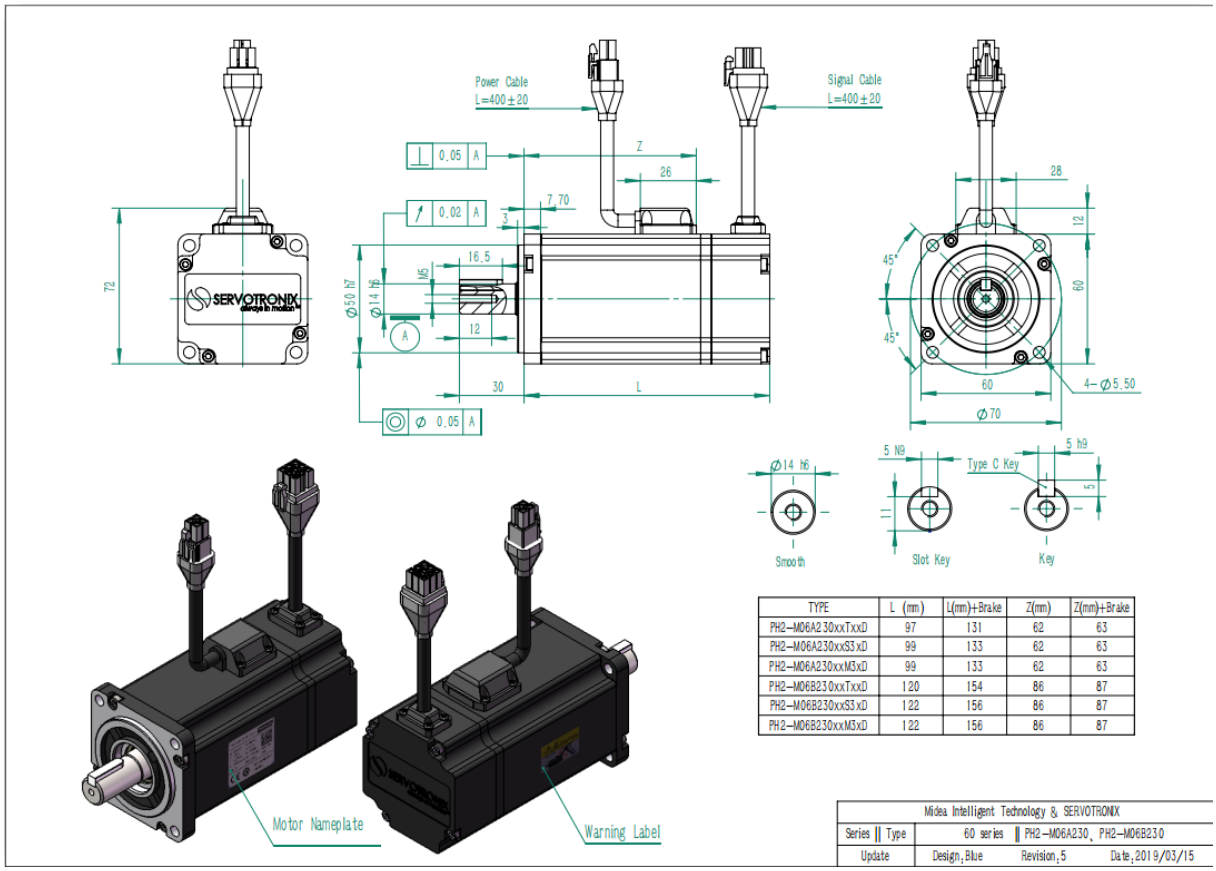



**Figure 4-11. Torque and Speed Curve - PH2 - M06B230**

### 4.3.6 PRHD2 Medium Inertia Motor R60 - Dimension Drawing




| TYPE | L (mm) | L(mm)+Brake | Z(mm) | Z(mm)+Brake |
|---|---|---|---|---|
| PH2-M06A230xxTxxD | 97 | 131 | 62 | 63 |
| PH2-M06A230xxS3xD | 99 | 133 | 62 | 63 |
| PH2-M06A230xxM3xD | 99 | 133 | 62 | 63 |
| PH2-M06B230xxTxxD | 120 | 154 | 86 | 87 |
| PH2-M06B230xxS3xD | 122 | 156 | 86 | 87 |
| PH2-M06B230xxM3xD | 122 | 156 | 86 | 87 |

**Figure 4-12. Dimension Drawing - PH2 - M06A230/PH2 - M06B230**

## 4.4 PRHD2 Motor R80

### 4.4.1 PRHD2 Low Inertia Motor R80 - Specifications

**Table 4-6. PRHD2 Low Inertia Motor R80 - Specifications**

| | | | PH2-L08A230 |
|---|---|---|---|
| Rated Torque | Tn | Nm | 2.39 |
| Peak Torque | Tmax | Nm | 8.36 |
| Rated Speed | ωn | min-1 | 3000 |
| Maximum Speed | ωmax | min-1 | 6000 |
| Rated Power | Pn | kW | 0.75 |
| Rated Current | In | Arms | 4.5 |
| Maximum Current | Imax | Arms | 16.6 |
| Rated Winding Voltage | Un | VAC | 220 |
| Maximum Winding Voltage | Umax | VDC | 340 |
| Maximum Ground Voltage | | VAC | 240 |
| Counter Electromotive Force Constant | Keu-v | Vrms/krpm | 36.1 |
| Torque Coefficient | Kt | N m/Arms | 0.53 |

| | | | PH2-L08A230 |
|---|---|---|---|
| Winding Resistance | R20 u-v | Ohm | 1.33 |
| Winding Inductance | Lu-v | mH | 8.1 |
| Rotor Inertia without Brake | Jm | ×10-4 kg·m2 | 0.791 |
| Rotor Inertia with Brake | Jm | ×10-4 kg·m2 | 0.861 |
| No-brake Mass | m | kg | 2.3 |
| Brake Mass | m | kg | 2.9 |
| Thermal Time Constant | | min-1 | 15 |
| Maximum Radial Shaft Load | | N | 392 |
| Maximum Axial Shaft Load | | N | 147 |

### 4.4.2 PRHD2 Low Inertia Motor R80 - Torque and Speed Curve

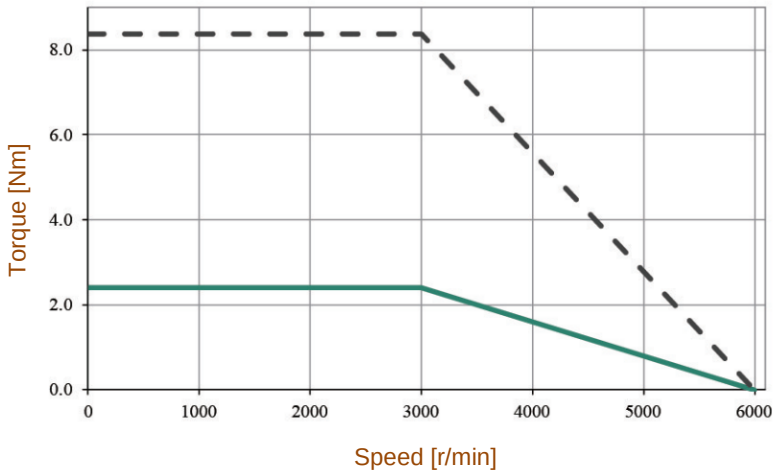



**Figure 4-13. Torque and Speed Curve - PH2 - L08A230**

### 4.4.3 PRHD2 Low Inertia Motor R80 - Dimension Drawing

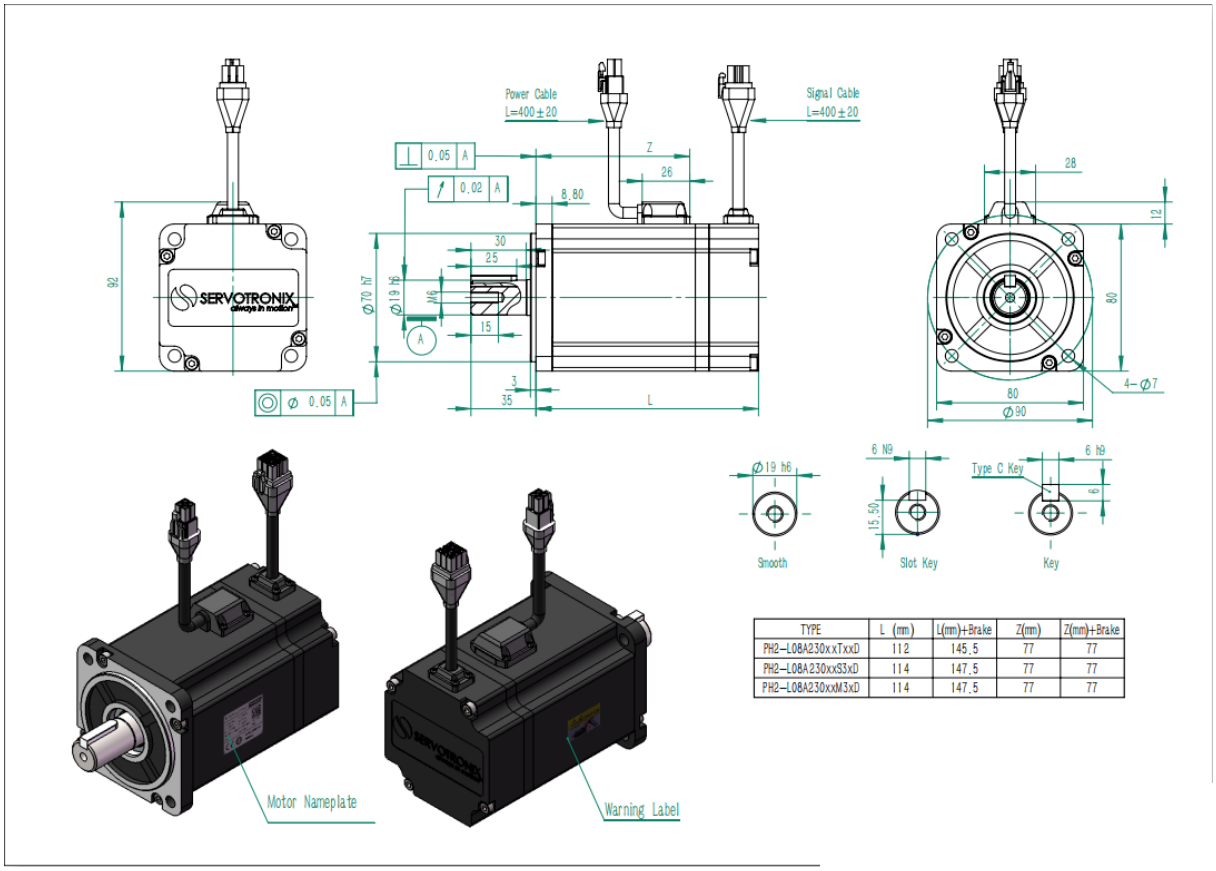



**Figure 4-14. Dimension Drawing - PH2 - L08A230**

### 4.4.4 PRHD2 Medium Inertia Motor R80 - Specifications

**Table 4-7. PRHD2 Medium Inertia Motor R80 - Specifications**

| | | | PH2-M08A230 |
|---|---|---|---|
| Rated Torque | Tn | Nm | 2.39 |
| Peak Torque | Tmax | Nm | 8.36 |
| Rated Speed | ωn | min-1 | 3000 |
| Maximum Speed | ωmax | min-1 | 6000 |
| Rated Power | Pn | kW | 0.75 |
| Rated Current | In | Arms | 5 |
| Maximum Current | Imax | Arms | 18.1 |
| Rated Winding Voltage | Un | VAC | 220 |
| Maximum Winding Voltage | Umax | VDC | 340 |
| Maximum Ground Voltage | | VAC | 240 |
| Counter Electromotive Force Constant | Keu-v | Vrms/krpm | 31.25 |
| Torque Coefficient | Kt | N m/Arms | 0.48 |
| Winding Resistance | R20 u-v | Ohm | 0.75 |
| Winding Inductance | Lu-v | mH | 2.6 |

| | | | PH2-M08A230 |
|---|---|---|---|
| Rotor Inertia without Brake | Jm | ×10-4 kg·m2 | 1.72 |
| Rotor Inertia with Brake | Jm | ×10-4 kg·m2 | 1.74 |
| No-brake Mass | m | kg | 2.7 |
| Brake Mass | m | kg | 3.3 |
| Thermal Time Constant | | min-1 | 15 |
| Maximum Radial Shaft Load | | N | 392 |
| Maximum Axial Shaft Load | | N | 147 |

### 4.4.5 PRHD2 Medium Inertia Motor R80 - Torque and Speed Curve

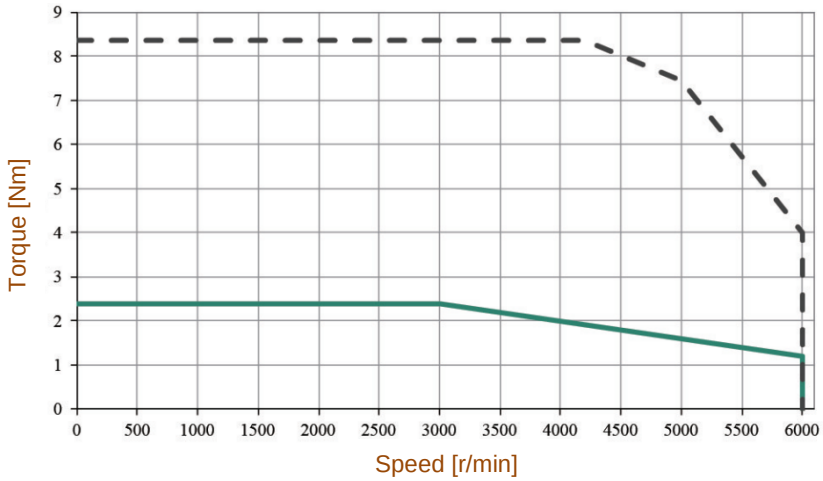
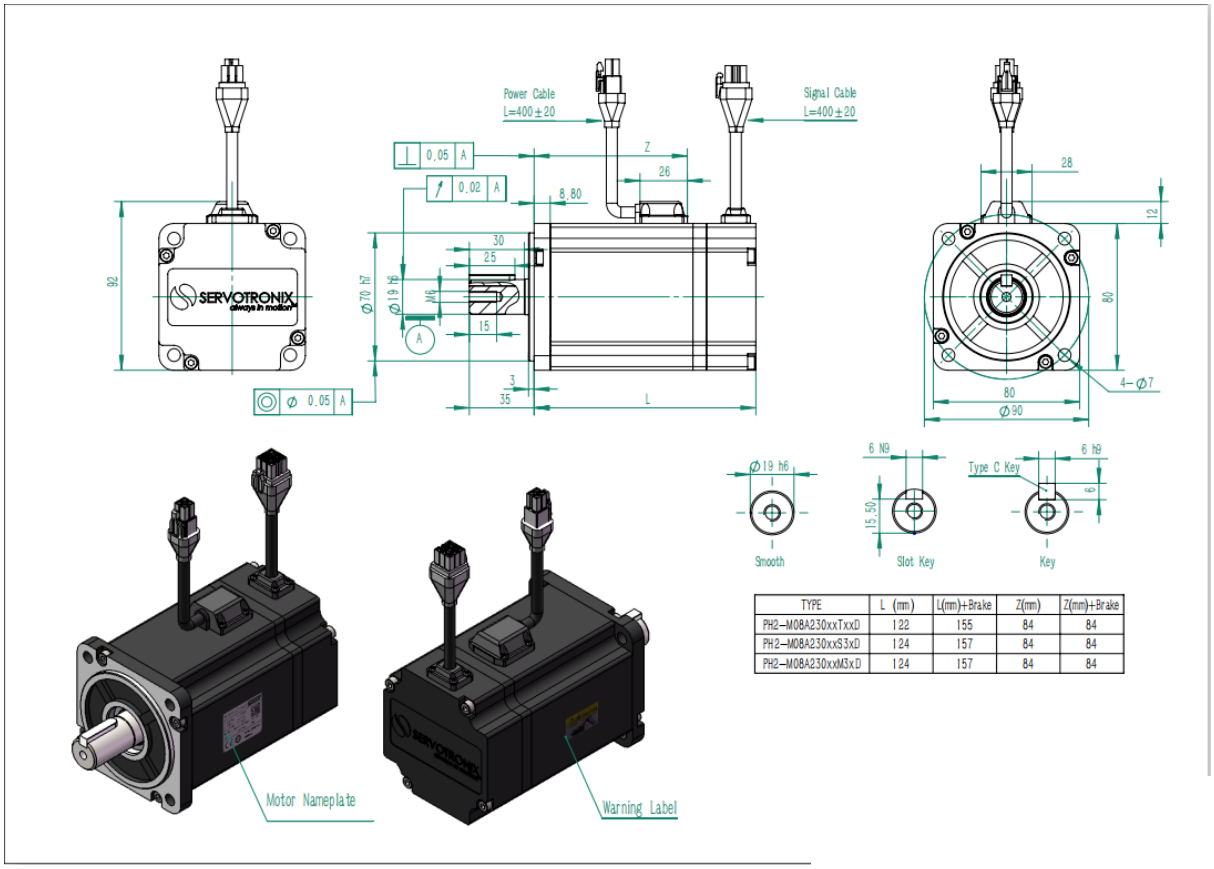



**Figure 4-15. Torque and Speed Curve - PH2 - M08A230**

### 4.4.6 PRHD2 Medium Inertia Motor R80 - Dimension Drawing




| TYPE | L (mm) | L(mm)+Brake | Z(mm) | Z(mm)+Brake |
|---|---|---|---|---|
| PH2-M08A230xxTxxD | 122 | 155 | 84 | 84 |
| PH2-M08A230xxS3xD | 124 | 157 | 84 | 84 |
| PH2-M08A230xxM3xD | 124 | 157 | 84 | 84 |

**Figure 4-16 Dimension Drawing - PH2 - M08A230**

## 4.5 PRHD2 Motor R100

### 4.5.1 PRHD2 Low Inertia Motor R100 -Specifications

**Table 4-8. PRHD2 Low Inertia Motor R100-Specifications**

| | | | PH2-L10A230 | PH2-L10B230 | PH2-L10C230 |
|---|---|---|---|---|---|
| Rated Torque | Tn | Nm | 3.18 | 4.78 | 6.37 |
| Peak Torque | Tmax | Nm | 8.38 | 14.34 | 19.11 |
| Rated Speed | ωn | min-1 | 3000 | 3000 | 3000 |
| Maximum Speed | ωmax | min-1 | 5000 | 5000 | 5000 |
| Rated Power | Pn | kW | 1 | 1.5 | 2 |
| Rated Current | In | Arms | 6 | 10 | 12 |
| Maximum Current | Imax | Arms | 18.0 | 34.2 | 37.3 |
| Rated Winding Voltage | Un | VAC | 220 | 220 | 220 |
| Maximum Winding Voltage | Umax | VDC | 340 | 340 | 340 |
| Maximum Ground Voltage | | VAC | 240 | 240 | 240 |
| Counter Electromotive Force Constant | Keu-v | Vrms/krpm | 34.4 | 33.7 | 36.8 |
| Torque Coefficient | Kt | N m/Arms | 0.53 | 0.48 | 0.53 |
| Winding Resistance | R20 u-v | Ohm | 0.55 | 0.32 | 0.27 |
| Winding Inductance | Lu-v | mH | 4.9 | 3.2 | 2.6 |
| Rotor Inertia without Brake | Jm | ×10-4 kg ṁ2 | 2.23 | 3.14 | 4.17 |
| Rotor Inertia with Brake | Jm | ×10-4 kg ṁ2 | 2.57 | 3.48 | 4.51 |
| No-brake Mass | m | kg | 3.7 | 4.6 | 5.5 |
| Brake Mass | m | kg | 4.7 | 5.5 | 6.5 |
| Thermal Time Constant | | min-1 | 30 | 36 | 44.3 |
| Maximum Radial Shaft Load | | N | 490 | 490 | 490 |
| Maximum Axial Shaft Load | | N | 196 | 196 | 196 |

### 4.5.2 PRHD2 Low Inertia Motor R100-Torque and Speed Curve

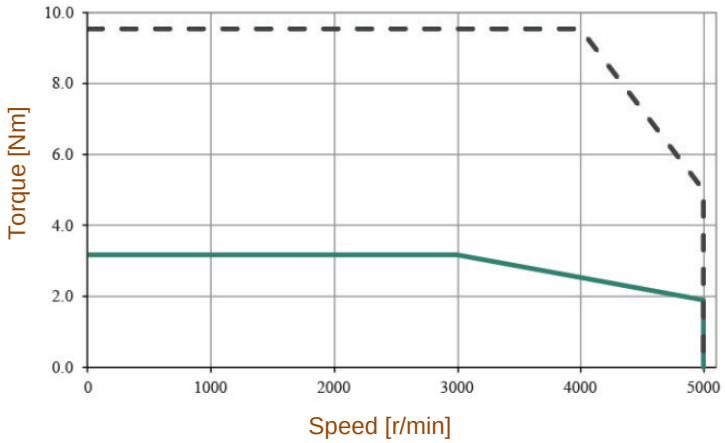



**Figure 4-17 Torque and Speed Curve - PH2 - L10A230**

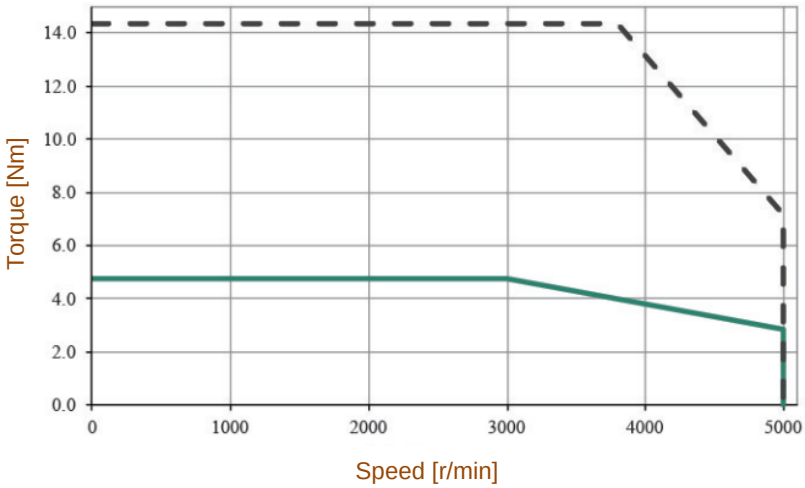



*Figure 4-18 Torque and Speed Curve - PH2 - L10B230*

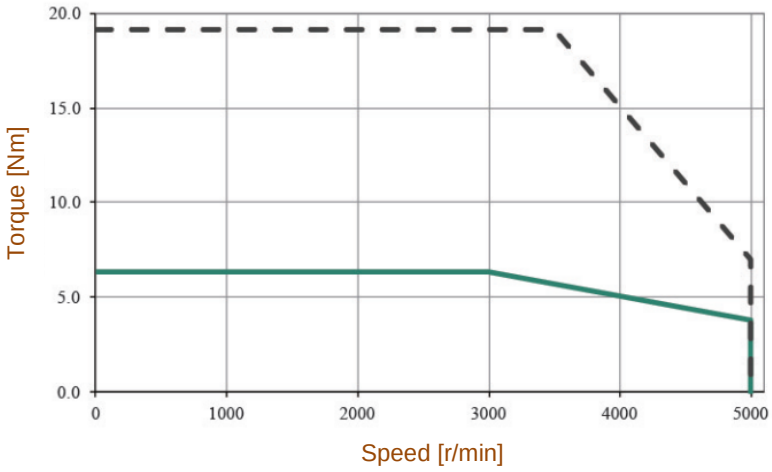
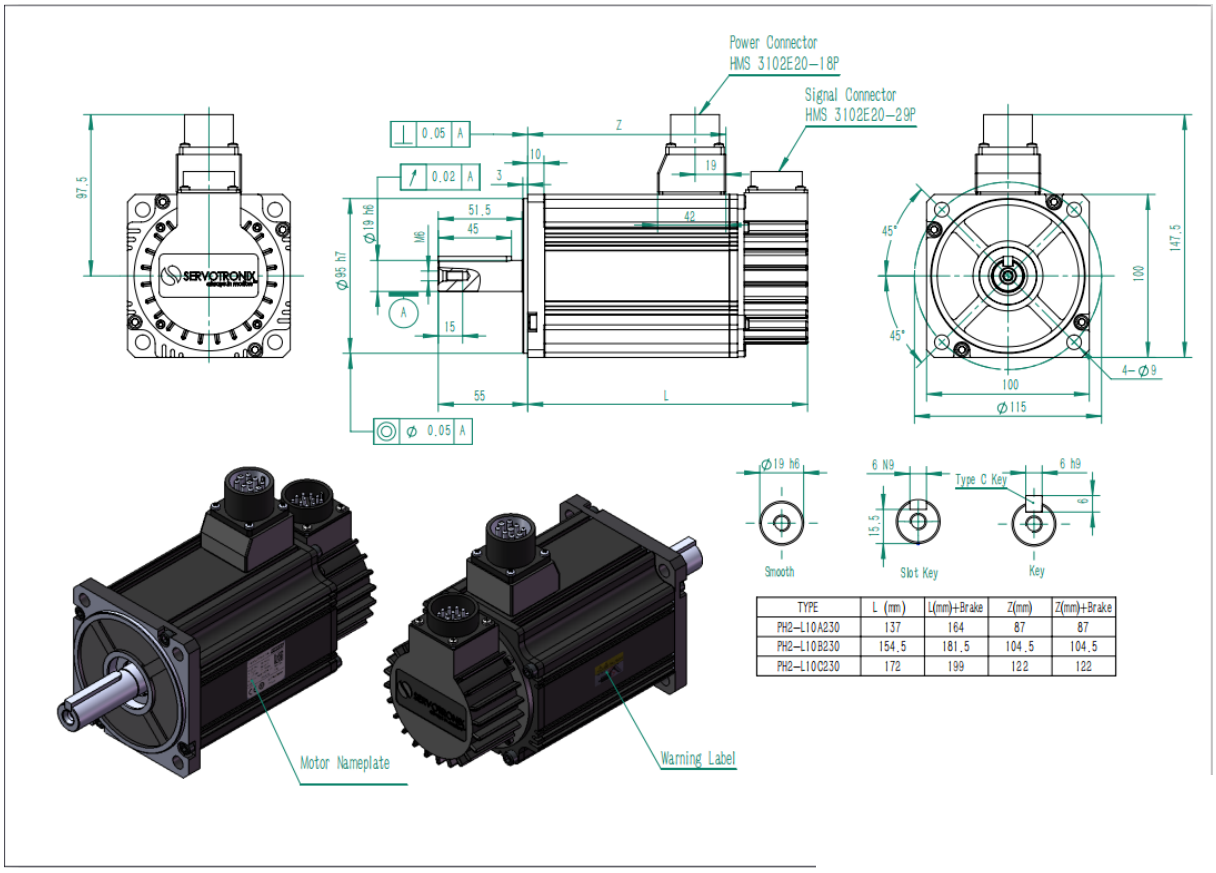



*Figure 4-19 Torque and Speed Curve - PH2 - L10B230*

### 4.5.3 PRHD2 Low Inertia Motor R100 - Dimension Drawing




| TYPE | L (mm) | L(mm)+Brake | Z(mm) | Z(mm)+Brake |
|---|---|---|---|---|
| PH2-L10A230 | 137 | 164 | 87 | 87 |
| PH2-L10B230 | 154.5 | 181.5 | 104.5 | 104.5 |
| PH2-L10C230 | 172 | 199 | 122 | 122 |

*Figure 4-20 Dimension Drawing - PH2 - Low Inertia Motor R100*

## 4.6 PRHD2 Motor R130

### 4.6.1 PRHD2 Medium Inertia Motor R130 - Specifications

**Table 4-9. PRHD2 Medium Inertia Motor R130 - Specifications**

| | | | PH2-M13A215 | PH2-M13B215 | PH2-M13B220 | PH2-M13C220 | PH2-M13D220 |
|---|---|---|---|---|---|---|---|
| Rated Torque | Tn | Nm | 6.37 | 6.37 | 9.55 | 9.55 | 5.39 |
| Peak Torque | Tmax | Nm | 19.1 | 19.1 | 28.65 | 28.65 | 16.17 |
| Rated Speed | ωn | min-1 | 1500 | 1500 | 1500 | 2000 | 2000 |
| Maximum Speed | ωmax | min-1 | 2000 | 2000 | 2000 | 3000 | 3000 |
| Rated Power | Pn | kW | 1 | 1 | 1.5 | 2 | 1.1 |
| Rated Current | In | Arms | 5.6 | 5.6 | 8.7 | 12.7 | 7.5 |
| Maximum Current | Imax | Arms | 16.8 | 16.8 | 26.1 | 38.1 | 21 |
| Rated Winding Voltage | Un | VAC | 220 | 220 | 220 | 220 | 220 |
| Maximum Winding Voltage | Umax | VDC | 340 | 340 | 340 | 340 | 340 |

| | | | PH2-M13A215 | PH2-M13B215 | PH2-M13B220 | PH2-M13C220 | PH2-M13D220 |
|---|---|---|---|---|---|---|---|
| Maximum Ground Voltage | | VAC | 240 | 240 | 240 | 240 | 240 |
| Counter Electromotive Force Constant | Keu-v | Vrms/krpm | 74.5 | 76.5 | 55.2 | 53.8 | 53.5 |
| Torque Coefficient | Kt | N m/Arms | 1.23 | 1.26 | 0.91 | 0.882 | 0.88 |
| Winding Resistance | R20 u-v | Ohm | 0.9 | 0.59 | 0.28 | 0.75 | 0.47 |
| Winding Inductance | Lu-v | mH | 9.9 | 7.1 | 3.6 | 5.65 | 3.7 |
| Rotor Inertia without Brake | Jm | ×10-4 kg•m2 | 8.45 | 12.32 | 12.97 | 12.5 | 18.5 |
| Rotor Inertia with Brake | Jm | ×10-4 kg•m2 | 8.6 | 12.5 | 13.16 | 14.5 | 20.5 |
| No-brake Mass | m | kg | 7.3 | 9.2 | 9.5 | 6.15 | 7.82 |
| Brake Mass | m | kg | 10.1 | 11.5 | 11.9 | 8.81 | 10.44 |
| Thermal Time Constant | | min-1 | 33 | 33 | 32 | 29 | 36 |
| Maximum Radial Shaft Load | | N | 686 | 686 | 686 | 686 | 686 |
| Maximum Axial Shaft Load | | N | 343 | 343 | 343 | 343 | 343 |

### 4.6.2 PRHD2 Medium Inertia Motor R130 - Torque and Speed Curve

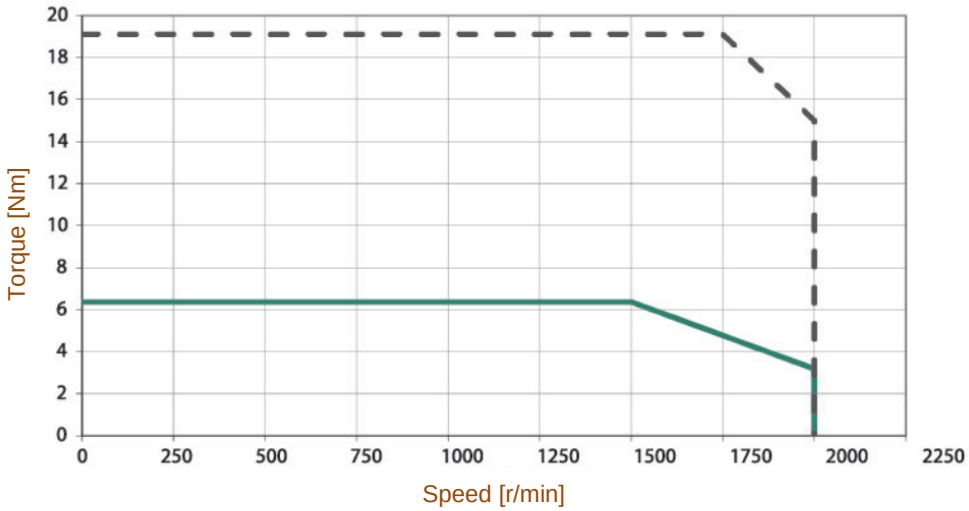



*Figure 4-21 Torque and Speed Curve – PH2 – M13A215*

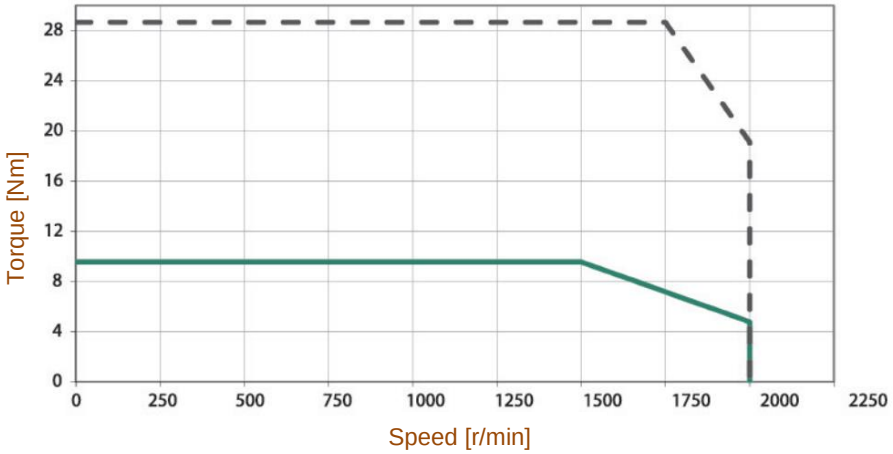



*Figure 4-22 Torque and Speed Curve – PH2 – M13B215*

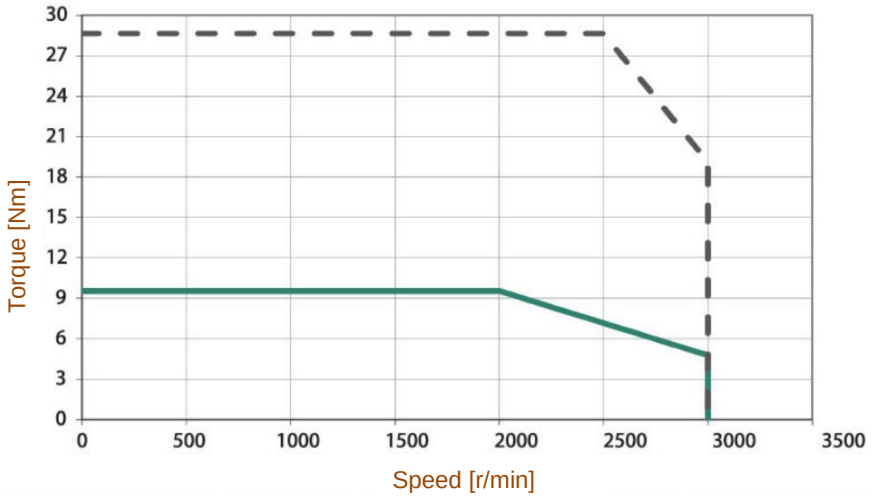



*Figure 4-23 Torque and Speed Curve – PH2 – M13B220*

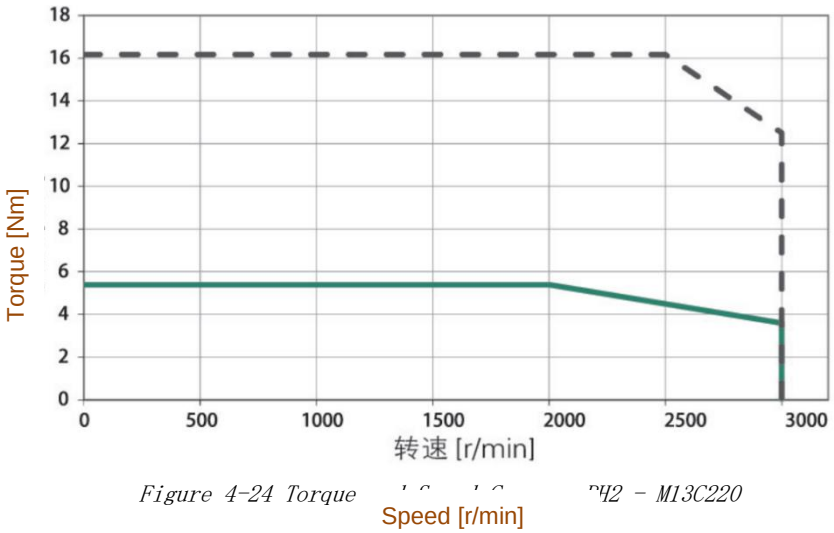



*Figure 4-24 Torque – PH2 – M13C220*

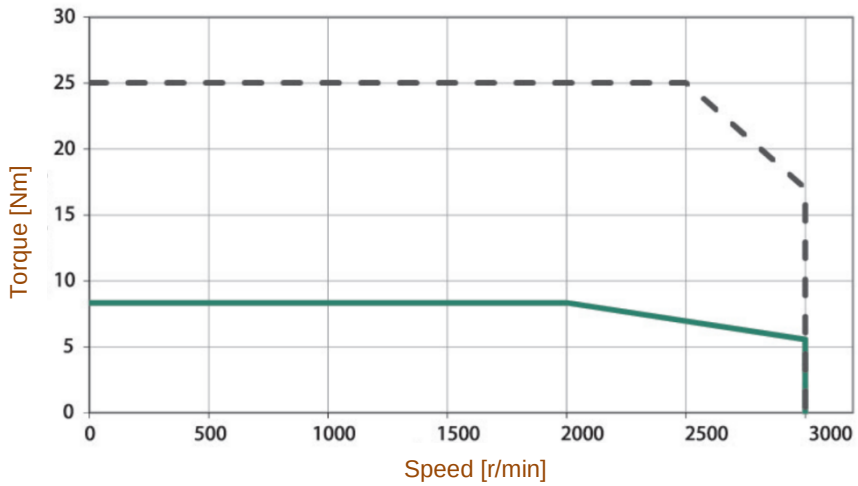
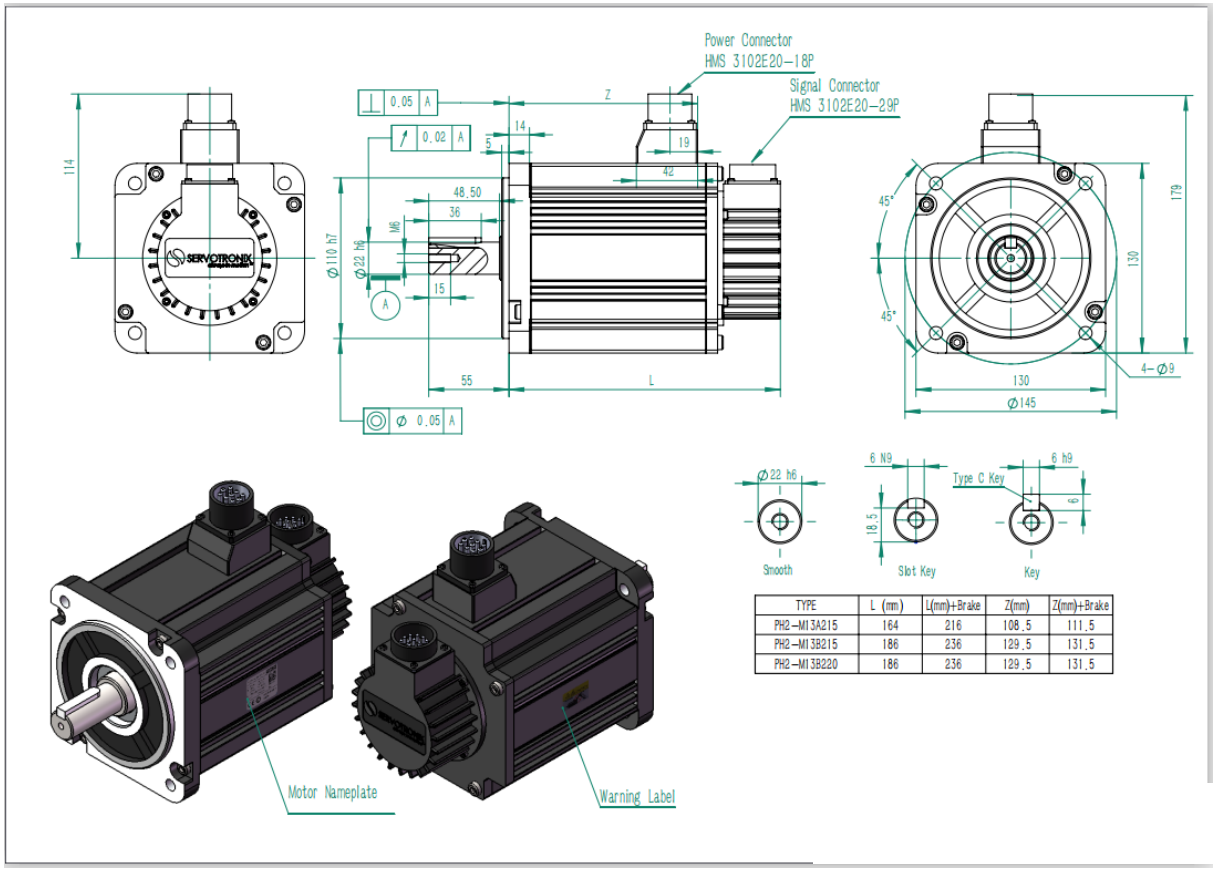


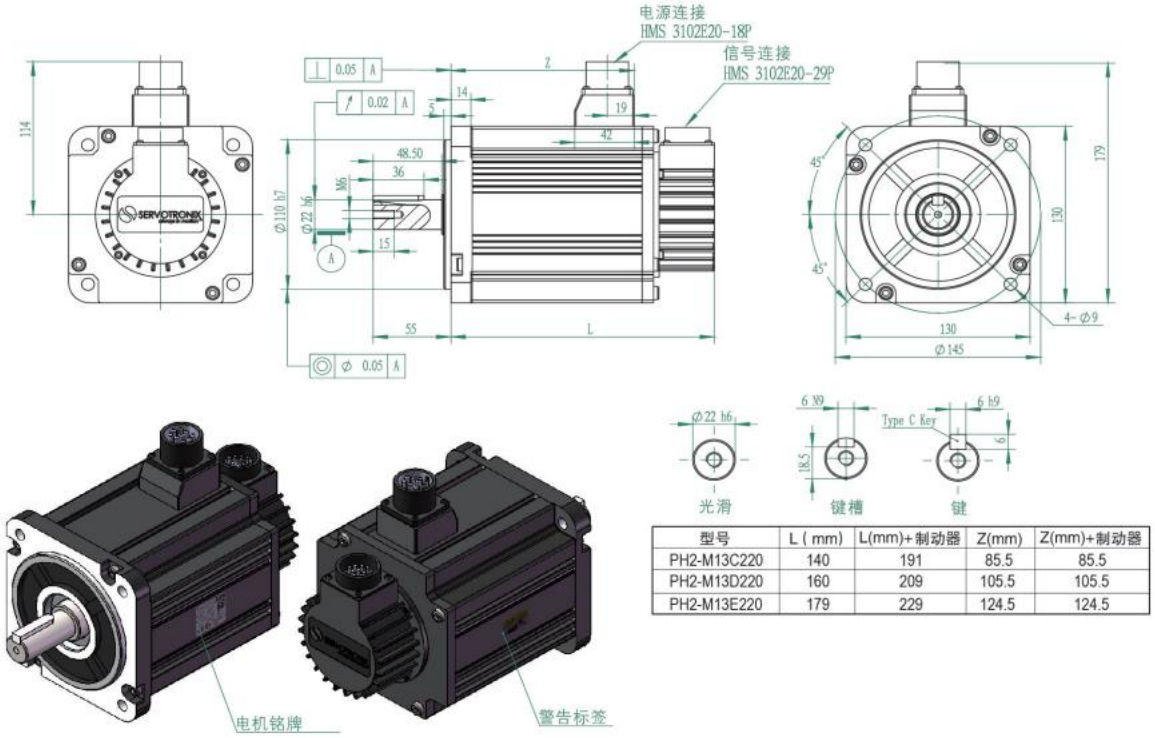

*Figure 4-25 Torque and Speed Curve – PH2 – M13D220*

### 4.6.3 PRHD2 Medium Inertia Motor R130 - Dimension Drawing




| TYPE | L (mm) | L(mm)+Brake | Z(mm) | Z(mm)+Brake |
|---|---|---|---|---|
| PH2-M13A215 | 164 | 216 | 108.5 | 111.5 |
| PH2-M13B215 | 186 | 236 | 129.5 | 131.5 |
| PH2-M13B220 | 186 | 236 | 129.5 | 131.5 |

*Figure 4-26 Dimension Drawing – PH2 – M13A215/ PH2 – M13B215/ PH2 – M13B220*




| 型号 | L ( mm) | L(mm)+制动器 | Z(mm) | Z(mm)+制动器 |
|---|---|---|---|---|
| PH2-M13C220 | 140 | 191 | 85.5 | 85.5 |
| PH2-M13D220 | 160 | 209 | 105.5 | 105.5 |
| PH2-M13E220 | 179 | 229 | 124.5 | 124.5 |

*Figure 4-27 Dimension Drawing – PH2 – M13C220/ PH2 – M13D220*

## 4.7 PRHD2 Brake Specifications

**Table 4-10. PRHD2 Motor Brake Specifications**

| | | PH2-x04 | PH2-x06 | PH2-x08 | PH2-x10 | PH2-x13 |
|---|---|---|---|---|---|---|
| Operating Motor Temperature | ℃ | -20 ~ +120 | -20 ~ +120 | -20 ~ +120 | -20 ~ +120 | -20 ~ +120 |
| Outside Ambient Temperature | ℃ | -20 ~ +40 | -20 ~ +40 | -20 ~ +40 | -20 ~ +40 | -20 ~ +40 |
| Standard Brake Quantity | | Static | Static | Static | Static | Static |
| Minimum Static Friction Torque (@-20 .. 120℃) | Nm | 0.32 | 1.3 | 2.5 | 6.5 | 9.6 |
| Rated Operating Voltage | $V_{DC}$ | 24±10% | 24±10% | 24±10% | 24±10% | 24±10% |
| Power Consumption (@ 20℃) | W | 4.35±7% | 11.2±7% | 10.2±7% | 10.4±7% | 19.7±7% |
| Brake Release Time | ms | 22 | 58 | 46 | 49 | 71 |
| Brake Closing Time (Pull-in) | ms | 77 | 25 | 58 | 30 | 39 |
| Backlash (Maximum) | deg | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |

# 5 Drive Setup

## 5.1 System Wiring Overview

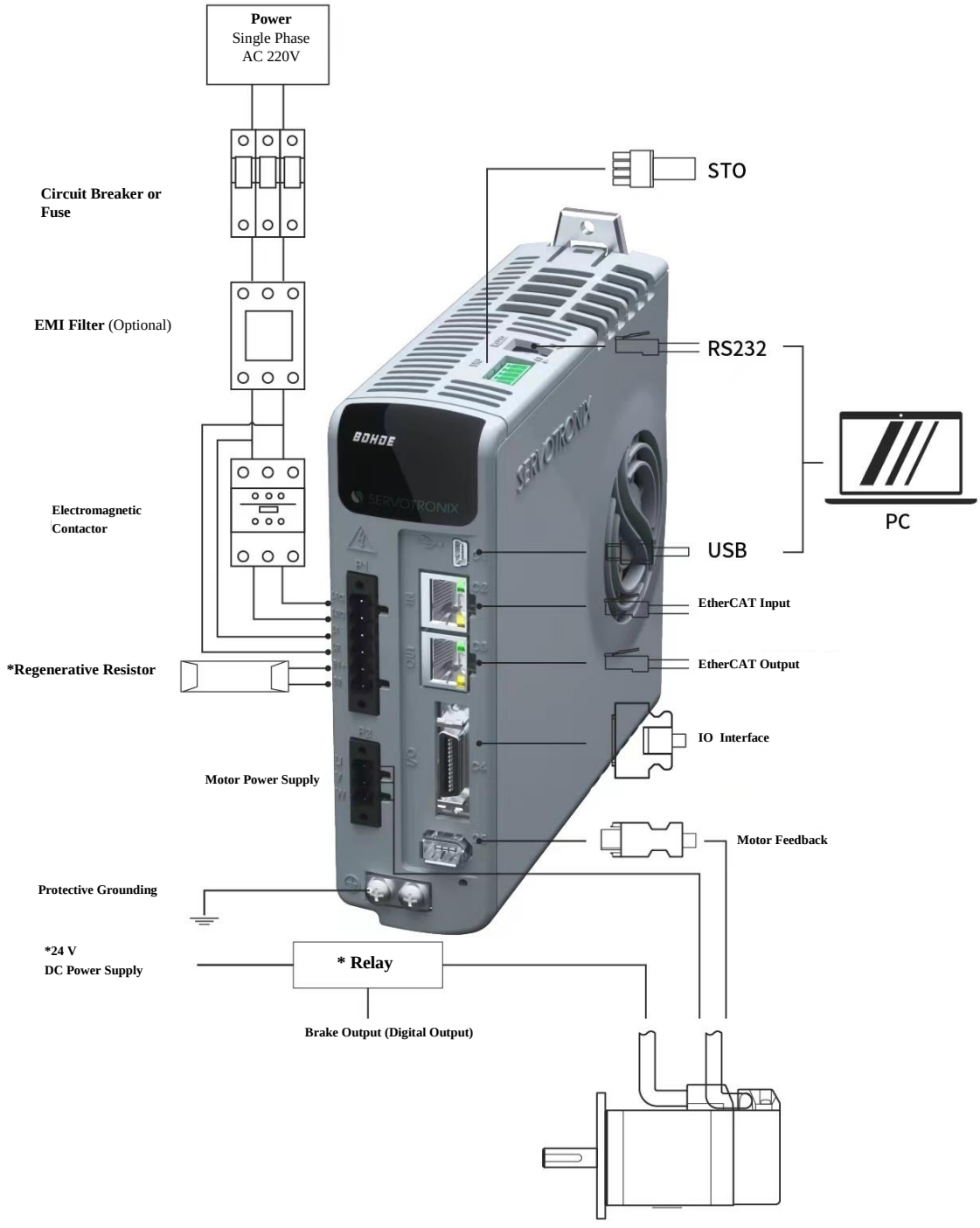



**Figure 5-1. Servo System Wiring**

## 5.2 Setup Procedure Overview

Perform the following steps to install and set up the BDHDE system.

1. Install BDHDE.
2. Make all wiring and cable connections as required by the application:
   - Grounding
   - Fieldbus or Motion Control Equipment
   - I/O
   - Motor Feedback
   - Motor
   - Regeneration Resistors (if Required)
   - Motor Brake (if Required)
   - AC Input Power
3. Connect the drive to the host computer.
4. Turn on the drive and the host power. Refer to the *Powering Up* chapter.
5. Install the ServoStudio2 software. Refer to the ServoStudio2 manual.

## 5.3 Power Up

After all hardware connections have been made, you can power on the drive.

**Notes** If the logic power supply and the power supply are connected separately, it is recommended to turn on the logic power supply before the power supply.

Check the digital display on the front panel of BDHDE.

The digital display shows 8 when power is initially applied.

## 5.4 Drive Addressing

In EtherCAT network, it is not necessary to assign a physical node address (identification number) specifically to the device; EtherCAT controller will do the address assignment.

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

## 5.5 Connectors and Cables

### 5.5.1 Tools and Accessories

No special tools are required for system setup.

Grounding requires M4 ring or spade terminals.

A power board mating connector kit is included with the system.

**Table 5-1. Power Board Mating Connector Kit**

| Manufacturer | Product Model | Manufacturer Part Number |
|---|---|---|
| Wcon Electronics | BDHDE -010/BDHDE-013 | GWD5085-1L00W01 |

### 5.5.2 Control Board Mating Connectors and Cables

**Table 5-2. C1 – USB 2.0A to Mini-B Cable**

**Notes**

USB cable with ferrite core is highly recommended.

Cables supplied by Servotronix have been tested and proven to be reliable.

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| USB2.0A to Mini-B Cable | Length: 1.5m | CBLr0000USBA-00 |
| Shielding | 85% Copper Braid Shield Coverage | |
| Twisted Pair | Essential | |
| Maximum length | 3 m | |
| Wire Gauge | 20–28 AWG | |
| Electromagnetic Interference Filter | 2 ferrite cores, located near each connector | |

**Table 5-3. C2 | C3 – RJ45 Industrial Ethernet/EtherCAT Cat 5e Cable**

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| RJ45 CAT5E Cable | Length: 0.5m<br>Length: 1m<br>Length: 2m<br>Length: 10m | CBLr00400100-00<br>CBLr00400180-00<br>CBLr00400110-00<br>CBLr00400140-00 |
| Shielding | 85% Copper Braid Shield Coverage | |
| Twisted Pair | Essential | |
| Maximum length | 10 m | |
| Wire Gauge | 26-27 AWG | |

**Table 5-4. C4–I/O Mating Connector**

| Manufacturer | Items | Manufacturer Part Number | Servotronix Part Number |
|---|---|---|---|
| 3M | Welding Plug Connector | 10126-3000PE | CONr00000026-31 |
| 3M | Welding Plug Connector Housing | 10326-52F0-008 | HODr00000026-00 |

**Table 5-5. C4-I/O Cable**

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| Lead Cable | Cable 1m, lead | CBL-MDR2-26-01 |
| | Cable 2m, lead | CBL-MDR2-26-02 |
| | Cable 3m, lead | CBL-MDR2-26-03 |
| | Cable 5m, lead | CBL-MDR2-26-05 |
| | Cable 10m, lead | CBL-MDR2-26-10 |

**Table 5-6. C5 - Feedback Mating Connector**

| Manufacturer | Items | Manufacturer Part Number | Servotronix Part Number |
|---|---|---|---|
| 3M | Welding Plug Connector | 3E206-0100KV | CONr10000006-64 |
| 3M | Enclosure kit | 3E306-3200-008 | HODr0003E306-00 |

**Table 5-7 C5 – PRHD2 Motor Feedback Cable**

| Encoder Type | Connector Type | Length | Servotronix Part Number |
|---|---|---|---|
| sensAR S3<br>Tamagawa T1 | D,A | 3m<br>5m<br>10m<br>15m<br>20m | CBL-FBPH21S300D0xx (non-flexible)<br>CBL-FBPH22S300D0xx (flexible)<br>CBL-FBPH21S300A0xx (non-flexible)<br>CBL-FBPH222S300A0xx (flexible) |
| sensAR M3 | D,A | 3m<br>5m<br>10m<br>15m<br>20m | CBL-FBPH21M300D0xx (non-flexible)<br>CBL-FBPH222M300D0xx (flexible)<br>CBL-FBPH21M300A0xx (non-flexible)<br>CBL-FBPH212M300A0xx (flexible) |
| Tamagawa T2, T4 | D,A | 3m<br>5m<br>10m<br>15m<br>20m | CBL-FBPH21T200D0xx (non-flexible)<br>CBL-FBPH22T200D0xx (flexible)<br>CBL-FBPH21T200A0xx (non-flexible)<br>CBL-FBPH22T200A0xx (flexible) |

**Notes**

Note 1: sensAR multi-turn encoder (M3) requires specified M3 cable (including battery box) and S3 cable (version D or A; order according to your system).

Encoder Type
S3:SensAR single-turn absolute encoder 17-bit
M3:SensAR multi-turn absolute encoder 17-bit
T1: Tamagawa single-turn absolute encoder 17-bit
T2: Tamagawa multi-turn absolute encoder 17-bit
T4: Tamagawa multi-turn absolute encoder 23-bit

Connector Type
D: 300mm cable with AMP connector for flange size: 04.06.08
A: MIL connector (aviation plug), for flange size: 10, 13

### 5.5.3 Power Board Mating Connectors and Cables

**Notes** The power board mating connector is supplied with the drive.

**Table 5-8 P1 - Power Mating Connector**

| Manufacturer | Product Model | Manufacturer Part Number |
|---|---|---|
| 宁波高松 | BDHDE -003/BDHDE-006 | 2EDGKCM-5.08-06P-13-15A(H) |
| 宁波高松 | BDHDE -010/BDHDE-013 | 9EDGK-7.5-07P-13-1022A(H) |

**Table 5-9. P2 - Motor Mating Connector**

| Manufacturer | Product Model | Manufacturer Part Number |
|---|---|---|
| 宁波高松 | BDHDE -003/BDHDE-006 | 2EDGKCM-5.08-03P-13-14A(H) |
| 宁波高松 | BDHDE -010/BDHDE-013 | 9EDGK-7.5-03P-13-1004A(H) |

**Table 5-10. P2 – Cable for** PRHD2 **Motor**

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| Motor Cable (lead) for PRHD2 Motor | 3m<br>5m<br>10m<br>15m<br>20m | CBL-PWPH21000yD0xx (non-flexible)<br>CBL-PWPH22000yD0xx (flexible)<br>CBL-PWPH21000yA0xx (non-flexible)<br>CBL-PWPH22000yA0xx (flexible)<br><br>xx: length<br>Y:1: with brake, 0: without brake<br>D: AMP connector<br>A: MIL connector |

### 5.5.4 Line Filters

Manufacturers and part number of the line filter recommended for BDHDE are listed in the table below.

| Table 5-11 Recommended Line Filters for BDHDE**Drive** | **Manufacturer Part Number** |
|---|---|
| BDHDE-003-2A | LCR: 055M.80601.00 |
| | LCR: 092.00623.00 |

| Table 5-11 Recommended Line Filters for BDHDE**Drive** | **Manufacturer Part Number** |
|---|---|
| | Schaffner: FN2070-6 |
| BDHDE-006-2A | LCR: 0923.01021.00 |
| | LCR: 092.01023.00 |
| | LCR: 055.81011.00 |
| | Schaffner: FN2070-10 |

### 5.5.5 Regeneration Resistors

The resistance value (Ω,Ω) is defined by the BDHDE servo drive, and the required power is determined by the application condition. Therefore, each drive has several options for regeneration resistors.

Manufacturers and part numbers of regeneration resistors recommended for BDHDE are listed in the table below. See Regeneration.

*Table 5-12 Recommended Regeneration Resistors for BDHDE*

| **Drive** | **Power (W)** | Resistance | **Manufacturer Part Number** |
|---|---|---|---|
| BDHDE-003-2A<br>BDHDE-006-2A | 150 | 40Ω | IsoTek：ULH150 N 40 K FL500 |
| | 300 | | IsoTek：ULH300 N 40 K FL500 |
| | 600 | | Frizlen：FZECU400x65-40 |
| | 1000 | | IsoTek：ULV1000 N 40 K FL500 |
| BDHDE-010-2A<br>BDHDE-013-2A | 150 | 33 | ISOTEK：ULH150 N 33 K FL500 |
| | 300 | 33 | ISOTEK：ULH300 N 33 K FL500 |
| | 600 | 33 | FRIZLEN：FZECU400x65-33 |
| | 1000 | 33 | ISOTEK：ULV1000 N 33 K FL50 |

## 5.6 Host Computer System

The following computer systems and software are required:

- 2 GHz CPU
- 1 GB RAM
- 1000 MB of free space on hard drive (after installation of .net 4)
- A USB interface for communication with the drive
- Operating system: Windows 7, Windows 8, Windows 10, 32-bit or 64-bit.
- For ServoStudio2, the recommended screen resolution is 1280×800;
  the minimum resolution is 1024×800.
  It is recommended to set the Windows monitor to smaller -100% (default).
- . Net4 (see. NET framework system requirements for details). If. NET 4 is not installed on the computer, ServoStudio2 will guide you through the installation, but not automatically.
- ServoStudio2 is used to configure and test the graphical software interface of the drive.
- Download from Servotronix website or contact technical support.
  See *Software Installation* in ServoStudio2 manual.

**Note s** ServoStudio2 provides compatibility with BDHDE firmware version 2.0 and higher.

**Installing ServoStudio2**

1. Download the ServerStudio2 software installation file (version number 2.18.5.11 and later) from the Servotronix website or contact technical support.
2. Install software on the host.
3. After installation, start ServoStudio2 from the Windows Start menu or a shortcut on the desktop.

**Notes**

If an error appears when installing the software and the system cannot find the specified file, do the following:

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

## 5.7 File for Fieldbus Devices

The XML EtherCAT device description file for BDHDE must be installed on the host or PLC controller. Download the file from the Servotronix website or contact technical support.

## 5.8 EMI Suppression

### 5.8.1 CE Filtering Techniques

BDHDE drive conforms to CE standard specified in *Standards Compliance*. Proper shielding, grounding and filtering techniques must be adopted to reach this standard.

Noise currents are usually of two types: the first is conducted noise drain through the ground loop, the quality of system grounding scheme is inversely proportional to the amplitude of line noise, and these conducted emission have common model from line to neutral point (or ground); the second is radiated high-frequency noise drain, usually line-to-line capacitive coupling, and is specific in nature.

To properly mount an EMI filter, the enclosure should have an unpainted metal surface so that more surface area is in contact with it, and this will provide a lower impedance path between that enclosure and the backplate; in turn, the backplate is connected by a high-frequency ground bus that connects to the housing or to ground.

### 5.8.2 Grounding



When connecting BDHDE to other control devices, make sure to follow two basic guidelines to prevent damage to the drive:

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

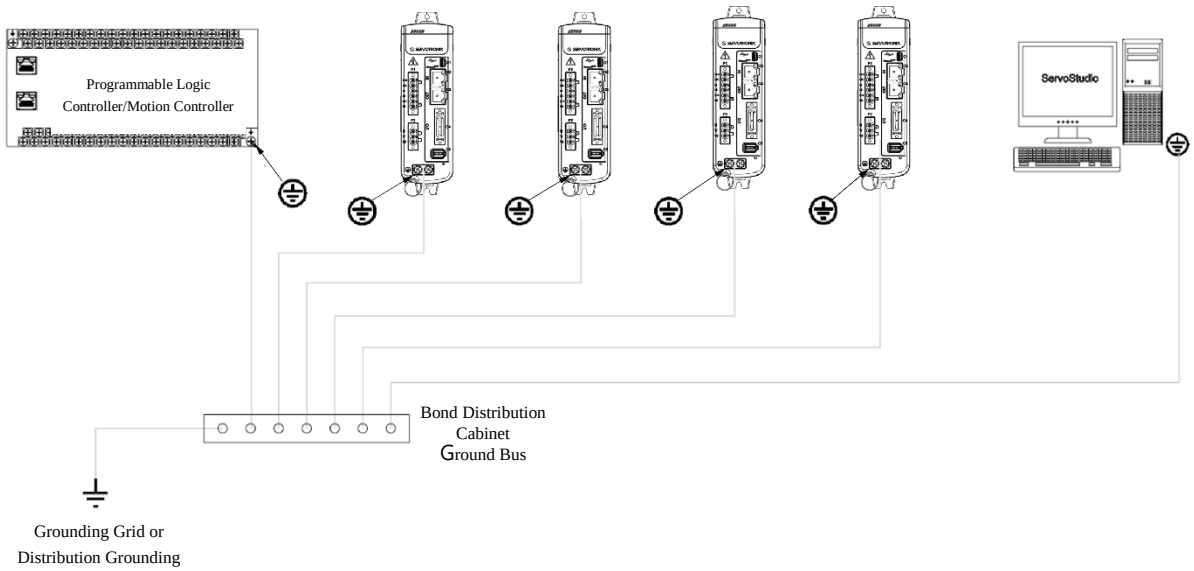



**Figure 5-2**. **BDHDE System Grounding**

System grounding is critical to the proper operation of the drive system.

The AC input power ground wire must be connected to the PE terminal located on the front panel of BDHDE for safety and to reduce electromagnetic interference.

The system uses a single point grounding to avoid grounding loops.

It is highly recommended that the BDHDE be mounted on a metal backplate and that a high frequency ground be provided to ground the backplate. Electric connections are provided across the entire back of the drive panel. The use of conductive plates, such as aluminum or galvanized steel, is recommended. For painted and other coated metal panels, remove all coatings from the back of the drive. The goal is to provide a very low impedance path between the filter, drive, power supply and ground for high frequency signals that may cause electromagnetic interference. High frequency grounding is achieved using flat braided wire or copper bus. When connecting high frequency grounding, use the shortest braided wire possible.

Ensure good connection between cabinet components: use multiple conductive braided wires to connect the back panel and cabinet door to the cabinet main body; never rely on hinges or mounting bolts for grounding connections. Make sure that the cabinet is well grounded to a proper grounding system. The grounding lead should be the same size as or one size smaller than the main power lead.

The host must also be properly grounded.

### 5.8.3 Shielding and Bonding

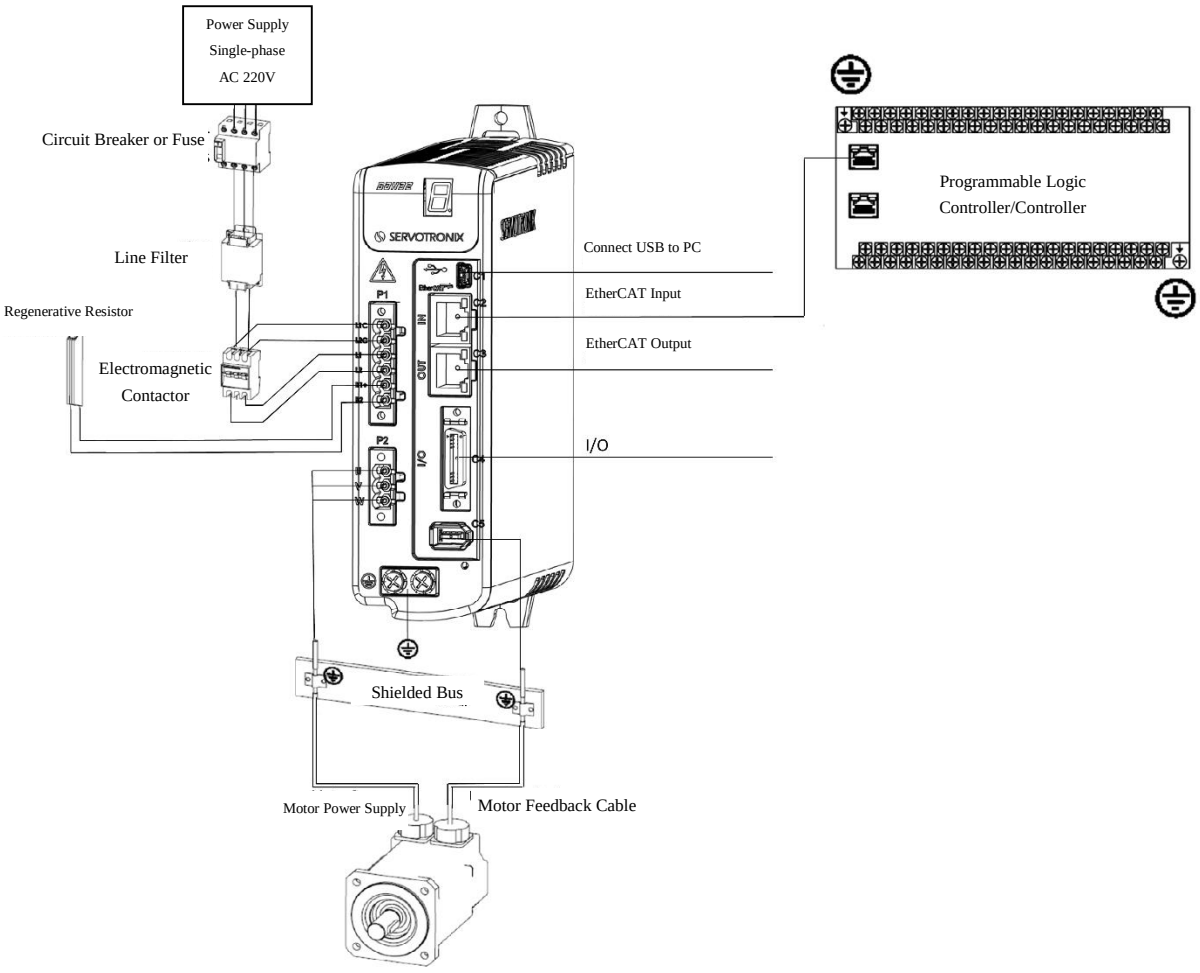



**Figure 5-3**. **BDHDE Shielding and Bonding**

In order to minimize the noise drain and maximize the immunity of the drive system, the motor and feedback cables must be shielded and properly connected to a grounded surface.

The shield 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 all shielded cables be bonded to the rear panel.

The motor and feedback shielding cables should be as close to the drive as possible. Use non-insulated metal cable clips or cable bonding clips to bond this exposed cable shield to the rear panel.

It is recommended to use shielded bus for star shield connection.

### 5.8.4 Input Power Filtering

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

Care must be taken to properly calibrate the system specifications. The type of filter is determined by the rated voltage and current values of the system and whether the input line is single-phase or three-phase. One input line filter can be used for multi-axis control applications.

See *Line Filters* for manufacturer names and part numbers of line filters recommended by BDHDE.

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

- The filter keeps the wires in and out of the power filter separate.
- The filter must be mounted on the same panel as the drive.
- The filter must be installed as close to the drive as possible to prevent noise when the capacitor is coupled to other signal lines and cables.
- When installing the filter on the panel, remove any paint or coating material. Use an unpainted metal backplate if possible.
- The filter is equipped with a ground terminal and must be grounded.
- The filter can generate high leakage currents. The filter must be grounded before connecting the power supply.
- The filter should not be touched 10 seconds after removing the power supply.

### 5.8.5 Additional EMI Suppression Recommendations

Power and control cables should be routed separately with a recommended distance of at least 200mm to improve immunity to interference.

If the input power and wires have to be crossed over each other, make sure a 90 °angle is used.

Avoid using bonded extensions for feedback lines since this can cause shielding interruptions and may interfere with signal processing.

Normal cable connection: if you need to tap the cable, use a connector with a metal backshell, making sure the two housings are connected along the perimeter of the sheath; no part of the wiring should be unshielded, and no cables should be tapped through the terminal strip.

## 5.9 Electrical System Considerations

### 5.9.1 Fuses

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

- US fuse: RK5, CC, J or T type, AC 600 V 200 kA, time delay. It must be UL and CSA certified; UR approval alone is not enough.
- EU fuse: gRL or gL type, 400 V/500 V, time delay.
- Fuse holder: standard fuse holder, or finger-safe fuse holder in accordance with IEC 60529 fuse standard. For example:
  - Bussmann: CH series modular fuse holder, fuse specification below 30A, J type J, 3-pole: CH30J3.
  - Ferraz: Ultrasonic fuse, fuse specification below 30A, J type, 3-pole: US3J3I.

### 5.9.2 Leakage Current Considerations

PE conductor leakage current comes from a combination of equipment and cable leakage current. The leakage current frequency mode includes multiple frequencies from which the residual current circuit breaker is ultimately estimated as a 50Hz current. Therefore, the leakage current cannot be measured by the traditional multimeter.

Empirically, depending on the PWM frequency of the output stage, the following assumptions can be made about the leakage current on the cable:

- *Ileak = n x 20 mA+L x 1 mA/m*, output stage 8 kHz PWM frequency

- *Ileak = n x 20 mA+L x 2 mA/m*, output stage 16 kHz PWM frequency

  (where Ileak = leakage current, n = number of drives, L = motor cable length)

Since the leakage current of PE is greater than 3.5 mA, it meets the requirements of IEC 61800-5-1 standard for doubling PE connections or using connection cables with a cross-sectional area greater than 10 mm². This requirement can be met by using PE terminals and PE connection screws.

## 5.10 Mechanical Installation

### 5.10.1 Mounting BDHDE

Use the bracket on the back of BDHDE to mount BDHDE on a grounded conductive metal panel, which must be strong enough.

For mounting dimensions, see *External Dimensions*.

### 5.10.2 Mounting Multiple Units

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

It is important to keep the ambient temperature in the enclosure no more than 45℃. If the BDHDE unit is mounted on the backplate, make sure that the backplate temperature does not exceed 45℃. It is recommended to install a cooling fan at the bottom of the cabinet for optimal circulation.

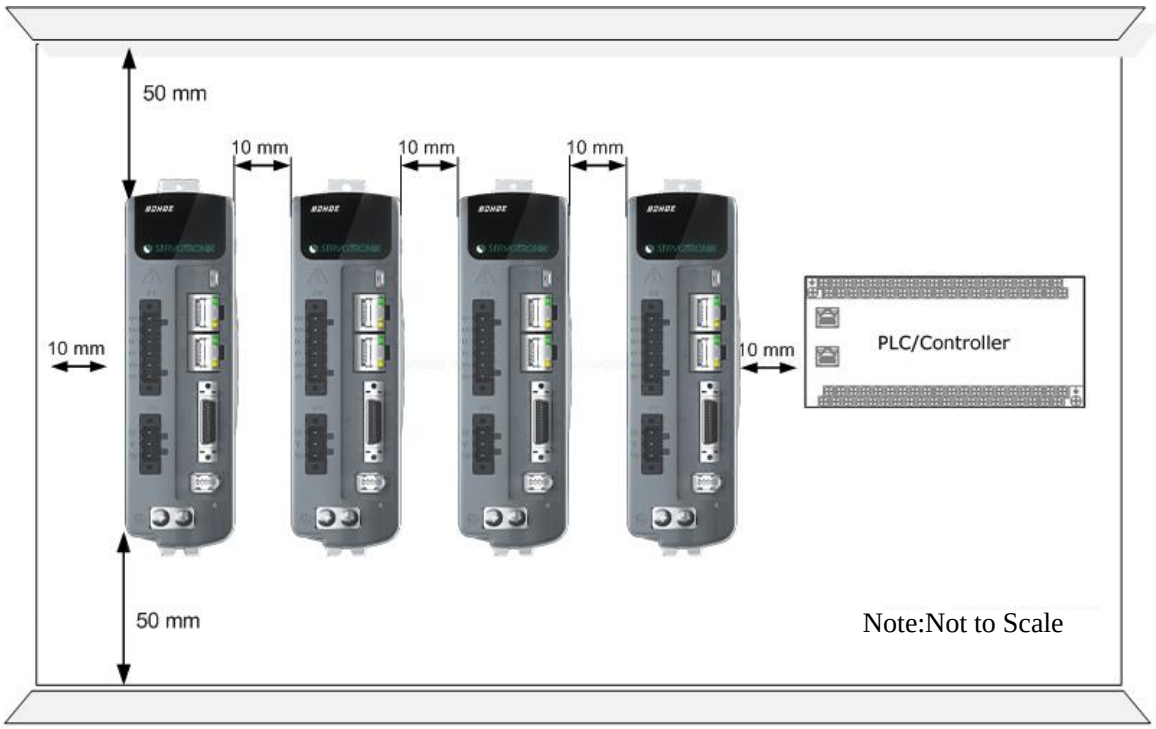



**Figure 5-4. Installing Multiple BDHDE Units in the Cabinet**

## 5.11 Control Board Connections

### 5.11.1 BDHDE Control Board Pinouts

**BDHDE-EC Drive**




| C7 Pin# | Function | C7 Pin# | Function |
|---|---|---|---|
| 1 | RxD Receive Data | 3 | TxD Send Dta |
| 2 | GND | | |

| C6 Pin# | Function | C6 Pin# | Function |
|---|---|---|---|
| 1 | 12V (No external power supply) | 4 | COM |
| 2 | STO1 | 5 | GND |
| 3 | STO2 | | |

| C1:USB Mini-B | |
|---|---|
| 1 | 5V |
| 2 | Data |
| 3 | Data + |
| 4 | |
| 5 | GND |

| C2/C3:RJ-45 | |
|---|---|
| 1 | TX+ |
| 2 | TX− |
| 3 | RX+ |
| 4 | |
| 5 | |
| 6 | RX− |
| 7 | |
| 8 | |

| C4:MDR 26 Plug \| 24-28 AWG | | | |
|---|---|---|---|
| 1 | Common Input | 14 | Fast Digital Input 1 |
| 2 | Fast Digital Input 2 | 15 | Digital Input 3 |
| 3 | Digital Input 4 | 16 | Digital Input 5 |
| 4 | Common Output | 17 | Digital Output 1 |
| 5 | Digital Output 2 | 18 | Digital Output 3 |
| 6 | Digital Output 4 | 19 | Reserve |
| 7 | Equivalent Encoder Output B+ | 20 | Equivalent Encoder Output A+ |
| 8 | Digital Input 6 | 21 | Reserve |
| 9 | Equivalent Encoder Output B- | 22 | Equivalent Encoder Output A- |
| 10 | Equivalent Encoder Output Z+ | 23 | GND |
| 11 | Pulse Input Output- | 24 | Digital Output 7 |
| 12 | Equivalent Encoder Output Z- | 25 | Direction Signal Input- |
| 13 | Pulse Signal Input+ | 26 | Direction Signal Input+ |

| C5:1394 \| 24-28 AWG | | | |
|---|---|---|---|
| 1 | 5V | 4 | |
| 2 | GND | 5 | Data+ |
| 3 | | 6 | Data- |

*Figure 5-5 Pin Assignment of BDHDE-EC Default Control*

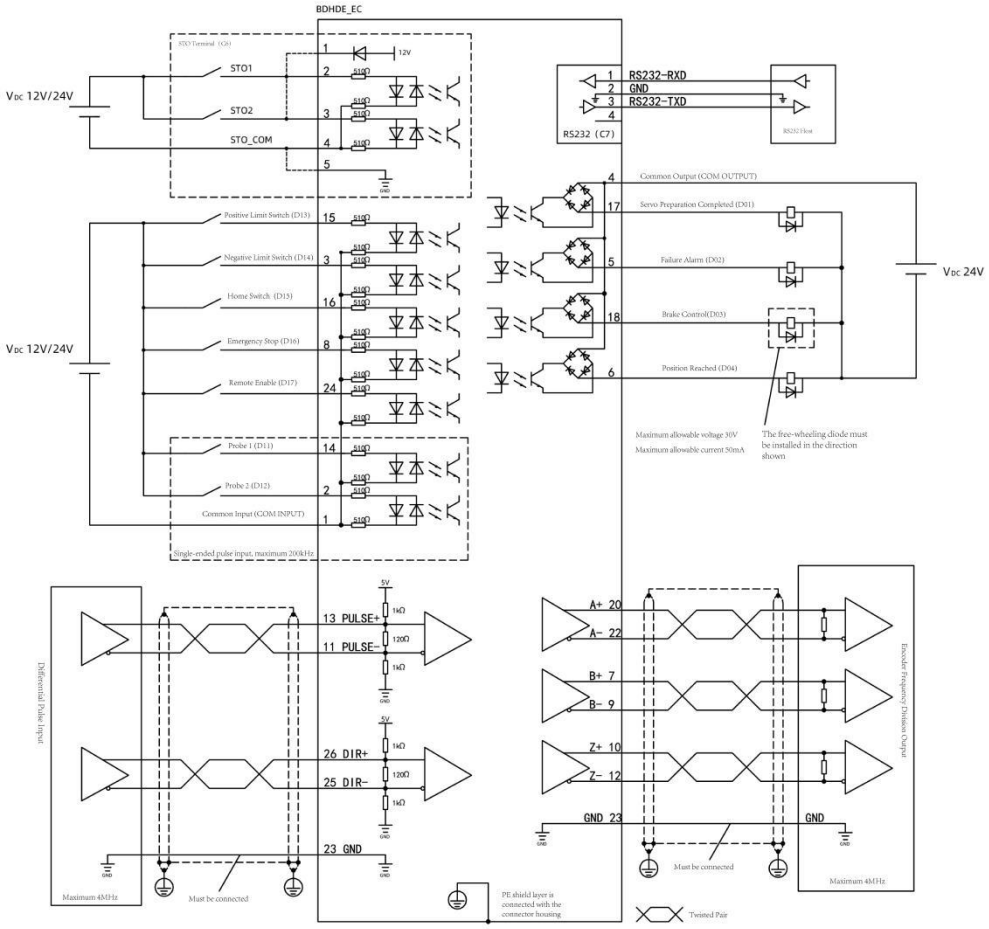



*Figure 5-6 BDHDE-EC Default IO Wiring Diagram*

**Notes:**

**1. The brake coil has no polarity.**

**2. The power supply for the brake is prepared by the customer. In addition, do not share the same power supply for the brake and the control signal power ($V_{DC}$).**

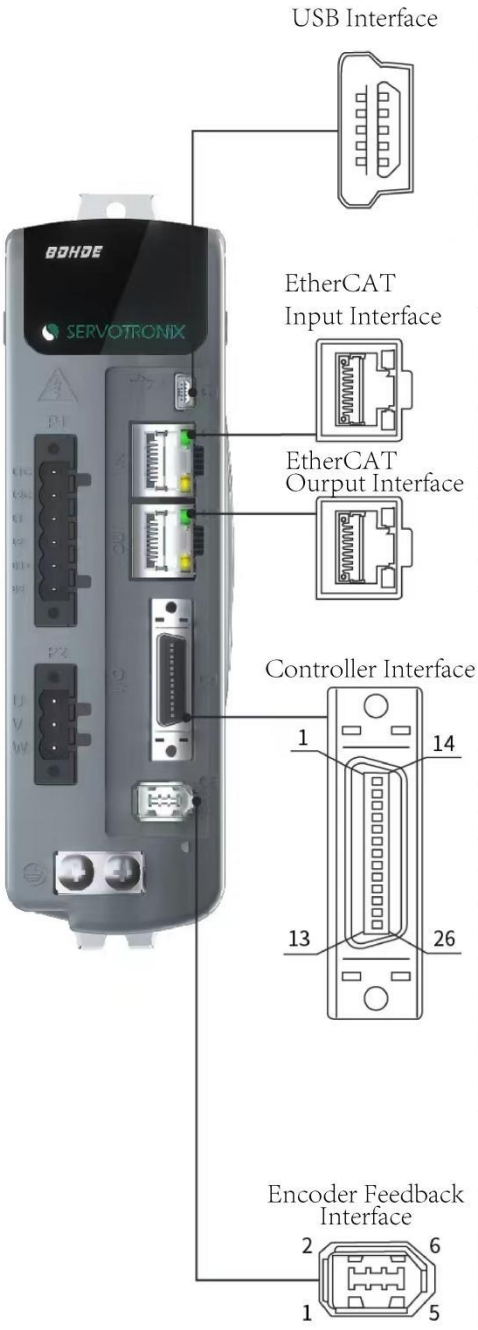
**3. Do not apply voltage above 24V and current above 50mA to the control signal output terminal.**

**4. When the output control signal drives the relays directly, lay the relays side by side and install the diode as shown in the figure; damage to the drive will occur if the diode is not installed or installed backwards.**

**5. It is recommended to use MY2N-D2_GSDC24V/ MY2N-D2-DSDC12V or other relays with internal free-wheeling diode. Or to put FR102/ FR103 or other fast recovery diodes with a voltage withstand of 70V and an overcurrent capacity greater than 1A in parallel at both ends of relay coils.**

**6. The STO12V power supply is for STO circuit use only and cannot be used for other purposes.**

## BDHDE-EB Drive




| C1:USB Mini-B | |
|---|---|
| 1 | 5V |
| 2 | Data |
| 3 | Data+ |
| 4 | |
| 5 | GND |

| C2/C3:RJ-45 | |
|---|---|
| 1 | TX+ |
| 2 | TX− |
| 3 | RX+ |
| 4 | |
| 5 | |
| 6 | RX− |
| 7 | |
| 8 | |

| C4:MDR 26 Plug \| 24-28 AWG | | | |
|---|---|---|---|
| 1 | Common Input | 14 | Fast Digital Input 1 |
| 2 | Fast Digital Input 2 | 15 | Digital Input 3 |
| 3 | Digital Input 4 | 16 | Digital Input 5 |
| 4 | Common Output | 17 | Digital Output 1 |
| 5 | Digital Output 2 | 18 | Digital Output 3 |
| 6 | | 19 | |
| 7 | | 20 | |
| 8 | | 21 | |
| 9 | | 22 | |
| 10 | | 23 | |
| 11 | | 24 | |
| 12 | | 25 | |
| 13 | | 26 | |

| C5:1394 \| 24-28 AWG | | | |
|---|---|---|---|
| 1 | 5V | 4 | |
| 2 | GND | 5 | Data+ |
| 3 | | 6 | Data- |

**Figure 5-5. Pin Assignment of BDHDE-AP Control Board**

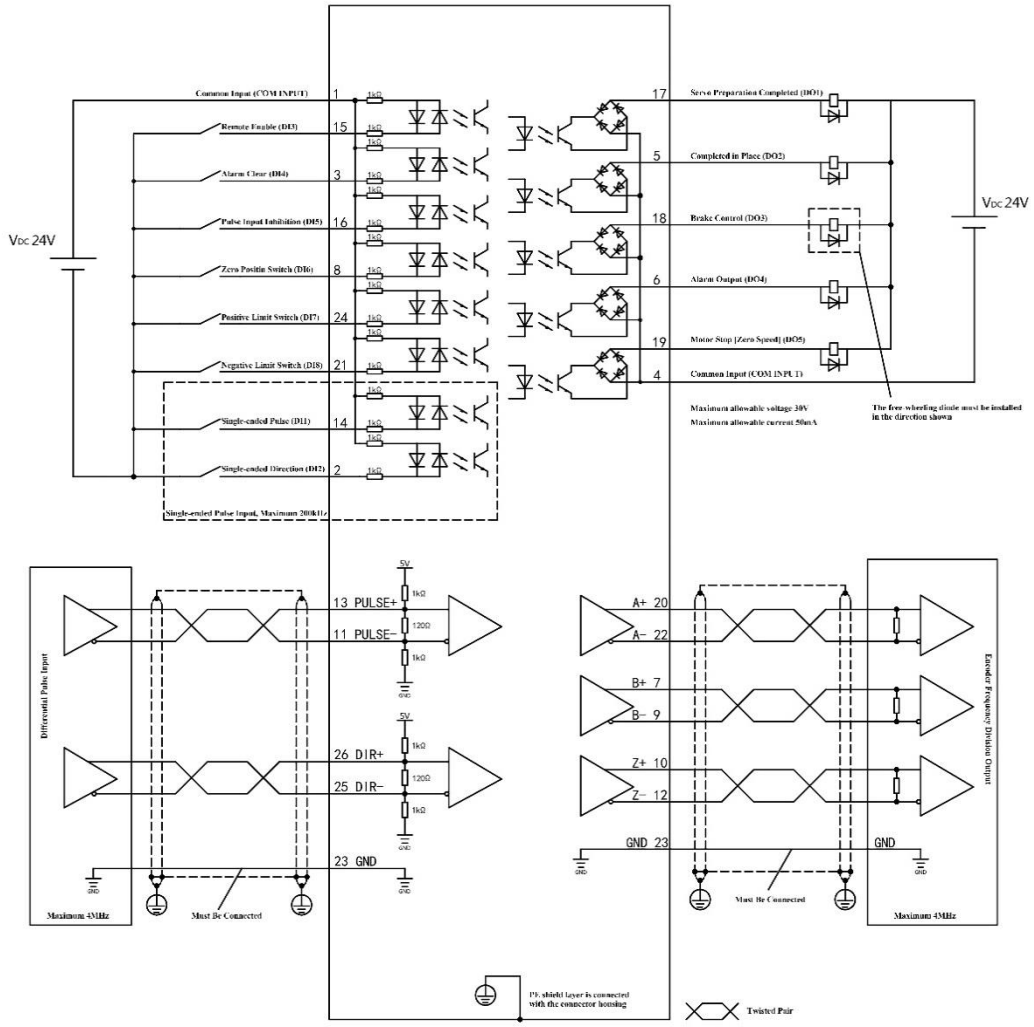



**Figure 5-6. BDHDE-AP Default IO Wiring Diagram**

**Notes:**

**1. The brake coil has no polarity.**

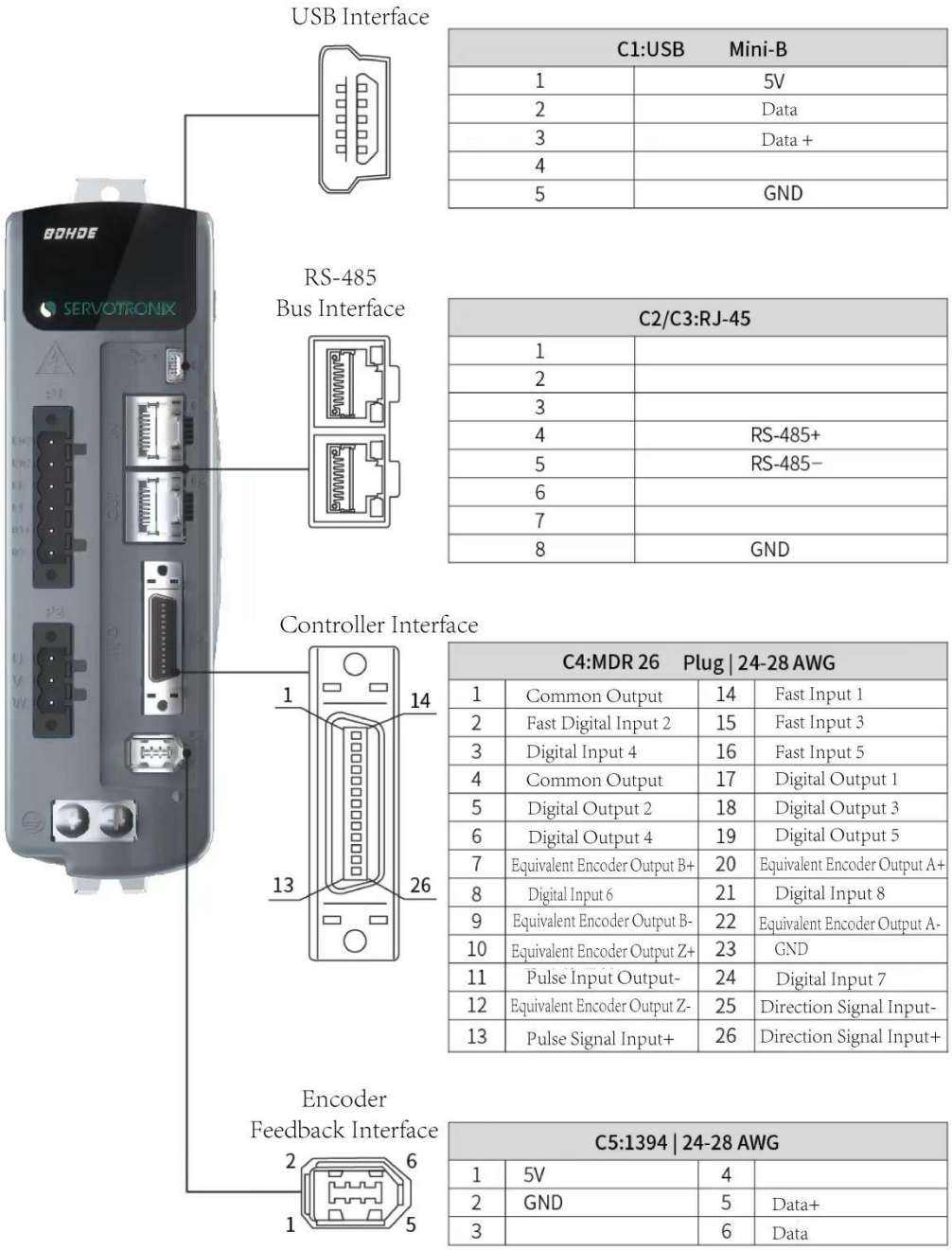
**2. The power supply for the brake is prepared by the customer. In addition, do not share the same power supply for the brake and the control signal power (VDC).**

**3. Do not apply voltage above 24V and current above 50mA to the control signal output terminal.**

**4. When the output control signal drives the relays directly, lay the relays side by side and install the diode as shown in the figure; damage to the drive will occur if the diode is not installed or installed backwards.**

**5. It is recommended to use MY2N-D2_GSDC24V/ MY2N-D2-DSDC12V or other relays with internal free-wheeling diode. Or to put FR102/ FR103 or other fast recovery diodes with a voltage withstand of 70V and an overcurrent capacity greater than 1A in parallel at both ends of relay coils.**

## BDHDE-AP Drive




| C1:USB Mini-B | |
|---|---|
| 1 | 5V |
| 2 | Data |
| 3 | Data + |
| 4 | |
| 5 | GND |

| C2/C3:RJ-45 | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | RS-485+ |
| 5 | RS-485− |
| 6 | |
| 7 | |
| 8 | GND |

| C4:MDR 26 Plug \| 24-28 AWG | | | |
|---|---|---|---|
| 1 | Common Output | 14 | Fast Input 1 |
| 2 | Fast Digital Input 2 | 15 | Fast Input 3 |
| 3 | Digital Input 4 | 16 | Fast Input 5 |
| 4 | Common Output | 17 | Digital Output 1 |
| 5 | Digital Output 2 | 18 | Digital Output 3 |
| 6 | Digital Output 4 | 19 | Digital Output 5 |
| 7 | Equivalent Encoder Output B+ | 20 | Equivalent Encoder Output A+ |
| 8 | Digital Input 6 | 21 | Digital Input 8 |
| 9 | Equivalent Encoder Output B- | 22 | Equivalent Encoder Output A- |
| 10 | Equivalent Encoder Output Z+ | 23 | GND |
| 11 | Pulse Input Output- | 24 | Digital Input 7 |
| 12 | Equivalent Encoder Output Z- | 25 | Direction Signal Input- |
| 13 | Pulse Signal Input+ | 26 | Direction Signal Input+ |

| C5:1394 \| 24-28 AWG | | | |
|---|---|---|---|
| 1 | 5V | 4 | |
| 2 | GND | 5 | Data+ |
| 3 | | 6 | Data |

**Figure 5-9. Pin Assignment of BDHDE-AP Control Board**

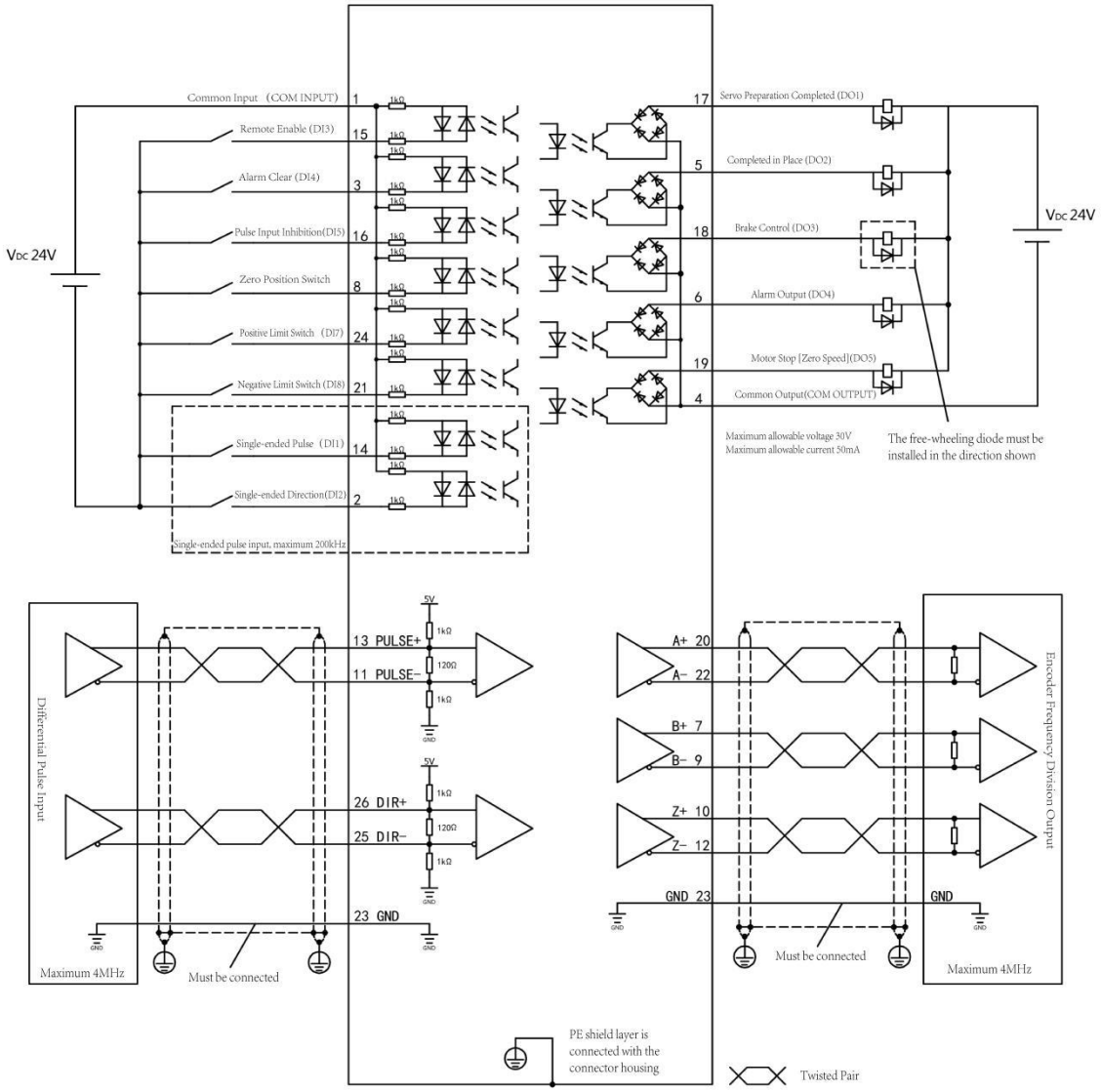



*Figure 5-10 BDHDE-AP Default IO Wiring Diagram*

**Notes:**

**1. The brake coil has no polarity.**

**2. The power supply for the brake is prepared by the customer. In addition, do not share the same power supply for the brake and the control signal power (VDC).**

**3. Do not apply voltage above 24V and current above 50mA to the control signal output terminal.**

**4. When the output control signal drives the relays directly, lay the relays side by side and install the diode as shown in the figure; damage to the drive will occur if the diode is not installed or installed backwards.**

**5. It is recommended to use MY2N-D2_GSDC24V/ MY2N-D2-DSDC12V or other relays with internal free-wheeling diode. Or to put FR102/ FR103 or other fast recovery diodes with a voltage withstand of 70V and an overcurrent capacity greater than 1A in parallel at both ends of relay coils.**

### 5.11.2 USB Serial Communication - C1

When debugging, the drive can be connected to the host through interface C1(USB port). It is highly recommended that you use the USB cable provided by Servotronix, which has been tested and verified for reliability.

See *Host Computer System*.

**Notes** The USB driver is digitally signed.

### 5.11.3 EtherCAT Communication/RS-485 Communication - C2 and C3

Interfaces C2 and C3 are RJ45 ports, which are used in the EB type as the transmitter and the receiver for the drive running on EtherCAT network, and in AP type on RS-485 network .

The LEDs (EB type) on the interfaces C2 and C3 display the state of the fieldbus. Please refer to the fieldbus state LED.

For more information on the installation, configuration and operation of the drives used on the EtherCAT network, refer to the BDHDE EtherCAT Reference Manual.

For more information on the installation, configuration, and operation of the drive for use on an RS-485 network, refer to Chapter 13, *Serial Communication*.

### 5.11.4 I/O Interface - C4

Connect input and output according to application requirements.

Unused pins must remain unconnected.

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

The digital inputs and digital outputs on all BDHDE models are opto-isolated.

When the digital output channel is configured as brake function, refer to the motor brake wiring section.

The motor brake requires a separate power supply. Do not share it with the digital input or pulse input.

*Table 5-13 BDHDE-AP I/O Interface*

| Pin | Function | Description | Pin | Function | Description |
|---|---|---|---|---|---|
| 1 | Common Input | 24V or 0V (depending on sink or source) | 14 | Fast Digital Inputs 1 | Opto-isolated programmable fast digital input Sink/source |
| 2 | Fast Digital Inputs 2 | Opto-isolated programmable fast digital input Sink/source | 15 | Digital Inputs 3 | Opto-isolated programmable digital input Sink/source |
| 3 | Digital Inputs 4 | Opto-isolated programmable digital input Sink/source | 16 | Digital Inputs 5 | Opto-isolated programmable digital input Sink/source |
| 4 | Common Output | 24V or 0V (depending on sink or source) | 17 | Digital Outputs 1 | Opto-isolated programmable digital output Sink/source |

| Pin | Function | Description | Pin | Function | Description |
|---|---|---|---|---|---|
| 5 | Digital Outputs 2 | Opto-isolated programmable digital output<br>Sink/source | 18 | Digital Outputs 3 | Opto-isolated programmable digital output<br>Sink/source |
| 6 | *Digital Outputs4 | Opto-isolated programmable digital output<br>Sink/source | 19 | *Digital Outputs 5 | Opto-isolated programmable digital output<br>Sink/source |
| 7 | * Equivalent Encoder Output B+ | Equivalent encoder output signal B high-side signal(RS-422) | 20 | * Equivalent Encoder Output A+ | Equivalent encoder output signal A high-side signal(RS-422) |
| 8 | *Digital Inputs 6 | Opto-isolated programmable digital input D rain /source | 21 | *Digital Inputs 8 | Opto-isolated programmable digital input D rain /source |
| 9 | * Equivalent Encoder Output B- | Equivalent encoder output signal B low-side signal(RS-422) | 22 | *Equivalent Encoder Output A- | Equivalent encoder output signal A low-side signal (RS-422) |
| 10 | *Equivalent Encoder Output Z+ | Equivalent encoder output signal Z high-side signal (RS-422) | 23 | *Digital Ground GND | Digital ground |
| 11 | * Pulse Signal input- | Pulse signal low-side signal (RS-422),<br>Or signal A low-side signal,<br>Or positive pulse signal low-side signal | 24 | *Digital Inputs 7 | Opto-isolated programmable digital input D rain /source |
| 12 | *Equivalent Encoder Output Z- | Equivalent encoder output signal Z low-side signal (RS-422) | 25 | *Direction signal input- | Direction signal low-side signal (RS-422),<br>Or signal B low-side signal,<br>Or negative pulse signal low-side signal |
| 13 | *Pulse signal input+ | Pulse signal high-side signal (RS-422),<br>Or signal A high-side signal,<br>Or positive pulse signal high-side signal | 26 | *Direction signal input+ | Direction signal high-side signal (RS-422),<br>Or signal B high-side signal,<br>Or negative pulse signal high-side signal |

*Table 5-14 BDHDE-EB I/O Interface*

| Pin | Function | Description | Pin | Function | Description |
|---|---|---|---|---|---|
| 1 | Common Input | 24V or 0V<br>(depending on sink or source) | 14 | Fast Digital Inputs 1 | Opto-isolated programmable fast digital input<br>Sink/source |
| 2 | Fast Digital Inputs 2 | Opto-isolated programmable fast digital input<br>Sink/source | 15 | Digital Inputs 3 | Opto-isolated programmable digital input<br>Sink/source |

| Pin | Function | Description | Pin | Function | Description |
|---|---|---|---|---|---|
| 3 | Digital Inputs 4 | Opto-isolated programmable digital input<br>Sink/source | 16 | Digital Inputs 5 | Opto-isolated programmable digital input<br>Sink/source |
| 4 | Common Output | 24V or 0V<br>(depending on sink or source) | 17 | Digital Outputs 1 | Opto-isolated programmable digital output<br>Sink/source |
| 5 | Digital Outputs 2 | Opto-isolated programmable digital output<br>Sink/source | 18 | Digital Outputs 3 | Opto-isolated programmable digital output<br>Sink/source |

*Table 5-15 BDHDE-EC I/O Interface*

| Pin | Function | Description | Pin | Function | Description |
|---|---|---|---|---|---|
| 1 | Common Input | 24V or 0V<br>(depending on sink or source) | 14 | Fast Digital Inputs 1 | Opto-isolated programmable fast digital input<br>Sink/source |
| 2 | Fast Digital Inputs 2 | Opto-isolated programmable fast digital input<br>Sink/source | 15 | Digital Inputs 3 | Opto-isolated programmable digital input<br>Sink/source |
| 3 | Digital Inputs 4 | Opto-isolated programmable digital input<br>Sink/source | 16 | Digital Inputs 5 | Opto-isolated programmable digital input<br>Sink/source |
| 4 | Common Output | 24V or 0V<br>(depending on sink or source) | 17 | Digital Inputs 1 | Opto-isolated programmable digital output<br>Sink/source |
| 5 | Digital Outputs 2 | Opto-isolated programmable digital output<br>Sink/source | 18 | Digital Inputs 3 | Opto-isolated programmable digital output<br>Sink/source |
| 6 | *Digital Outputs 4 | Opto-isolated programmable digital output<br>Sink/source | 19 | * Reserve | |
| 7 | * Equivalent Encoder Output B+ | Equivalent encoder output signal B high-side signal(RS-422) | 20 | *Equivalent Encoder Output A+ | Equivalent encoder output signal A high-side signal(RS-422) |
| 8 | *Digital Inputs 6 | Opto-isolated programmable digital output<br>Sink/source | 21 | * Reserve | |
| 9 | * Equivalent Encoder Output B- | Equivalent encoder output signal B low-side signal(RS-422) | 22 | *Equivalent Encoder Output A- | Equivalent encoder output signal A low-side signal (RS-422) |

| Pin | Function | Description | Pin | Function | Description |
|---|---|---|---|---|---|
| 10 | *Equivalent Encoder Output Z+ | Equivalent encoder output signal Z high-side signal (RS-422) | 23 | *Digital Ground GND | Digital ground |
| 11 | * Pulse Signal input- | Pulse signal low-side signal (RS-422),<br>Or signal A low-side signal,<br>Or positive pulse signal low-side signal | 24 | Digital Inputs 7 | Opto-isolated programmable digital output<br>Sink/source |
| 12 | *Equivalent Encoder Output Z- | Equivalent encoder output signal Z low-side signal (RS-422) | 25 | * input - | Direction signal low-side signal (RS-422),<br>Or signal B low-side signal,<br>Or negative pulse signal low-side signal |
| 13 | *Pulse signal input+ | Pulse signal high-side signal (RS-422),<br>Or signal A high-side signal,<br>Or positive pulse signal high-side signal | 26 | *Direction signal input+ | Direction signal high-side signal (RS-422),<br>Or signal B high-side signal,<br>Or negative pulse signal high-side signal |

*Some features are only available in some models, please refer to *Ordering Information*

### 5.11.5 Motor Feedback Interface - C5

BDHDE supports sensAR and Tamagawa feedback, and the pin assignments below illustrate the connection between the feedback and the drive.

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 5-16 Feedback Interface (C5)*

| Pin # | Function | Pin # | Function |
|---|---|---|---|
| 1 | 5V power supply | 4 | |
| 2 | GND | 5 | Data + |
| 3 | | 6 | Data - |

### 5.11.6 Motor Feedback Wiring

The following table shows the feedback wiring for BDHDE servo bundle.

**Wiring - sensAR Encoder**

**Table 5-17. Feedback Wiring - sensAR Encoder - AMP Connector**

| C5 Pin # | Twisted Pair | PRHD2 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 |

*Table 5-18 Feedback Wiring - sensAR Encoder - MIL Connector*

| C5 Pin # | Twisted Pair | PRHD2 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 |

**Wiring - Tamagawa Absolute Encoder 17-Bit Single-Turn**

*Table 5-19 Feedback Wiring - Tamagawa 17-Bit Absolute Single-Turn Encoder - AMP Connector*

| C5 Pin # | Twisted Pair | PRHD2 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 |

*Table 5-20 Feedback Wiring - Tamagawa 17-bit Absolute Single-Turn Encoder - MIL Connector*

| C5 Pin # | Twisted Pair | PRHD2 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 |

**Wiring - Tamagawa Absolute Encoder 17-Bit/23**

*Table 5-21 Feedback Wiring - Tamagawa 17-Bit/23-Bit Absolute Multi-Turn Encoder - AMP Connector*

| C5 Pin # | Twisted Pair | PRHD2 Pin # | Signal Description |
|---|---|---|---|

| C5 Pin # | Twisted Pair | PRHD2 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 5-22 Feedback Wiring - Tamagawa 17-Bit/23-Bit Absolute Multi-Turn Encoder - MIL Connector*

| C5 Pin # | Twisted Pair | PRHD2 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 shield must be connected to both poles of the connecting plug.

**Note 2**
Needs to be connected to the battery.
The encoder backup battery is external to the BDHDE drive.
A 3.6V, 1000mAh lithium battery is recommended.
Use the backup battery recommended by the encoder manufacturer.

### 5.11.7 STO Interface C6

The STO function blocks the PWM signal output to the drive power level via the external redundant hardware terminals STO1 and STO2, thus preventing motor movement, with the input connector pins defined in the table below.

*Table 5-23 STO Interface (C6)*

| C6 Pin # | Function | C6 Pin # | Function |
|---|---|---|---|
| 1 | 12V 电源 | 4 | COM |
| 2 | STO1 | 5 | GND |
| 3 | STO2 | | |

Remark 1 The ST012V power supply is for STO circuit use only and cannot be used for other purposes.

### 5.11.8 RS232 Interface

During commissioning, the drive can be connected to the host computer via interface C7 (RS232 port).

Table 5-24 RS232 Interface (C7)

| C7 Pin # | Function | C7 Pin # | Function |
|---|---|---|---|
| 1 | RxD Receive data | 3 | TxD Send data |
| 2 | GND | 4 | |

## 5.12 Power Board Connections

Refer to the power board pin assignment diagram.



Ensure that the main voltage rating is in accordance with the drive specifications; applying an incorrect voltage may cause drive to malfunction.

Do not energize until all hardware connections are completed.



Preventing Surge:

Bus power (L1-L2): Turn on the drive 1 minute after shutting down the bus power.

Logic power (L1C-L2C): Turn on the drive 30 seconds after shutting down the logic power.

### 5.12.1 BDHDE Power Board Pinouts

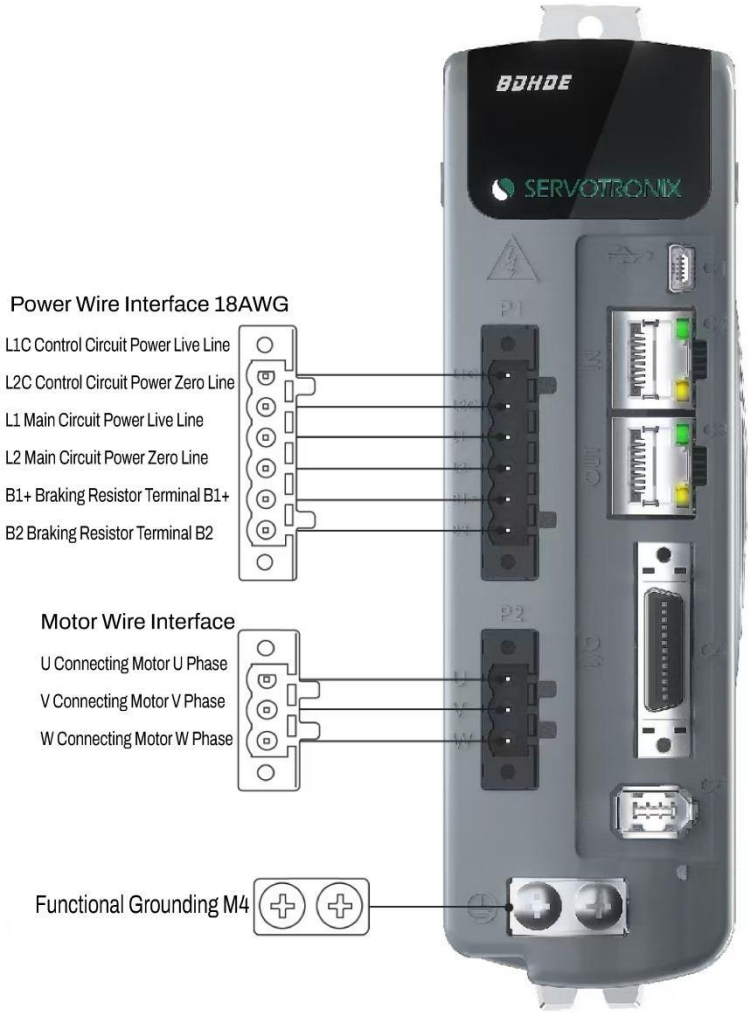



*Figure 5-11 BDHDE-3/6A Power Pin Assignment*

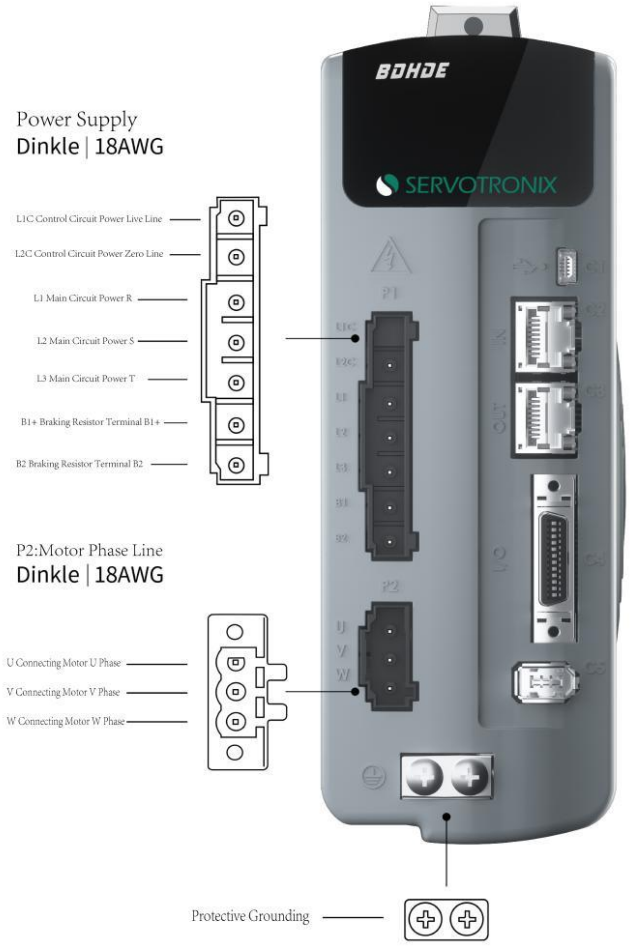



Figure 5-12 BDHDE-10/13A Power Pin Assignment

### 5.12.2 Functional Ground - ⏚

Connect the AC input power grounding line to the functional ground terminal located on the front panel of BDHDE. Please use M4 ring or spade terminal.

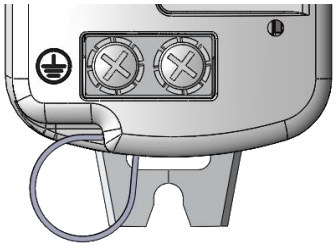


**Figure 5-13 Ground Terminal**

### 5.12.3 Power Input - P1

Use the mating connector of this interface.

- Connect L1 and L2 (for main loop power supply): connect the line and neutral line to L1 and L2 respectively;

  **Note: L1 connects to the L line and L2 to the N line, so as to avoid damage to the drive caused by powering up the motor power line when the PE is shorted.**

- Connect L1C and L2C (for control loop power supply): connect the line and the neutral line to L1C and L2C respectively;
- If the application requires a regeneration resistor, connect this resistor between terminals B1 + and B2. See Regeneration chapter.

### 5.12.4 Motor Power Output - P2

Use the mating connector of this interface.



BDHDE must be grounded. Ensure that the AC input power ground line is connected to the functional ground terminal on the BDHDE front panel.

## 5.13 Regenerative Brake

### 5.13.1 Regenerative Energy Overview

When the motor and load decelerate rapidly, the kinetic energy of the load releases the motor shaft energy back to the drive, which is called regenerative energy or regeneration, and this energy must be released or absorbed.

The unreleased regenerative energy will be stored in the DC bus capacitor, and if the capacitor is capable of storing this energy, the system does not need a regeneration resistor.

In some cases, usually due to a high inertia mismatch between the load and the motor, too much energy is added to the capacitor, causing the voltage across the capacitor to reach the overvoltage threshold, which then causes the drive to be disabled. In order to prevent overvoltage and potential damage to the system, excessive regenerative energy must be consumed through regeneration resistors.

To determine if a system requires a regeneration resistor and to determine the capacity level (if required), refer to the "Regenerative Resistance Calculation" to measure the system performance.

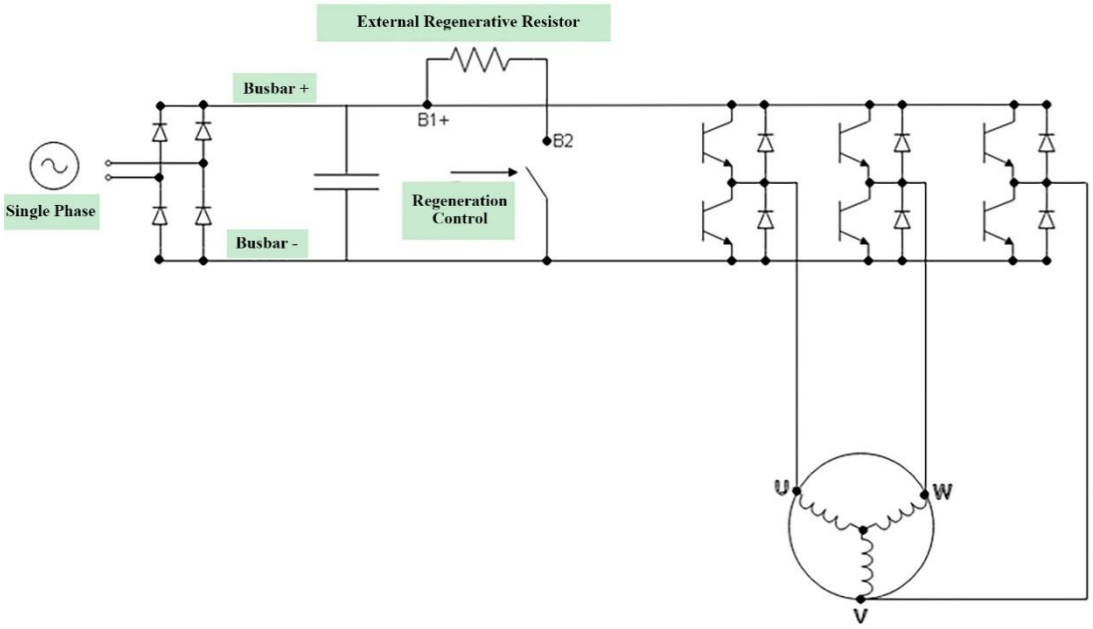



**Figure 5-14. Regeneration Resistors Circuit**

### 5.13.2 Regeneration Resistance - BDHDE DC Bus Specifications

**Table 5-25. DC Bus Specifications - Single-Phase AC Voltage 220V**

| Drive Model | Capacitance (μF) | Rated Voltage (DC Voltage) | Regeneration Stop Voltage (DC Voltage) | Regeneration Running High Voltage (DC Voltage) | Maximum Voltage (DC Voltage) |
|---|---|---|---|---|---|
| BDHDE-003 | 780 | 311 | 360 | 380 | 400 |
| BDHDE-006 | 1110 | 311 | 360 | 380 | 400 |
| BDHDE-010 | 2040 | 311 | 360 | 380 | 400 |
| BDHDE-013 | 2040 | 311 | 360 | 380 | 400 |

### 5.13.3 Regeneration Resistors Overload Protection

Motor energy regeneration in BDHDE is always active.

The motor energy regeneration function has two modes:

- Regeneration with resistor overload protection.

  The regeneration resistor circuit itself requires overload protection to ensure reliable resistor operation. In this mode, protection is provided using configurable BDHDE regeneration resistor parameters.

- Regeneration without resistor overload protection. This mode is also referred to as bang-bang mode.

  In bang-bang mode, the drive will activate the regeneration resistor when the upper threshold level (380V) is exceeded; when the DC bus voltage drops to the lower threshold level (360V), the regeneration resistor will be disabled.



Use regeneration resistor protection discreetly.

If the motor increases the DC bus voltage, causing the protection mechanism to be activated, an overvoltage condition may result.

### 5.13.4 Regeneration Resistor Parameters

The regeneration resistor capacity is defined by several parameters.

To activate the regeneration resistor protective function in BDHDE, the parameter REGENRES and/or the parameter REGENPOW must be set to a value other than -1.

| VarCom | Description |
|---|---|
| REGENRES | The regeneration resistor resistance is measured in ohms. |
| REGENPOW | Regeneration resistor power is in watts. |
| REGENMAXONTIME | The maximum time that a regeneration resistor can be continuously activated (turned on) is in milliseconds. |

**Notes**

Set REGENRES = -1 and REGENPOW = -1 if the system has no regeneration resistor

If the system has a regeneration resistor, a value of -1 for REGENRES or REGENPOW will disable the regeneration resistor overload protection algorithm.

# 6. Motor Setup

The BDHDE drive will attempt to detect the motor feedback device and electronic motor nameplate (MTP) when powered up. If the electronic motor nameplate (MTP) is detected, the parameters of the motor and feedback will be transmitted directly to the drive and no additional operation is required.

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



The drive needs to be disabled before operating the motor and feedback parameters.

When the drive is enabled, many parameters can be modified.

However, please proceed with caution, as motion behavior can change.

If the parameters cannot be modified while the drive is enabled, ServoStudio2 will prompt you to disable the drive.

## 6.1 Motor Setup Wizard

ServoStudio2 "Motor Setup" wizard provides the quickest and easiest way to start and run the drive and motor. This wizard configures basic parameters and the current control loop for the motor without load.

When connecting the host, drive and motor for the first time, the "Motor Setup" wizard is recommended.

This chapter describes the functions and parameters that are configured during motor setting and initialization.

**Motor Setup - Connection**

Generally, the wizard starts by establishing communication between the drive and the ServoStudio2 software.

If ServoStudio2 has communicated with the drive, the wizard will skip this step.

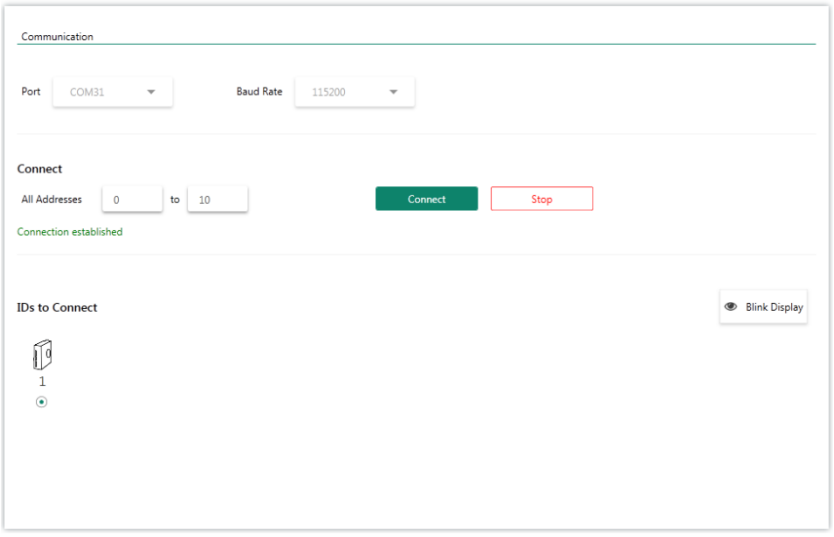



**Figure 6-1. Motor Setup Wizard - Connecting**

1. Select a specific COM port or "Search all".
2. Click "Connect".

See *Communication*.

## Motor Setup - Drive Identification

If ServoStudio2 has communicated with the drive, the wizard will start with the drive information.

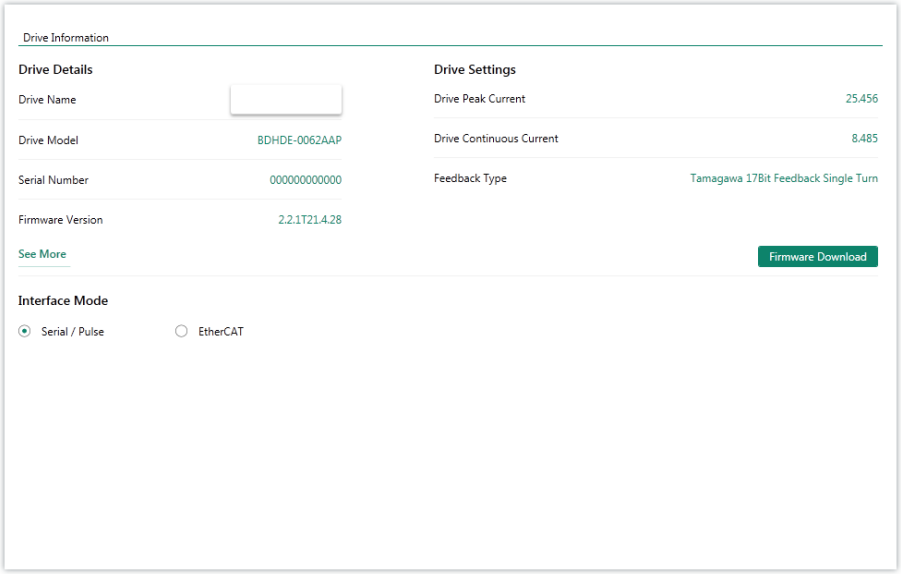



**Figure 6-2 Motor Setup Wizard - Drive Information**

1. View drive information.
2. Enter the name of the drive, then press Enter, and the name field will change from blue to white, indicating that the name has been sent to the drive.

This step also includes an option to restore the factory settings of the drive: Restore Factory Default.

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

- Serial/pulse/analogue indicates that the drive is active (servo-on) and that motion commands are transmitted via the serial communication, pulse input or analogue input interface, when COMMODE = 0;
- EtherCAT/CANopen indicates that the drive is in active state (servo on), and the motion command is transmitted via the EtherCAT interface, when COMMODE = 1.

The ServoStudio2 drive information screen allows you to view drive properties and define the drive name.

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

| VarCom | Description |
|---|---|
| INFO | Hardware definition. Returns to the drive model and serial number, as well as the version numbers of firmware, control board, power board and FPGA. |
| DRIVENAME | Optional user-defined parameters. It is useful when the application has multiple drives. A name is recommended for the drive to reflect the function it performs, e.g. Axis-1. |

## Motor Setup - Motor Selection

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

As the PRHD2 motor in the BDHDE kit has an electronic motor nameplate, the parameters on the motor selection screen are set automatically and cannot be manipulated.

Just click Next to continue the operation.

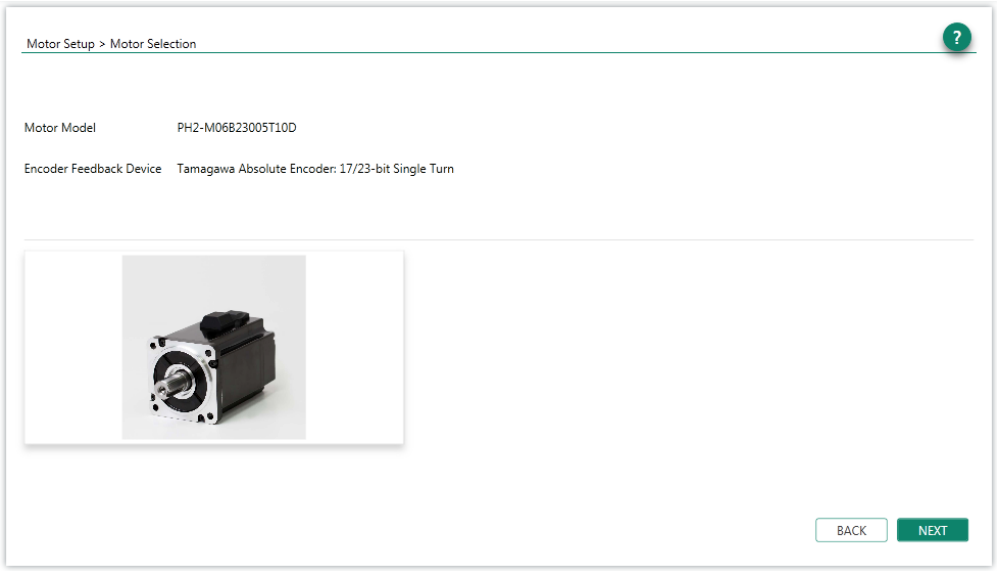



**Figure 6-3. Motor Setup Wizard – Motor Setup**

## Motor Setup - Current, Speed and Position Limits

The "limits" screen allows you to define current limits, velocity limits and position error limits.

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

Please refer to *Current Limits*, *Velocity Limits* and *Position Limits*.

The wizard also allows setting the error threshold level of the position, i.e. the maximum value above which a fault of out-of-tolerance position will occur.

See VarCom PEMAX .

**Notes** If the limit is set too low, the "AutoTune" wizard may not produce the best results.

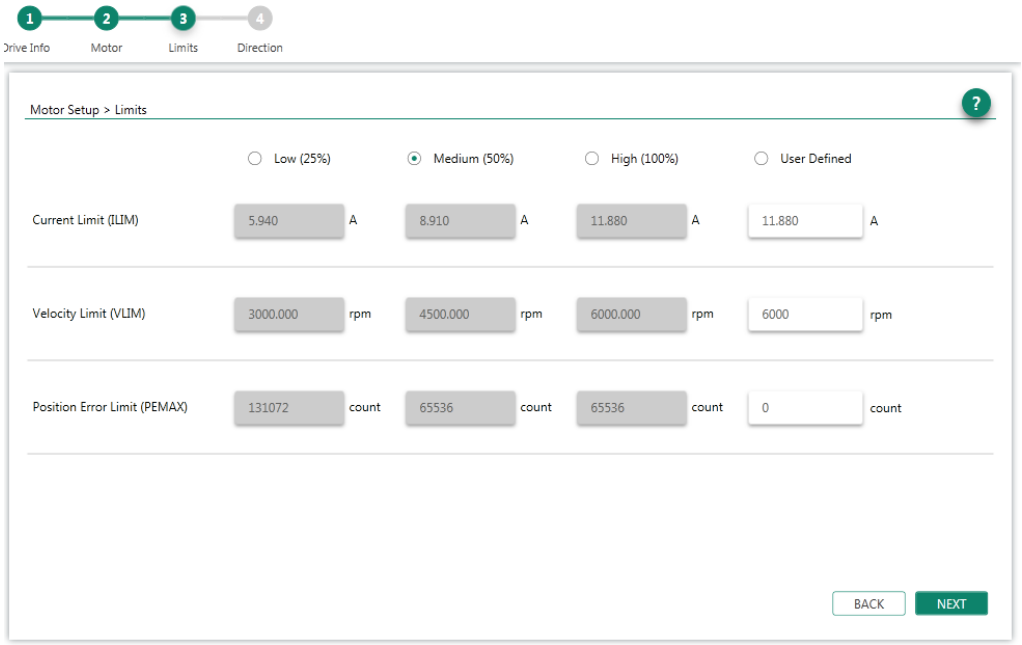



**Figure6-4. Motor Setup Wizard - Limits**

1. Perform any of the following operations to set speed and current limits and position error limits:
   - Select the recommended low, medium, or high value.
   - Select User Defined, and enter your preferred values.
2. Click "Agree" to send the value to the drive.

If the current limit or velocity limit is set to a user-defined value of 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 fault is generated.

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

| VarCom | Description |
|---|---|
| DIPEAK | Rated peak current of drive, hardware definition, read only. |
| MIPEAK | Rated peak current of the motor, the value of which can be modified. |
| IMAX | This value is the maximum current of the drive and motor combination, calculated by the software, and is read only. |
| ILIM | The present current limit of the application, which allows you to limit the peak current of the drive to a value lower than DIPEAK. |
| ILIMACT | Actual drive current limit, read only. |

### Motor Setup - Save

After completing the "Motor Setup", it is recommended that you save the parameters to the drive's non-volatile memory and to a file on the host computer for backup purposes.

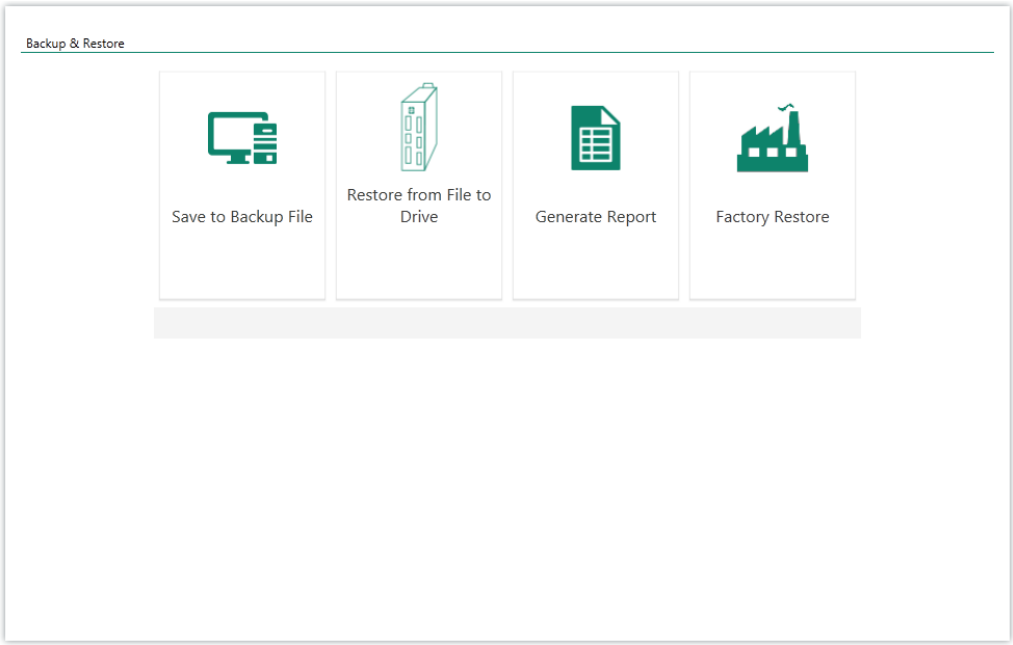



**Figure 6-5. Motor Setup Wizard - Save**

Perform the following two operations:

- Click on Save to Drive to save the parameters in the drive RAM to its permanent memory.
- Click on Save to Computer to save the parameters in the drive RAM to a backup file on the computer. Parameters are saved in a text file with TXT or SSV extension. Text files can be edited using Notepad or any other text editor.

It is also recommended that you create an application report:

- Click on Generate Report.

  Once activated, the report generator will open a dialog box allowing you to enter application and user information. A set of CSV and TXT files are then generated in the compressed file which can be attached to an email sent to technical support. The address can be changed and sent to another recipient.

  See *Report Generator* in the ServoStudio2 manual.

## 6.2 Drive Identification

Display and confirm the drive information in the "Motor Setup" wizard.

ServoStudio2 "Drive Information" screen allows you to view drive properties and define drive names.

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

| VarCom | Description |
|---|---|
| INFO | Hardware definition, returning to drive model and serial numbers, as well as firmware, control board, power board and FPGA version numbers. |
| DRIVENAME | Optional user-defined parameters. It is useful when the application has multiple drives. A name is recommended for the drive to reflect the function it performs, e.g. Axis-1. |

## 6.3 Current Limits

Modify and/or confirm the current limit in the "Motor Setup Wizard".

The current limits tab in the ServoStudio2 "Limits" screen allows you to define position limits.

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

| VarCom | Description |
|---|---|
| DIPEAK | Rated peak current of drive, hardware definition, read only. |
| MIPEAK | Rated peak current of the motor, the value of which can be modified. |
| IMAX | This value is the maximum current of the drive and motor combination, calculated by the software, and is read only. |
| ILIM | The present current limit of the application, which allows you to limit the peak current of the drive to a value lower than DIPEAK. |
| ILIMACT | Actual drive current limit, read only. |

## 6.4 Velocity Limits

Modify and/or confirm the velocity limit in the "Motor Setup Wizard".

The Velocity Limits tab in the ServoStudio2 "Limits" screen allows you to define position limits.

Hardware defines the maximum speed that the drive can calculate.

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

| VarCom | Description |
|---|---|
| MSPEED | Maximum motor speed as defined in the motor data sheet. |
| VMAX | This value is the maximum speed of the combination of drive and motor, and VMAX is based on the maximum motor speed, which is read only. |
| VLIM | Maximum application speed. This parameter allows you to limit the maximum speed of the motor to a value lower than VMAX. |

## 6.5 Position Limits

Modify and/or confirm position limits via the "Motor Setup" wizard.

The position limits tab in the limits screen of ServoStudio2 allows you to define position limits.

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

| VarCom | Description |
|---|---|
| PEMAX | Maximum allowable position error without fault, in encoder counts. |
| PEINPOS | Tolerance window declaring the "in place" state. |
| INMODE # 5 | Defines the digital input number as a signal indicating whether the position limit has been reached in the positive direction. |
| INMODE # 6 | Defines the digital input number as a signal indicating whether the position limit has been reached in the negative direction. |

| VarCom | Description |
|---|---|
| LIMSWITCHPOS<br>LIMSWITCHNEG | Indicates the state of all positive and negative limit events, read only. |
| POSLIMMODE | Enables and disables software position limit and/or transient position limit and/or homing limit. |
| POSLIMPOS<br>POSLIMNEG | Maximum and minimum software position limits. |

# 7 Application Setup

## 7.1 Parameters

### 7.1.1 Configuration Parameters

VarCom is a set of proprietary commands, variables and parameters used to configure drive functions by means of serial connection communication between the host and the drive.

VarCom parameters can be accessed and controlled from the GUI screen or the command line terminal screen via the ServoStudio2 software.



When setting parameters, keep a close eye on any alarms or error messages that appear on the ServoStudio2, as well as any flashing codes on the drive's digital display.

Disable the drive before controlling the motor and feedback parameters.

Many parameters can be modified with the drive being enabled.

However, special care should still be taken as motor behaviour may change.

If the parameters cannot be modified while the drive is enabled, the disable drive prompt will be displayed.

### 7.1.2 Managing Parameters - Drive Memory

BDHDE drives have two memory types for storing drive parameters:

- Flash memory: non-volatile memory. Saves the drive default parameter values (included in the drive firmware) as well as saving parameter groups.
- RAM: volatile memory. Drive working memory. When you configure and test the drive and adjust the parameters, the parameter values are saved in RAM. If the drive is disconnected from the power supply, any unsaved parameter changes will be lost.

During power-up, the BDHDE loads parameter values from non-volatile memory into RAM and calculates the checksum of these parameter values. If the checksum is invalid, the default parameter values (hard-coded into the drive firmware) are loaded into RAM and set to a "parameter memory checksum failure" fault.

The figure below shows the relationship between the different memory types and the commands used to manage drive parameters.

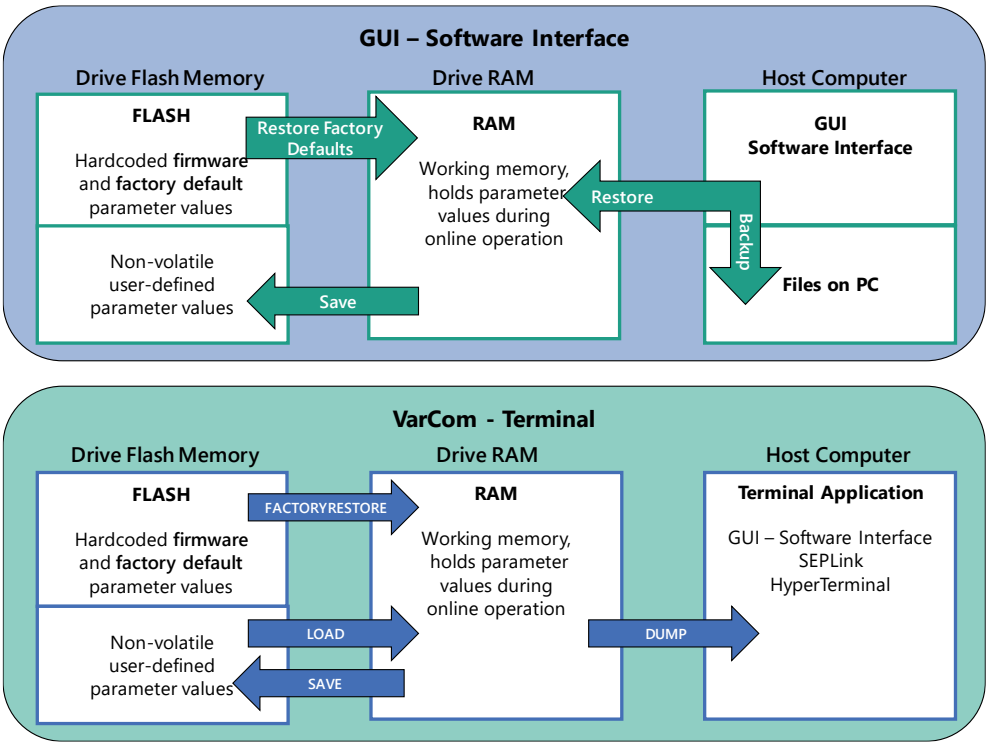



**Figure 7-1. Memory and Parameter Management Commands**

All BDHDE motor encoder units are equipped with a set of motor parameters, stored on an electronic motor nameplate (MTP) in the encoder EEPROM. When MTP is detected by the drive, the values of these parameters will be directly loaded into the drive RAM from the encoder memory.

In ServoStudio2, the drive parameters can be saved to non-volatile memory at any time by clicking on the Save button in the toolbar.

## 7.2 Application Setup Wizard

Go to the ServoStudio2 "Application Setup" wizard screen.

### 7.2.1 Application Setup - Interface

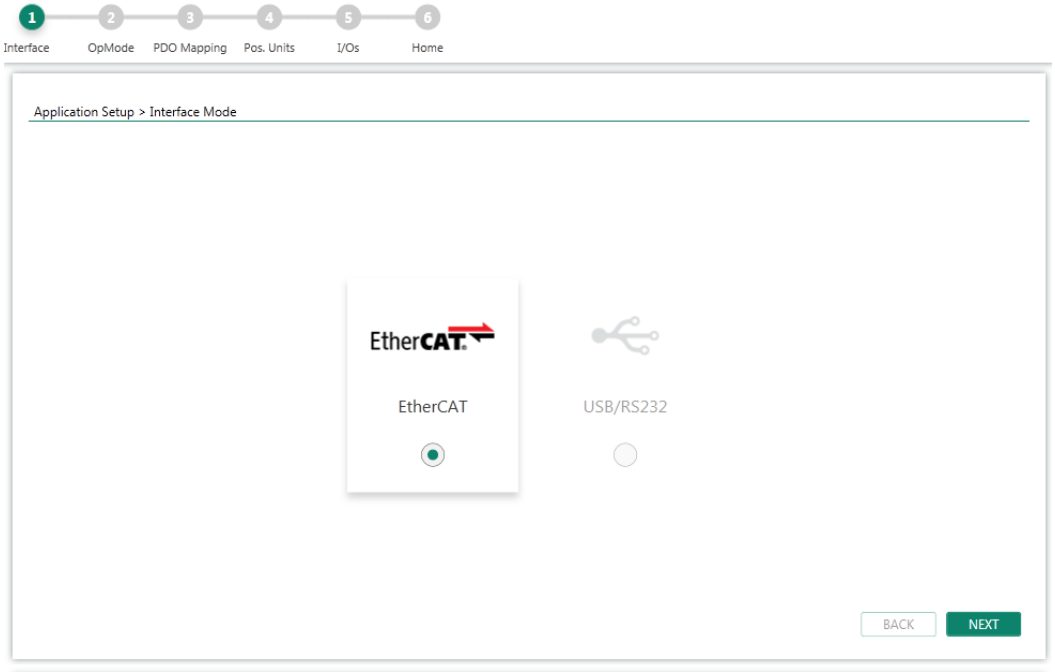



**Figure 7-2 ServoStudio2 - Application Setup Wizard - Interface Mode**

The "Application Setup Wizard" will guide you through the drive parameters according to the particular application.

In the first step, the specific application settings are determined via the selected "Interface Mode". Subsequent steps may contain PDO mapping, position unit definition, electronic gearing ratios, limits, homing and I/O functions.

**Notes**

When the software is offline, all "Interface Modes" options will be displayed.

When the software is communicating with the drive, only the relevant modes are displayed.

BDHDE currently supports the following interface modes:

- EtherCAT
- USB

### 7.2.2 Application Setup - Operation Mode

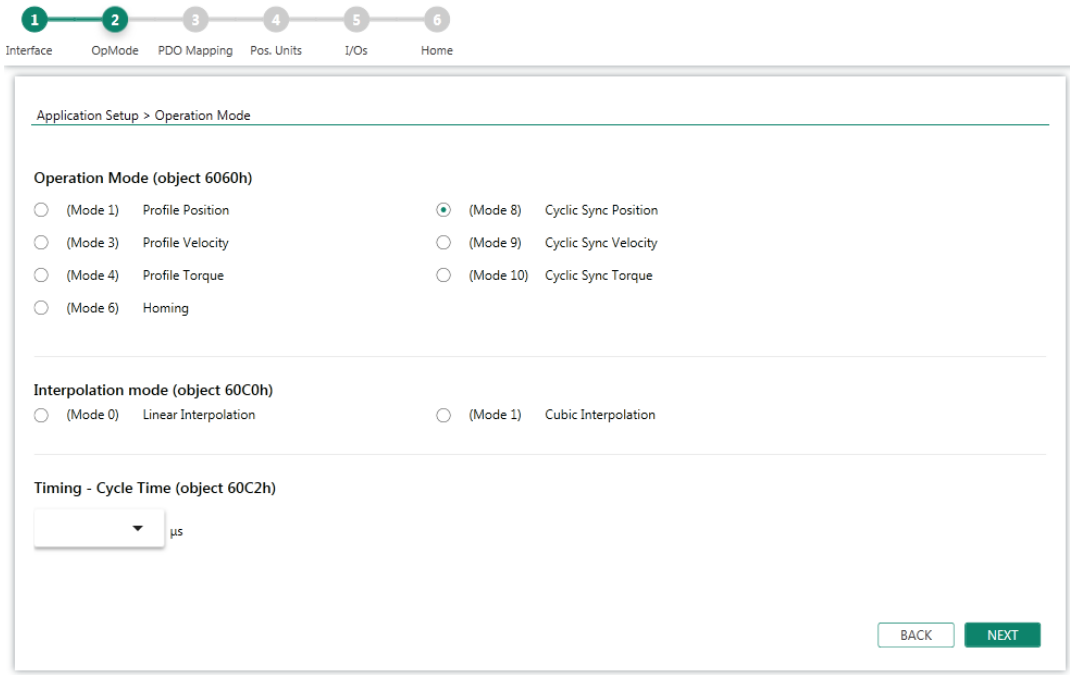



Figure 7-3 ServoStudio2 - Application Setup Wizard - Operation Mode (EtherCAT)

Displayed when the "Interface Mode" is EtherCAT.

Defines the operation mode of the drive system running in the EtherCAT network.

See the *BDHDE EtherCAT Reference Manual*.

### 7.2.3 Application Setup - Position Units

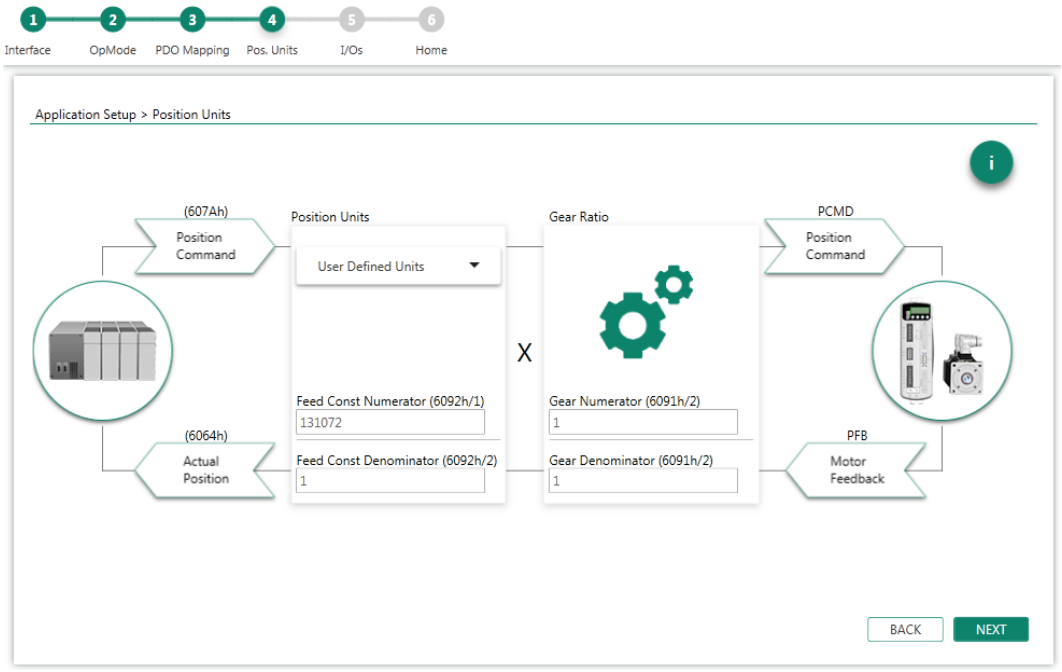



*Figure 7-4. ServoStudio2- Application Setup Wizard - Position Unit*

Displayed when the interface mode is EtherCAT mode.

### 7.2.4 Application Setup - I/O

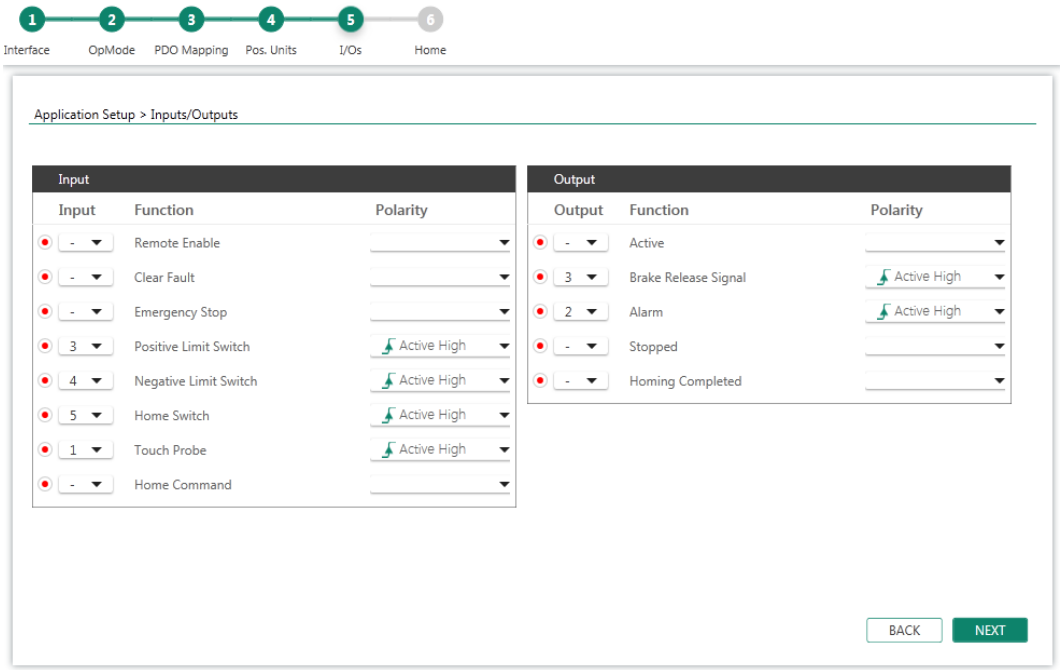



**Figure 7-5. ServoStudio2 - Application Setup Wizard - I/O**

When the interface mode is:

- EtherCAT
- USB

### 7.2.5 Application Setup - Home

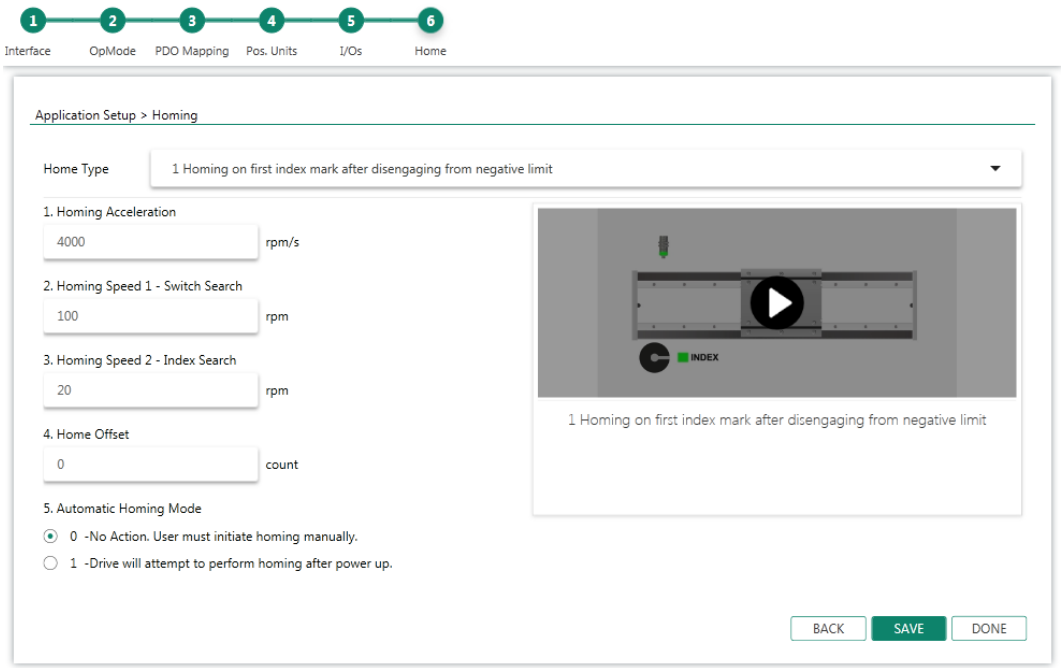



**Figure 7-6 ServoStudio2 - Application Setup Wizard - Home**

When the interface mode is:

- EtherCAT
- USB

### 7.2.6 Application Setup - Save

When the software is communicating with the drive, this option is displayed in the "Application Setup - Home" step.

## 7.3 Communication

A USB connection is required to commission the drive via ServoStudio2. Once the drive has been configured, it can be connected to the PLC or controller via the EtherCAT network.

**Notes**

To communicate via the USB connection, the drive must be set to COMMODE 0. COMMODE 1 is the factory default setting for the drive.

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

The following parameters are used to configure and monitor communication:

| VarCom | Description |
|---|---|
| COMMODE0 | When COMMODE 0 is in effect:<br>Enable USB communication.<br>Disable EtherCAT communication.<br>Accept commands via serial only.<br>The drive can be fully controlled via ServoStudio2 (enabling, motor action, parameter modification). |
| COMMODE1 | When COMMODE 1 is in effect:<br>Enable EtherCAT communication.<br>USB communication can be used as a limited function tool for monitoring and changing parameters.<br>Reference commands can be received via the serial interface.<br>The drive can be fully controlled via the fieldbus device.<br>It is not allowed to enable the drive and speed the motor via ServoStudio2 .<br>Note: certain functions must be performed via ServoStudio2. These functions are limited to parameters that do not interfere with fieldbus operation. If you want to set parameters that interfere with the fieldbus operation, the drive will issue an error code on the digital display and/or an error message on ServoStudio2. |
| BAUDRATE | For setting the serial communication bit rate between the drive and the host. For BDHDE this variable is fixed to 115200. |

Communication between the serially connected host and the drive can be established via the ServoStudio2 "Communication" screen. In addition, the first step of the "Motor Setup" wizard is to configure the communication between the host and the drive.

## 7.4 Power Level

Preset rated power parameters and write them into the drive. These parameters are defined by the manufacturer and cannot be changed by the user. If you wish to change them, please contact technical support.

Use ServoStudio2 "Power Level" screen to view current and voltage values and to set certain voltage parameters.

The following parameters are used to monitor and control the power rating.

| VarCom | Description |
|---|---|
| DICONT | Drive continuous current, hardware definition, read only. |
| DIPEAK | Drive peak current, hardware definition, read only. |
| OVTHRESH | DC bus overvoltage protection level, hardware definition, read only. |
| UVMODE | Defines how the drive will respond to an undervoltage fault. |
| UVRECOVER | Defines how the drive will recover after an undervoltage fault. |
| UVTHRESH | DC bus undervoltage protection level. |
| UVTIME | Duration of the condition in which the undervoltage fault occurs. |
| VBUS | DC bus voltage. |
| VBUSREADOUT | Drive actual DC bus voltage, hardware definition, read only. |

## 7.5 Feedback

Motors in the BDHDE servo bundle are equipped with one of the following encoders:

- SensAR single-turn absolute encoder 17-bit
- SensAR multi-turn absolute encoder 17-bit
- Tamagawa single-turn absolute encoder 17-bit
- Tamagawa multi-turn absolute encoder 17-bit
- Tamagawa multi-turn absolute encoder 23-bit

SensAR series absolute magnetic encoder is developed by Servotronix.

These encoders include the motor nameplate (MTP), which means that certain feedback parameters are transferred directly to the drive after power-up and cannot be modified.

FEEDBACKTYPE defines the type of motor feedback used in the drive application.

### 7.5.1 Single-Turn and Multi-Turn Encoders

The BDHDE servo bundle offers two types of motor encoder:

- Single-turn absolute encoder: After restart, the encoder retains its absolute position within one turn of mechanical rotation, the multi-turn absolute position is 0.
- Multi-turn absolute encoder: After restart, the encoder retains its absolute position within one turn of mechanical rotation and the total number of motor revolutions since the last restart. The multi-turn encoder does not need to return to the home position after each restart.

  The multi-turn encoder can store up to 65535 revolutions if accompanied by an external battery backup. The encoder battery is inserted into the battery box located to the cable between the motor and the drive. If the cable between the motor and the battery box is disconnected, or if the

encoder cannot receive the battery or drive voltage, the encoder will lose multi-turn revolutions; however, the single-turn absolute position is retained.

The commands below are used to configure and enable the multi-turn absolute encoder.

| VarCom | Description |
|---|---|
| MTTURNRESET | Reset the encoder multi-turn position and clear the multi-turn position fault in the encoder. MTTURNRESET command is applicable to sensAR and Tamagawa multi-turn encoders. |
| IGNOREBATTFLT | Prevents the multi-turn absolute encoder from issuing faults caused by a depleted battery backup, disconnected or missing cables, thus allowing the encoder to be used as a single-turn absolute encoder. |

### 7.5.2 Backup Battery Replacement for Multi-Turn Encoders

Measure the battery voltage level in the power-up sequence only. If the battery voltage drops below the specified value during operation, no warning or fault will be issued before re-powering.

- If the battery power drops below 3.15V, the encoder issues a low battery warning, prompting replacement of the battery as soon as possible.

  When replacing the battery, keep the drive energised, so that the multi-turn position in the memory is maintained during replacement. Remove the old battery and insert a new one.

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

  In this case, power off the drive before replacing the battery, then remove the old battery and insert a new one, connect the drive to the power supply and issue a command to reset the position counter of the multi-turn encoder (MTTURNRESET).

## 7.6 Motion Units

The physical units of acceleration, velocity and position supported by  can be viewed via the " Motion Units " interface in BDHDE.

In particular, the following parameters are used to monitor and operate the motion units.

| VarCom | Description |
|---|---|
| PNUM | Numerator of the electronic gearing unit conversion factor. |
| PDEN | Denominator of the electronic gearing unit conversion factor. |
| FBGDS | Fieldbus drive shaft speed conversion factor. |
| FBGMS | Fieldbus gear shaft speed conversion factor. |

## 7.7 Current Foldback

Current foldback is a mechanism used by  to protect the drive and motor from overheating caused by overcurrent. The current foldback of the drive and motor shall be set separately.

The current foldback limits the root mean square (RMS) value of the current supplied to the drive and/or motor.

Use ServoStudio2 "Current Foldback" screen to view and configure the current foldback parameters of the motor and drive.

The parameters below are used to monitor and operate foldback properties.

| VarCom | Description |
|---|---|
| IFOLD | Drive current foldback |
| DICONT | Drive continuous current |
| IFOLDFTHRESH | Drive foldback fault threshold |
| DIPEAK | Drive peak current |
| MIFOLD | Motor current foldback |
| MICONT | Motor continuous current |
| MIFOLDFTHRESH | Motor foldback fault threshold |
| MIPEAK | Motor peak current |
| MFOLDD | Motor foldback delay |
| MFOLDT | Motor foldback time constant |
| MFOLDR | Motor foldback recovery time |
| MFOLDDIS | Enable/disable motor foldback |

## 7.8 Digital Inputs

The BDHDE has a transmission delay of ≤ 1ms for normal digital inputs and ≤ 1us for high speed digital inputs.

Use ServoStudio2 "Digital I/O" interface to configure and view digital input state.

Use the following parameters to configure and monitor digital inputs.

| VarCom | Description |
|---|---|
| IN | Reads the input state of specified digital input channel, and takes values (EB type 1~5, AP type 1~8). |
| INPUTS | Reads input state of all digital input channels. |
| INMODE | Defines digital input function. |
| ININV | Converts specified input polarity. |

## 7.9 Digital Outputs

Transmission delay of BDHDE digital output ≤1ms.

Use ServoStudio2 "Digital I/O" screen to configure and view digital output state.

Use the following parameters to configure and monitor digital outputs.

| VarCom | Description |
|---|---|
| OUT | Reads the output state of the specified digital output channel, and takes values (EB type 1~3, AP type 1~5). |
| OUTPUTS | Reads output state of all digital output channels. |
| OUTMODE | Defines digital output function. |
| OUTINV | Converts specified output polarity. |

## 7.10 Disable Mode

The drive is disabled as a result of an explicit command from the motion controller or the drive itself responding to a fault condition. When the drive is disabled, the "Disable Mode" function can be used in special cases: the motor is brought to a quick stop before the power to the motor is switched off, which reduces the amount of motor coasting.

Use the ServoStudio2 "Emergency Stop" interface to select the method and parameters for stopping the motor when the drive is disabled.

The Disable Mode includes two mechanisms:

- Active Disable stops the motor by reducing the speed to zero and then disables the drive. Active Disable cannot not be implemented when the drive is operating in current control mode (OPMODE 2 or OPMODE 3).

| VarCom | Description |
|---|---|
| DISMODE | Defines how the drive will respond when disabled. |
| DISMODE 0 | Non-Active Disable, non-dynamic brake |
| DISMODE 1 | Non-Active Disable, dynamic brake on fault only |
| DISMODE 2 | Non-Active Disable, dynamic brake on Active Disable |
| DISMODE 3 | Active Disable on fault, non-dynamic brake |
| DISMODE 4 | Active Disable on fault, dynamic brake on fault only |
| DISMODE 5 | Active Disable on fault, dynamic brake on Active Disable |

**Notes** Active Disable cannot be issued for faults that need to be disabled immediately (to prevent drive damage) and for feedback faults that may cause communication errors (motor runaway condition).

Four parameters influence the disabling and braking action.

| VarCom | Description |
|---|---|
| DISSPEED | Defines the speed threshold. Below this value the motor will be considered as stopped and the Active Disable timer starts a disabling countdown. For the motor to be considered as stopped, its speed must be at least 50 ms below this threshold. |
| DISTIME | Defines the continuous time that the motor must remain below DISSPEED before the drive is disabled. The DISTIME counter only starts counting after the motor speed has fallen below DISSPEED by at least 50 ms. |
| DECSTOP | Define slow descent deceleration rate. |
| DECSTOPTIME | Define slow descent deceleration time. |

### 7.10.1 Active Disable

Active Disable prevents the motor from coasting when the shaft is disabled.

Active Disable mechanism stops the motor by quickly reducing the speed to zero and then disables the drive.

**Notes** Active Disable cannot not be implemented when the drive is operating in current control mode (OPMODE 2 or OPMODE 3); it is valid in all other operation modes.

Figure 7-7 shows how motor coasting occurs when active disabling is not applied. When the drive is disabled, the speed command is immediately set to zero, the drive is disconnected from powering the motor and the actual speed is reduced as a function of inertia and friction.

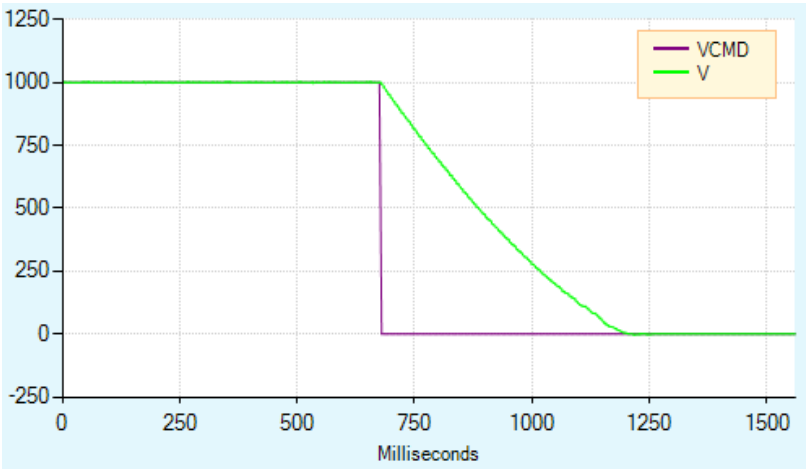



**Figure 7-7 Disabling (Active Disable Is Not Available)**

Figure 7-8 shows what happens when active disabling takes effect. Immediately after the drive receives the disabling command, the speed command and speed feedback will drop to zero at the set slope before the drive is disabled.

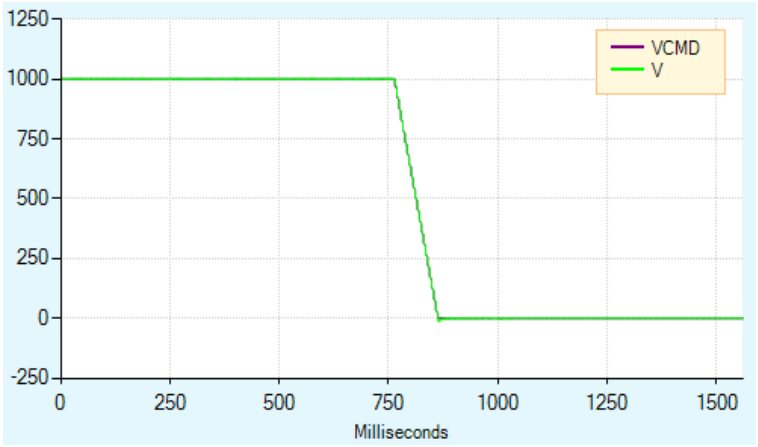



**Figure 7-8- Disabling (Active Disable Is Used)**

The effects of DISSPEED and DISTIME are shown in 7- 9. In this example, DISSPEED is set to 1000 and DISTIME is set to 1ms. After the motor speed remains below 1000 for 50ms and the time defined by DISTIME has been used up, the drive is disabled and the motor coasts to a stop.

In this example, it takes about 110ms since the motor speed drops below 1000 and the drive is disabled.

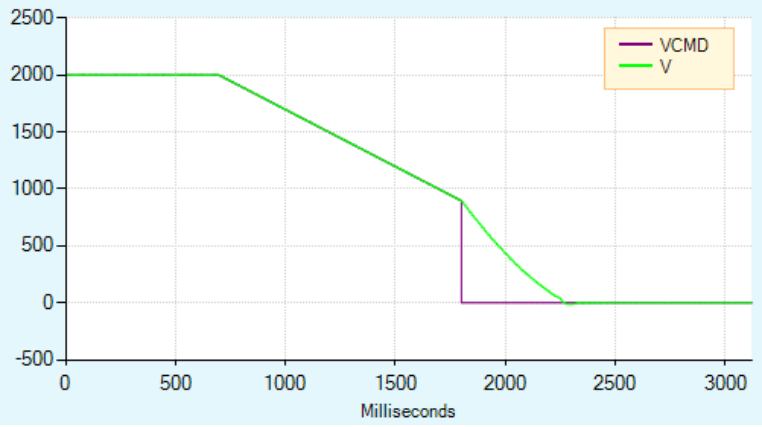



**Figure 7-9 Effect of DISSPEED and DISTIME on Active Disable**

During Active Disable descending, the drive ignores any new motion commands.

If an additional disabling command (VarCom K) is issued during the slow descent process, the slow descent process will be aborted and the drive will be disabled immediately.

Figure 7-10 shows the effect of the second disabling command. In this example, DISSPEED is set to 1000, and the second disabling command is issued before the motor speed is slowed down to that level.

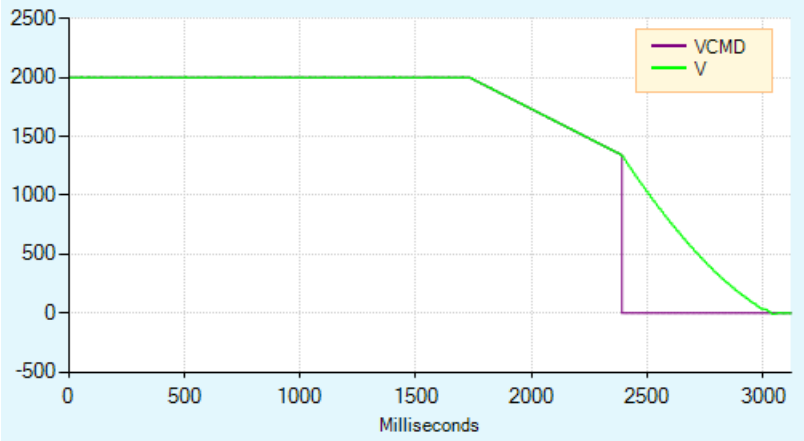



**Figure 7-10. Effect of the Second Disabling Command on Active Disable**

The legend in the ServoStudio2 "Emergency Stop" interface shows the active disabling action.

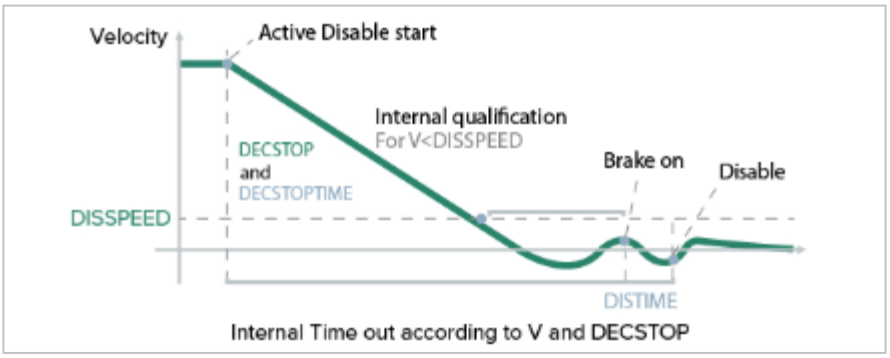



**Figure 7-11. Disabling Stop**

**Notes**

If a digital output is configured for the braking control, braking will be enabled as soon as the DISTIME timer starts counting.

If the internal timeout (calculated based on actual speed and DECSTOP) is exhausted, the slow descent mechanism will also be aborted, as shown in the disabling stop diagram.

### 7.10.2 Dynamic Brake

When the drive is de-enabled, the motor can be controlled by dynamic brake function, when only the reverse electric potential of the motor is used to generate

the braking current. The variable ISTOP is used to set the maximum permitted current during dynamic brake.

Figure 7 shows the motor coasting process, i.e. the stopping process without the dynamic brake (no Active Disable) mechanism. Once the drive is de-enabled, the speed command immediately drops to 0 and the actual speed of the motor is slowed down to 0 by friction.

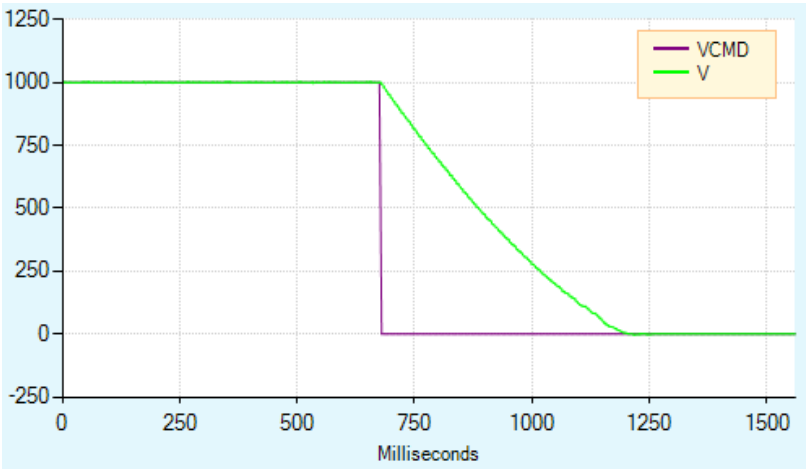



**Figure 7-12. Motor Coasting Curve without Dynamic Brake Mechanism**

Figure 7-13 shows the motion curve when the dynamic brake mechanism is in action. Once the drive is de-enabled and the speed command is set to 0, the actual speed quickly drops to 0 due to the dynamic brake function taking effect.

Unlike the Active Disable function, the actual speed does not drop to 0 according to a certain motion curve. The deceleration is the result of the combined effect of the maximum braking current (variable ISTOP) and the inertia and friction of the system.

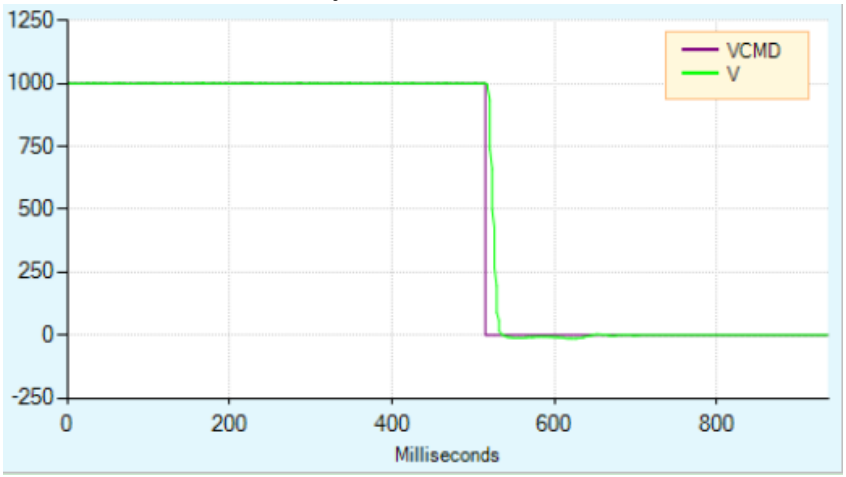



**Figure 7-13 Dynamic Brake Curve**

Figure 7-14 shows the braking curve for dynamic braking with a very small value of the variable ISTOP. In this example, the motor takes a long time to stop, showing the role of the ISTOP variable in the dynamic brake process.

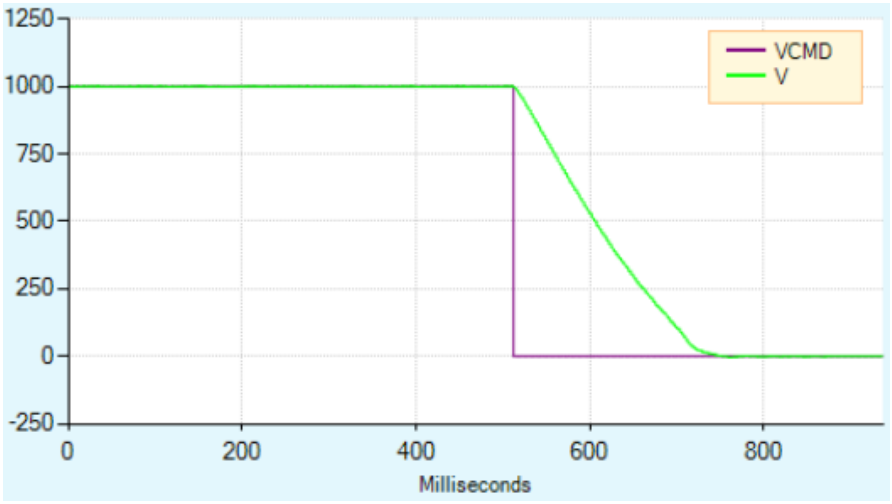



**Figure 7-14. Dynamic Brake with Low ISTOP Value**

Active Disable and dynamic brake are both supported in DISMODE4 and DISMODE5 modes. In these examples, active disable is used to stop the motor and dynamic brake comes into play after DISTIME.

## 7.11 Motor Brake Control

BDHDE has a dedicated brake output.

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

The digital output polarity can be changed to match the drive electronics to the motor control circuit.

BDHDE disabling time can be set via the DISTIME parameter. When the drive receives a disabling command, it first turns off the brake output and then waits for the brake disengagement time to expire before the actual disabling takes place.

The brake engagement time cannot be set. When the drive receives the enabling command, the brake output is turned on at the same time to complete enabling.

It takes up to 1.5ms for the drive to be enabled, while brake disengagement usually takes tens of milliseconds.

**Procedure: Configure Digital Outputs Control Brake**

To configure the digital output, please execute the following procedure of BDHDE .

1. Define the Output.

   Go to the "Digital I/O" interface and set Output 3 to Mode 2 - Brake release signal.




**Figure 7-15. Digital Outputs Setup for Motor Brake Control**

Default:

- When BDHDE is enabled, the brake output is turned on.
- When BDHDE is disabled, the brake output is turned off.

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

   DISTIME defines the time period after the motor falls below the "Active Disable Speed Threshold" (DISSPEED) until the drive is disabled by the "Active Disable" function.

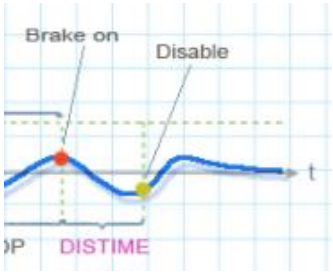



**Figure 7-16. Active Disable Time (DISTIME)**

When the "Disabling" command is executed, BDHDE immediately changes the brake output value and waits for the "Active Disable Time" (DISTIME) to expire before disabling the BDHDE control.

In the event of a fault such as hardware overcurrent or loss of feedback, the drive immediately switches the brake output value and disables BDHDE control.

## 7.12 Homing

BDHDE offers a variety of methods for motor homing.

Use ServoStudio2 "Home" interface to define and execute the homing procedure.

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

| VarCom | Description |
|---|---|
| HOMEACC | Acceleration and deceleration values in the process of homing. |
| HOMECMD | Start homing process. |
| HOMECMD 0 | Stop homing process. |
| HOMEOFFSET | Set the "zero" offset (count). |
| HOMESPEED1 | Initial speed used for the homing process during the search for limit switches and zero position switches. |
| HOMESPEED2 | The speed used for the homing process during a search for a homing trigger (which may be an index pulse, limit switch transition, zero position switch transition or other source (as defined by HOMETYPE)). |
| HOMESTATE | Displays the current state of the system homing process. |
| HOMETYPE | Defines the homing process type that will be executed. |

The parameter HOMETYPE defines the time to reverse the direction of motion during the homing, the homing trigger (e.g. switch, index) and other conditions.

Homing types 1-14, 17-30 and 33-35 are standard homing methods, as defined in *CiA 402*.

### 7.12.1 Home at Index

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

Homing methods: HomeType 1–14, 33, 34.

In these methods, HOMESPEED1 is used before a limit switch, zero position switch or hard stop is detected.

Once the appropriate sequence time has occurred (e.g. limit switch direction reversal), the axis detects the index pulse (or equivalent signal from the absolute encoder) with HOMESPEED2 motion.

### 7.12.2 Home at Positive or Negative Edge

Homing Method: HOMETYPE 17-30

Home on the falling edge of the positive/negative limit or on the upper/lower edge of the homing switch.

### 7.12.3 Specify the Current Position as the Homing Position

Homing method: HOMETYPE 35

Specifies the current position as the homing position.

# 8 Operation

## 8.1 Drive Enable



WARNING! Enabling the drive may cause motor movement.

Three conditions are required to enable the BDHDE drive:

- No fault.
- The software enabling switch must be ON (SWEN = 1).
- The remote enabling switch must be ON (remote = 1).

Use the ServoStudio2 "Enabling and Fault" interface to view and control the conditions required to enable the drive.

The following elements provide a visual indication of the drive's enabled or disabled state:

- The Enable|Disable button in the ServoStudio2 toolbar indicates the state of the drive.




If the light is on, the drive is enabled (activated). The motor is being energized.

If the light is not on, the drive is disabled.

- The decimal point on the drive's digital display indicates the drive's enabling/disabling state.



If the point is illuminated when the operation mode is displayed, the drive is enabled, as shown in the example here.

If it is not illuminated, the drive is in a disabled state.

## 8.2 Drive Operation Modes

BDHDE can run in multiple operation modes. Each operation mode has a main control loop (current/torque, speed or position) and a specific type of command input.

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

0 = speed control, using serial commands

2 = current control, using serial commands

4 = pulse sequence control (AP type drive only)

8 = position control, using serial commands

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

1 = outline position

3 = outline speed

4 = outline torque

6 = Homing

8 = periodic synchronization position

9 = periodic synchronization speed

10 = Periodic synchronisation torque

See the *EtherCAT Reference Manual* for details.

## 8.3 Current Operation

### 8.3.1 Serial Current Operation

In serial current mode (OPMODE 2), only the current loop is active and the drive responds to the commands received through USB.

Apart from tuning the current loop, no drive variables need to be set to operate the drive in this mode.

In the ServoStudio2 "Motion" interface, select "Work Mode" - Serial Current for modifying and testing parameters.

### 8.3.2 Current Control

**Note s** There is no need to manipulate the values in the "Current Loop" interface unless requested by technical support.

The current control loop tuning is derived from the motor parameters and the bus voltage, and the current control loop can be tuned via the ServoStudio2 "Motor Setup" wizard.

## 8.4 Velocity Operation

### 8.4.1 Serial Velocity Operation

In serial speed mode (OPMODE 0), the drive current and speed loops are activated and the drive responds to the command received via USB. The speed specified by the command is subject to the settable acceleration and deceleration limits.

In the "Motion-Work Mode" interface of ServoStudio2, select "Working Mode"-Serial Speed for modifying and testing parameters.

### 8.4.2 Speed Control

Refer to VarCom VELCONTROLMODE .

- PDFF Controller (Using KVP, KVI, KVFR)

**Pseudo-Differential Feedforward Feedback (PDFF) Controller**

Refer to VarCom VELCONTROLMODE 1.

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

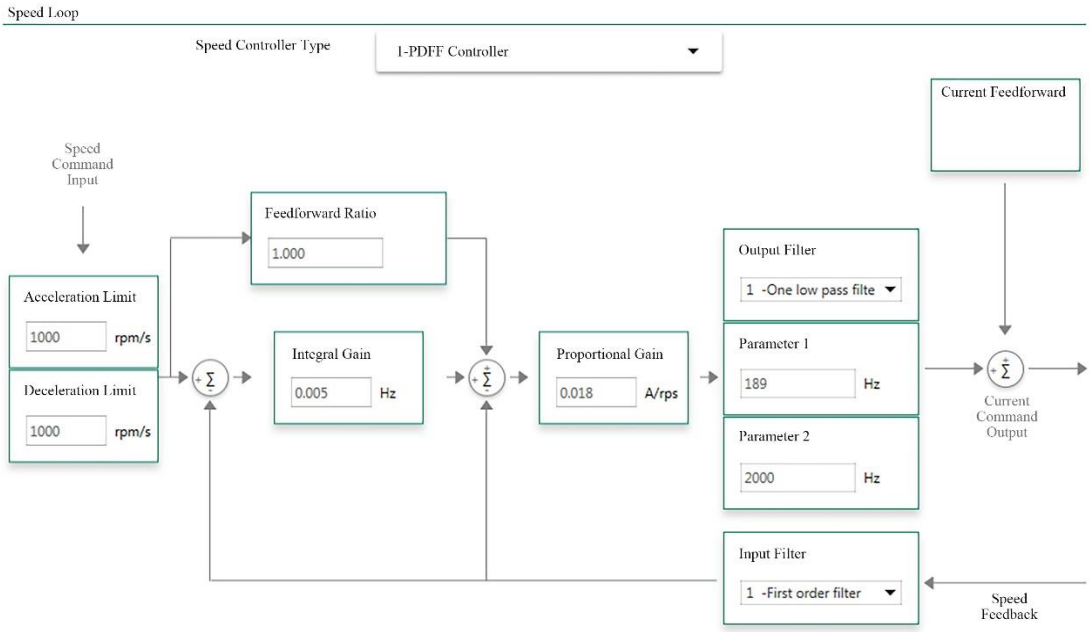



**Figure 8-1. -Speed Control Loop - PDFF Controller**

When the practical application requires fast responsiveness, the KVFR can be set to a higher value. When the application requires low overshoot, the KVFR can be set to a lower value, but this also results in a slower system response.

## 8.5 Position Operation

### 8.5.1 Serial Position Operation

BDHDE has a dedicated operation mode (OPMODE 8) for simple positioning applications on the serial port. The host transmits serial commands through the serial port, which include the target position and cruise speed, as well as additional motion track information (such as acceleration, deceleration and track type).

The parameters can be modified and tested by selecting "Work Mode" - Serial Position in the ServoStudio2 "Motion" interface.

| VarCom | Description |
|---|---|
| ACC | Acceleration |
| DEC | Deceleration |
| PE | Position error. PE is the difference between the position command PCMD and position feedback PFB |
| PCMD | Position command |
| PFB | Actual position feedback |

**Incremental (Relative) Motion**

Incremental or relative motion, motion relative to the current position.

| VarCom | Description |
|---|---|
| MOVEINC | Execute incremental position motion according to settings |

The position feedback (PFB) value can be modified or compensated using the parameter PFBOFFSET. This parameter is used to manually home or to test incremental motion.

**Procedure: Set the Current Position to 0**

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

**Absolute Motion**

Absolute motion is always relative to an absolute point of reference.

Refer to the point where position feedback (PFB) = 0.

| VarCom | Description |
|---|---|
| MOVEABS | Perform absolute position motion according to settings |

**Motion Completed**

The following parameters are used to define and indicate the motor state at the end of the motion.

| VarCom | Description |
|---|---|
| PEMAX | Maximum permissible position error (not generating fault). |
| PEINPOS | Tolerance window declaring the "in place" state.<br>The motor is considered to be in place when the PE (Position Error) value is less than the PEINPOS (Position Error Tolerance) value.<br>The motor is considered stable when the PE (Position Error) remains below PEINPOS for the time defined by PEINPOSTIME. |
| INPOS | Indicates the "motor in place" state. Read only.<br>When the motor is in place, INPOS=1, regardless of the motion track state.<br>As long as the motor is not in place, INPOS=0. |
| STOPPED | Indicates the "motor stable" state. Read only.<br>STOPPED=0, motion track in progress.<br>STOPPED=1, track completed. |

## 8.5.2 Position Control

BDHDE uses a linear position controller algorithm.

**Linear Position Controller**

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

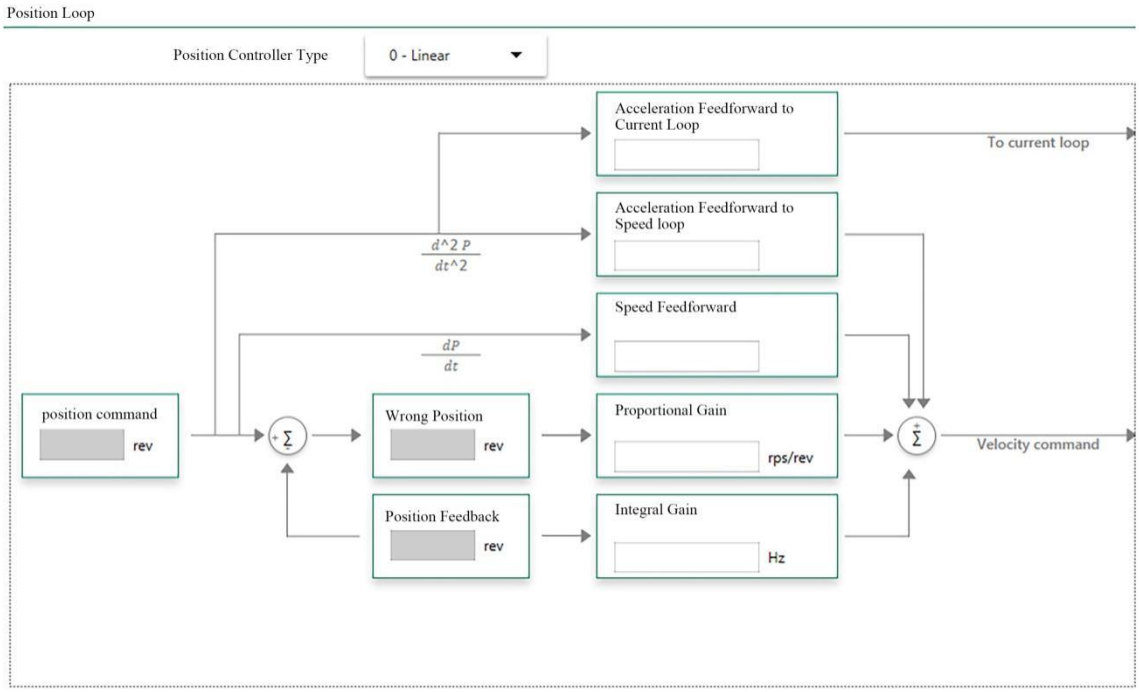



**Figure 8-2. Position Control Loop - Linear**

## 8.6 Pulse Sequence

**Notes**

Only AP type drives have pulse sequence control mode.

To set the AP type drive parameters using the ServoStudio2 GUI, versions 2.18.5.11 and later are required.

The parameters below are used to configure and monitor pulse sequence control:

| VarCom | Description |
|---|---|
| OPMODE | For OPMODE 4:<br>The drive system is controlled by pulse sequence. |
| GEAR | Pulse input enabled.<br>GEAR = 0: pulse input disabled.<br>GEAR = 1: pulse input enabled. |
| APINSOURCE | Pulse input source.<br>APINSOURCE = 0: single-ended signal input.<br>For setting as single-ended input, DI 1 has to be configured as 17-pulse signal and DI 2 as 18-directional signal.<br>The default DI 1 function of the AP type BDHDE drive is 17-pulse signal, and DI 2 is 18-directional signal.<br>APINSOURCE = 1: differential signal input. No additional port function selection and configuration is required. |
| GEARMODE | Pulse input shape.<br>Gear mode = 0: AB orthogonal signal.<br>GEARMODE = 1: pulse + direction.<br>GEARMODE = 2:CW+CCW. |

| VarCom | Description |
|---|---|
| APINLOGIC | Pulse input logic.<br>APINLOGIC = 0: Positive logic, i.e. idle time pulse low.<br>APINLOGIC = 1: inverse logic, i.e. idle time pulse high. |
| XENCRES | Pulse input resolution. |
| GEARIN | Numerator of the gear ratio.<br>GEARIN/GEAROUT> 0 means that the direction of input rotation is positive.<br>GEARIN/GEAROUT< 0 means that the direction of input rotation is negative. |
| GEAROUT | Denominator of the gear ratio.<br>GEARIN/GEAROUT>0 means that the direction of input rotation is positive.<br>GEARIN/GEAROUT< 0 means that the direction of input rotation is negative. |
| APCOUNTER<br>HWPEXT | The 2 variables both represent the cumulative value of the number of pulses received by the drive. |
| APCOUNTERCLR | The pulse count value is cleared to zero.<br>Clear the cumulative value of pulses received by the drive, and after entering APCOUNTERCLR at the terminal, APCOUNTER and HWPEXT = 0. |
| INFLTTIME2 | Pulse filter time constant, in 10ns.<br>APINSOURCE = 0: default INFLTTIME2 = 80.<br>APINSOURCE = 1: default INFLTTIME2 = 5. |
| ENCOUTMODE | Frequency division pulse output mode.<br>ENCOUTMODE = 0: no output.<br>ENCOUTMODE = 1: output the input pulse directly.<br>ENCOUTMODE = 2: Outputs pulses according to ENCOUTRES frequency division. |
| ENCOUTRES | Pulse output resolution.<br>A positive number means that phase A leads phase B by 90 degrees.<br>A negative number means that phase B leads phase A by 90 degrees. |

### 8.6.1 Pulse Sequence Control Operation

Select "Pulse sequence" via "Wizard" - "Application setup" - "Interface mode". Click "Next".

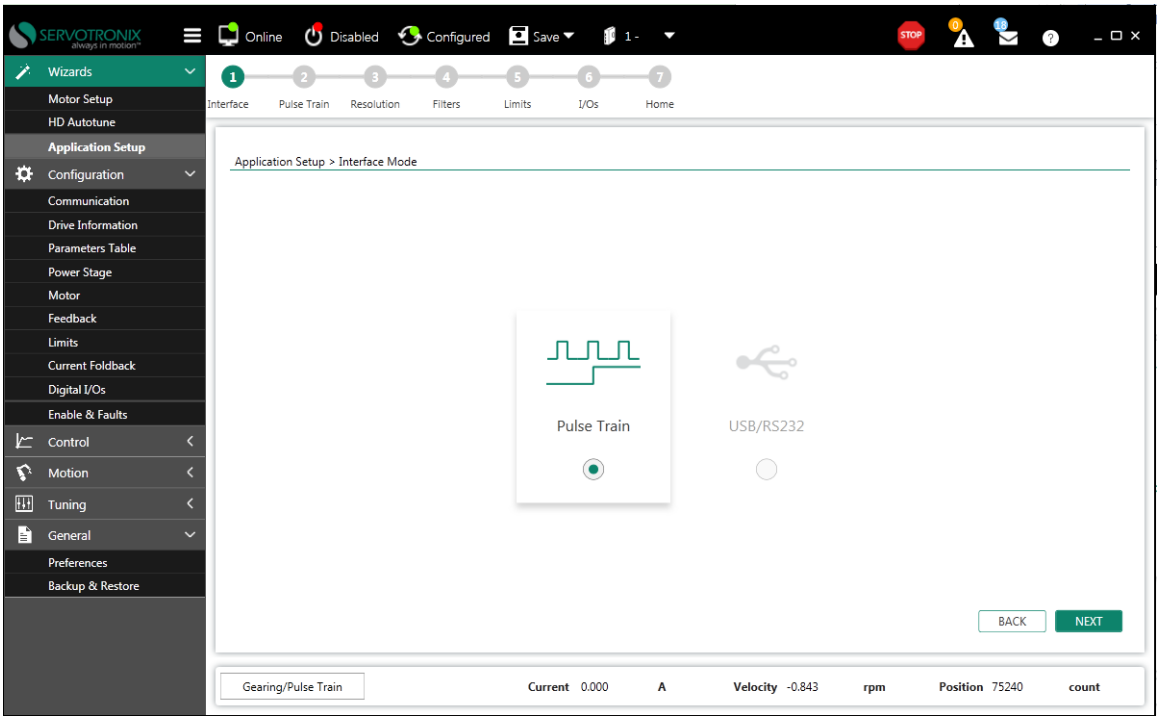



**Figure 8-3 ServoStudio2 - Application Setup Wizard - Interface Mode**

The "Pulse Sequence Setup" interface allows you to set the shape of the accepted pulse, with differential or single-ended pulses to be selected on the left and 3 pulse shapes on the right. For pulses entering the BDHDE drive control chip, the idle level is low by default. If a pulse signal with a high idle level needs to be accepted, the APINLOGIC needs to be set to 1. Click "Next".

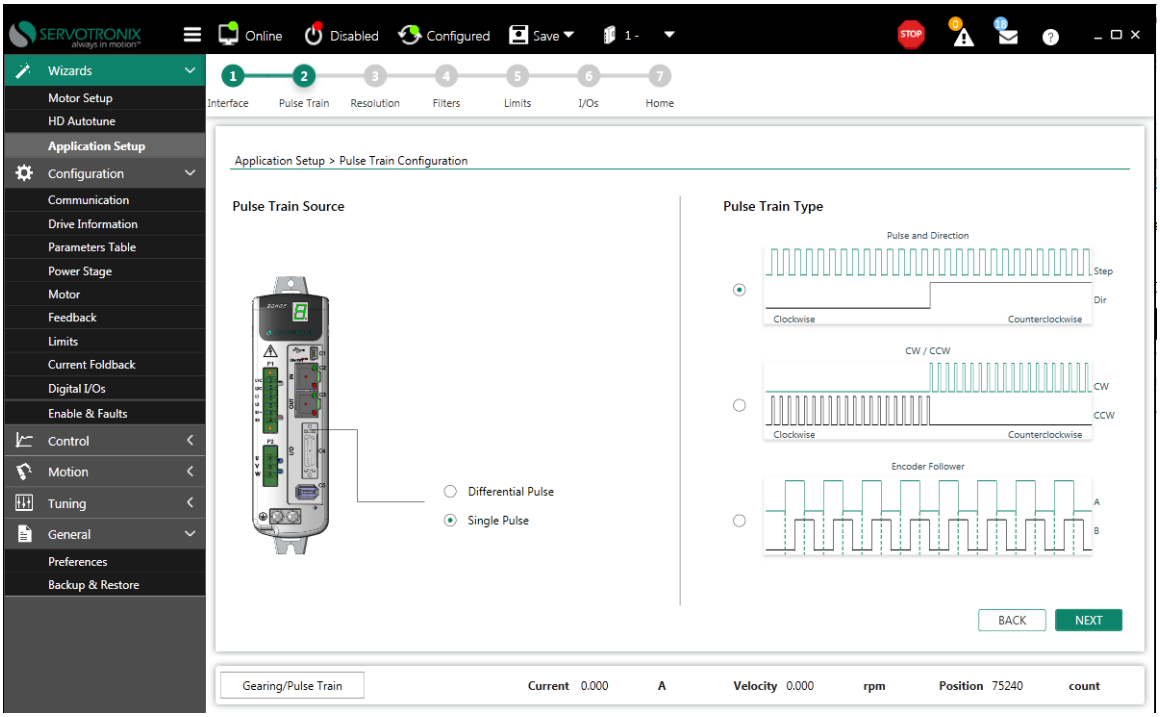



**Figure 8-4 ServoStudio2 - Application Setup Wizard - Pulse Sequence Configuration**

The "Resolution" interface allows you to set the resolution of the pulse reception and output; the "Input Resolution" corresponds to the variable XENCRES, the "Gear Numerator" to GEARIN and the "Gear Denominator" to GEAROUT. The conversion relationship between the controller output pulse and the internal position command is:

$$\text{Internal Position Command} = \text{Controller Output Pulse} \times \frac{\text{MENCRES} * 4}{\text{XENCRES}} \times \frac{\text{GEARIN}}{\text{GEAROUT}}$$

The AP/EC type BDHDE supports pulse divider output with an "output resolution" corresponding to ENCOUTRES, i.e. when ENCOUTRES is 10000 and the motor turns 1 revolution, the drive actually outputs 2500 A and B pulses with a phase difference of 90 degrees to the controller.

When the "Mode" corresponds to ENCOUTMODE, select "On (Analogue Index)", then the pulse output is given at the resolution set by ENCOUTRES; select "On (Output Following Input)", then the drive outputs the 2 pulses received as they are; select "Off", then the output is not divided. Only when "Mode" is selected as "On (Analogue Index)" can the "Output Resolution" be set on this interface.

The conversion relationship between the pulse received by the controller and the encoder feedback is:

$$\text{Controller reception} = \text{Encoder Feedback} \times \frac{\text{ENCOUTRES}}{\text{MENCRES} * 4}$$

Click "Next".

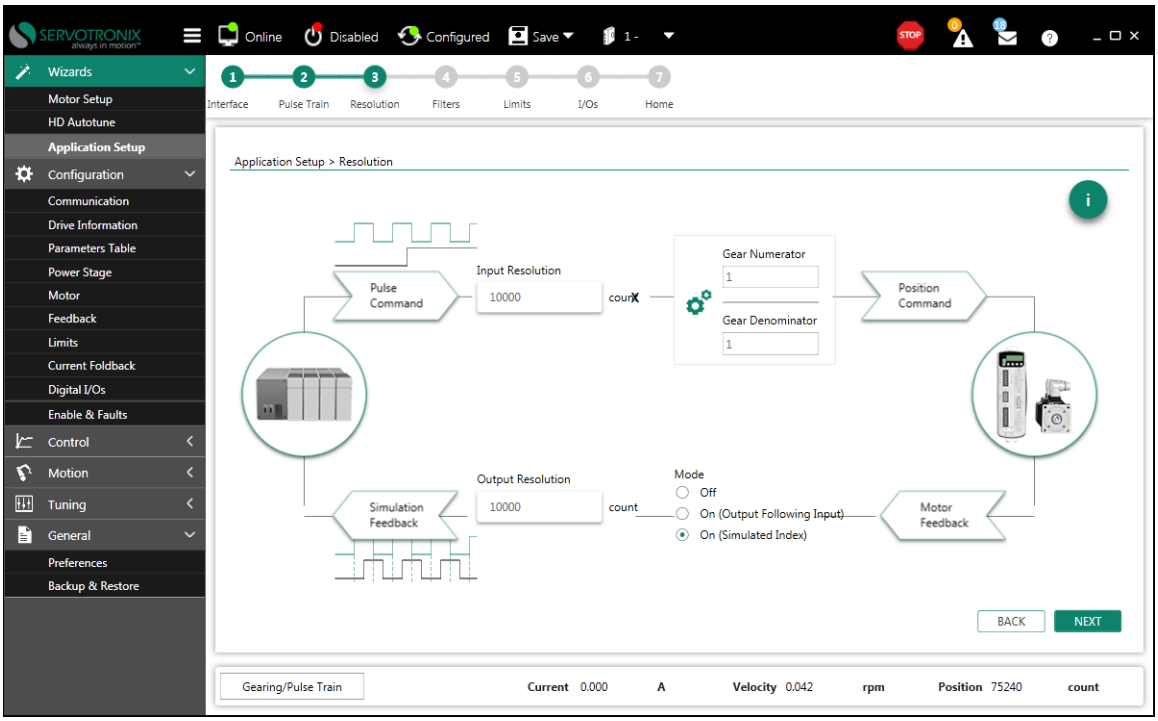



**Figure 8-5. ServoStudio2 - Application Setup Wizard - Resolution**

In the "Filter" interface, you can select and set the command smoothing filter; check the "Smoothing filter" to use the smoothing filter, or uncheck the box to refuse it. The filter time constant of the smoothing filter can be set by moving the filter slider or by setting the filter time constant in the settings box above the slider. The constant can only be set to an integer multiple of 0.25, otherwise a pop-up window will warn of an error.

Click "Next".

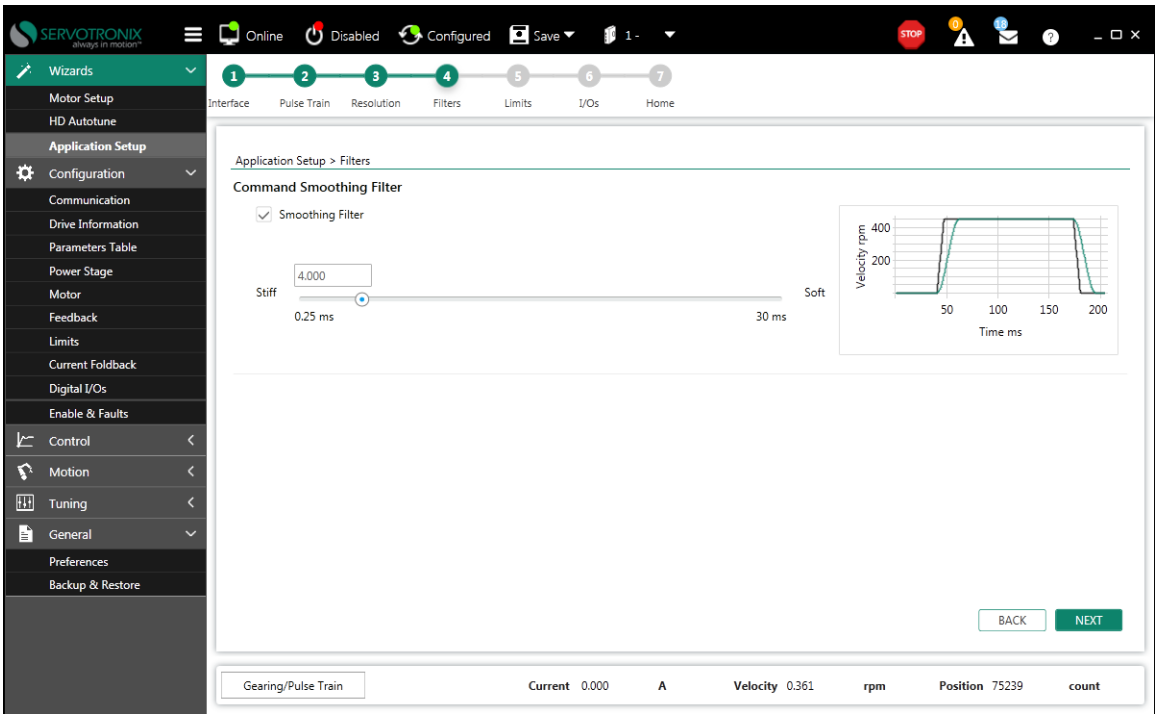



**Figure 8-6. ServoStudio2 - Application Setup Wizard - Filter**

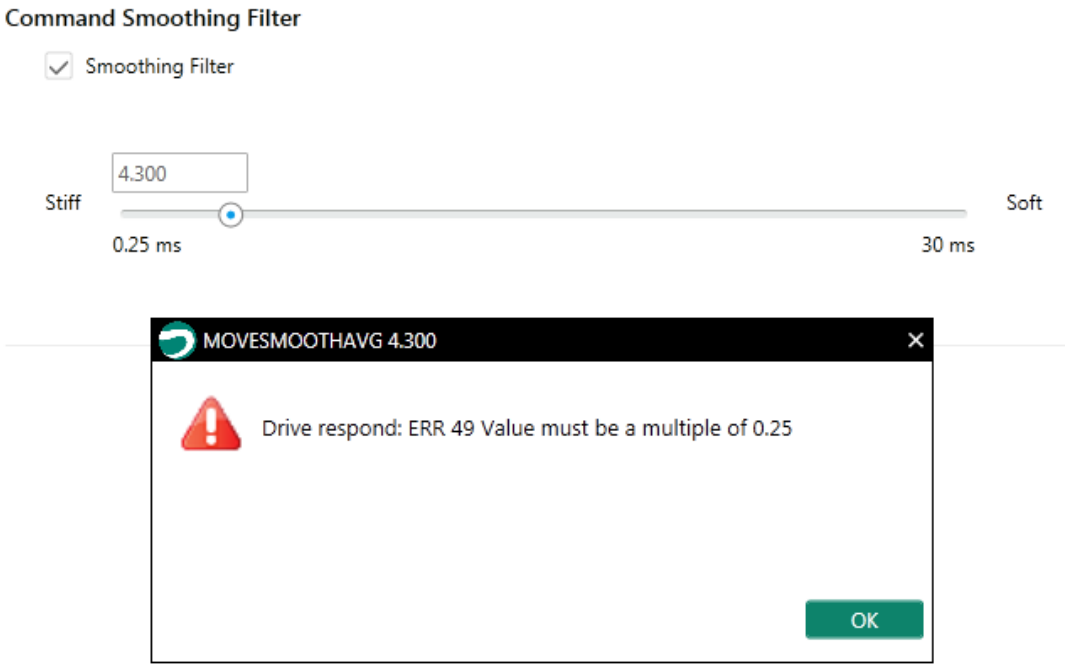



**Figure 8-7 ServoStudio2 - Application Setup Wizard - Filter Setting Error**

The "Limits" interface allows setting the limit values for the servo system, which is similar to the "Serial Position" mode and therefore not further explained.

Click "Next".

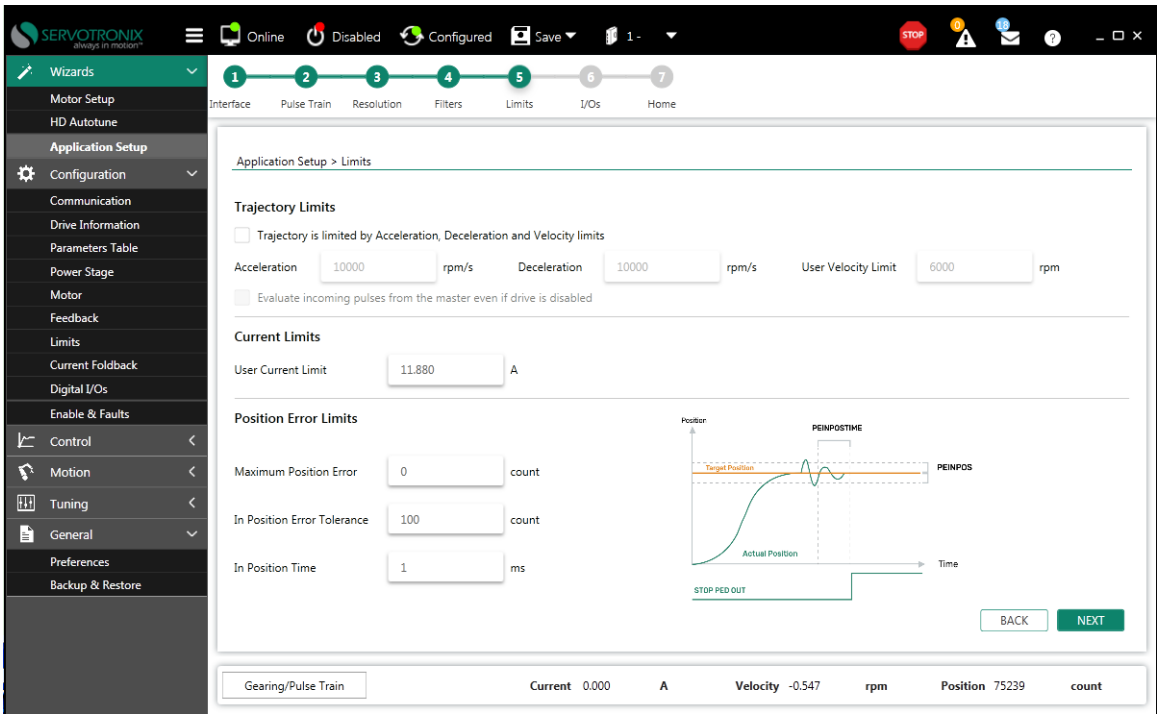



**Figure 8-8. ServoStudio2 - Application Setup Wizard - Limits**

The "I/O" interface lists a number of commonly used input and output functions where the user can easily configure the desired port to these functions.

Click "Next".

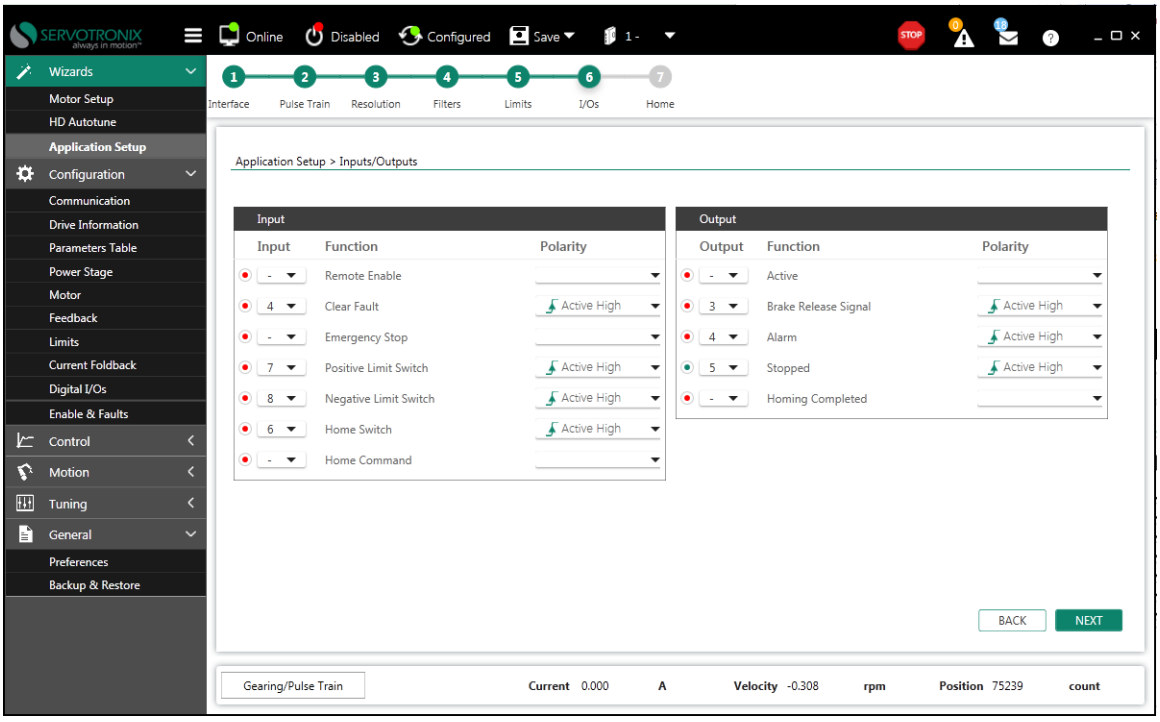



**Figure 8-9 ServoStudio2 - Application Setup Wizard - I/O**

The "Home" interface allows the setting of homing parameters; please refer to the relevant section for details. Click "Save" to save the configured parameters. Click on "Finish" and the screen jumps to the "Motion" - "Operation Mode " interface.

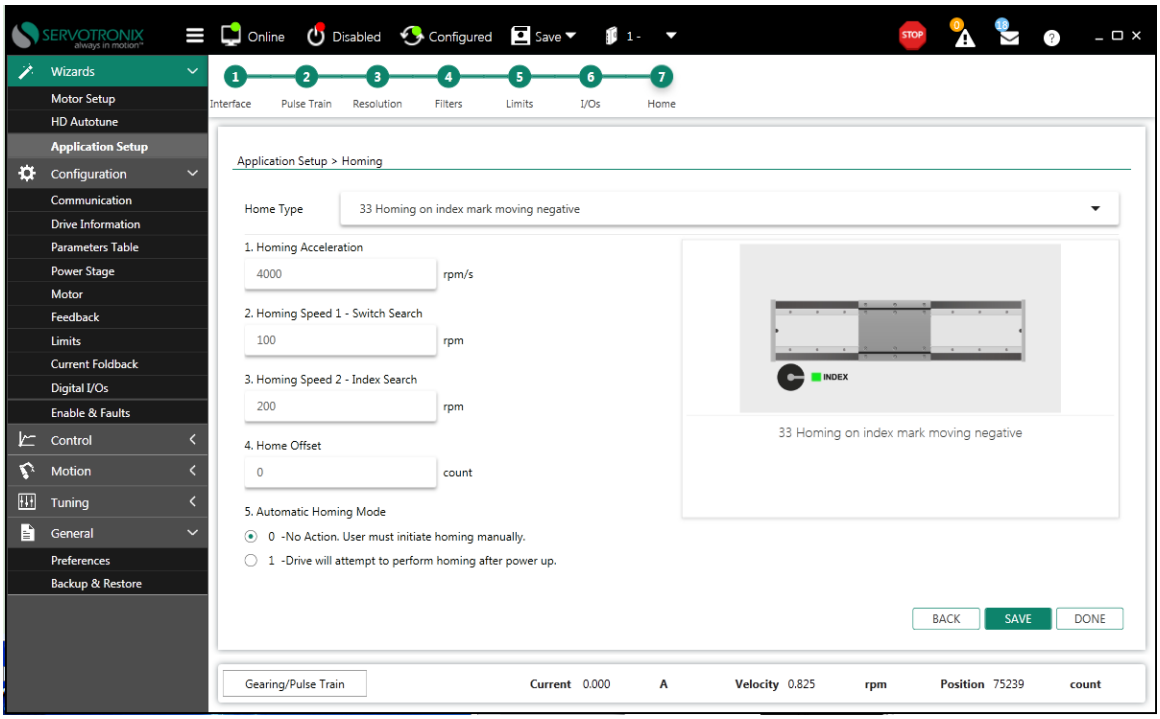



**Figure 8-10. ServoStudio2 - Application Setup Wizard - Home**

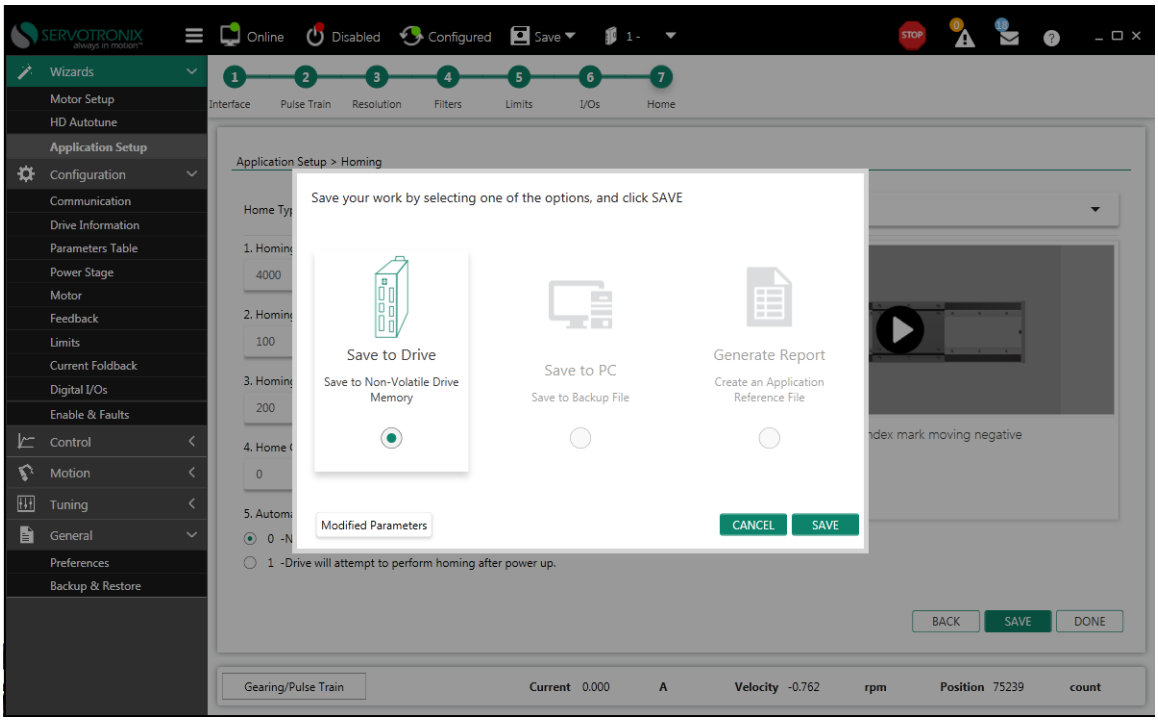



**Figure 8-11. ServoStudio2 - Application Setup Wizard - Save**

Select "Pulse Sequence" for "Work Mode" to modify some parameters of the pulse sequence control.

The "External Output" shows the value of the pulse count sent by the controller, which is a cumulative value, 32 bits.

If the "Electronic Gearing Active" option is checked, pulse input is allowed. If it is not checked, pulse input is disabled.

The "Filter" indicator is green to indicate that the command smoothing filter is used, red to indicate that the command smoothing filter is not used.

The "Ratio" shows the value of GEARIN/GEAROUT at this time.

"Position Command" shows the position command of encoder unit at this time, which is generally offset from "External Input".

Below are 3 tabs where the parameters of the pulse control mode can be easily modified by selecting "Pulse Sequence", "Ratio" and "Filter".

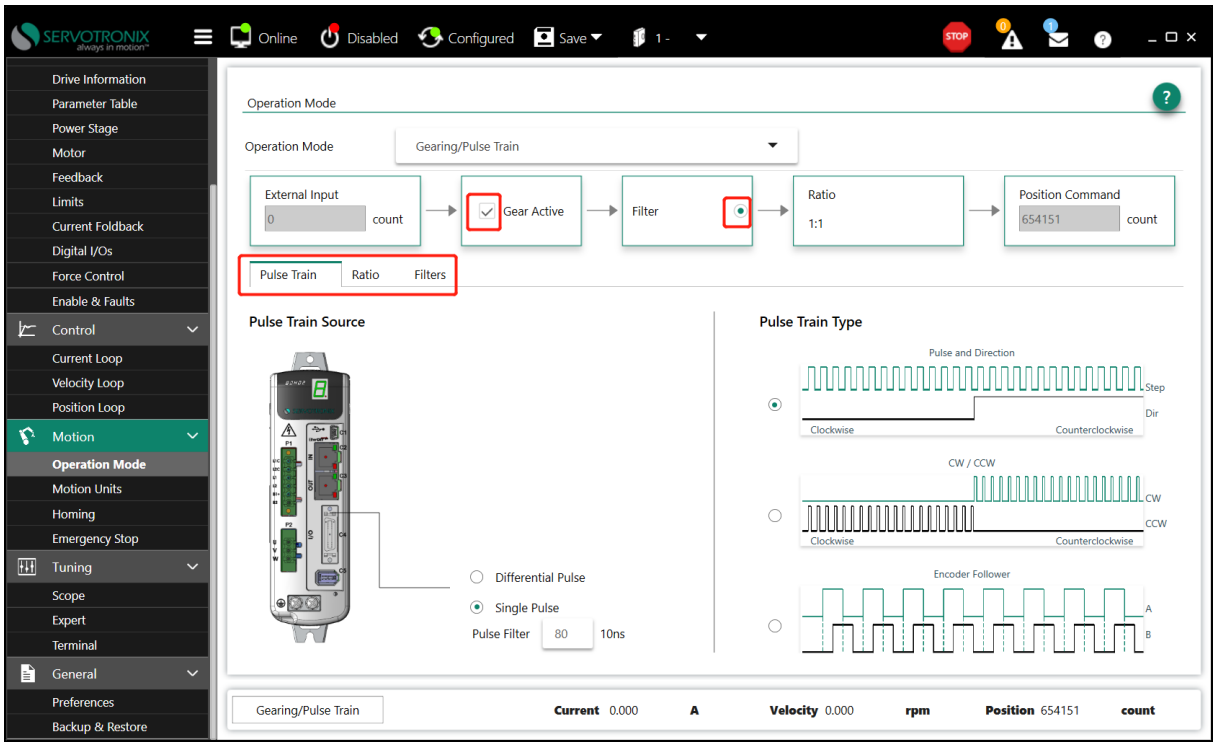



**Figure 8-12. ServoStudio2 - Motion - Operation Mode - Pulse Sequence**

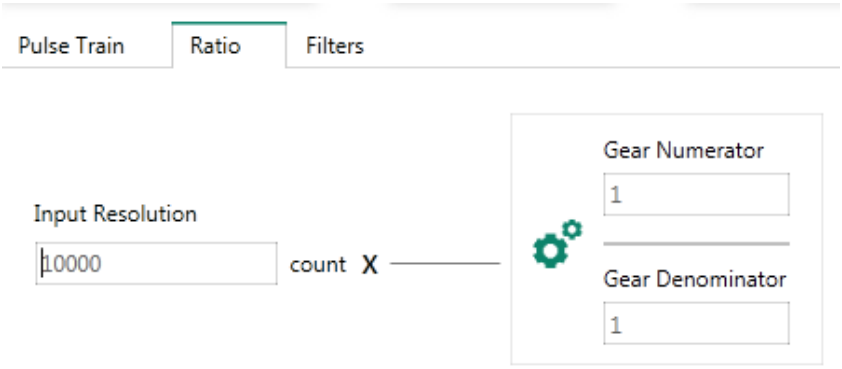



**Figure 8-13. ServoStudio2 - Motion - Operation Mode - Pulse Sequence - Ratio**

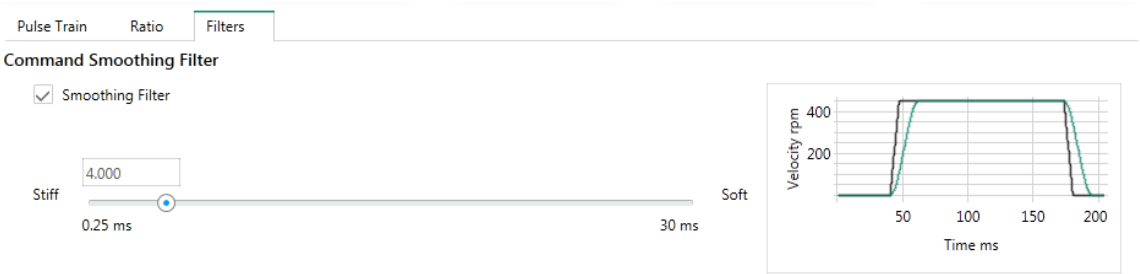



**Figure 8-14 ServoStudio2 - Motion - Operation Mode - Pulse Sequence - Filter**

### 8.6.2 Pulse Sequence Control

Adjustment of drive control parameters, as in section 8.5.2 *Position Control*.

# 9 Tuning

## 9.1 Inertia Identification

When you are not sure about the inertia ratio of the load to the motor, you can use the "Inertia Identification" function to estimate the load inertia ratio.

### 9.1.1 Parameters

| VarCom | Description |
|---|---|
| LOADESTEN | Inertia identification enabling control<br>0: Inertia identification is not activated (read), or inertia identification is switched off (write)<br>1: Inertia identification is activated (read), or inertia identification is switched on (write) |
| LOADESTMOTION | Motion direction of inertia identification<br>0: Positive direction first, then reverse direction (default)<br>1: Reverse direction first, then positive direction<br>2: Positive direction<br>3: Reverse direction |
| LOADESTRATIO | Identified load inertia ratio |
| LOADESTVAL | Identified total inertia |
| LOADESTDIST | Inertia identification distance (in rev/turn) |
| LOADESTMAXVEL | Inertia identification speed |
| LOADESTSTATUS | Inertia identification state |

### 9.1.2 Example

The LOADESTRATIO command is entered into the ServoStudio2 command terminal to perform inertia identification and obtain the load inertia ratio, and the identified rotational inertia ratio is assigned to the controller by means of the LMJR command.

```
-->LOADESTEN 1
-->LOADESTRATIO
5.595
-->LMJR 5.6
```

The figure below shows the speed response curve before and after setting the rotational inertia ratio based on the identification results.

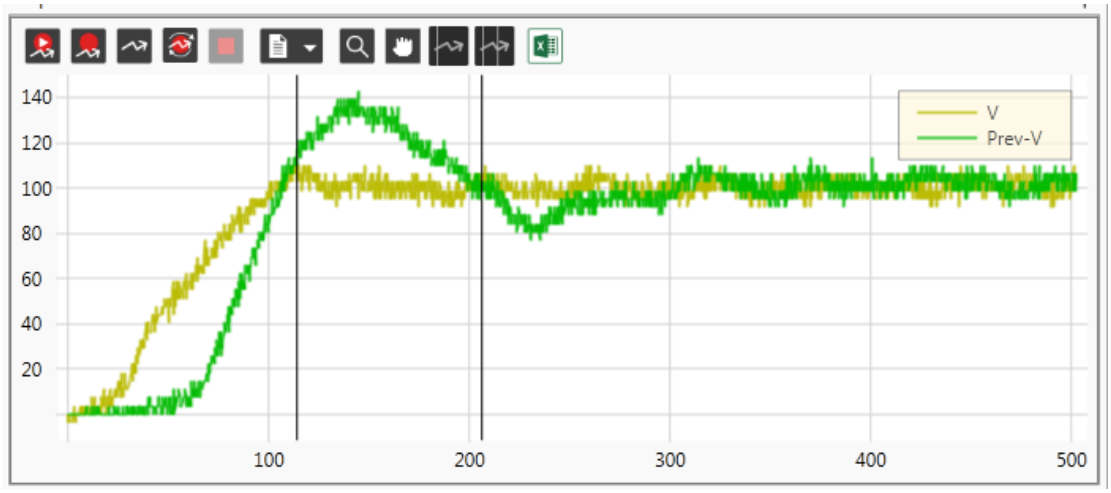



**Figure 9-1. The Speed Response Curve Before and After Setting the Rotational Inertia Ratio Based on the Identification Results**

## 9.2 Rigidity Table

The rigidity table stores the combination of gain and filter parameters for the control loop, with different rigidity grade (RIGID) corresponding to different dynamic response performance of the system.

### 9.2.1 Parameters

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

### 9.2.2 Example

Enter RIGID {rigidity grade} in the ServoStudio2 command terminal.

The figure below shows a comparison of the speed response of rigid 13 and rigid 16.

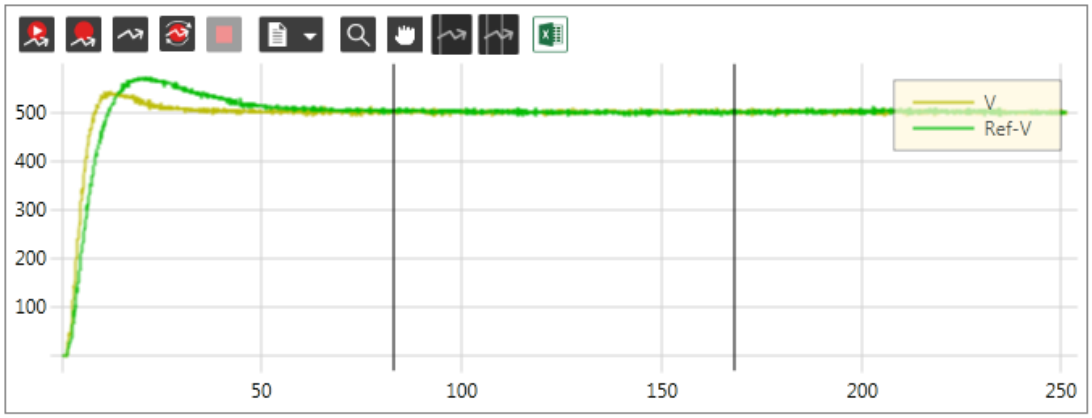



**Figure 9-2. Speed Response for Different Rigidities (1)**

The figure below shows a comparison of the speed response of rigid 13 and rigid 10.

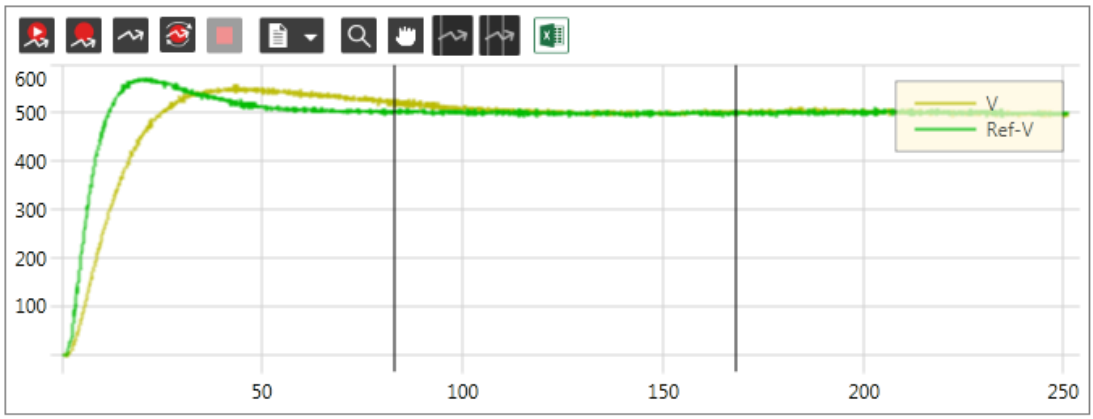



**Figure 9-3. Speed Response for Different Rigidities (2)**

| Rigidity Grade | Position Loop Gain (1/s) | Speed Loop Gain (Hz) | Speed Integration 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 |
| 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 |

| Rigidity Grade | Position Loop Gain (1/s) | Speed Loop Gain (Hz) | Speed Integration Time Constant (ms) | Torque Filter Time Constant (ms) |
|---|---|---|---|---|
| 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 |

## 9.3 Load Adjustment Free Function

### 9.3.1 Parameters

| VarCom | Description |
|---|---|
| TUNINGAUTOEN | 0: Load adjustment free function off<br>1: Load adjustment free function on<br>Default value: 0 |
| TUNINGLEVEL | Range: 0-6, the higher the value, the higher the speed response. Choose the right range for your specific application.<br>Default value: 2 |
| TUNINGLOAD | 0: Optimal speed response with 2x inertia ratio load<br>1: Optimal speed response with 5x inertia ratio load<br>2. Optimal speed response with 10x inertia ratio load<br>3. Optimal speed response with 20x inertia ratio load<br>Default value: 2 |

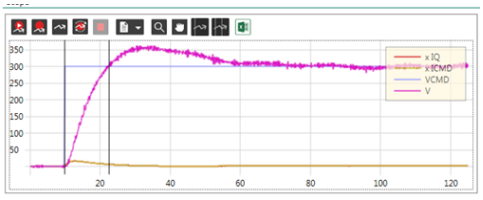
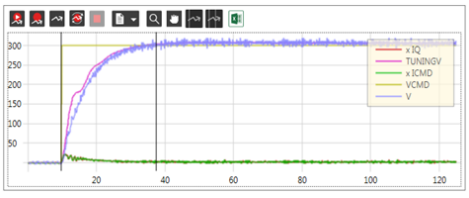
**Notes**

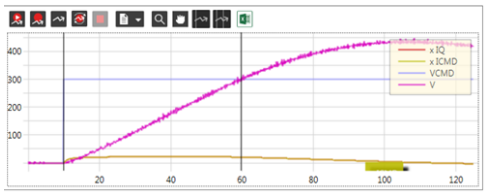
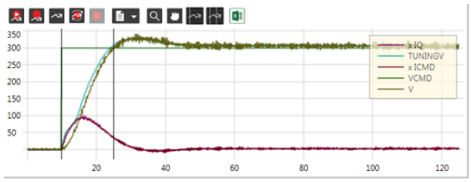
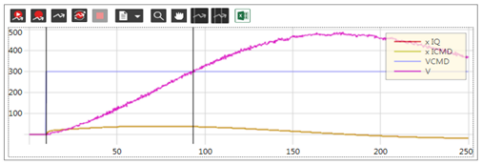
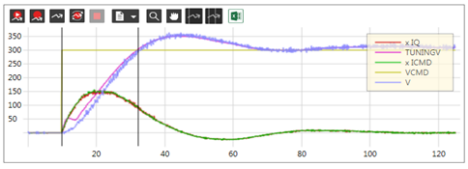
When the load adjustment free function is switched on, the commands related to the original speed loop regulator, torque feedforward filter and speed feedback filter are blocked and modified.

The open-loop bandwidth (KVBW value) of the speed loop corresponding to TUNINGLEVEL is not exactly the same as the actual system bandwidth; the speed loop bandwidth after enabling load adjustment free is subject to actual measurement .

### 9.3.2 Example

Compare the different speed response performance with no load, 8x inertia ratio and 20x inertia ratio with load adjustment free off and on.

| | Load Adjustment Free Off | Load Adjustment Free On |
|---|---|---|
| VarCom Command | TUNINGAUTOEN 0<br>RIGID 13 | TUNINGAUTOEN 1<br>TUNINGLEVEL 2<br>TUNINGLOAD 2 |
| No Load |  |  |

| | Load Adjustment Free Off | Load Adjustment Free On |
|---|---|---|
| 8x inertia |  |  |
| 20x inertia |  |  |

## 9.4 Recording and Evaluating Performance

### 9.4.1 Record Data in ServoStudio2

**Procedure: Record Data in ServoStudio2 - Example**

1. Select the Motion tab in the "Tuning - Oscillogram" interface of ServoStudio2.
   - Make sure that the operation mode is set to serial position.
   - Set the value of the target position to 3 rev.
   - Sett motion parameters
     - Maximum velocity (cruise velocity) set to 1000 rpm
     - Acceleration (and deceleration) set to 50000 rpm/s
   - Please select the "Alternating" option if back and forth motion is required.

   The aim is to obtain motional tracks with sufficient duration of acceleration, smoothing and deceleration stages.
2. In the Oscillogram panel, select the following "Record Variables":
   - PTPVCMD (Position command speed)
   - ICMD (Current command)
   - PE (Position error)
3. In the Oscillogram panel, enter sample values and trigger variables:
   - Samples: 1000 (sampling depth 1000 points)
   - Time Interval: 16 (time interval between two adjacent points: 31.25us * 16 = 0.5ms)
   - Trigger Setup: IMM (immediate trigger mode)
4. Make sure that the drive is enabled, and then click the "Run Record and Draw" button in the "Oscillogram" toolbar.



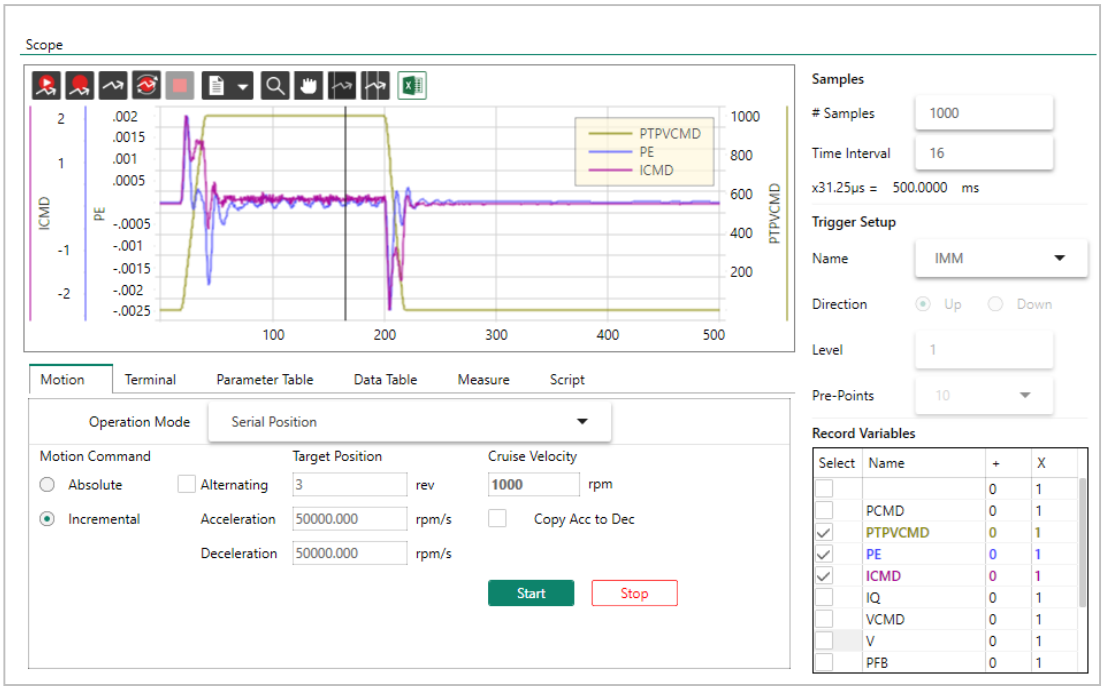



**Figure 9-4 Motion Resulting from Default Parameter Values**

## 9.4.2 Record Data in the Terminal

**Procedure: Record Data (Terminal)**

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

   The syntax of the record command is:

   RECORD {sampling time} {points} {variable 1} [variable 2] [variable 3]

   Example: RECORD 32 100 "VCMD "V "ICMD

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

   Note that the variable must be preceded by an inverted comma (").

2. Use the command RECTRIG to define variables and conditions that trigger sampling.

   The syntax of the sample trigger command is:

   RECTRIG {name} [level] [reserve point] [up|down]

**Notes**

If the specified number of pre-trigger samples is greater than the number of points actually sampled before the trigger, the pre-trigger segment of the sample will include the variable sampling values prior to the start of the motion.

For example, record a Jog(J) that starts at zero and spins to 1000 rpm with an acceleration of 10,000 rps/s; specify a trigger speed of 1 rpm, direction up, 128 pre-trigger points and 1 time interval. As there will be no 128 point pre-trigger action, the recorded data will be filled with zeros (zero speed command before motion).

3. Use the variables RECORD (record completed) and/or RECING (record in progress) to determine whether data for the record is available.
4. In BDHDE, recordable variables and trigger variables support all VarCom.

| Function | VarCom | Description |
|---|---|---|

| Function | VarCom | Description |
|---|---|---|
| Record Activation Commands | RECORD | Defines the variables to be recorded , and records time span and sampling time. |
| | RECTRIG | Define the trigger conditions for starting records and the duration of pre-trigger. |
| | RECOFF | Close active recording. |
| State Flags | RECRDY | Indicates that the record is ready. |
| | RECING | Indicates that a trigger condition has occurred and the record is active. |
| | RECDONE | Indicates that the record is complete. |
| Data Retrieval | GETMODE | Defines the format of recorded data (binary/ASCII). |
| | GET | Retrieve the data recorded. |

### 9.4.3 Evaluate 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 speed command, which can only be used as a derivative of position.

PTPVCMD is a track speed command applicable to all position loops.

An example of a PTPVCMD record indicating poor performance is shown in the figure below.

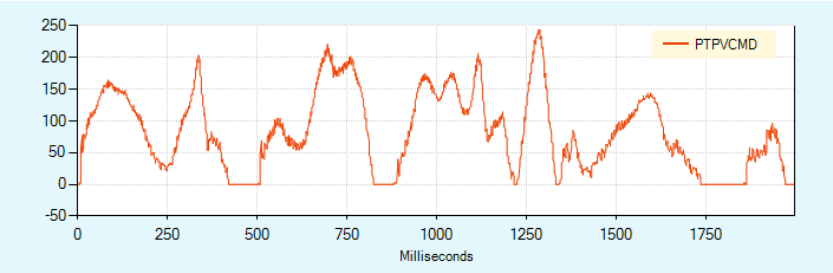



**Figure 9-5. Poor PTPVCMD Results**

### 9.4.4 Evaluate ICMD and/or PE Oscillation

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

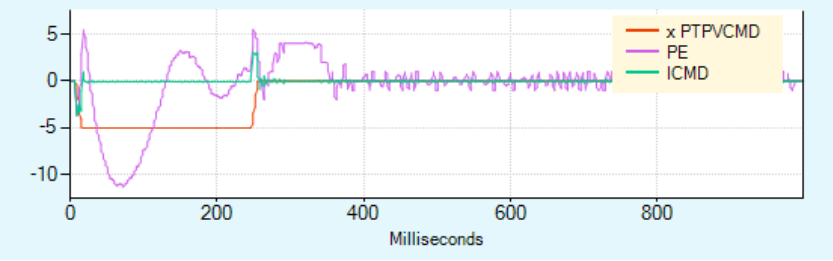



**Figure 9-6. Poor ICMD and PE Results**

To determine if there are oscillations and their frequency, use the ServoStudio2 FFT function on the PE or ICMD record:

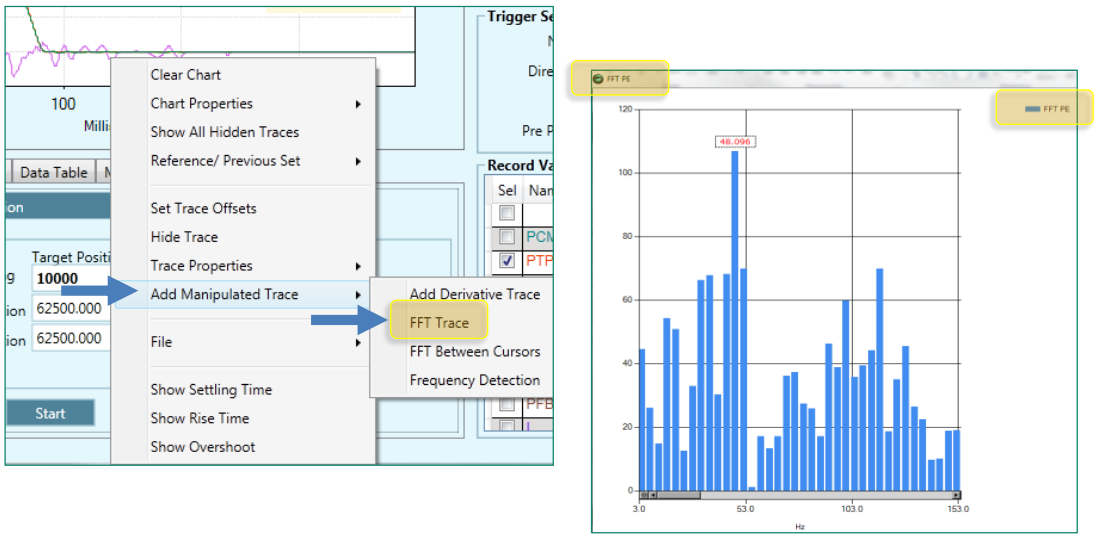



**Figure 9-7. FFT Track Evaluation**

## 9.5 Notch Filter

Notch filter can be used to eliminate high-frequency oscillation that may occur in a system with flexible connection between the motor and the load, such as:

- Ball screw linear slides with coupling
- Belt drive
- Harmonic reducer drive

Oscillation usually occurs in the first step of tuning (adjusting the gain), which is done by checking the oscillation frequency and setting the notch accordingly.

During tuning, notch filter can be used at any time to suppress oscillation at fixed frequency greater than 100 Hz.

The system is equipped with 2 sets of notch filters, connected in series to the speed controller output channels, the first set being in manual mode, with the following corresponding parameter variables:

- NOTCHMODE is set to 1, and the first group of notch filters is enabled
- NOTCHCENTER, the center frequency of the first group of notch filters
- NOTCHBW, the 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 to automatic, with the following corresponding parameter variables:

- NOTCH2MODE is set to 1, and the second group of notch filters is enabled
- NOTCH2CENTER, the center frequency of the second group of notch filters
- NOTCH2BW, the notch width of the second group of notch filters
- NOTCH2DEP, the notch depth of the second group of notch filters
- ANFEN configuration is 1, the second group of notch filters centre frequency automatic retrieval and automatic parameter setting is enabled

Note that the second set of notch filters must have NOTCH2MODE set to 1 before ANFEN is set to 1, and that NOTCH2CENTER cannot be set manually when ANFEN = 1 and only when ANFEN = 0.

The notch parameters of the second group of notch filters can be copied to the first group by command:

- NOTCHDUMP, the command sets no-follow parameters to achieve batch copying of the parameters of the second group of notch filters to the first group, while the parameters of the second group of notch filters are restored to their default values in order to re-conduct automatic detection and suppression of the new resonant frequencies.

# 10 Troubleshooting

## 10.1 Report Generator

Before contacting technical support, generate the application settings report through the report generator in ServoStudio2. The information contained in the report file will help technical support to troubleshoot your problems and provide support.

Generally speaking, it is highly recommended that you generate a report every time you finish the application configuration, even when the system is working properly.

The report generator option can be accessed from two locations in ServoStudio2:

- Application Setup Wizard (final step)
- Backup and recovery interface

## 10.2 Faults and Warnings

If BDHDE is connected to the host via USB interface, the fault code is transmitted to the host via text message. The message is saved in the fault history log (FLTHIST) in the non-volatile memory of the drive, so the fault history will not be lost when the power supply of the drive is restored.

- The warning is not considered a fault and does not disable operation. When the conditions for generating warnings no longer exist, the system will automatically clear the warning state.
- Fault will occur when settings or conditions may cause improper operation of the drive/motor and/or equipment damage. The fault will automatically disable the drive and display the fault state in the drive display and in the software interface.

  The fault state of the drive is usually latched, and the drive cannot be enabled until the fault state is explicitly cleared. The fault state can be cleared only when the fault condition no longer exists.
- Some faults are referred to as fatal faults as these will disable almost all drive functions (sometimes even communication functions) and prevent the drive from being enabled. This condition is typical of internal failure faults, such as a watchdog event or internal power fault. Fatal faults require technical support and guidance.

| VarCom | Description |
|---|---|
| CLEARFAULTS | Clears all latched faults. |
| FLT | Returns the list of faults latched by the drive. |
| FLTHIST | Returns the contents of the fault buffer history. |
| K \| EN | Disables the drive \| Enables the drive |
| READY | Indicates whether the drive is ready to start. |
| REMOTE | Indicates the external remote enabled input state. |
| ST | Returns the drive detailed state message. |

## 10.3 Fieldbus State LEDs

The interfaces C2 and C3 each have two LEDs to indicate the fieldbus state during communication on the EtherCAT network.




**Figure 10-1. EtherCAT Ports and LED**

| Indicators | Meaning |
|---|---|
| **Green** | Blinking: communication activity |
| | Constantly off: no communication activity |
| **Orange** | Constantly on: Operation (OP) state |
| | Slow blinking: Safe operation (SAFEOP) state |
| | Fast blinking: pre-operation (PREOP) state |
| | Very fast blinking: program loaded (BOOT) state |
| | Constantly off: initial (INIT) state |

## 10.4 Digital Display - Warning Codes

### _ MCU Real-Time Task Overload Warning



| | |
|---|---|
| **Definition** | MCU Real-Time Task Overload Warning |
| **Type** | Warning |
| **Message #** | WRN 36 |
| **Description** | The drive has detected that the CPU is approaching its calculation limit. |
| **Actions to Be Taken** | Please contact technical support. |

### b Multi-turn encoder battery low voltage



| | |
|---|---|
| **Definition** | Absolute multi-turn encoder battery low voltage warning |
| **Type** | Warning |
| **Message #** | WRN 22 |
| **Description** | Backup battery voltage level for absolute multi-turn encoder has dropped below 3.15V. |

| Definition | Absolute multi-turn encoder battery low voltage warning |
|---|---|
| Actions to Be Taken | Replace the battery as soon as possible.<br>If the battery is replaced when the drive is powered up, the encoder position information will be saved.<br>If the battery power is turned off before replacing the battery, an MTTURNRESET command will be issued to reset the multi-turn position after the battery power is restored. |

**c Overload of Regenerative Brake Resistor**



| Definition | Overload of Regenerative Brake Resistor |
|---|---|
| Type | Warning |
| Message # | WRN 34 |
| Description | Overload of Regenerative Brake Resistor. |
| Actions to Be Taken | Please check whether the resistance value of THE regenerative brake resistor is appropriate. |

**n STO Warning**



| Definition | STO Warning |
|---|---|
| Type | Warning |
| Message # | WRN 1 |
| Description | The STO signal is not properly connected when the driver is not enabled. |
| Actions to Be Taken | Check whether STO signal cable is correctly connected |

**cd Collision detection**



| Definition | Collision detected |
|---|---|
| Type | Warning |
| Message # | WRN 75 |
| Description | The collision detection function has detected a collision. |
| Actions to Be Taken | |

**CF Failed to Clear Error History**



| Definition | Failed to Clear Error History |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 67 |
| **Description** | Failed to Clear Error History. |
| **Actions to Be Taken** | Please disable the drive. |

### Ee1 Failed to Read Parameter EEPROM



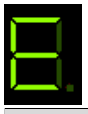
| Definition | Failed to Read Parameter EEPROM |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 66 |
| **Description** | Failed to Read Parameter EEPROM. |
| **Actions to Be Taken** | Restore factory settings, and if error persists, please contact technical support. |

### Ee2 EEPROM parameters read out of range



| Definition | EEPROM parameters read out of range |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 68 |
| **Description** | When reading parameter EEPROM, the parameter read is out of range. |
| **Actions to Be Taken** | Re-power up. If the error still exists, please contact technical support. |

### Ee3 Failed to Write the Power Board EEPROM



| Definition | Failed to Write the Power Board EEPROM |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 71 |
| **Description** | Failed to write the power board EEPROM. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### Ee4 Failed to Writing Control Board EEPROM



| | |
|---|---|
| **Definition** | Failed to Writing Control Board EEPROM |
| **Type** | Warning |
| **Message #** | WRN 72 |
| **Description** | Failed to write control board EEPROM. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

**Est Emergency Stop**



| | |
|---|---|
| **Definition** | Emergency Stop |
| **Type** | Warning |
| **Message #** | WRN 70 |
| **Description** | An emergency stop signal is detected. |
| **Actions to Be Taken** | No treatment required. |

**L1 Hardware Positive Limit Switch Triggered**



| | |
|---|---|
| **Definition** | Hardware Positive Limit Switch Triggered |
| **Type** | Warning |
| **Message #** | WRN 15 |
| **Description** | The positive hardware limit switch is triggered. |
| **Actions to Be Taken** | No treatment required. |

**L2 Hardware Negative Limit Switch Triggered**



| | |
|---|---|
| **Definition** | Hardware Negative Limit Switch Triggered |
| **Type** | Warning |
| **Message #** | WRN 16 |
| **Description** | The negative hardware limit switch is triggered. |
| **Actions to Be Taken** | No treatment required. |

**L3 Hardware Positive and Negative Limit Switch Triggered**



| Definition | The hardware positive and negative limit switch are triggered |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 17 |
| **Description** | The positive and negative hardware limit switches are triggered simultaneously. |
| **Actions to Be Taken** | Check if DI wiring is sound. |

### L4 Software Positive Limit Switch Triggered



| Definition | Software Positive Limit Switch Triggered |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 18 |
| **Description** | Software positive limit switch is triggered.<br>Position feedback (PFB)> POSLIMPOS and POSLIMMODE = 1. |
| **Actions to Be Taken** | No treatment required. |

### L5 Software Negative Limit Switch Triggered



| Definition | Software Negative Limit Switch Triggered |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 19 |
| **Description** | The software negative limit switch is triggered.<br>Position feedback (PFB)< POSLIMPOS and POSLIMMODE = 1. |
| **Actions to Be Taken** | No treatment required. |

### L6 Software Limit Switch Triggered



| Definition | Software Limit Switch Triggered |
|---|---|
| **Type** | Warning |
| **Message #** | WRN 20 |
| **Description** | The positive and negative software limit switches are triggered.<br>Position feedback (PFB)> POSLIMPOS and position feedback (PFB)< POSLIMNEG and POSLIMMODE = 1. |

| | |
|---|---|
| **Definition** | Software Limit Switch Triggered |
| **Actions to Be Taken** | No treatment required. |

**o** **Main Circuit Power Supply Line Disconnected**



| | |
|---|---|
| **Definition** | Main Circuit Power Supply Line Disconnected |
| **Type** | Warning |
| **Message #** | WRN 32 |
| **Description** | At least one phase of the main circuit power supply is not connected. |
| **Actions to Be Taken** | Check power supply line. |

**PFE** **Differential Pulse Input Frequency Too High**



| | |
|---|---|
| **Definition** | Differential pulse input frequency exceeds 4MHz |
| **Type** | Warning |
| **Message #** | WRN 74 |
| **Description** | Differential pulse input frequency is too high. |
| **Actions to Be Taken** | Check whether the differential pulse generator is normal and whether the input line is subject to strong electromagnetic interference. |

**t** **IPM Module Over Temperature**



| | |
|---|---|
| **Definition** | IPM Module Over Temperature |
| **Type** | Warning |
| **Message #** | WRN 38 |
| **Description** | The temperature of the Integrated Power Module (IPM) exceeds the preset limit. |
| **Actions to Be Taken** | Check whether the ambient temperature exceeds the drive specifications.<br>Otherwise, contact technical support. |

**u** **Undervoltage**



| | |
|---|---|
| **Definition** | Undervoltage |
| **Type** | Warning |
| **Message #** | WRN 4 |

| Definition | Undervoltage |
|---|---|
| **Description** | Bus voltage is below detection threshold. |
| **Actions to Be Taken** | Check whether the main circuit power supply is disconnected from the drive, and read the undervoltage threshold through UVTHRESH command. |

## 10.5 Digital Display - Fault Modes

Here the fault code is represented by a mixed alphanumeric code, using the following format:

| Definition | Short name. Used in ServoStudio2. |
|---|---|
| **Type** | Fault; see *Faults and Warnings* for description of the fault type. |
| **Active Disable** | Indicates whether the fault can trigger the Active Disable function. See *Disable Mode*. |
| **Message #** | The number of fault messages displayed in the terminal. |
| **Description** | Describes the state or fault indicated by the fault code. |
| **Actions to Be Taken** | Describes the recommended fault correction procedure. |

**-1** **Not Configured**



| Definition | Not Configured |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 12 |
| **Description** | Drive configuration is required.<br>Configuration (CONFIG) is required for any specific parameter value modification.<br>Configuration (CONFIG) is required after a specific parameter has been sent to the drive, even if the parameter value has not changed. |
| **Actions to Be Taken** | Set drive parameters and/or perform configuration (CONFIG). |

**_** **MCU Real-Time Task Overload Error**



| Definition | MCU Real-Time Task Overload Error |
|---|---|
| **Type** | Fault |
| **Message #** | FLT 89 |
| **Description** | The drive has detected that the CPU is approaching its calculation limit. |
| **Actions to Be Taken** | Please contact technical support. |

**e** **Parameter Memory Checksum Failure**



| **Definition** | Parameter Memory Checksum Failure |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 2 |
| **Description** | The non-volatile memory used to store the drive parameters is empty or the data is corrupted.<br>The fault is displayed after the first power-up. The fault will be cleared after the drive is configured and the parameters are saved in the drive non-volatile memory.<br>The fault also appears during power off if the save operation has not been completed. |
| **Actions to Be Taken** | Reconfigure the drive or restore the parameters and save the parameters.<br>If the problem persists, please contact technical support. |

### E Failed to Writing EEPROM Parameters



| **E** | Blinking |
|---|---|
| **Definition** | Failed to Writing EEPROM Parameters |
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 13 |
| **Description** | Failed to write parameter EEPROM. The drive cannot be enabled. |
| **Actions to Be Taken** | Please contact technical support. |

### e101 FPGA Configuration Failed



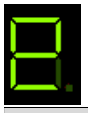
| **Definition** | FPGA Configuration Failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 5 |
| **Description** | FPGA code isn't loaded, MCU and FPGA communication has an error. The drive cannot be enabled. |
| **Actions to Be Taken** | Please contact technical support. |

### e106 Control Board EEPROM Fault



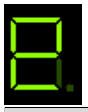
| Definition | Control Board EEPROM Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 6 |
| **Description** | Control board EEPROM access problem. The drive cannot be enabled. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### e107 Power Board EEPROM Fault



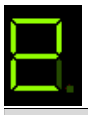
| Definition | Power Board EEPROM Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 7 |
| **Description** | Power board EEPROM access problem. The drive cannot be enabled. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### e109 Invalid Current Sensor Bias



| Definition | Invalid Current Sensor Bias |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 43 |
| **Description** | The calculated current sensor bias exceeds the set threshold. |
| **Actions to Be Taken** | Reset the fault. If the fault persists, the drive may need to be repaired. Please contact technical support. |

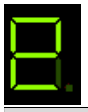
### e120 FPGA Version Mismatch



| Definition | FPGA version mismatch |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 47 |
| **Description** | FPGA version does not match MCU firmware version.<br>The fault will disable the drive. |

| Definition | FPGA version mismatch |
|---|---|
| **Actions to Be Taken** | Update FPGA version or MCU version. |

### e123 Electronic Nameplate (MTP) Reading Failed



| Definition | Electronic nameplate reading failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault can issue an Active Disable function. |
| **Message #** | FLT 85 |
| **Description** | Motor type nameplate data cannot be read.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Reconnect the feedback device. Ensure that the motor type nameplate data is readable. |

### e131 Motor Name Does Not Match MTP Data



| Definition | Motor Name Does Not Match MTP Data |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 108 |
| **Description** | Motor name does not match MTP data.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Reconnect the feedback device. Ensure that the motor type nameplate data is readable. |

### F0 EEPROM Version Error



| Definition | EEPROM Version Error |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 154 |
| **Description** | FPGA version does not match MCU firmware version. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### F1 Drive Current Foldback



| Definition | Drive Current Foldback |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 16 |
| **Description** | The drive current foldback is below the drive current foldback fault threshold (IFOLDFTHRESH) |
| **Actions to Be Taken** | Check the motor drive power. This fault can occur if the drive current rating is too low for the application (underpowered).<br>Check that the encoder bias angle is correct.<br>Check the IFOLDFTHRESH value. |

### F2 Motor Current Foldback



| Definition | Motor Current Foldback |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 17 |
| **Description** | The motor current foldback is lower than the motor current foldback fault threshold (MIFOLDFTHRESH) |
| **Actions to Be Taken** | Check the drive motor power calibration. This fault occurs if the motor current rating is too low (underpowered) for the application.<br>Check the MIFOLDFTHRESH value. |

### F3 Locked-Rotor Fault



| Definition | Locked-Rotor Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 59 |
| **Description** | Motor stalls. This fault disables the drive when the motor speed is below the locked-rotor threshold and the actual current is greater than the rated motor current or greater than the locked-rotor current for the duration of the blocking time threshold (when 90% of the current limit value is less than the drive rated current, the locked-rotor current magnitude is the drive rated current, when 90% of the current limit value is greater than the drive rated current, the locked-rotor current magnitude is 90% of the current limit value). |
| **Actions to Be Taken** | Clear the locked-rotor conditions, and take care to avoid them. |

### F4 Regeneration Fault



| Definition | Regeneration Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 148 |
| **Description** | The brake pipe opening signal does not match the brake pipe state signal. |
| **Actions to Be Taken** | Check the brake pipe wiring for short circuits or disconnections and the braking resistor for connection. |

### F7 Drive Parameter Initialization Failed



| Definition | Drive Parameter Initialization Failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 151 |
| **Description** | Drive parameter configuration failed (this error will not be triggered when power board EEPROM is normal). |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### F8 Motor Parameter Initialization Failed



| Definition | Motor Parameter Initialization Failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 152 |
| **Description** | Wrong motor parameter setting (wrong motor model setting when MTP is not used). |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### F9 Power Board EEPROM Checksum Failed



| Definition | Power Board EEPROM Checksum Failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 153 |

| Definition | Power Board EEPROM Checksum Failed |
|---|---|
| **Description** | Power board EEPROM checksum error. |
| **Actions to Be Taken** | Reconfigure the drive, or download the parameter set and save the parameters.<br>If the problem persists, please contact technical support. |

### F10 Power-Up Timeout



| Definition | Power-Up Timeout |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 156 |
| **Description** | The relay still does not pull in more than 5s after the detection of the IPM lower bridge short circuit fault and the motor power line short circuit to ground fault is complete. |
| **Actions to Be Taken** | Please check the input circuit. |

### F11 Parameter EEPROM Fault



| Definition | Parameter EEPROM Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 157 |
| **Description** | Failed to Read Parameter EEPROM. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### F12 Control board EEPROM checksum failed



| Definition | Control board EEPROM checksum failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 158 |
| **Description** | Control board EEPROM checksum error. |
| **Actions to Be Taken** | Reconfigure the drive, or download the parameter set and save the parameters.<br>If the problem persists, please contact technical support. |

### F13 Failed to Write the Power Board EEPROM



| Definition | Failed to Write the Power Board EEPROM |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 159 |
| **Description** | Failed to write power board EEPROM. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### F14 Failed to Writing Control Board EEPROM



| Definition | Failed to Writing Control Board EEPROM |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 160 |
| **Description** | Fail to write control board EEPROM. |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

### F15 Control Board and Drive Board Do Not Match



| Definition | Control Board and Drive Board Do Not Match |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 161 |
| **Description** | The control board does not match the power board (the power board model does not match the one stored in the control board). |
| **Actions to Be Taken** | Restore the factory settings, if the error still exists, please contact technical support. |

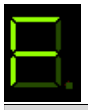
### F16 No Signal from Touch Probe



| Definition | No Signal from Touch Probe |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 162 |
| **Description** | Touch Probe signal is enabled and Touch Probe digital IO is not configured. |

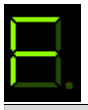
| Definition | No Signal from Touch Probe |
|---|---|
| **Actions to Be Taken** | Touch Probe digital IO needs to be configured. |

### F17 Electronic Gearing Calculation Overflow



| Definition | Electronic Gearing Calculation Overflow |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 163 |
| **Description** | Electronic gearing calculation data overflowed. |
| **Actions to Be Taken** | Set a valid electronic gearing ratio. |

### F18 Electronic Gearing out of Range



| Definition | Electronic Gearing out of Range |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 164 |
| **Description** | Electronic gearing setting range is out of limits. |
| **Actions to Be Taken** | Set valid electronic gearing ratio parameters. |

### F19 SensAR Encoder Initialization Failed



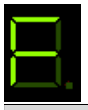
| Definition | SensAR Encoder Initialization Failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | Not applicable |
| **Message #** | FLT 165 |
| **Description** | Change of encoder type without enabling; mismatch in number of single-turn bits when changing encoder type via FeedBackType. |
| **Actions to Be Taken** | Check feedback wiring. Ensure that the motor does not run at high speed during encoder initialization. |

### F20 Short circuit in the lower bridge arm of integrated power module (IPM)



| Definition | Short circuit in the lower bridge arm of integrated power module (IPM) |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 166 |
| **Description** | Overcurrent of IPM lower bridge is detected during power-up self-test. |
| **Actions to Be Taken** | Please contact technical support. |

### F21 Three-Phase (UVW) Short to Ground



| Definition | Three-Phase (UVW) Short to Ground |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 167 |
| **Description** | Short circuit fault of motor power line to ground. |
| **Actions to Be Taken** | Wiring check to avoid short circuit in motor power cable. |

### F22 Encoder Multi-Turn Count Overflow



| Definition | Encoder Multi-Turn Count Overflow |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 168 |
| **Description** | Encoder multi-turn count overflow . |
| **Actions to Be Taken** | Use the command MTTURNRESET to clear multi-turn information, and it is recommended to reset the zero point. |

### F23 Current Sensor Correction Error



| Definition | Current Sensor Correction Error |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 155 |
| **Description** | Current sensor zero bias correction error. |
| **Actions to Be Taken** | Please contact technical support. |

### F24 Hardware Overcurrent



| Definition | Integrated power module (IPM) overcurrent |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 146 |
| **Description** | Hardware overcurrent; the actual current is greater than IPM overcurrent threshold, which triggers IPM overcurrent signal. |
| **Actions to Be Taken** | Please contact technical support. |

### F25 Regenerative Resistance Less Than 40Ω



| Definition | Regenerative Resistance Less Than 40Ω |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 147 |
| **Description** | The braking resistance value input by the user is less than the minimum required value. |
| **Actions to Be Taken** | Replace the braking resistor with a suitable resistance value. |

### F26 Encoder Power Supply Error



| Definition | Encoder Power Supply Error |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 175 |
| **Description** | The drive has detected an encoder power supply error. |
| **Actions to Be Taken** | Check the encoder cable and the socket. |

### F27 PDO Mapping to Maximum Number



| Definition | PDO Mapping to Maximum Number |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 176 |

| Definition | PDO Mapping to Maximum Number |
|---|---|
| **Description** | The number of channels mapped by the PDO is greater than 1 or the number of PDO objects is greater than 8. |
| **Actions to Be Taken** | Reduce the number of PDO channels or PDO objects. |

### F28 Unsupported interpolation cycles



| Definition | Unsupported interpolation cycles |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 177 |
| **Description** | DC cycle or time set via 0x60C2 is not supported. |
| **Actions to Be Taken** | Replace with appropriate interpolation cycle. |

### F29 Collision detected



| Definition | Collision detected |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 178 |
| **Description** | The collision detection function has detected a collision. |
| **Actions to Be Taken** | No treatment required. |

### F180 Collision detected



| Definition | Position notch filter overflow |
|---|---|
| **Type** | Fault |
| **Active Disable** | Yes |
| **Message #** | FLT 180 |
| **Description** | The position notch filter is calculation overflow. |
| **Actions to Be Taken** | Check the parameters of position notch filter. |

### Fb3 Fieldbus Disconnected



| Definition | Fieldbus Disconnected |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 91 |
| **Description** | The bus between the controller and the slave station is disconnected |
| **Actions to Be Taken** | Make sure that the network cable connection between the EtherCAT master (controller) and the slave is working properly. |

### Fb8 EtherCAT Packet Loss



| Definition | EtherCAT Packet Loss |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 91 |
| **Description** | EtherCAT packet is lost. When DC synchronization is on, EtherCAT is in OP state, and SYNC0 event has not been received or SM/SYNC0 queue is illegal.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Make sure that the EtherCAT host (controller) sends the packet within the (host) specified time. |

### Fb9 EtherCAT State Inoperative



| Definition | EtherCAT State Inoperative |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 91 |
| **Description** | The current state of the EtherCAT slave does not allow this type of operation. |
| **Actions to Be Taken** | Ensure operations that are allowed in the slave state. |

### J Overspeed



| Definition | Overspeed |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 14 |

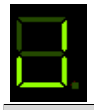
| Definition | Overspeed |
|---|---|
| **Description** | The actual speed exceeds the velocity limit which is set by VLIM.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Check whether VLIM settings meet the application requirements.<br>Use speed loop tuning to check for excessive speed overshoot. |

**J2 Speed out of Tolerance**



| Definition | Speed out of Tolerance |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 67 |
| **Description** | The velocity error (VE) has exceeded the velocity error limit (VEMAX). When VEMAX value is 0, speed out of tolerance is not detected.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Change drive tuning to improve speed tracking performance, or increase VEMAX to allow greater speed errors. |

**J3 Position out of Tolerance**



| Definition | Position out of Tolerance |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 87 |
| **Description** | The position error (PE) has exceeded the position error limit (PEMAX). When PEMAX value is 0, position out of tolerance is not detected.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Change drive tuning to improve position tracking performance, or increase PEMAX to allow greater position errors. |

**n STO**



| Definition | STO Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 4 |
| **Description** | STO Signal Trigger<br>The fault will disable the drive. |

| Definition | STO Fault |
|---|---|
| **Actions to Be Taken** | Check the STO fault signal. |

### n3 Emergency Stop



| Definition | Emergency Stop |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 57 |
| **Description** | Emergency stop signal trigger<br>The fault will disable the drive. |
| **Actions to Be Taken** | Switch off power and confirm safety. |

### o Overvoltage



| o | Bus Overvoltage |
|---|---|
| **Definition** | Overvoltage |
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 9 |
| **Description** | Bus voltage exceeds overvoltage threshold.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check if the application requires regeneration resistors. |

### o7 Main Circuit Power Cable Disconnected



| Definition | Main Circuit Power Cable Disconnected |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 78 |
| **Description** | At least one phase of the main circuit power supply is not connected.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check connection of main circuit power supply. Ensure that the supply is OK. See wiring diagram and related parameters. |

### o8 Overload of Regenerative Brake Resistor



| Definition | Overload of Regenerative Brake Resistor |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 83 |
| **Description** | The regenerative brake resistor is loaded beyond its permissible power. Brake pipe open continuously overload or brake pipe open repeatedly overload.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Please check whether the regenerative resistance is suitable. |

### o9 Digital Outputs Overcurrent Fault



| Definition | Digital Outputs Overcurrent Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 105 |
| **Description** | Digital output overcurrent is detected.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check the digital output connection. Ensure that the output circuit is not shorted. |

### P Software Overcurrent



| Definition | Software Overcurrent |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 3 |
| **Description** | Software overcurrent; the actual current is greater than the software overcurrent threshold and the duration reaches the overcurrent time threshold.<br>The fault will disable the drive. |
| **Actions to Be Taken** | Check the motor connection for short circuit. Check the current loop for excessive overshoot. |

### r20 Encoder Feedback Communication Error



| Definition | Encoder Feedback Communication Error |
|---|---|
| **Type** | Fault |

| Definition | Encoder Feedback Communication Error |
|---|---|
| **Active Disable** | No |
| **Message #** | FLT 34 |
| **Description** | Encoder communication timeout or communication CRC error; encoder may be disconnected.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check whether the feedback device is wired correctly. Check whether the selected encoder type (MENCTYPE) is correct. |

### r24 Tamagawa Encoder Initialization Failed



| Definition | Tamagawa Encoder Initialization Failed |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 42 |
| **Description** | Tamagawa encoder initialization process failed.<br>Possible situations are overrun of the encoder type configured using MENCTYPEUSER, change of encoder type without enabling, mismatch of the number of single-turn bits when changing the encoder type via FeedBackType.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check whether the encoder wiring is correct. |

### r26 Tamagawa Operation Fault



| Definition | Tamagawa Operation Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 49 |
| **Description** | Tamagawa encoders have multiple faults, including one or more of the following: overspeed, count error, multi-turn error.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check feedback wiring. Ensure that the motor does not run at high speed during encoder initialization. |

### r27 Motor Power Line out of Phase



| Definition | Motor Power Line out of Phase |
|---|---|
| **Type** | Fault |

| Definition | Motor Power Line out of Phase |
|---|---|
| **Active Disable** | This fault can trigger the Active Disable function |
| **Message #** | FLT 51 |
| **Description** | The motor power line is out of phase, in which a certain phase current is always 0 and the current command is greater than a certain value. |
| **Actions to Be Taken** | Check whether the motor power line is correct. |

### r29 Low Battery Voltage on Absolute Multi-turn Encoder



| Definition | Low battery voltage on absolute multi-turn encoder |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 56 |
| **Description** | The voltage level of the absolute multi-turn encoder backup battery has dropped below 3.0V.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Replace the encoder battery and restart the drive.<br>If the battery is replaced when the drive is on, the position information will be effectively saved.<br>If the battery power is cut before the it is replaced, use the MTURNRESET command to reset the multi-turn information after the battery power is restored. |

### r40 SensAR Encoder Fault



| Definition | SensAR Encoder Fault |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 82 |
| **Description** | SensAR Encoder has several faults, including one or more of the following: over-speed, counting error and multi-turn error.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check feedback wiring. Ensure that the motor does not run at high speed during encoder initialization. |

### r41 Sankyo Encoder Fault



| Definition | Sankyo Encoder Fault |
|---|---|
| **Type** | Fault |

| Definition | Sankyo Encoder Fault |
|---|---|
| **Active Disable** | No |
| **Message #** | FLT 99 |
| **Description** | Sankyo Encoder has several faults, including one or more of the following: over-speed, counting error and multi-turn error.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check feedback wiring. Ensure that the motor does not run at high speed during encoder initialization. |

### r52 General fault of Multi-turn Encoder



| Definition | General fault of Multi-turn Encoder |
|---|---|
| **Type** | Fault |
| **Active Disable** | No |
| **Message #** | FLT 118 |
| **Description** | The multi-turn information of Multi-turn Absolute Encoder is not ready yet.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Eliminate the drive fault.<br>Wait for multi-turn information of Multi-turn Encoder to be ready, and the fault will be automatically eliminated. |

### t1 Power Board Over-Temperature



| Definition | Power Board Over-Temperature |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 10 |
| **Description** | Sampling temperature of NTC resistor exceeds the threshold of driver Over-Temperature protection.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check whether the ambient temperature exceeds the drive specifications. Otherwise, please contact technical support. |

### t2 Integrated Power Module Over-Temperature



| Definition | Integrated Power Module Over-Temperature |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 39 |

| Definition | Integrated Power Module Over-Temperature |
|---|---|
| **Description** | The internal temperature of the Integrated Power Module (IPM) exceeds the set threshold, which triggers the Over-Temperature OT signal.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | Check whether the ambient temperature exceeds the drive specifications. Otherwise, please contact technical support. |

**toL** **Torque output limit**



| Definition | Torque output reaches limit |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 179 |
| **Description** | Torque output reaches the torque limit set by the user.<br>This fault prevents the drive from starting. |
| **Actions to Be Taken** | No treatment required. |

**U** **Undervoltage**



| Definition | Undervoltage |
|---|---|
| **Type** | Fault |
| **Active Disable** | This fault may trigger the Active Disable function. |
| **Message #** | FLT 11 |
| **Description** | Bus Voltage is lower than Under-Voltage Threshold (according to under-voltage detection mode). |
| **Actions to Be Taken** | Checking whether the main AC power supply is connected to the drive and turned on. The under-voltage limit can be read with the UVTHRESH command. |

## 10.6 Warning, Error and Fault Messages

The following table shows the fault, warning and error codes that may be displayed when working in terminal.

All faults and many warnings are also displayed by the driver's digital display. Specific conditions only generate interface Warning Messages.

### 10.6.1 Warning Messages

BDHDE drive warning is reported in object 2011h.

Because the BDHDE warning has 96 bits, it is divided into three 32-bit segments.

**Table 10-1 Warning Codes and Messages**

| Exception Code | Description | 7-segment display code | Warning No. |
|---|---|---|---|
| 00000000 00000000 00000008h | Undervoltage | u | WRN 4 |
| 00000000 00000000 00000010h | Power Module Over-Temperature | t | WRN 5 |
| 00000000 00000000 00004000h | Hardware Positive Limit Switch Triggered | L1 | WRN 15 |
| 00000000 00000000 00008000h | Hardware Negative Limit Switch Triggered | L2 | WRN 16 |
| 00000000 00000000 00010000h | Hardware Positive and Negative Limit Switches Triggers | L3 | WRN 17 |
| 00000000 00000000 00020000h | Software Positive limit trigger | L4 | WRN 18 |
| 00000000 00000000 00040000h | Software Negative Limit Trigger | L5 | WRN 19 |
| 00000000 00000000 00080000h | Positive and Negative Limit Triggers | L6 | WRN 20 |
| 00000000 00000000 00200000h | Low battery voltage of Multi-turn Encoder | b | WRN 22 |
| 00000000 00000000 80000000h | The Main Circuit Power Supply Phase Loss | o | WRN 32 |
| 00000000 00000002 00000000h | Overload of braking resistance | c | WRN 34 |
| 00000000 00000008 00000000h | MCU real-time load warning | _ | WRN 36 |
| 00000000 00000020 00000000h | IPM Module Over Temperature | t | WRN 38 |
| 00000000 00008000 00000000h | Default drive configuration | n/a | WRN 48 |
| 00000001 00000000 00000000h | Failed to restore default parameter configuration | n/a | WRN 65 |
| 00000002 00000000 00000000h | Failed to read EEPROM parameters | Ee1 | WRN 66 |
| 00000004 00000000 00000000h | Clearing error history failed | CF | WRN 67 |
| 00000008 00000000 00000000h | Out of range of reading back EEPROM parameter | Ee2 | WRN 68 |
| 00000010 00000000 00000000h | Sync0 time does not mate interpolation time | n/a | WRN 69 |
| 00000040 00000000 00000000h | Failed to Write the Power Board EEPROM | Ee3 | WRN 71 |
| 00000080 00000000 00000000h | Failed to Writing Control Board EEPROM | Ee4 | WRN 72 |
| 00000200 00000000 00000000h | Differential pulse input frequency exceeds 4MHz | PFE | WRN 74 |
| 00000400 00000000 00000000h | Collision detected | cd | WRN 75 |
| 00000000 00000000 00000001h | STO Warning | n | WRN 1 |
| 00000000 00000000 00000008h | Undervoltage | u | WRN 4 |

### 10.6.2 Error Messages-Manufacturer-Specific

**Table 10-2 Error codes and messages-Manufacturer only**

| Error Serial number | # | Error message | Error code |
|---|---|---|---|
| ERR | 20 | Unknown command | 0800 0000h |
| ERR | 21 | Unknown variable | 0800 0000h |
| ERR | 22 | Checking code error | 0800 0000h |
| ERR | 23 | Driver enable | 0800 0000h |
| ERR | 24 | Drive disable | 0800 0000h |
| ERR | 25 | Data out of range | 0609 0030h |
| ERR | 26 | Data is too small | 0609 0032h |
| ERR | 27 | Invalid OPMODE | 0800 0000h |
| ERR | 28 | Syntax error | 0800 0000h |
| ERR | 29 | The data is too large | 0609 0031h |
| ERR | 36 | Not programmable | 0601 0002h |
| ERR | 37 | Not Configured | 0800 0000h |
| ERR | 38 | N/A | 0800 0000h |
| ERR | 42 | Invalid Flash | 0606 0000h |
| ERR | 43 | Waveform recording is in use | 0800 0000h |
| ERR | 44 | Waveform data is not available | 0800 0000h |
| ERR | 45 | Nonvolatile RAM is empty | 0800 0000h |
| ERR | 46 | Data must be even | 0800 0000h |
| ERR | 49 | Data must be multiplied by 0.25 | 0800 0000h |
| ERR | 50 | Failed to save flash | 0800 0000h |
| ERR | 51 | Not available | 0606 0000h |
| ERR | 56 | Data must be multiplied by 4 | 0800 0000h |
| ERR | 66 | Password is protected | 0800 0000h |
| ERR | 82 | Function defined | 0800 0000h |
| ERR | 96 | Variable of unrecorded waveform | 0800 0000h |
| ERR | 104 | The movement order is not executed | 0800 0000h |
| ERR | 116 | Bus mode (COMMODE 1) | 0800 0000h |
| ERR | 210 | Velocity limit value out of range | 0800 0000h |
| ERR | 270 | Unable to set when MTPMODE>0 | 0800 0000h |
| ERR | 300 | Too much data is recorded | 0800 0000h |
| ERR | 380 | Remote enabled available | 0800 0000h |

### 10.6.3 Fault Messages

**Table 10-3 Fault codes and messages**

| Fault code | Description | 7-segment display code | Fault No. |
|---|---|---|---|
| 0x2214 | Hardware Overcurrent | F24 | FLT 146 |
| 0x2214 | Software Overcurrent | P | FLT 3 |
| 0x2250 | Short circuit of IPM lower bridge arm | F20 | FLT 166 |
| 0x2310 | Motor Current Foldback | F2 | FLT 17 |
| 0x2311 | Drive Current Foldback | F1 | FLT 16 |
| 0x2330 | UVW short circuit to ground | F21 | FLT 167 |
| 0x2380 | Abnormal bias of current sensor | e109 | FLT 43 |
| 0x2380 | Abnormal precharging of current sensor | F23 | FLT 155 |
| 0x2381 | Motor phase line is out of phase | r27 | FLT 51 |
| 0x2382 | Digital output over-current | o9 | FLT 105 |
| 0x3110 | Overvoltage | o | FLT 9 |
| 0x3120 | Undervoltage | u | FLT 11 |
| 0x3183 | The Main Circuit Power Supply Phase Loss | o7 | FLT 78 |
| 0x3181 | STO Fault | n | FLT 4 |
| 0x3187 | General fault of Multi-turn Encoder | r52 | FLT 118 |
| 0x3199 | Brake circuit error | F4 | FLT 148 |
| 0x3199 | Overload of braking resistance | o8 | FLT 83 |
| 0x4080 | IPM Over-Temperature | t2 | FLT 39 |
| 0x4310 | Power Board Over-Temperature | t1 | FLT 10 |
| 0x5530 | EEPROM error on Power Board | e107 | FLT 7 |
| 0x5530 | Failed to Write the Power Board EEPROM | F13 | FLT 159 |
| 0x5581 | EEPROM error on Control Board | e106 | FLT 6 |
| 0x5581 | Parameter EEPROM error | F11 | FLT 157 |
| 0x5581 | Failed to Writing Control Board EEPROM | F14 | FLT 160 |
| 0x5585 | Parameter storage verification failed | e | FLT 2 |
| 0x5585 | EEPROM Version Error | F0 | FLT 154 |
| 0x5585 | EEPROM check error on Control Board | F12 | FLT 158 |
| 0x5585 | The Control Board does not mate the Power Board | F15 | FLT 161 |
| 0x5585 | EEPROM check error on Power Board | F9 | FLT 153 |
| 0x5586 | Writing parameter EEPROM failed | E | FLT 13 |
| 0x6100 | Homing error | HE | FLT 174 |
| 0x6320 | Main power-on timeout | F10 | FLT 156 |

| Fault code | Description | 7-segment display code | Fault No. |
|---|---|---|---|
| 0x6320 | Touch Probe signal is not configured | F16 | FLT 162 |
| 0x6320 | Calculation overflow of electronic gearing ratio | F17 | FLT 163 |
| 0x6320 | Out of range of electronic gearing ratio | F18 | FLT 164 |
| 0x6320 | The braking resistance is less than 40 Ω | F25 | FLT 147 |
| 0x6320 | Drive Parameter Initialization Failed | F7 | FLT 151 |
| 0x6320 | Motor Parameter Initialization Failed | F8 | FLT 152 |
| 0x6320 | Position notch filter overflow | F180 | FLT 180 |
| 0x6381 | Not Configured | -1 | FLT 12 |
| 0x6581 | FPGA configuration failed | e101 | FLT 5 |
| 0x7090 | FPGA version mismatch | e120 | FLT 47 |
| 0x7091 | Emergency Stop | n3 | FLT 57 |
| 0x7121 | Stall | F3 | FLT 59 |
| 0x7305 | Overflow of encoder multi-turncounter | F22 | FLT 168 |
| 0x7380 | Communication error of encoder | r20 | FLT 34 |
| 0x7380 | Encoder Power Supply Error | F26 | FLT 175 |
| 0x7382 | SenseAR failed to initialize | F19 | FLT 165 |
| 0x7382 | Tamagawa failed to initialize | r24 | FLT 42 |
| 0x7385 | Low battery voltage of Multi-turn Encoder | r29 | FLT 56 |
| 0x7388 | Tamagawa encoder error | r26 | FLT 49 |
| 0x7388 | Sankyo encoder error | r41 | FLT 99 |
| 0x738D | SensAR encoder error | r40 | FLT 82 |
| 0x7580 | Bus communication is disconnected | Fb3 | FLT 65 |
| 0x7580 | PDO Mapping to Maximum Number | F27 | FLT 176 |
| 0x7580 | Unsupported interpolation cycles | F28 | FLT 177 |
| 0x7580 | Collision detected | F29 | FLT 178 |
| 0x7580 | Torque output reaches limit | toL | FLT 179 |
| 0x818D | EtherCAT frame is missing | Fb8 | FLT 91 |
| 0x8481 | Overspeed | J | FLT 14 |
| 0x8482 | Speed out of Tolerance | J2 | FLT 67 |
| 0x8689 | Excessive position error | J3 | FLT 87 |
| 0xF080 | CAN/EtherCAT is in inoperable state | Fb9 | FLT 92 |
| 0xFF01 | Internal error | e121 | FLT 70 |
| 0xFF02 | Electronic nameplate of motor failed to read | e123 | FLT 85 |
| 0xFF04 | MCU real-time load overload error | _ | FLT 89 |

# 11 Accessories

## 11.1 Mating Connectors

**Notes** The power board mating connector is supplied with the drive.

**Table 11-1. Mating connector kit**

| Description | Servotronix Part Number |
|---|---|
| BDHDE mating connector kit-a kit of P1 and P2 interfaces | KIT-2B-PWSPR-01 |
| BDHDE C4 mating connector kit -MDR26 pin | KIT-C4MDR26 0 0 0 |

**Table 11-2. C4–I/O Mating Connector**

| Manufacturer | Items | Manufacturer Part Number | Servotronix Part Number |
|---|---|---|---|
| 3M | Welding Plug Connector | 10126-3000PE | CONr00000026-31 |
| 3M | Welding Plug Connector Housing | 10326-52F0-008 | HODr00000026-00 |

**Table 11-3. C5 - Feedback Mating Connector**

| Manufacturer | Items | Manufacturer Part Number | Servotronix Part Number |
|---|---|---|---|
| 3M | Welding Plug Connector | 3E206-0100KV | CONr10000006-64 |
| 3M | Enclosure assembly | 3E306-3200-008 | HODr0003E306-00 |

**Table 11-4. P1 - Power Mating Connector**

| Manufacturer | Items | Manufacturer Part Number | Servotronix Part Number |
|---|---|---|---|
| Dinkle | Plug for pluggable terminal | 2ESDPLM-06P or equivalent. | CONr10000006-92 |

**Table 11-5 P2 - Motor Mating Connector**

| Manufacturer | Items | Manufacturer Part Number | Servotronix Part Number |
|---|---|---|---|
| Dinkle | Plug for pluggable terminal | 2ESDPLM-03P or equivalent. | CONr10000003-86 |

## 11.2 Cables

**Table 11-6 C1–USB 2.0A to Mini-B cable**

**Notes** It is strongly recommended that you use the USB cable provided by Servotronix, which has been tested and proved to be reliable.

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| USB 2.0 A to Mini-B cable | Length: 1.5m | CBLr0000USBA-00 |

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| Shielding | 85% copper braided wire shielding coverage | |
| Twisted Pair | Yes | |
| Maximum length | 3m | |
| Wire Gauge | 20–28 AWG | |
| EMI filtering | Two ferrite cores located near each connector | |

*Table 11-7 C2 / C3 – RJ45 Industrial Ethernet/EtherCAT Cat 5e Cable*

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| RJ45 CAT5E Cable | Length: 0.5m<br>Length: 1m<br>Length: 2m<br>Length: 10m | CBLr00400100-00<br>CBLr00400180-00<br>CBLr00400110-00<br>CBLr00400140-00 |
| Shielding | 85% copper braided wire shielding coverage | |
| Twisted Pair | Yes | |
| Maximum length | 10 m | |
| Wire Gauge | 26-27 AWG | |

**Table 11-8 C4-I/O Cable**

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| Lead Cable | Cable 1m, lead wire<br>Cable 2m, lead<br>Cable 3m, lead<br>Cable 5m, lead<br>Cable 10m, lead wire | CBL-MDR2-26-01<br>CBL-MDR2-26-02<br>CBL-MDR2-26-03<br>CBL-MDR2-26-05<br>CBL-MDR2-26-10 |

*Table 11-9 C5 – PRHD2 Motor Feedback Cable*

| Encoder Type | Connector Type | Length | Servotronix Part Number |
|---|---|---|---|
| sensAR S3<br>Tamagawa T1 | D,A | 3m<br>5m<br>10m<br>15m<br>20m | CBL-FBPH21S301D0xx (inflexible)<br>CBL-FBPH22S301D0xx (flexible)<br>CBL-FBPH21S301A0xx (inflexible)<br>CBL-FBPH22S301A0xx (flexible) |
| sensAR M3 | D,A | 3m<br>5m<br>10m<br>15m<br>20m | CBL-FBPH21M301D0xx (inflexible)<br>CBL-FBPH22M301D0xx (flexible)<br>CBL-FBPH21M301A0xx (inflexible)<br>CBL-FBPH22M301A0xx (flexible) |

| Encoder Type | Connector Type | Length | Servotronix Part Number |
|---|---|---|---|
| Tamagawa T4 | D,A | 3m<br>5m<br>10m<br>15m<br>20m | CBL-FBPH21T201D0xx (inflexible)<br>CBL-FBPH22T201D0xx (flexible)<br>CBL-FBPH21T201A0xx (inflexible)<br>CBL-FBPH22T201A0xx (flexible) |

Notes

Note 1: sensAR multi-turn encoder (M3) requires specified M3 cable (including battery box) and S3 cable (version D or A; order according to your system).

Encoder type:

S3SensAR single-turn absolute encoder 17 bits

M3SensAR multi-turn absolute encoder 17 bits

T1 Tamagawa single-loop absolute encoder 17 bits

T4 Tamagawa multi-turn absolute encoder 23 bits

Connector type:

D300 mm cable with AMP connector. Available for frame sizes: 04, 06, 08

AMIL connector. Available for frame sizes: 10, 13

**Table 11--10. P2 – Cable for PRHD2 Motor**

| Items | Specifications | Servotronix Part Number |
|---|---|---|
| Power cable (lead) for PRHD2 motor | 3m<br>5m<br>10m<br>15m<br>20m | CBL-PWPH21000yD0xx (non-flexible)<br>CBL-PWPH22000yD0xx (flexible)<br>CBL-PWPH21000yA0xx (non-flexible)<br>CBL-PWPH22000yA0xx (flexible)<br><br>xx: length<br>Y: 1: with brake, 0: without brake<br>D: AMP connector<br>A: MIL connector |

## 11.3 Line Filters

The manufacturer and part number of line filter recommended by BDHDE are listed in the following table.

**Table 11-11. Line filter recommended by BDHDE**

| Drive | Manufacturer Part Number |
|---|---|
| BDHDE-0032A | LCR: 055M.80601.00 |
| | LCR: 092.00623.00 |
| | Schaffner: FN2070-6 |
| BDHDE-0062A | LCR: 0923.01021.00 |
| | LCR: 092.01023.00 |

| Drive | Manufacturer Part Number |
|---|---|
| | LCR: 055.81011.00 |
| | Schaffner: FN2070-10 |

## 11.4 Regeneration Resistors

The resistance value (ohm,) is defined by the BDHDE servo driver, and the required power is defined by the application. ΩTherefore, each driver has multiple regeneration resistor options.

Manufacturers and part numbers of regeneration resistors recommended by BDHDE are listed in the following table.

**Table 11-12 Regeneration resistor recommended by BDHDE**

| Drive | Power (W) | Minimum Resistance | Manufacturer Part Number |
|---|---|---|---|
| BDHDE-0032A<br>BDHDE-0062A | 150 | 40Ω | IsoTek: ULH150 N 40 K FL500 |
| | 300 | | IsoTek: ULH300 N 40 K FL500 |
| | 600 | | Frizlen: FZECU400x65-40 |
| | 1000 | | IsoTek: ULV1000 N 40 K FL500 |

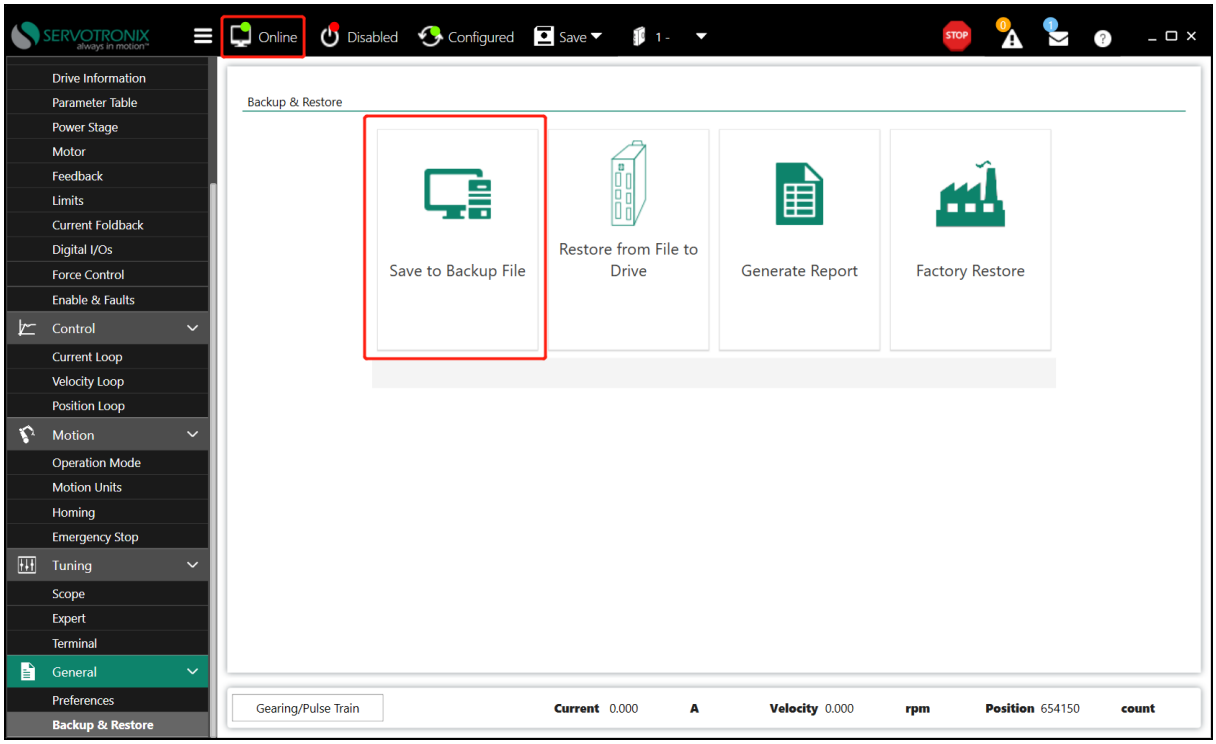
# 12 Application guidelines

## 12.1 Firmware Upgrade

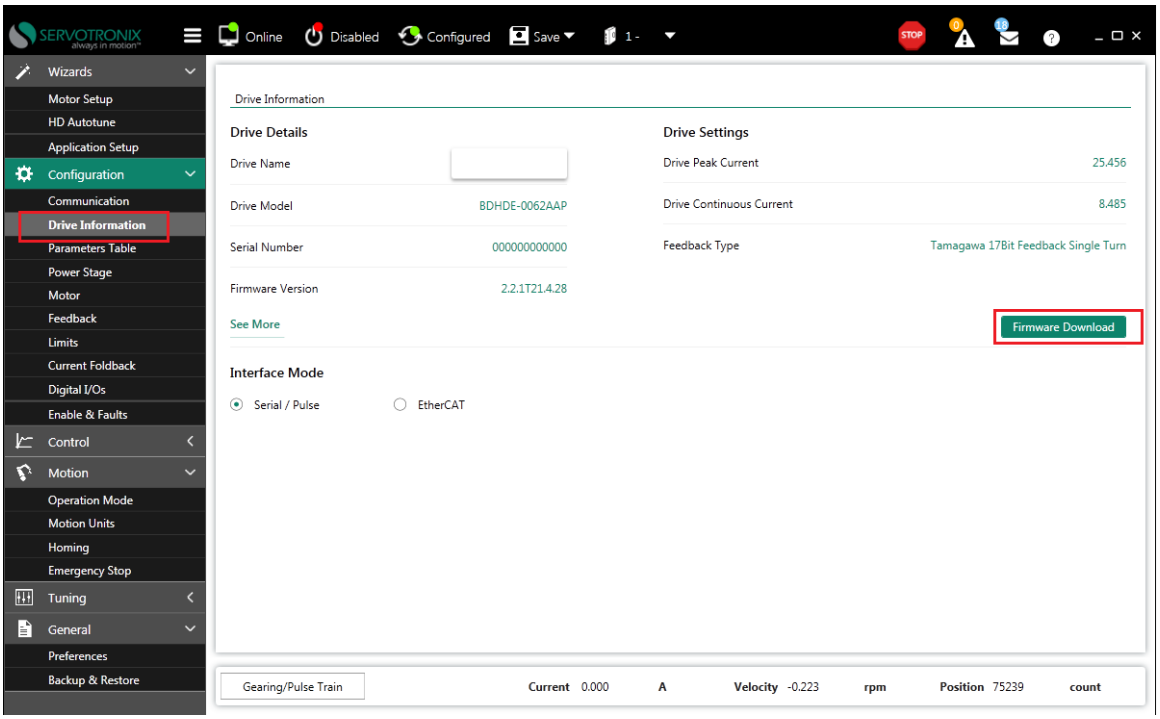
This application guide describes the firmware upgrade methods of MCU and FPGA of BDHDE driver and the solutions when encountering problems. In the process of MCU firmware update, the LED displays a fast flashing", while in the process of FPGA firmware update, the LED displays a fast flashing'-'.

### 12.1.1 MCU Firmware Upgrade

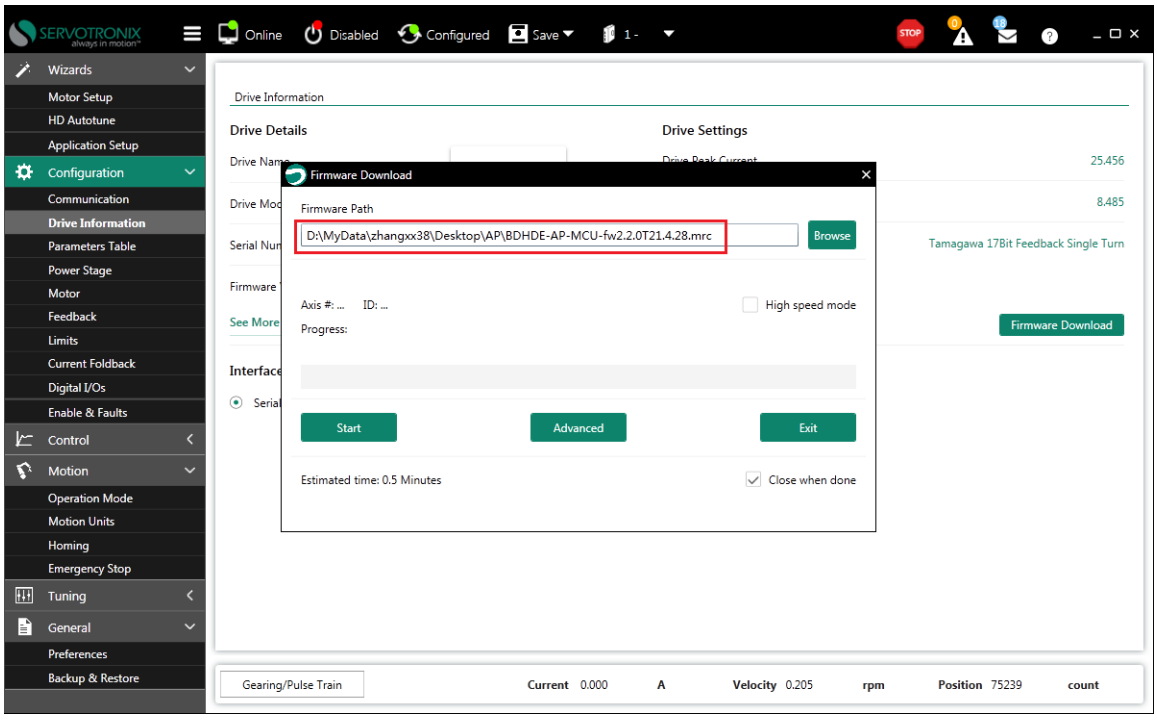
1) To open ServoStudio2 software for parameter backup. this step is not necessary, but it is recommended to back up drive parameters to. ssv file before upgrading MCU firmware every time.



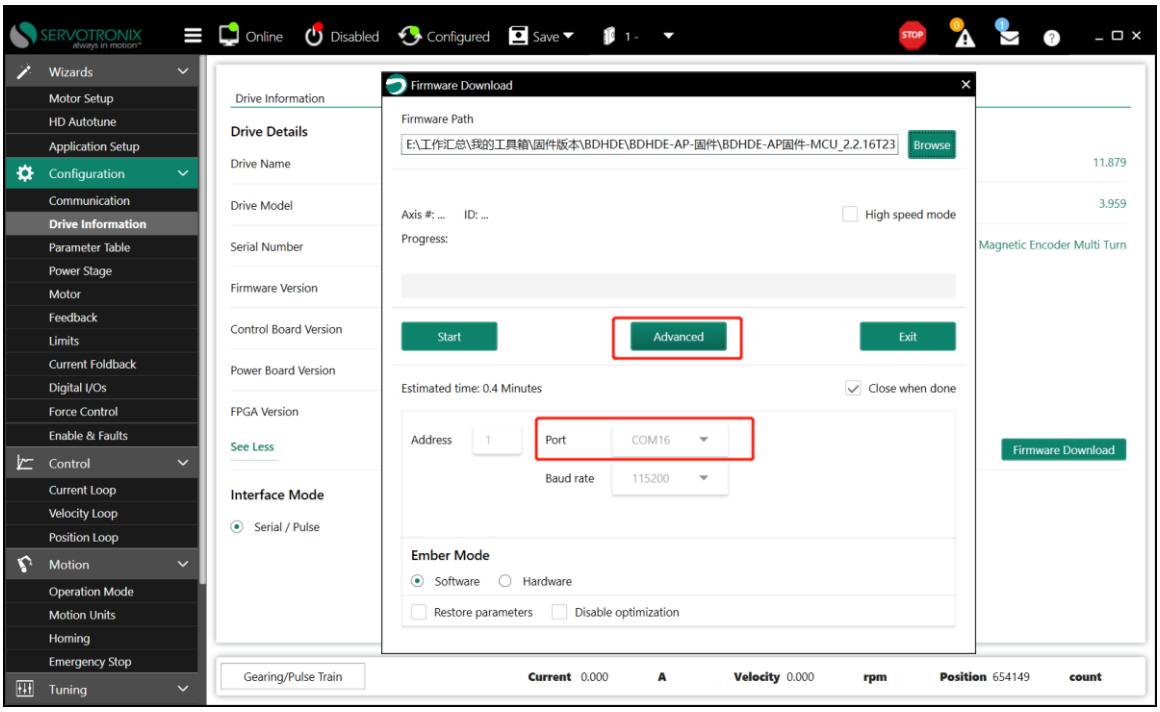

2) To enter the firmware download interface.



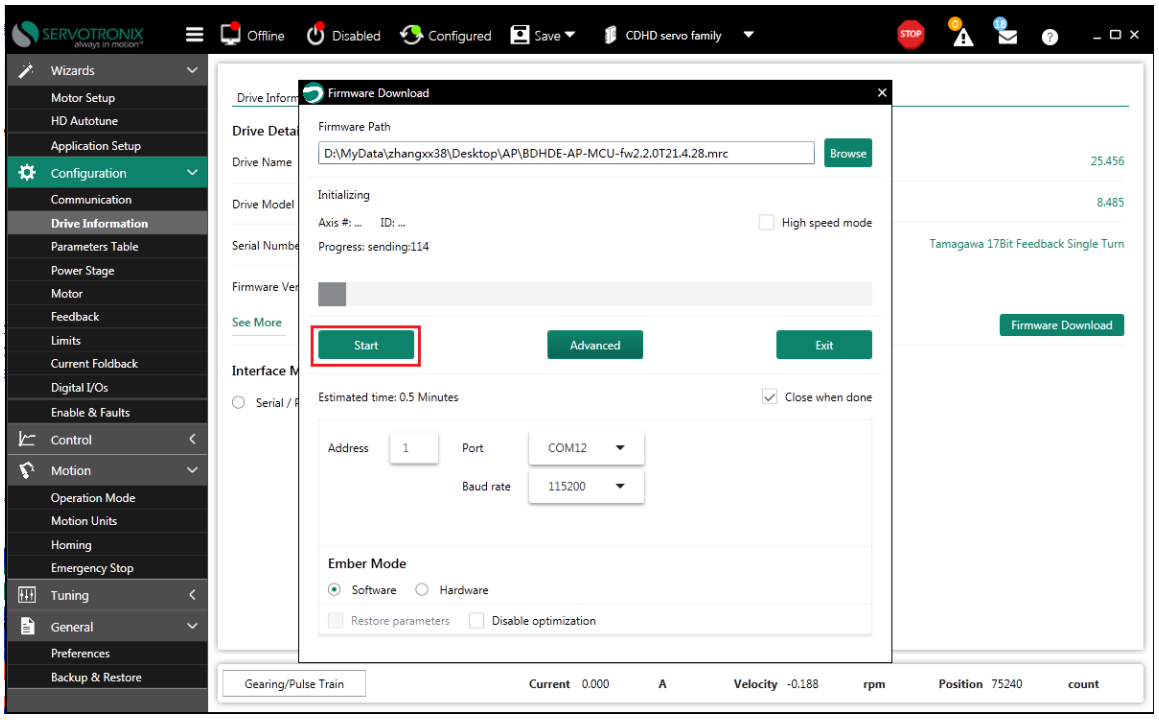

3) To select MCU firmware with suffix. mrc, **and there should be no Chinese characters in the firmware storage path.**



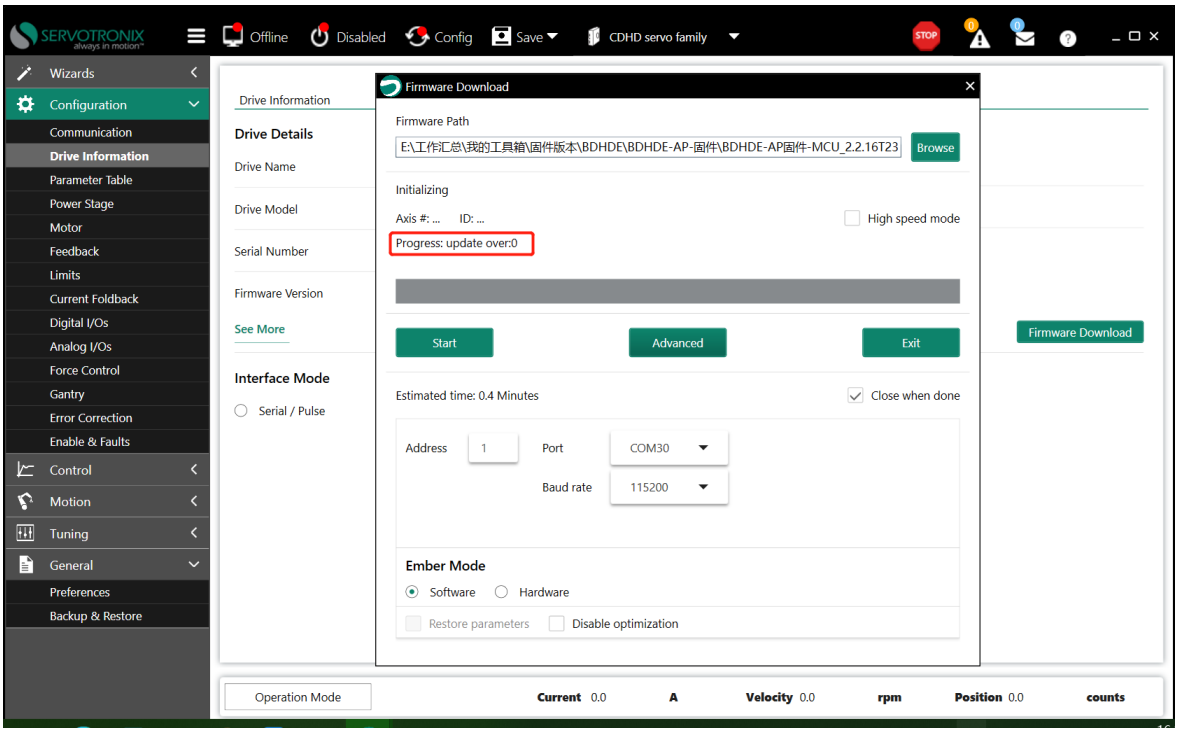

4) To expand the "Advanced" option, and select the COM port corresponding to the BDHDE drive to be upgraded in the "Port" option.



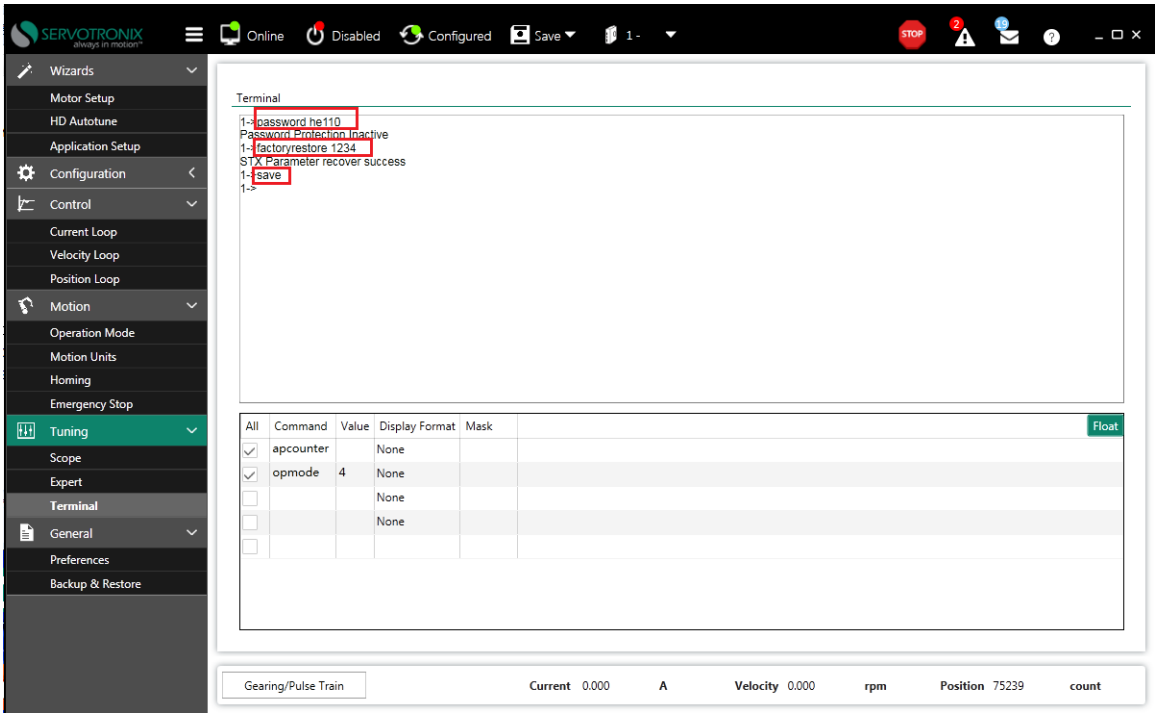

5) To click the "Start" button to start the upgrade.



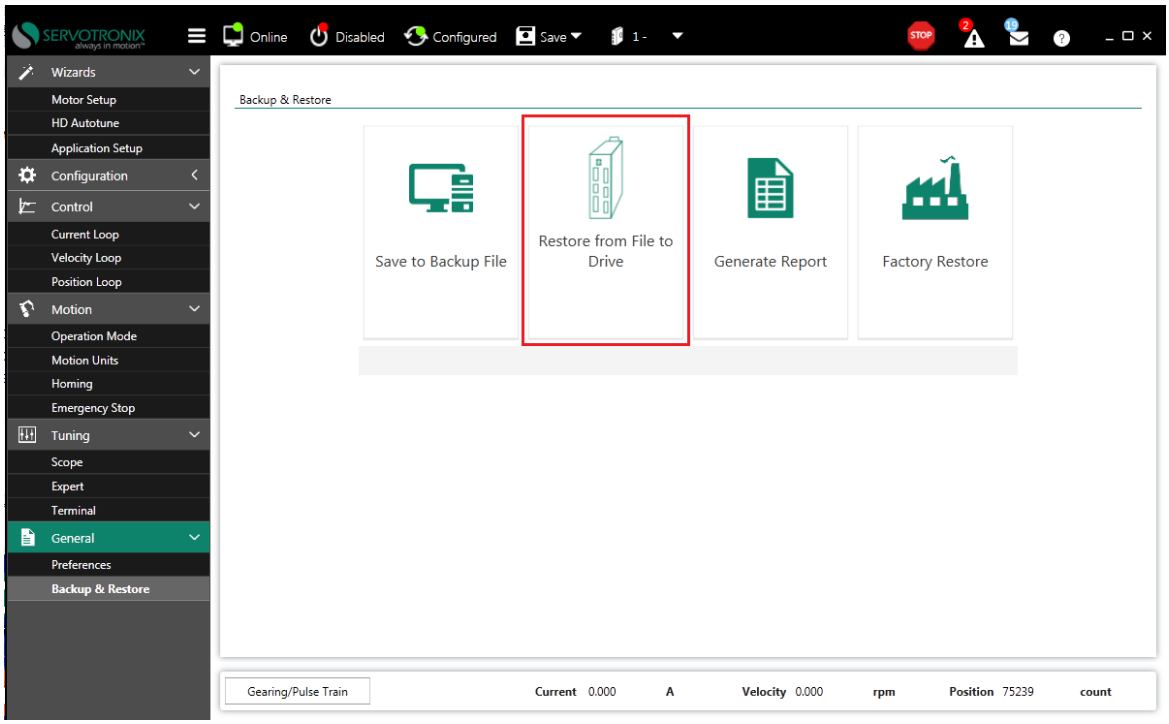

6) To update over:0 is displayed in the status bar, the MCU firmware upgrade is completed, and the driver will restart automatically.




7) Restore factory settings

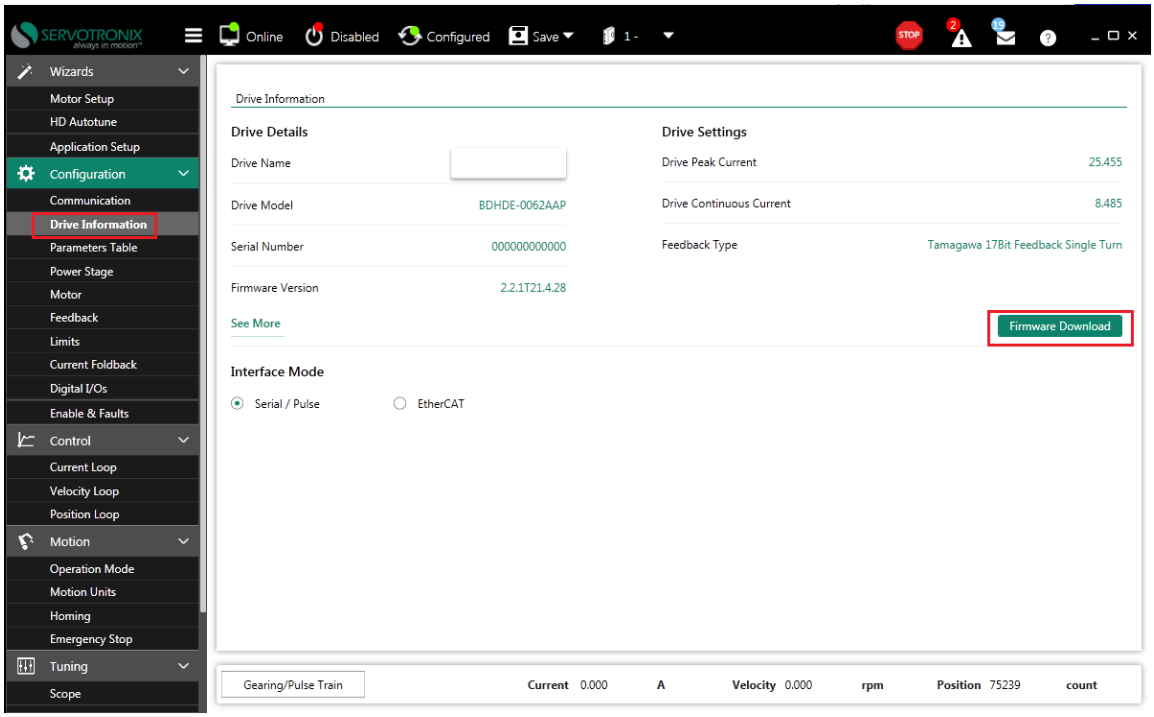



8) To import the parameter backup file, save it to the drive and power it on again (if there is no parameter backup file, this step can be skipped).

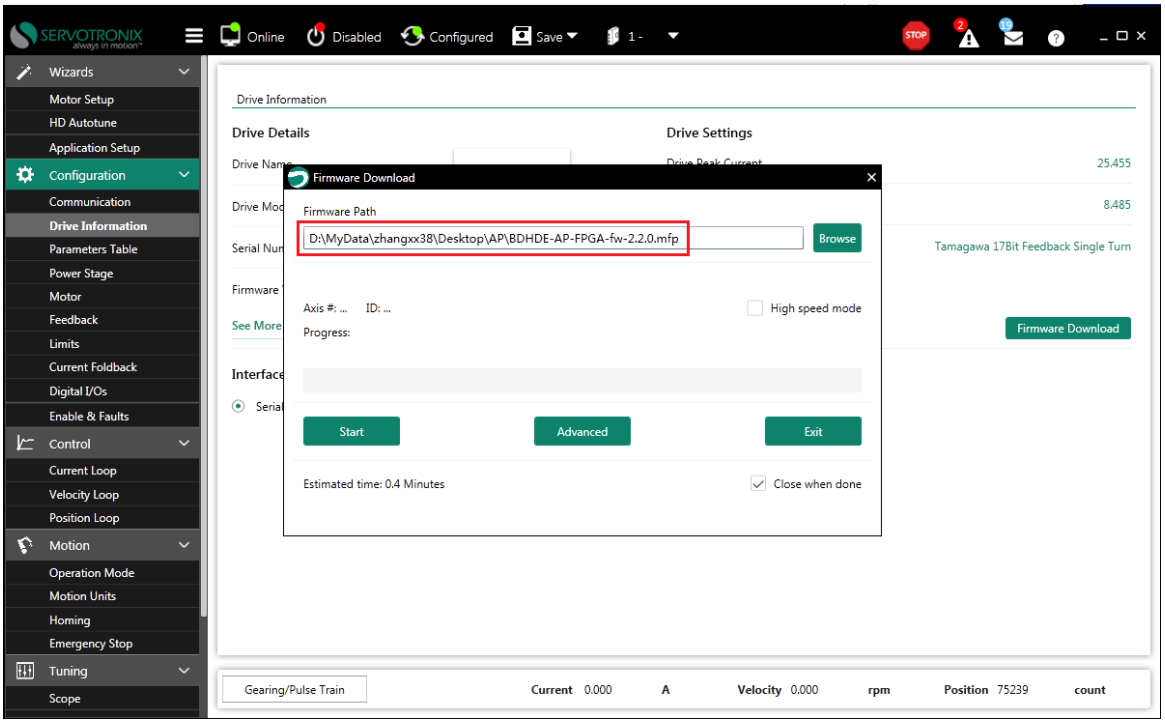



### 12.1.2 FPGA Firmware Upgrade

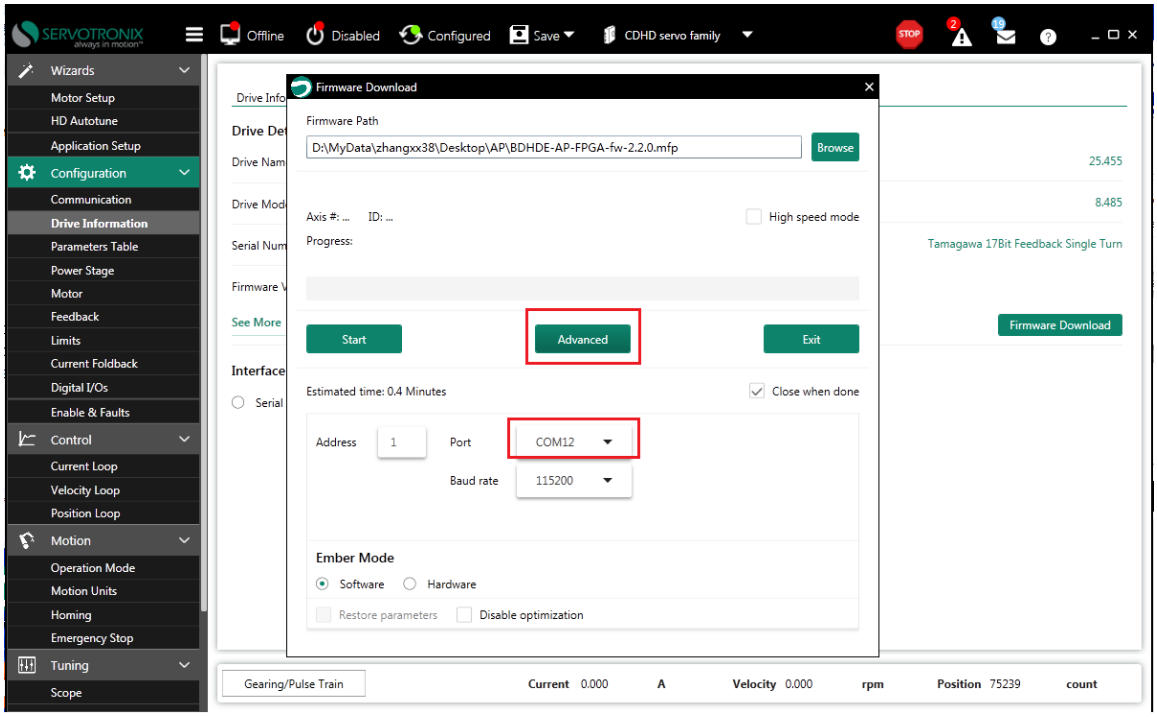
1) To open ServoStudio2 software and enter the firmware upgrade interface.



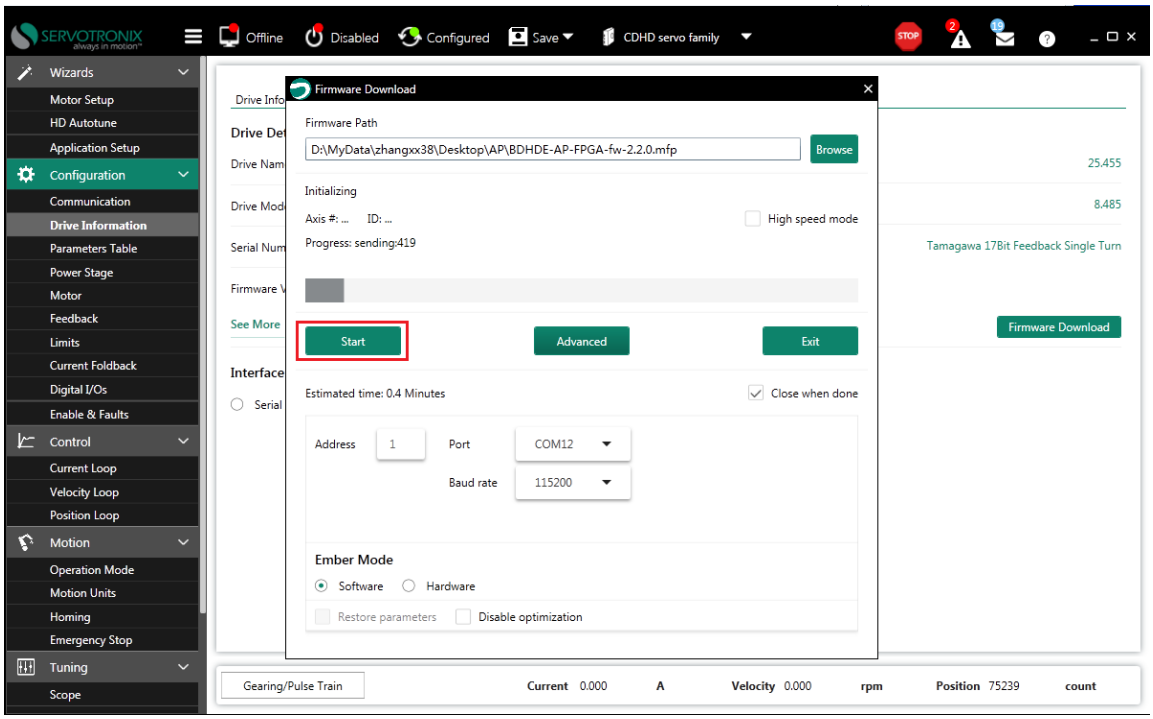

2) To select FPGA firmware with suffix. mfp, and there should be no Chinese characters in the firmware storage path.



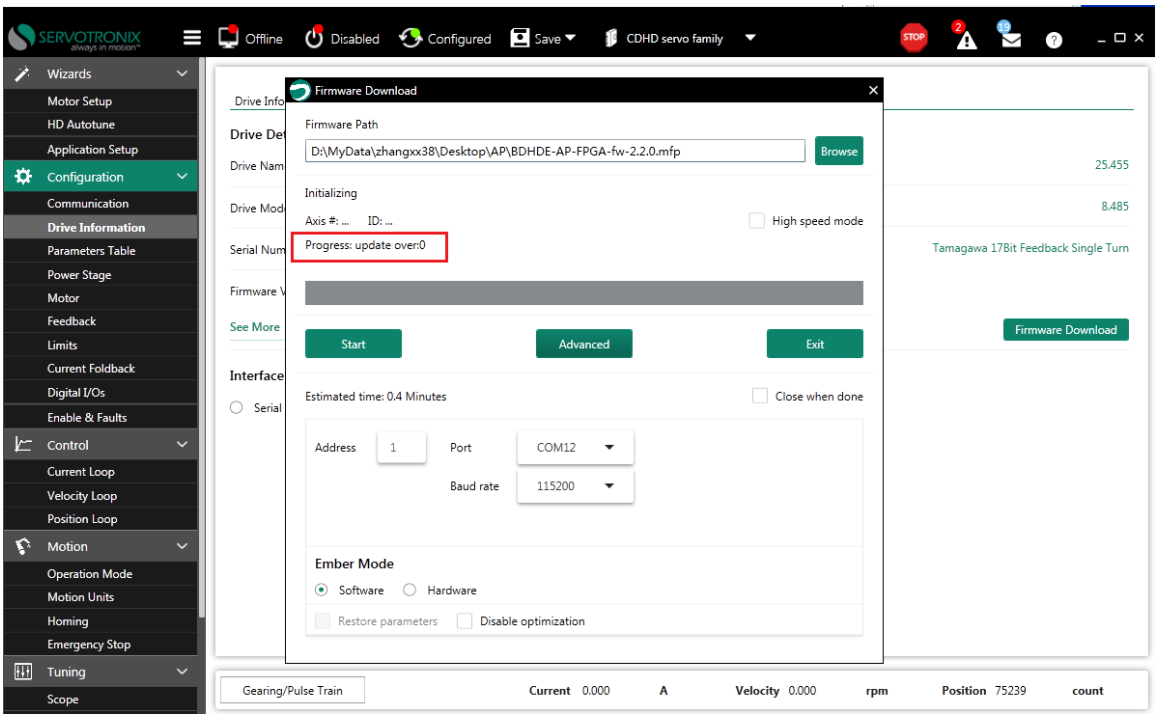

3) To expand the "Advanced" option, and select the COM port corresponding to the BDHDE drive to be upgraded in the "Port" option.




4) To click the "Start" button to start the upgrade.

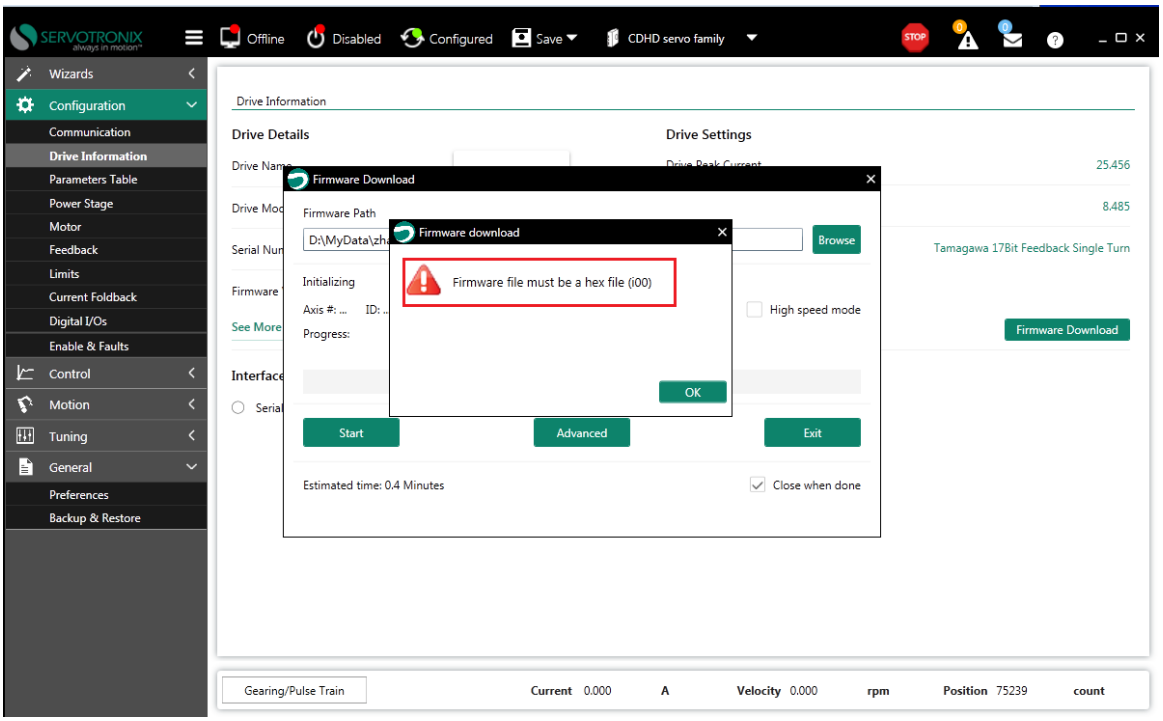



5) To update over:0 is displayed in the status bar, the FPGA firmware upgrade is completed, and the driver will restart automatically.



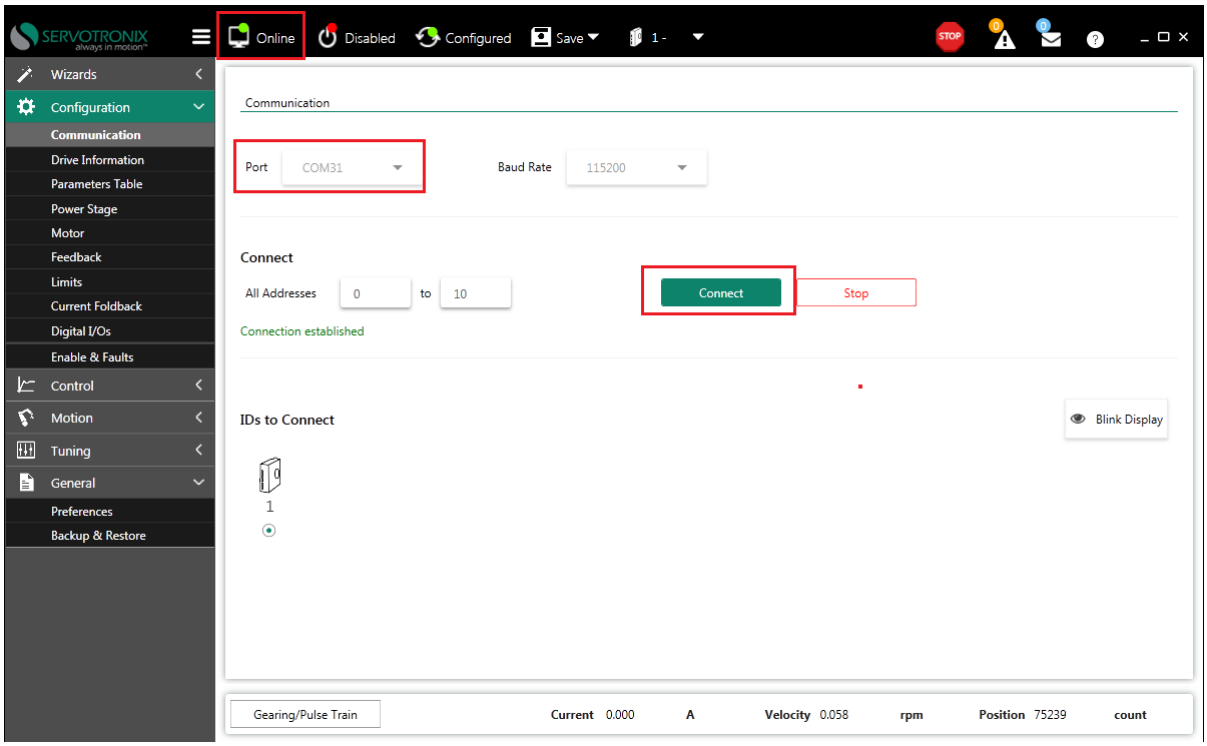

### 12.1.3 Possible Problems And Solutions

1) To prompt that. i00 format firmware needs to be selected, but. mrc or. mfp format firmware cannot be selected.

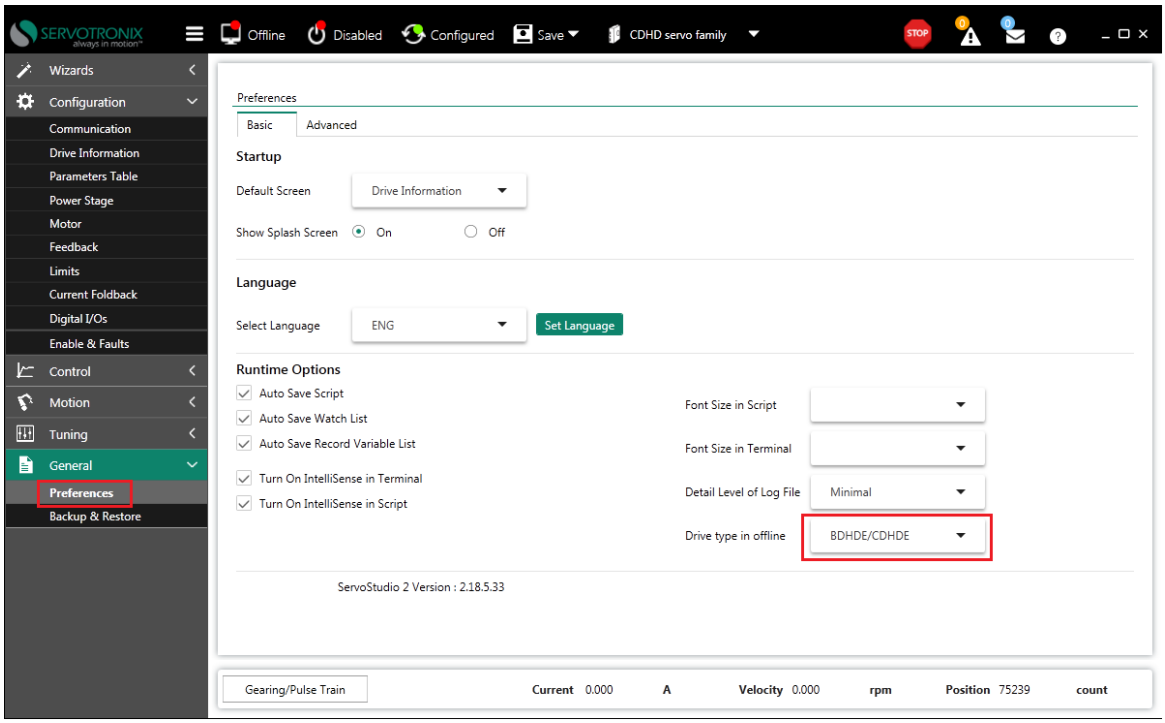



**Solution:**

This phenomenon occurs because the ServoStudio2 software has not communicated with the drive after opening, and can be upgraded after communicating with the drive.




If the drive can't communicate normally, and the drive shows "-"Flash, it can be upgraded normally after the default setting of ServoStudio2 software is changed to BDHDE.

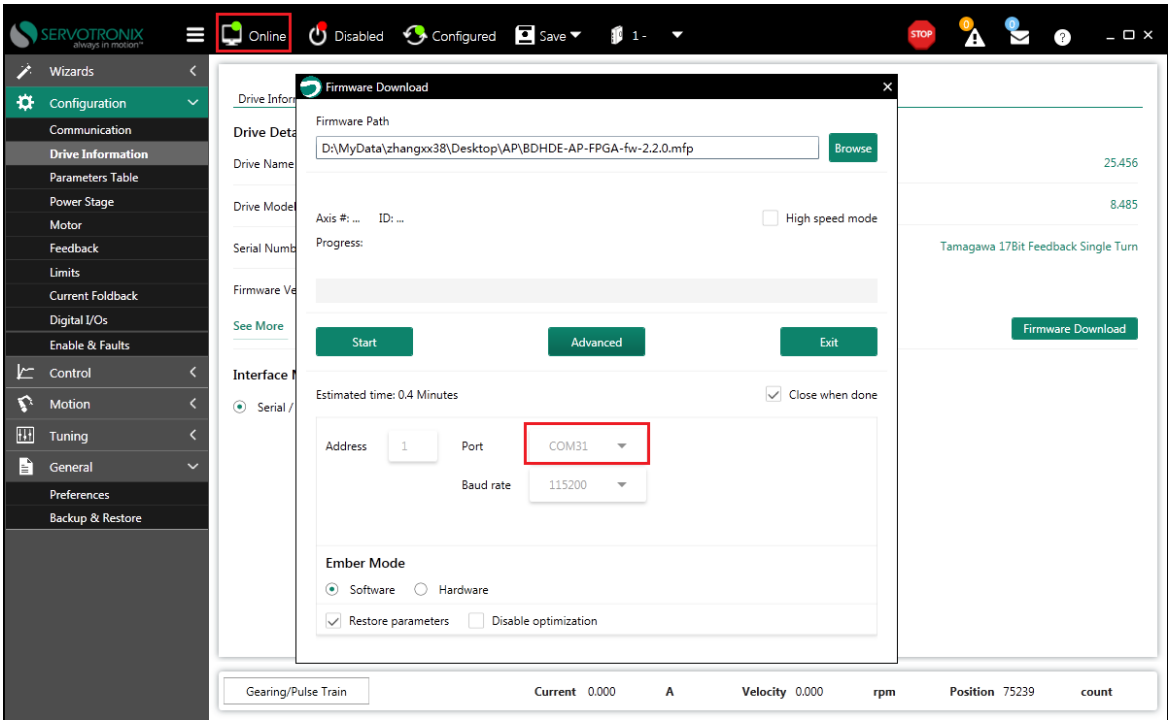



2) During the upgrade process, it is stuck in Open COMxx:0 or COM communication timeout:0 occurs or IAP ack error:0 occurs.

**Solution:**

To click the "Start" button again to upgrade again, without any other operation. If the message "Failed to download to BDHD-E" is prompted, it cannot be connected due to the active rejection of the target computer. 127.0.0.1:8000 ", please go to the task manager to end the" BDHDE_FW_Download.exe "process, and click the “Start "button again to upgrade.

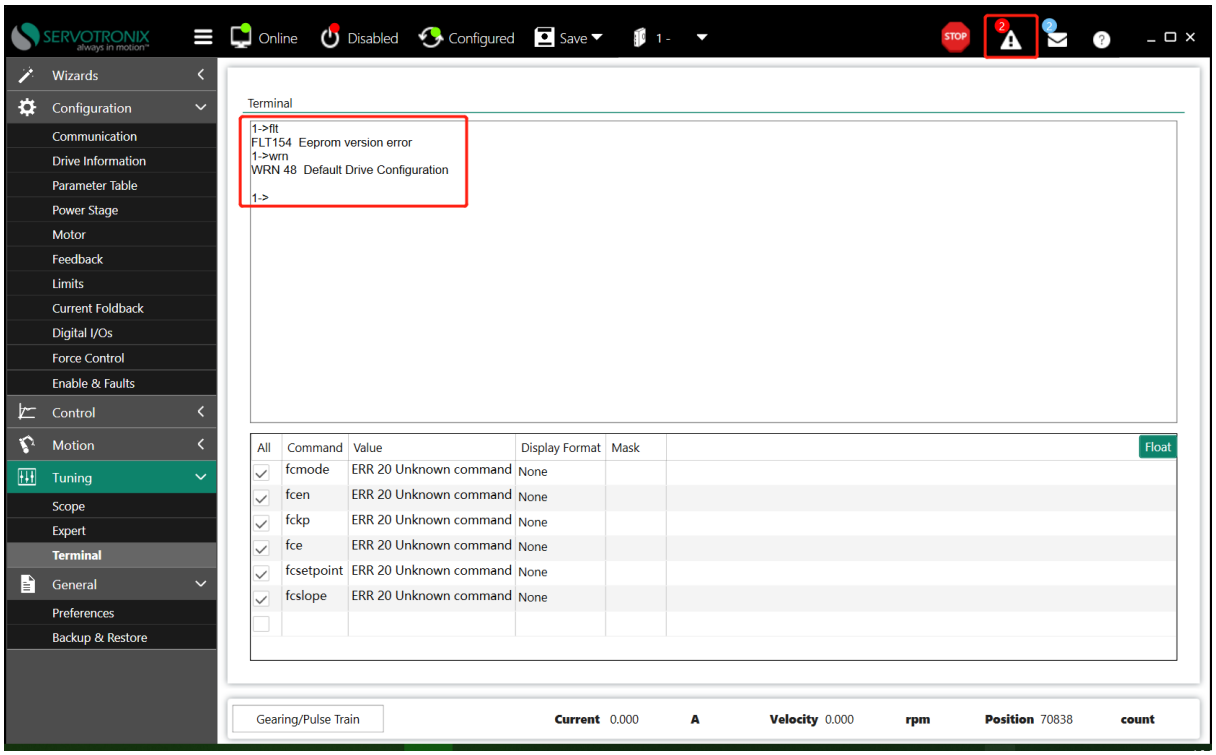
3) The Port of the upgrade interface cannot be selected.



**Solution:**

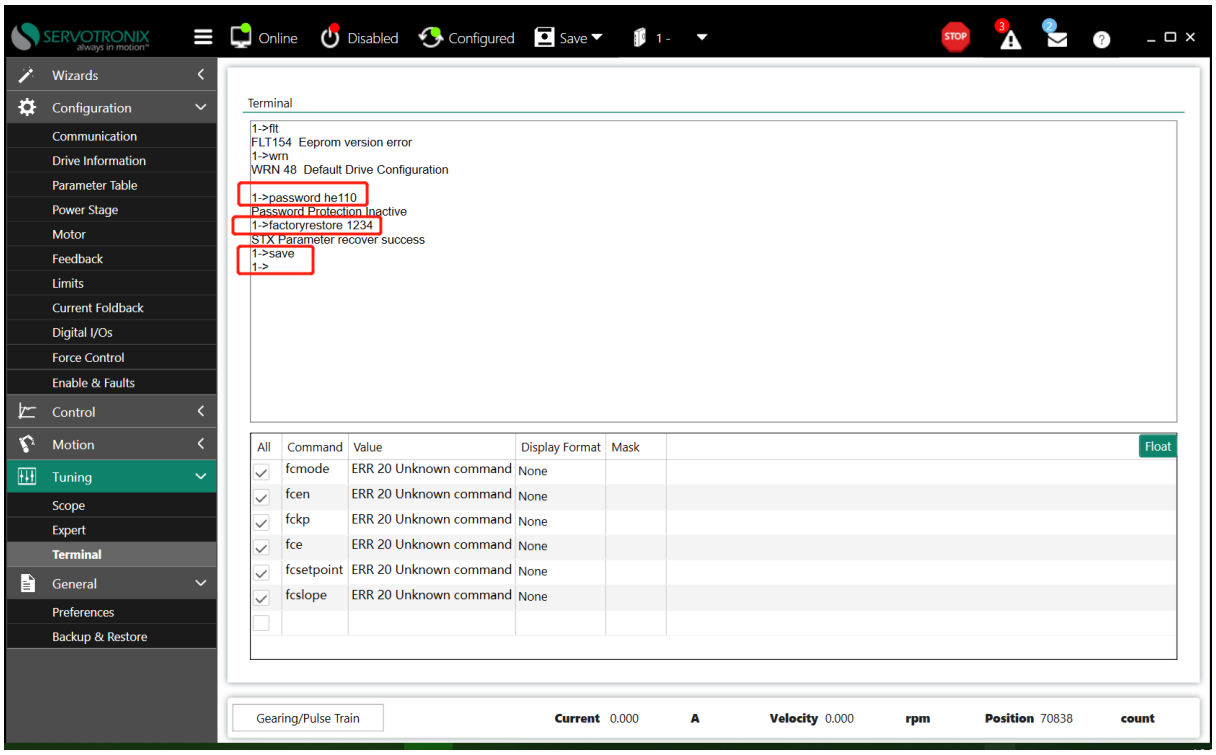
ServoStudio2 has established communication with the drive, so it is impossible to select the port. Skip selecting the port and upgrade directly.

4) ServoStudio2 reports an error Eeprom version error after the upgrade is completed.

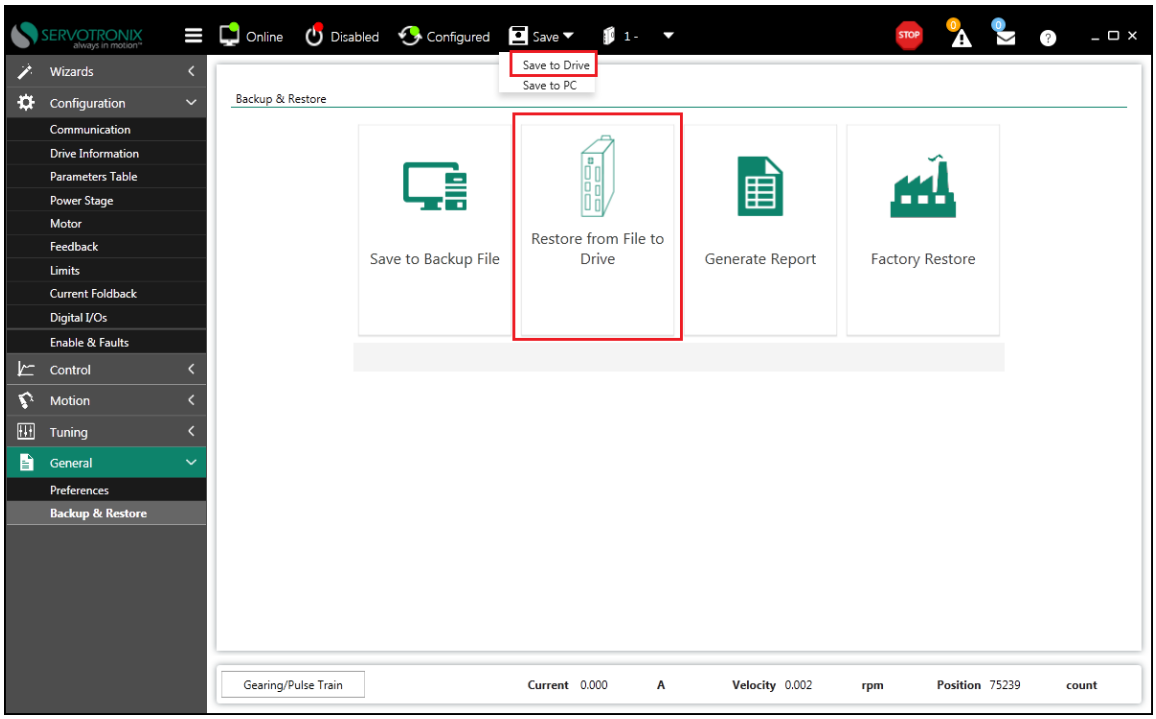



**Solution:**

After the upgrade, the firmware version changes, which leads to the mismate between EEPROM parameters and firmware. Restore the factory parameters in the terminal interface, and then power on again.




If you need to restore the backed-up drive parameters, import the parameters through the parameter recovery interface, and power on the drive again after saving.




5) To clicking the firmware upgrade button will not pop up the upgrade box, and the software is stuck, so there is no response after clicking it.

**Solution:**

ServoStudio2 has an upgrade protection mechanism, and clicking the firmware download button will automatically send the disable enable command. In EtherCAT mode, however, ServoStudio2 has no disable enable authority, so if EtherCAT master station does not send disable enable command now, ServoStudio2 cannot pop up the firmware download interface and the software cannot operate. Now, EtherCAT master station

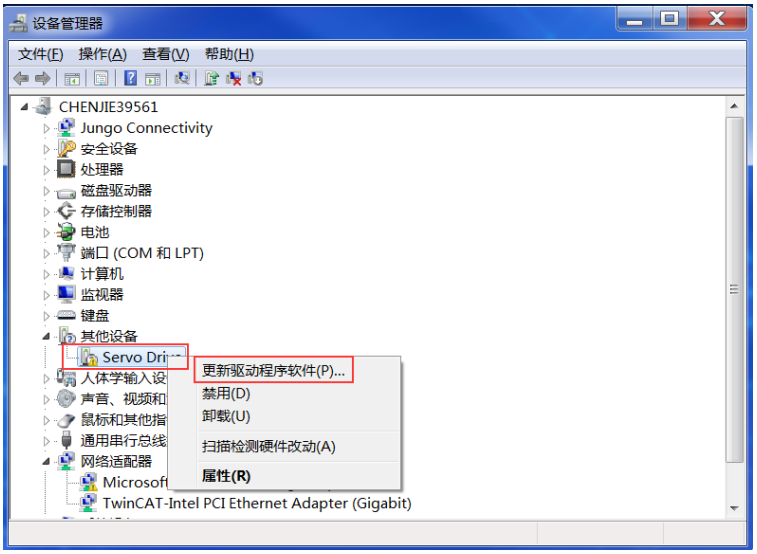
should send a disable enable command, and ServoStudio2 will automatically pop up the firmware upgrade interface.

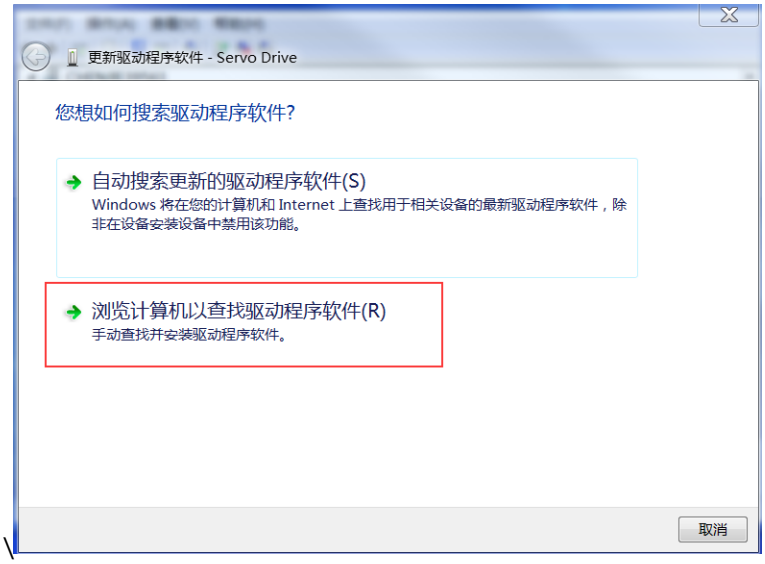
6) Unable to find serial port after upgrade.

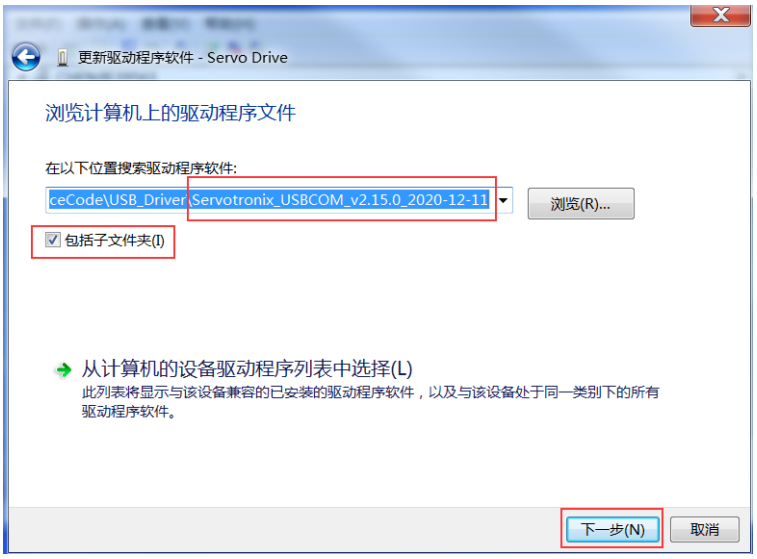
**Solution:**

If you are upgrading MCU firmware from version before 2.1.6 to after 2.1.6 (2.1.6 including), you can do the following:

For example, when installing ServoStudio2 version after 2.38.6.6(excluding) in Windows 7, you can Open Device Manager -> Other Devices -> Right-click Problem Devices' Servo Drive '-> Update Driver Software -> Browse your computer to find driver software -> manually select the driver path to install the drivers.







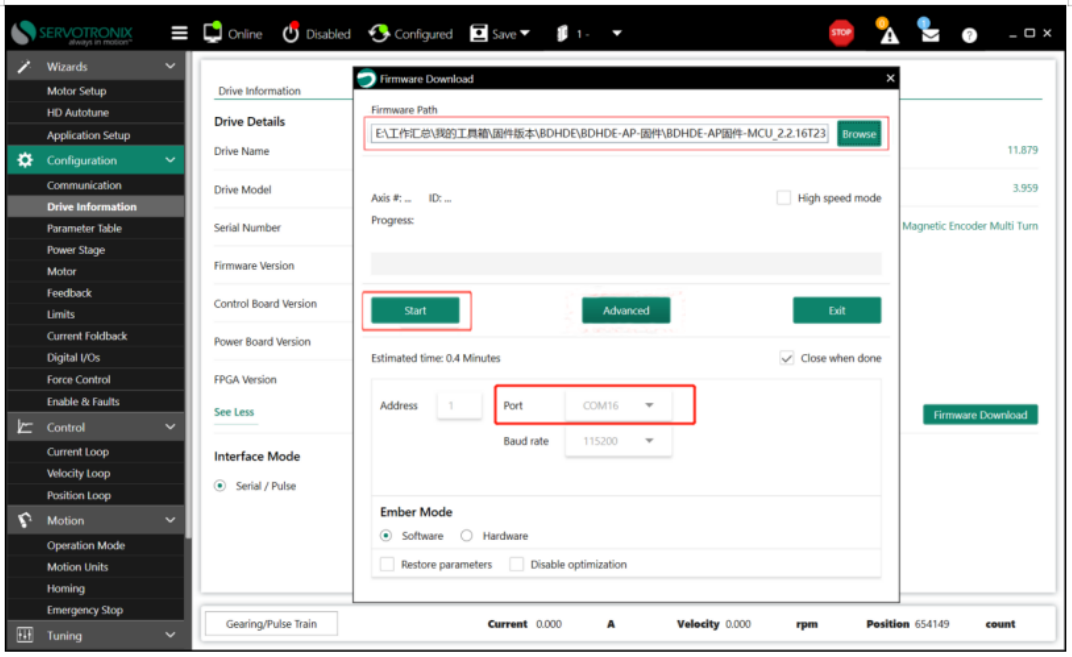


7) USB driver upgrade operation when cross-version.

**Solution:**

- General -> Preference -> Drive type in offline, choosing BDHDE. If ServoStudio2 has already connected to the drive, you can skip this step.
- Enter the firmware update interface, select firmware file, serial port number, and click Start.

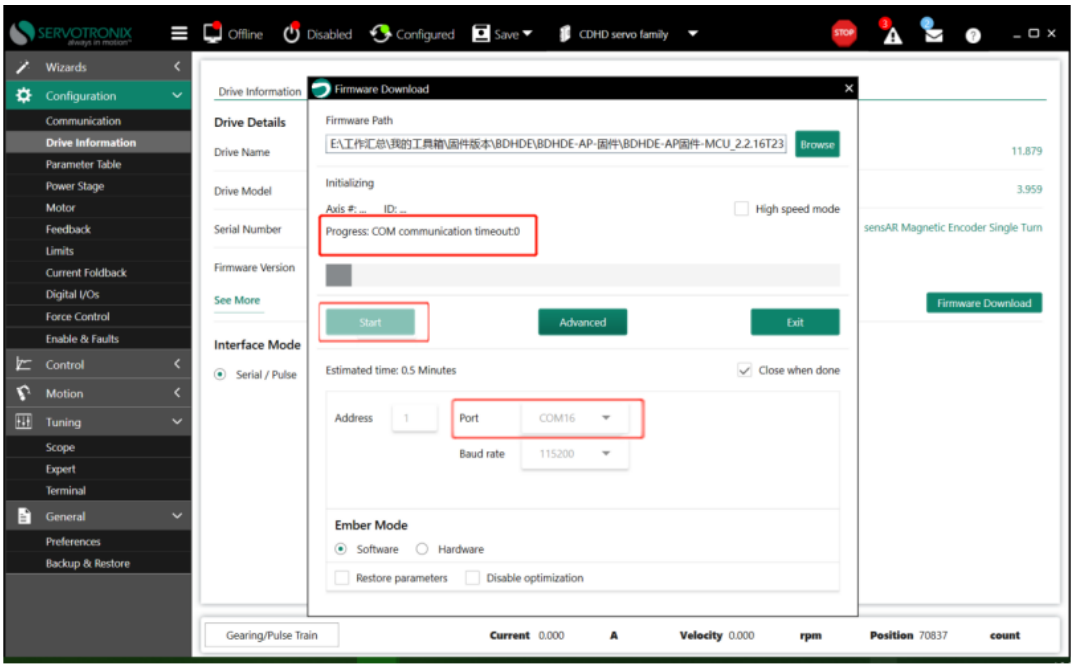
BDHDE Serial communication




- Drive restarts, LED displays' - 'and flashes quickly.

- Drive restarts, LED displays' - 'and flashes quickly.

- Select the serial port number again. If you are not sure about the serial port number, you can enter the device manager to view it. The serial port name is' Servo Drive 'or' Communicate Port '.




- Click "Upgrade" again. If the upgrade fails, you don't need to close the interface, just click "Upgrade" again.
- Upgrade finished.

8) After connecting to USB, the serial port number in Device Manager blinks all the time, and no digital signature is displayed in the property of driver.

**Solution:**

- Right-click the serial port in Device Manager.
- Uninstall the serial driver.
- Restart the computer and press F8 to disable forced digital signature.
- Install the driver manually, refer to point 6) above.

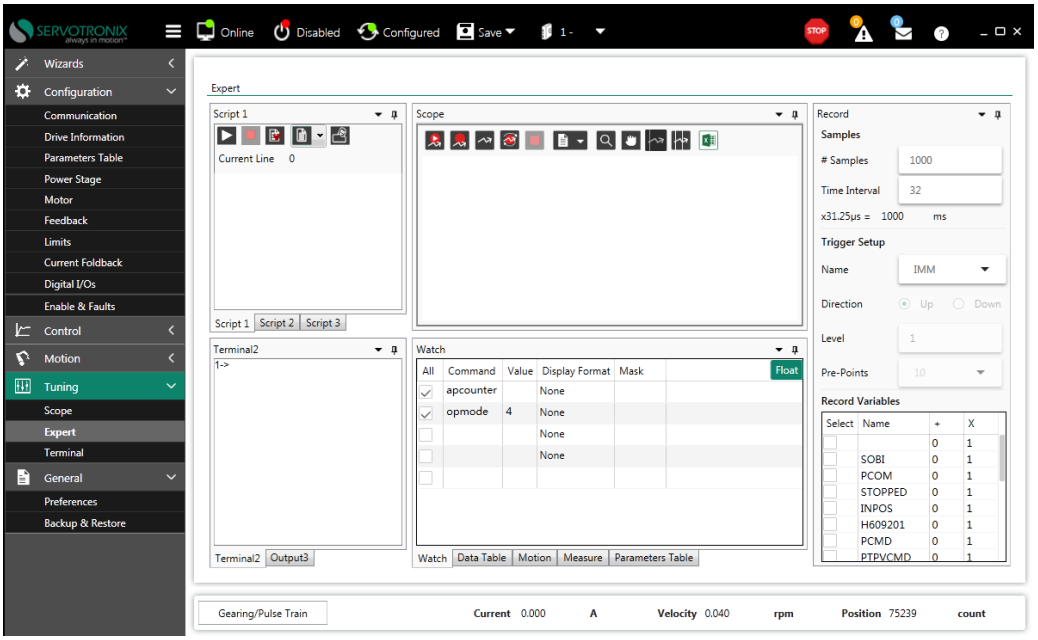
If the serial port is still blinking after restart and and no digital signature is displayed in the property, check if there is any external software that restricts the driver installation.

## 12.2 Load Adjustment Free Function

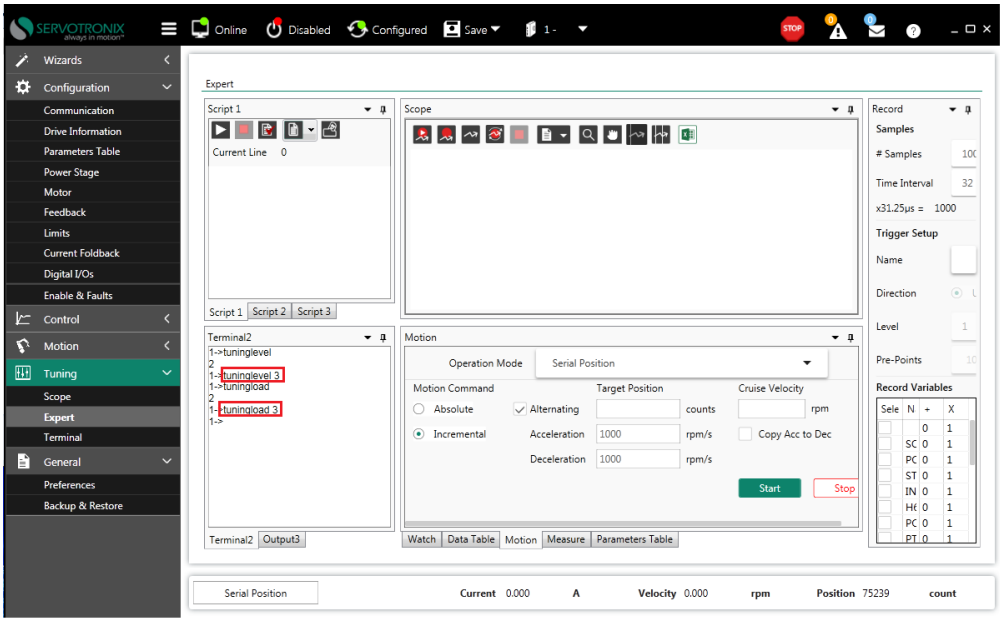
This application instruction describes how to perform the load adjustment-free function, and assumes that you are familiar with the use of ServoStudio software.

### 12.2.1 Steps of Operation

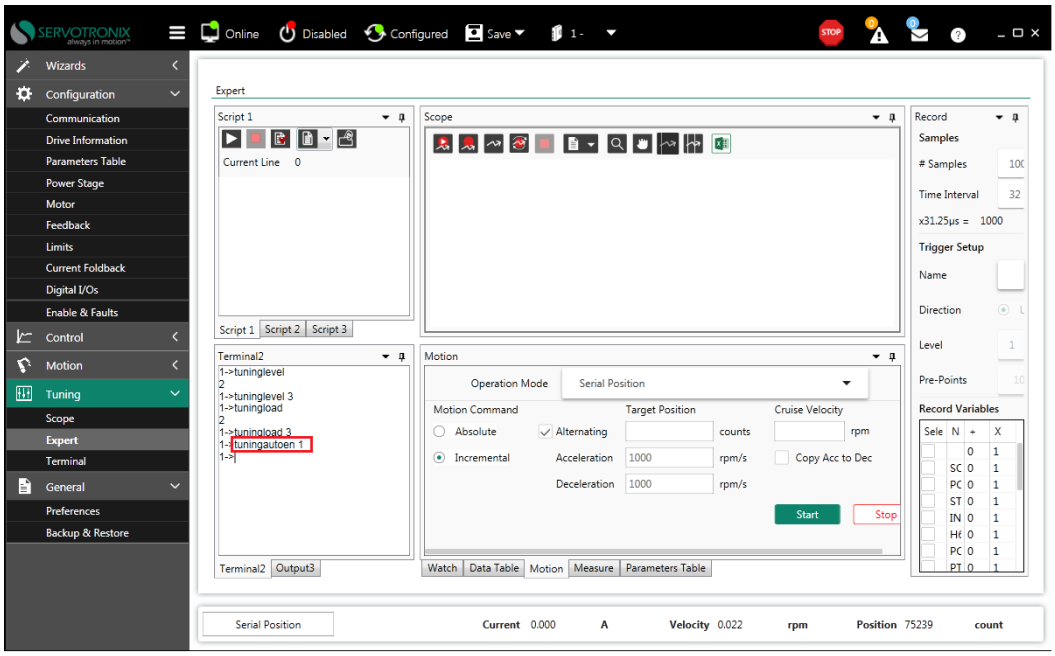
1) To open ServoStudio2 software and enter the "Expert" interface.




2) To set the adjustment-free performance level through the parameter "tuninglevel" and the adjustment-free load level through the parameter "tuningload" in the Terminal window.




3) To enter the command "tuningautoen 1"in the Terminal window to turn on the adjustment-free function.




4) To plan the motion trajectory, run the motor, and check whether the response meets the requirements.

5) If the demand is not met, adjust the adjustment-free level "tuninglevel" and the load level "tuningload" until the demand is met.

### 12.2.2 Parameter Description:

1) Description of load adjustment-free parameter definition:

| VarCom | Description |
|---|---|
| TUNINGAUTOEN | Turning off the adjustment-free function of TUNINGAUTOEN 0.<br>Turning on the adjustment-free function of TUNINGAUTOEN 1. |
| TUNINGLEVEL | Adjustment-free grade with range: 0~6 |
| TUNINGLOAD | Load level without adjustment with range: 0~3 |

1) After the adjustment-free function is turned on, there is no need to set the Rigidity grade(RIGID)and load inertia ratio (LMJR).

2) The adjustment-free function is not applicable to situations where the load inertia ratio is particularly large.

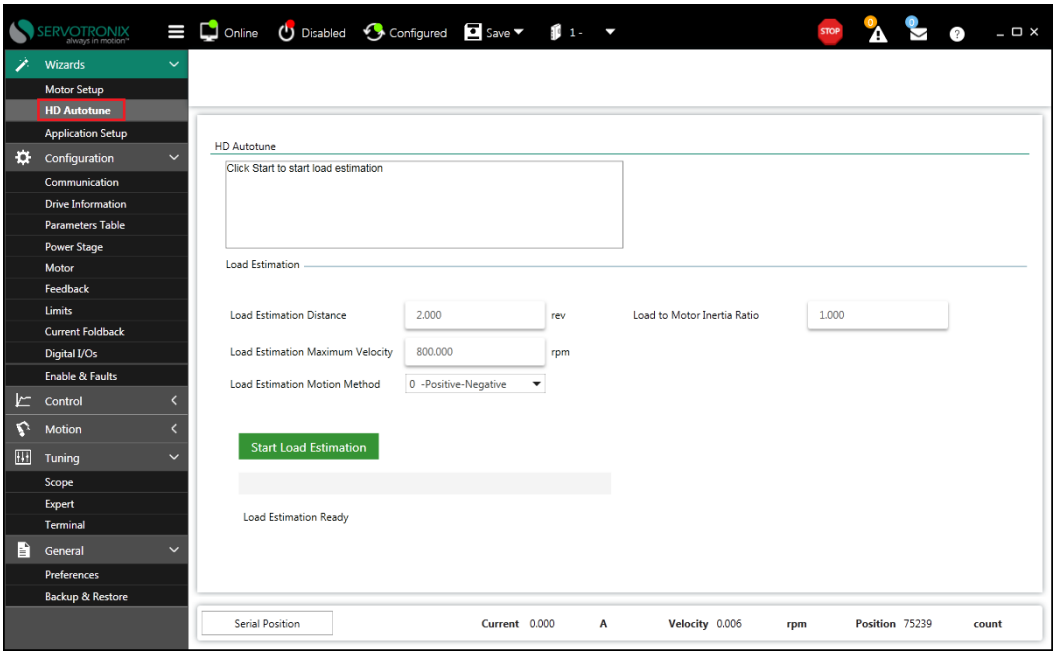
3) When the load inertia is relatively large, it is necessary to increase the TUNINGLOAD for Increasing TUNINGLEVEL can improve the gain of servo system.

## 12.3 Offline Inertia Identification Function

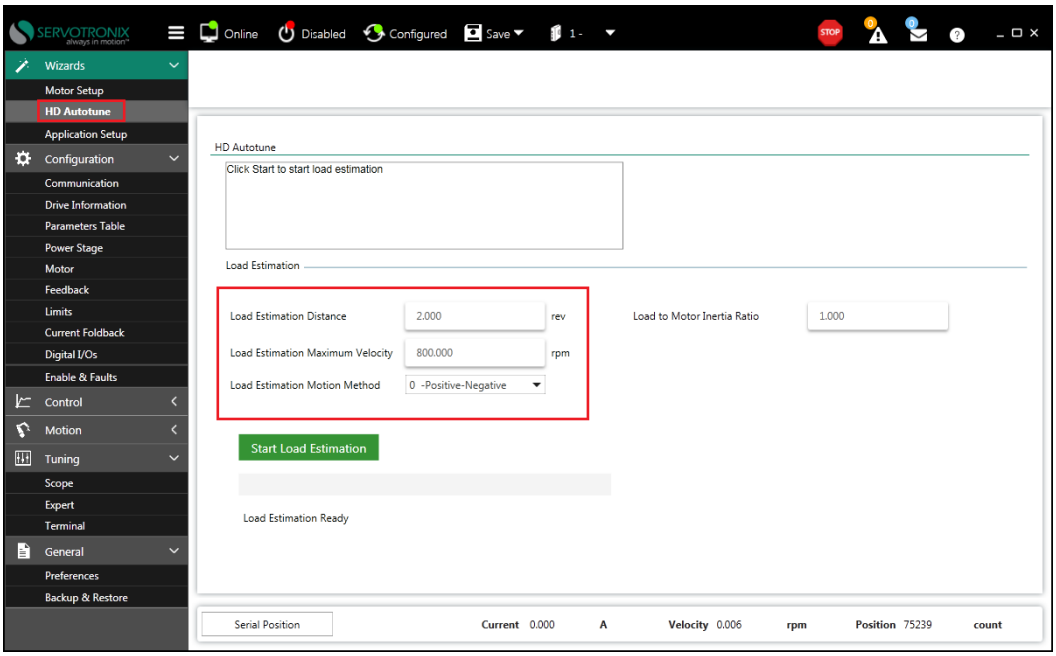
This application note describes how to perform the offline inertia identification function, and assumes that you are familiar with the use of ServoStudio software.

### 12.3.1 Execution Steps of ServoStudio Interface

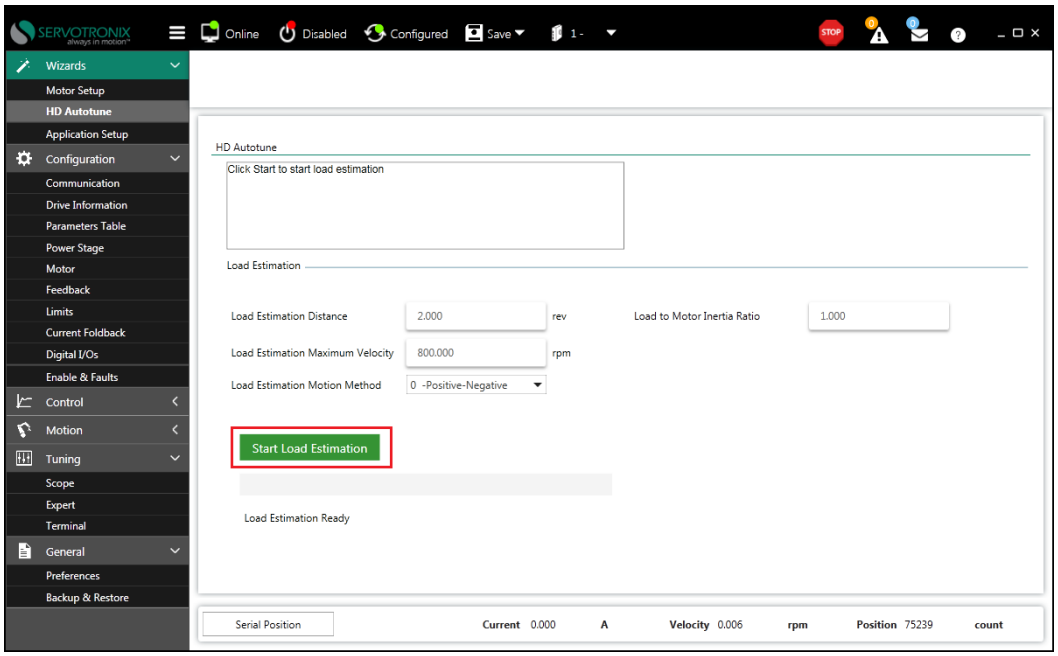
1) To open ServoStudio2 software and enter the "HD Autotune" interface.



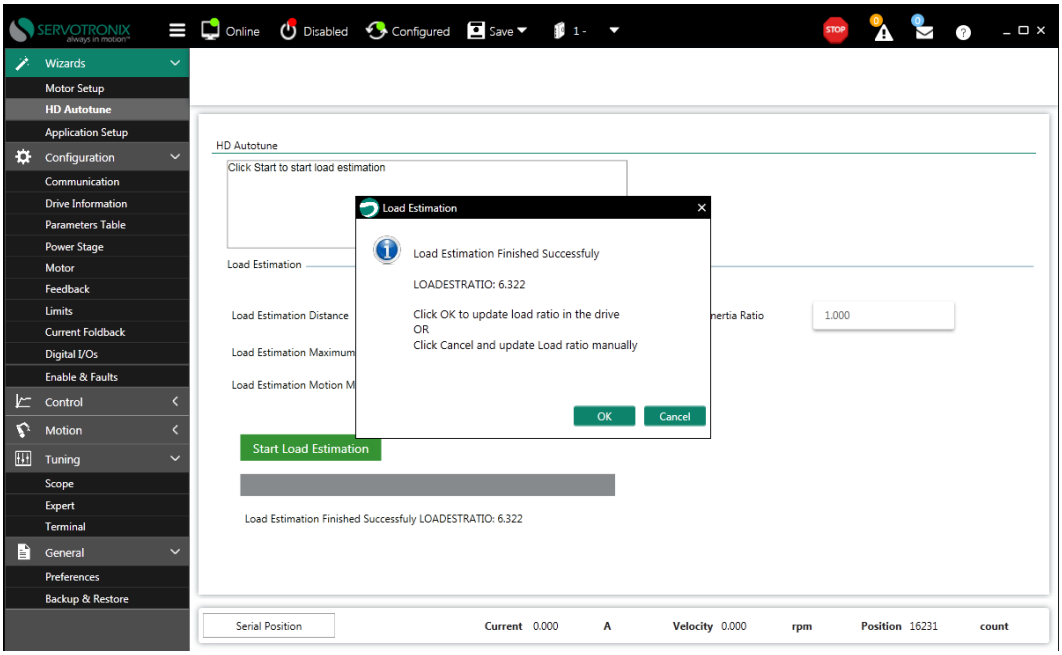

2) To set offline inertia identification parameters.




3) To click "Start Load Estimation" to start inertia identification.

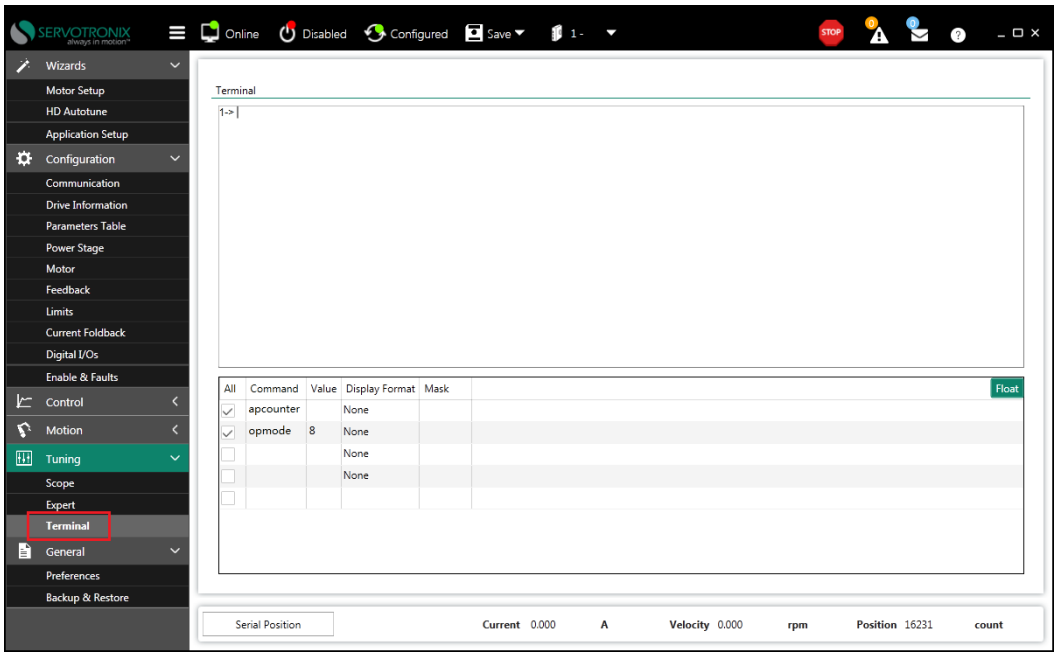



4) After successful identification, click OK to automatically assign the identification result of load inertia ratio to variable LMJR, click Cancel to return to inertia identification interface, and manually assign the identification result of load inertia ratio to variable LMJR.

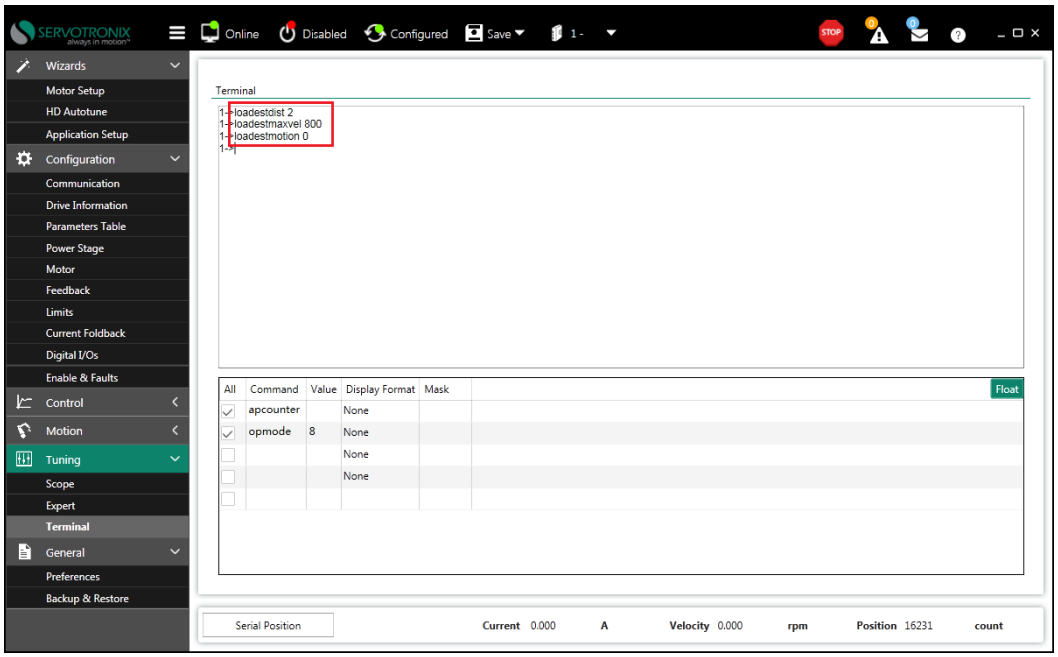



### 12.3.2 Execution Steps of ServoStudio Terminal Command

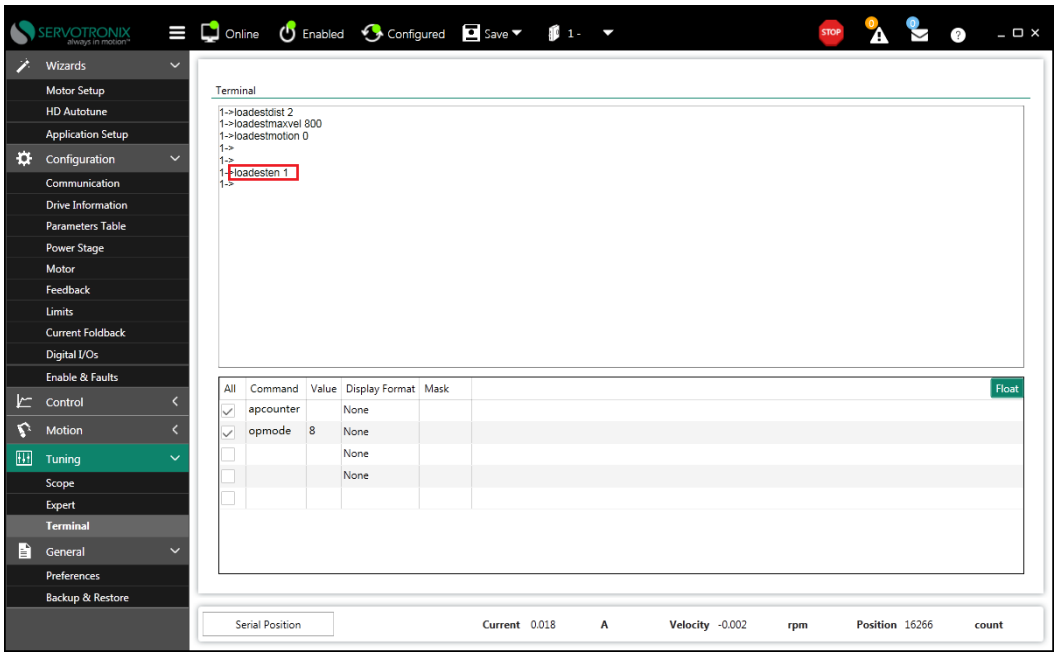
1) To open ServoStudio2 software and enter Terminal interface.



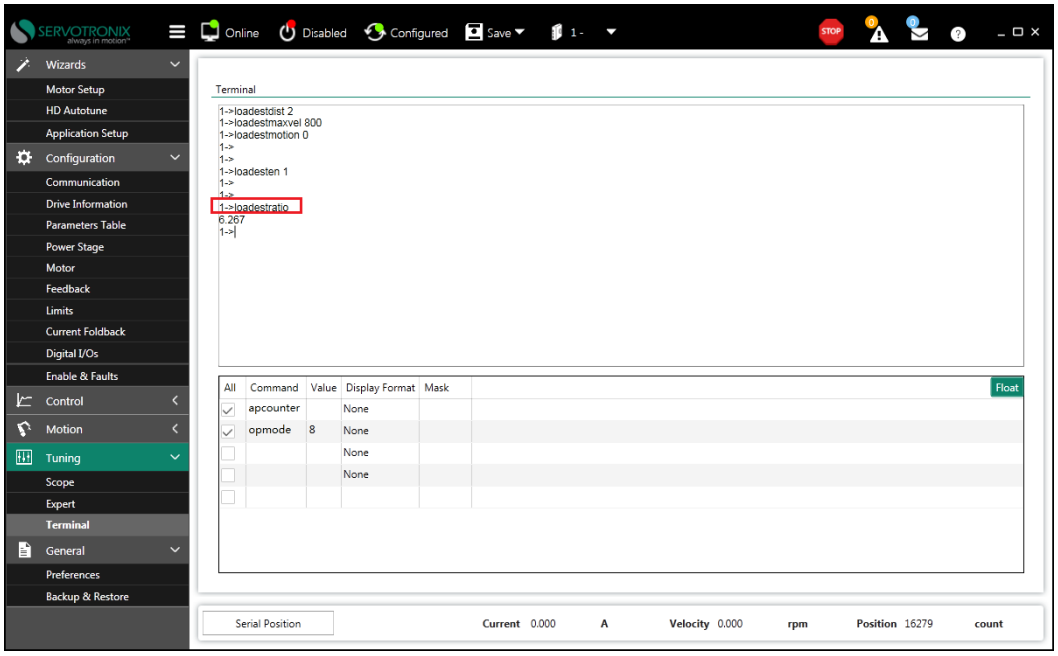

2) To set off-line inertia identification parameters at the Terminal through commands such as "loadestdist", "loadestmaxvel" and "loadestmotion".



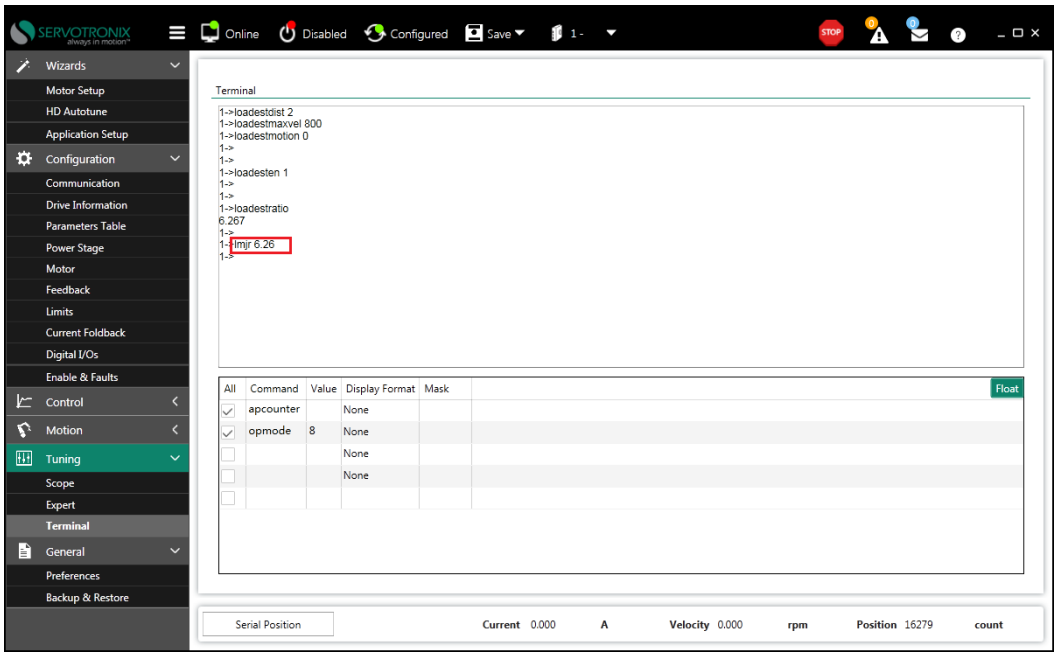

3) To enter the command "LOADESTEN 1" at the Terminal to turn on the inertia identification function switch.




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

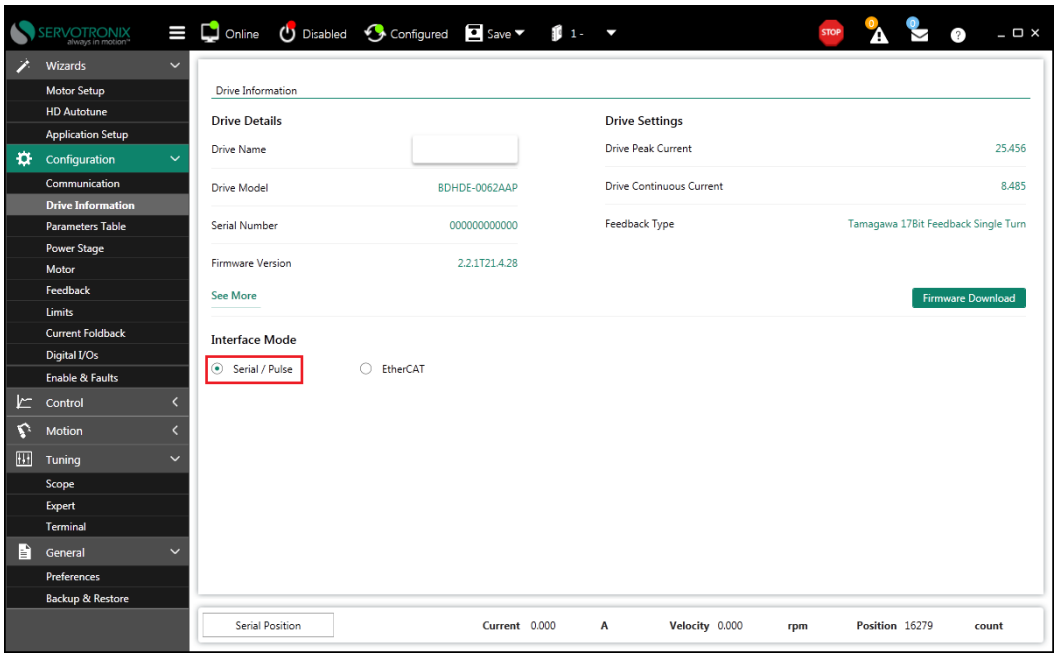



5) To write the load inertia ratio into the servo system through variable "LMJR".




### 12.3.3 Parameter Description:

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




2) Description of relevant commands

| VarCom | Description |
|---|---|
| LOADESTACC | Off-line inertia identification of acceleration values during acceleration and deceleration.<br>Range: 5000rpm/s~60000rpm/s |
| LOADESTDIST | Running distance in off-line inertia identification process, unit: coil.<br>Range: 0.25rev~3.0rev |

| VarCom | Description |
|---|---|
| LOADESTEN | Offline inertia identification function switch.<br>Off-line inertia identification start of LOADESTEN 1<br>Off-line inertia identification stop of LOADESTEN 0 |
| LOADESTMAXVEL | Maximum running speed in off-line inertia identification.<br>Range: 300rpm~1000rpm |
| LOADESTMOTION | Off-line inertia identification operation mode.<br>The LOADESTMOTION 0 motor rotates forward first and then reversely<br>The LOADESTMOTION 1 motor reverses first and then rotates forward<br>The LOADESTMOTION 2 motor only rotates forward<br>The LOADESTMOTION 3 motor only reverses |
| LOADESTRATIO | Load inertia ratio obtained by off-line inertia identification. |
| LOADESTSTATUS | Displays the current status of offline inertia identification.<br>LOADESTSTATUS 0 is initialized, and inertia identification is not performed<br>Inertia identification of LOADESTSTATUS 1 is in progress<br>The LOADESTSTATUS 2 does not meet the identification conditions, and the current speed feedback exceeds 50rpm or the position error PE exceeds 100count.<br>LOADESTSTATUS 3 was not successfully enabled during inertia identification, or it was incorrectly enabled midway.<br>The load inertia ratio after identification of LOADESTSTATUS 5 is over 50.<br>Inertia identification of LOADESTSTATUS 6 succeeded. |
| LOADESTVAL | The total inertia of the system (including the inertia of the motor and the load inertia) obtained by off-line inertia identification. |

### 12.3.4 Possible Problems and Solutions

1) Current saturation problem

When the load is large, current saturation will occur in the acceleration or deceleration stage of inertia identification process, which leads to the failure of offline identification process.

**Solution:** to reduce the acceleration in the identification process through the variable "loadestacc".

2) It is not automatically enabled in the identification process.

When DI is configured with "Remote Enable" and the status is invalid, or when the system reports error in the identification process, the offline inertia identification function cannot be automatically enabled, and the offline inertia identification fails.

**Solution:** to set DI “Remote Enable " to be valid or re-identify inertia after clearing the error.

3) When the load-inertia ratio of the system is large, the off-line inertia identification process will have oscillation problems caused by current saturation and improper loop parameters.

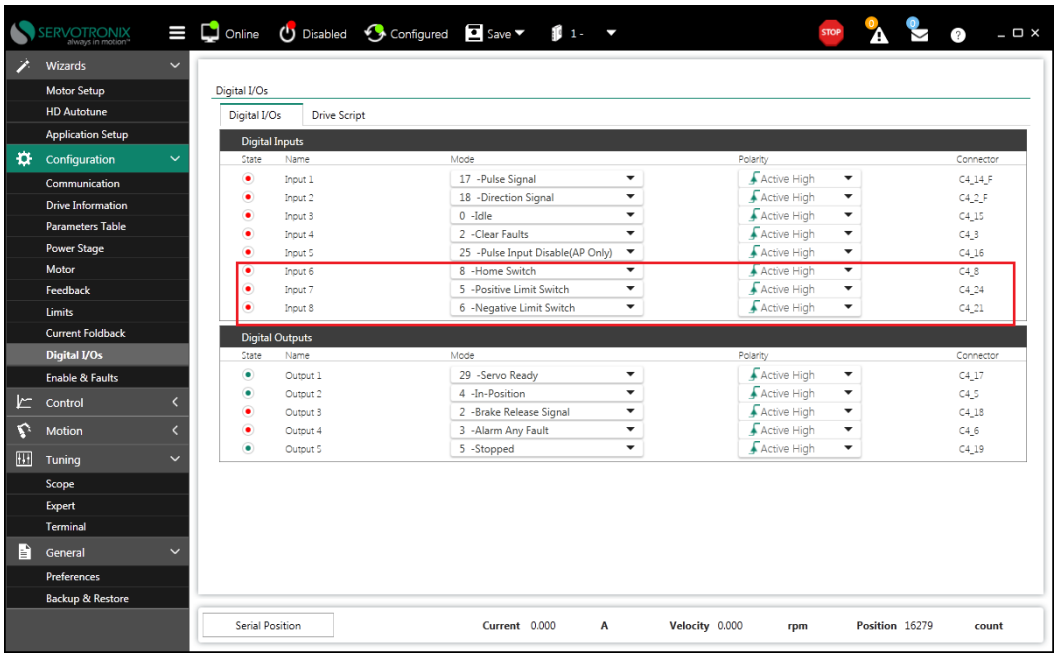
Even if this kind of situation is identified successfully, the result is not credible, which is only for reference.

**Solution:** manually adjust the load level through the variable "loadestload". (loadestload defaults to 0, and loop parameters are set values. ) if the current is still saturated, the acceleration in the identification process can be reduced by the variable "loadestacc". After adjusting the above parameters, identify the inertia.

## 12.4 Homing Function

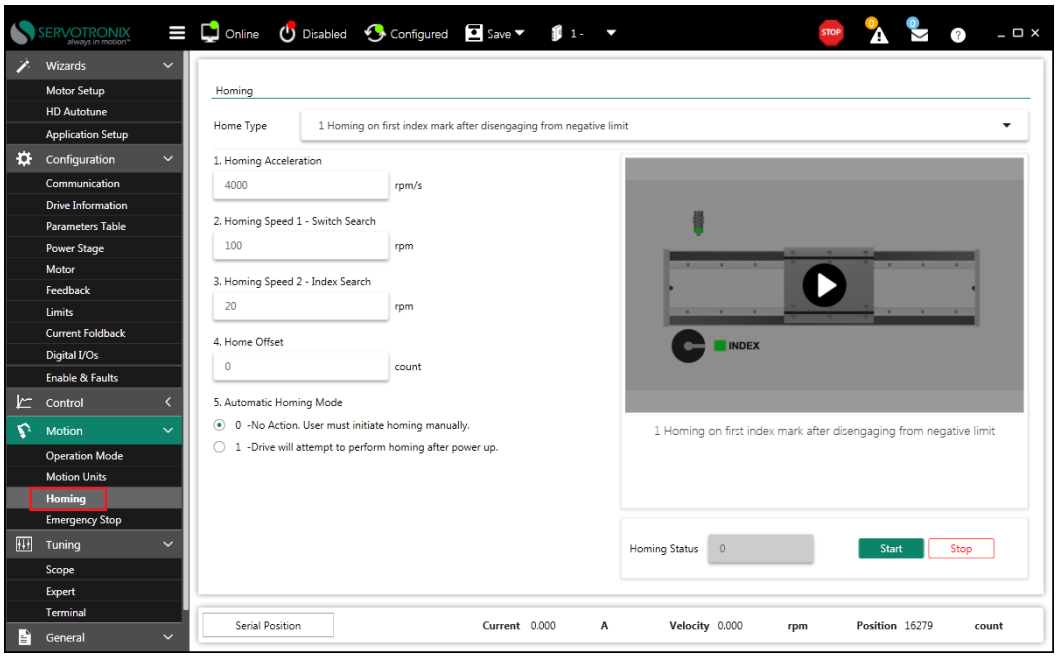
This application instruction describes how to perform the homing function, and assumes that you are familiar with the use of ServoStudio software.

Before homing, please assign "Home Switch", "Positive Limit Switch" or "Negative Limit Switch" through the "Digital I/O" interface of ServoStudio2 as required. For example:

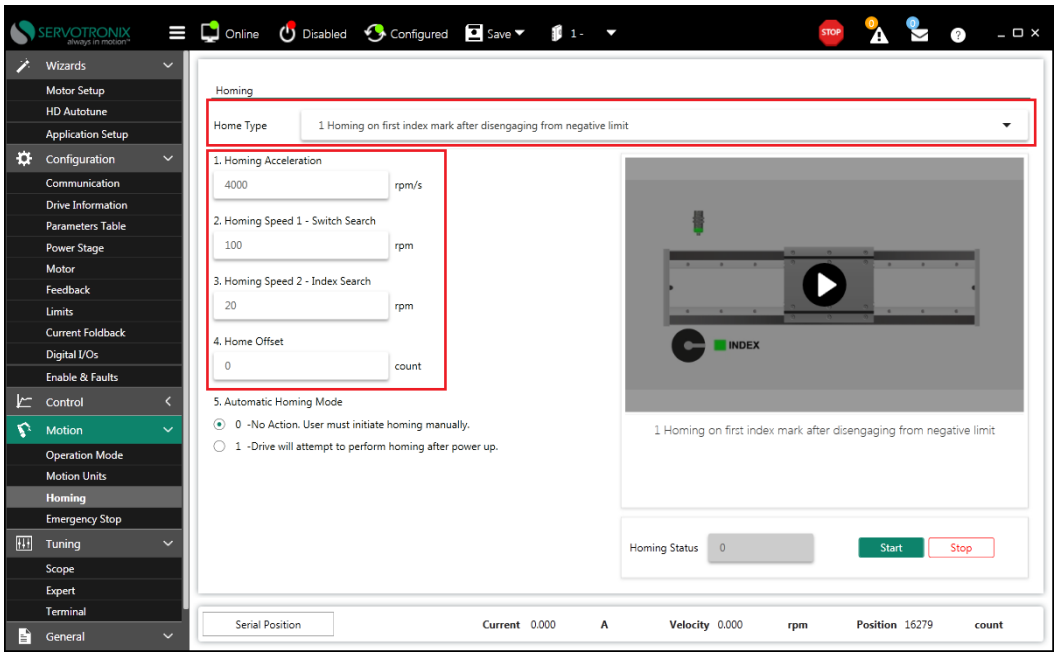



### 12.4.1 Execution Steps of ServoStudio Interface

1) To open ServoStudio2 software and enter the "Homing" interface.



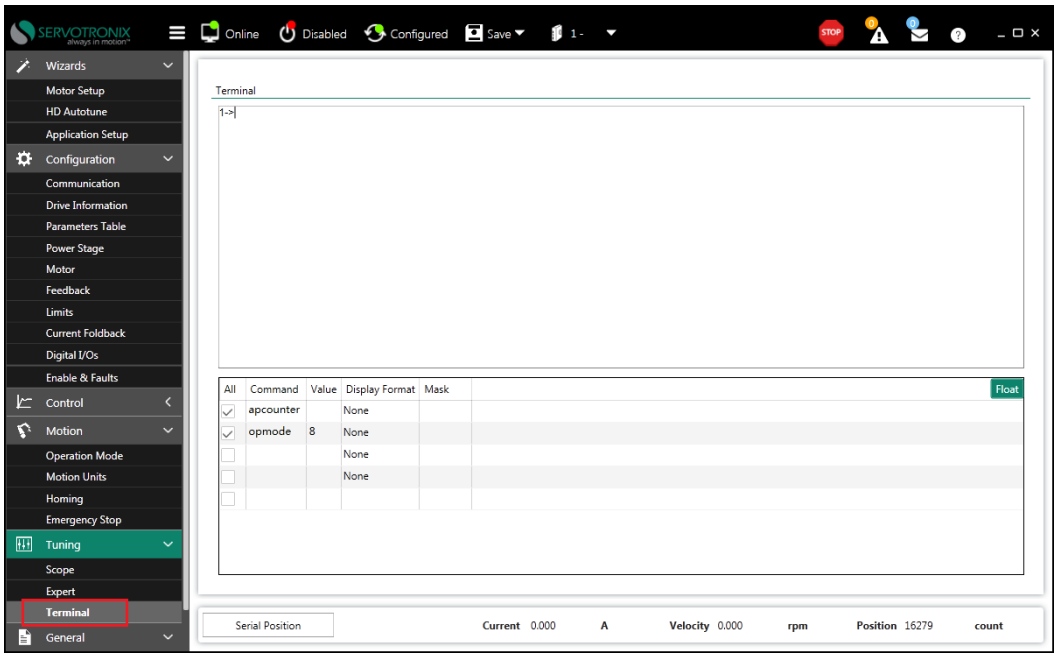

2) To select "Home Type" and set Homing Acceleration, Homing Speed1- Switch Search, Homing Speed 2- Index Search and Home Offset.



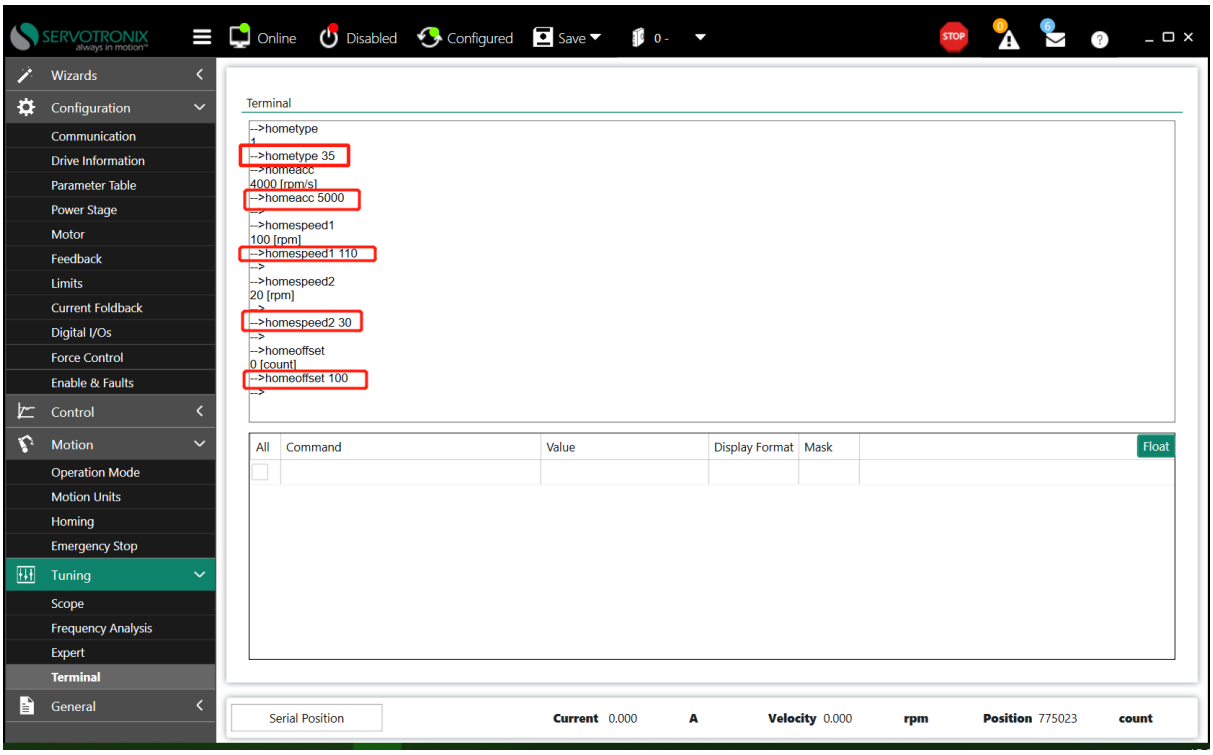

3) To click "Start" to homing.

### 12.4.2 Execution Steps of ServoStudio Terminal Command

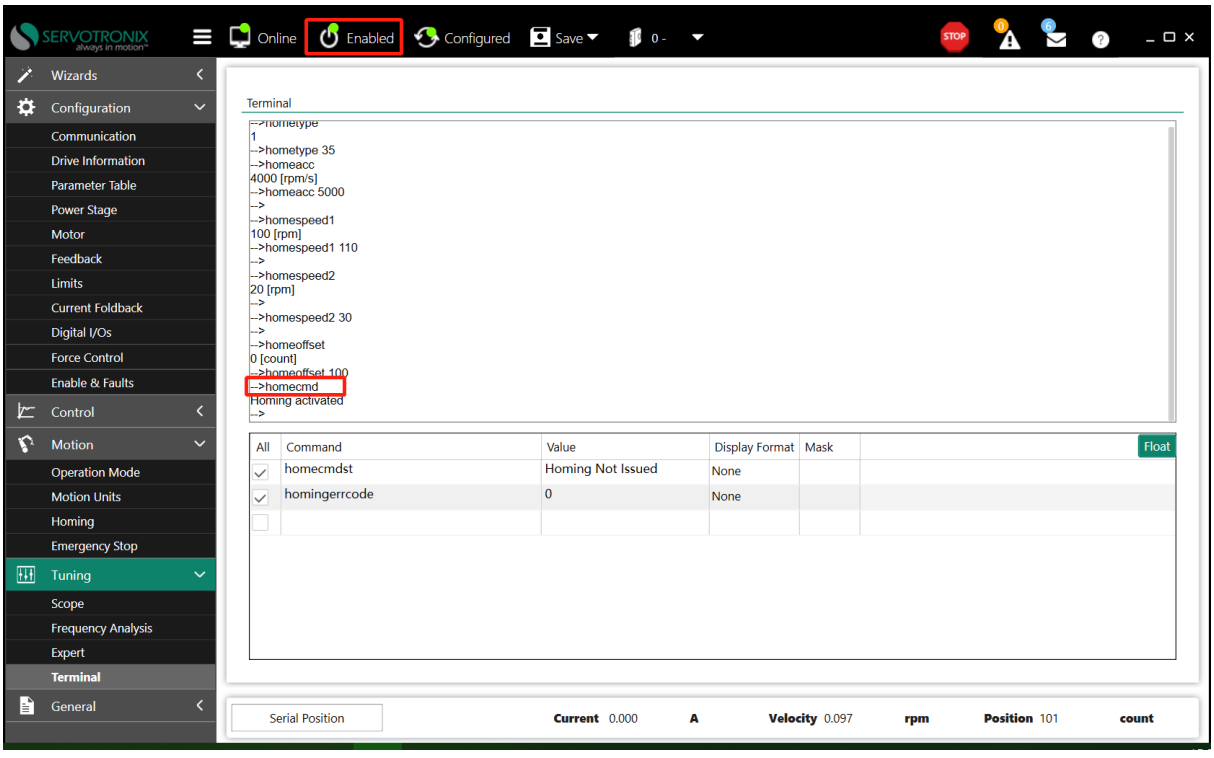
1) To open ServoStudio2 software and enter the "Terminal" interface.




2) At the "Terminal", select the homing type through the command "hometype", and set the homing parameters through the commands "homeacc", "homespeed1", "homespeed2" and "homeoffset".




3) After the servo is enabled, enter the command "homecmd" at the "Terminal" to reset to homing.




### 12.4.3 Parameter Description:

**Description of homing type :**

1) Indexing homing: HOMETYPE 1-14, 33, 34.

Use HOMESPEED1 before detecting limit switch, zero switch or hard stop. Once a proper Sequence # #time occurs (for example, the direction of limit switch is reversed), the shaft detects the index pulse (or equivalent signal on absolute value encoder) with HOMESPEED2 motion.

2) Returning to homing along positive and negative edges: HOMETYPE 17-30.

Home on the falling edge of the positive/negative limit or on the upper/lower edge of the homing switch.

3) To specify the current position as the homing position: HOMETYPE 35.

Specifies the current position as the homing position.

**The definition of homing parameter is as follows:**

| VarCom | Description |
|---|---|
| HOMEACC | Acceleration and deceleration values in the process of homing. |
| HOMEOFFSET | Set the "zero" offset (count). |
| HOMEOFSTMOVE | Defines whether the axis moves in the process of returning to zero.<br>When HOMEOFSTMOVE is used, the value of PFB is 0 after returning to zero.<br>HOMEOFSTMOVE is ignored if HOMETYPE=35. |
| HOMESPEED1 | Searching for the initial speed used in limit switch, zero switch and zero return process during hard stop. |
| HOMESPEED2 | Searching for the speed used in the zeroing process during the zeroing trigger (which may be index pulse, limit switch transition, zero switch transition or other source (defined by HOMETYPE)). |
| HOMETYPE | Defines the homing process type that will be executed. |
| HOMECMD | Start homing process. |
| HOMECMD 0 | Stop homing process. |
| HOMESTATE | Displaying the current status of the system homing.<br>HOMESTATE 0 has not started to homing<br>HOMESTATE 1 homing in progress<br>HOMESTATE 19 homing and completes<br>HOMESTATE 20 homing to report an error |
| HOMINGERRCODE | Displays the error type for homing. |
| HOMINGRUNTIMEMAX | Defining the maximum running time for homing. If the running time for homing exceeds this value, a homing error will be reported. |

When a homing occurs, you can check the specific homing error type through the command "HOMINGERRCODE", which is explained as follows:

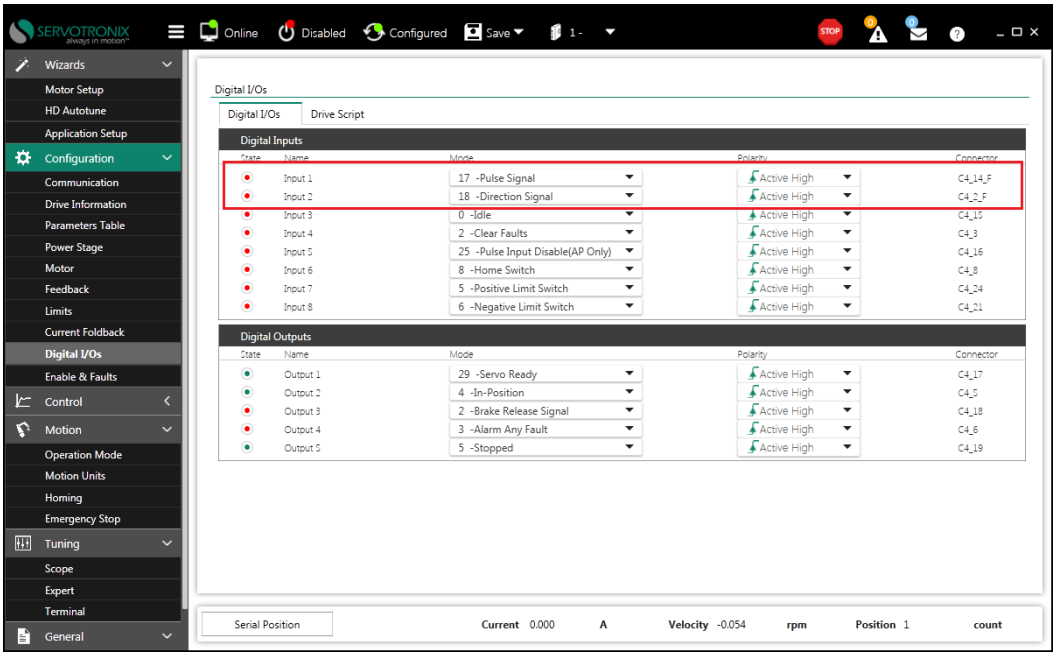
| HOMINGERRCODE | Description |
|---|---|
| 0 | No errors |
| 1 | When the interface mode is Serial/Pulse, homing is not finished, so stop homing to report this error. |
| 2 | When the interface mode is Serial/Pulse, homing is not finished, and turn off the enable to report the error.. |
| 3 | The error occurs when the actual running time of homing exceeds the value of HOMINGRUNTIMEMAX (unit: ms).<br>Note: when HOMINGRUNTIMEMAX=0, the running time of homing is not limited, and this error will not be reported. |
| 4 | Startup with a target speed of 0 will report this error.<br>Note: HomingSpeed1 or HomingSpeed2 of homing types 1~14,17~32 are set to 0, and this error is reported.<br>HomingSpeed2 of the homing types 33~34 is set to 0, and this error is reported.<br>Two speeds of homing type 35 are set to 0, so this error is not reported. |

| HOMINGERRCODE | Description |
|---|---|
| 5 | DI is not assigned the zero position switch and limit switch required by the homing type.<br>For example, homing type 1 requires negative limit switch, which will be reported when DI is not equipped with negative limit switch, but will not be reported when DI is not equipped with positive limit switch and zero position switch. |
| 6 | When the positive limit switch, negative limit switch and zero position switch are in effective state at the same time, report the error. |
| 7 | When the positive limit switch and the negative limit switch are in valid state at the same time, report the error. |
| 8 | When the zero switch and the positive limit switch are in effective state at the same time, report the error. |
| 9 | When the zero switch and the negative limit switch are in valid state at the same time, report the error. |
| 10 | The limit switch is incorrectly installed.<br>The homing type does not need a limit switch, which is in effective state in actual operation.<br>For example, no positive limit is required for type 1 of homing, and if the positive limit is in effective state during homing, this error will be reported. |
| 12 | In the type of homing by reversing the positive limit switch, when the rising edge of the positive limit switch detects the deceleration of reversing, the falling edge of the positive limit switch is detected, which will cause piercing and report the error.<br>It is suggested to reduce the speed of homing or increase the acceleration of homing. |
| 13 | In the type of homing through the negative limit switch reversal, when the rising edge of the negative limit switch detects the reversal deceleration process, the falling edge of the negative limit switch is detected, which will cause puncture and report the error.<br>It is suggested to reduce the speed of homing or increase the acceleration of homing. |
| 14 | In the type of homing through the homing switch, when the rising edge of the homing switch detects the deceleration process of reversion, the falling edge of the homing switch is detected, which will cause puncture and report the error.<br>It is suggested to reduce the speed of homing or increase the acceleration of homing. |

## 12.5 Pulse Mode Configuration

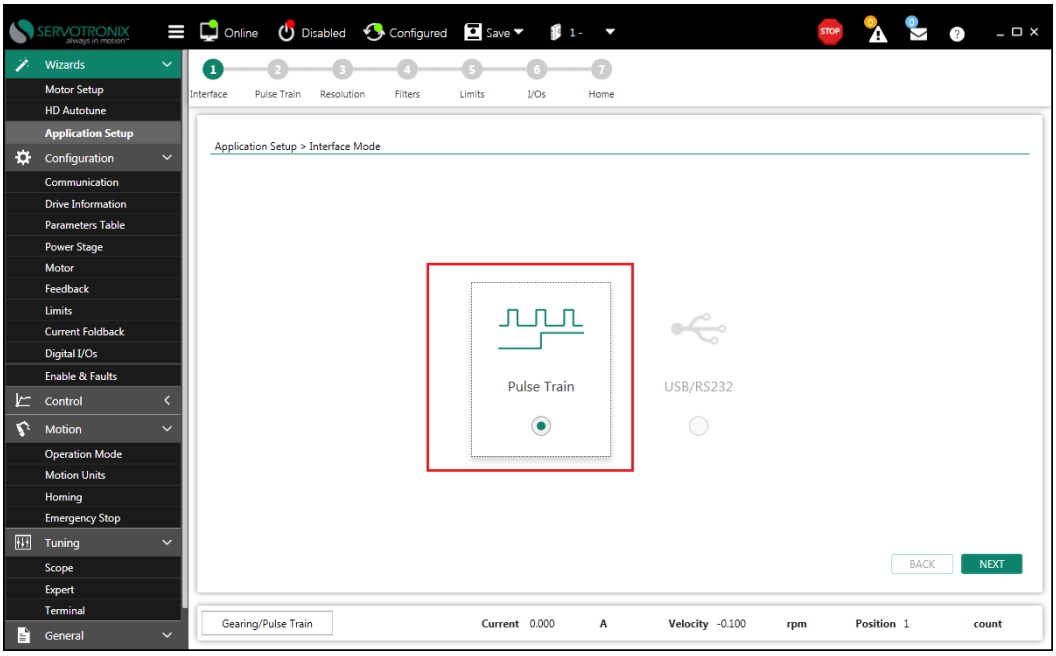
This application instruction describes how to perform pulse mode configuration for BDHDE-AP model, and assumes that you are familiar with the use of ServoStudio software.

To use single-ended pulse control, please assign a Pulse Signal to input 1 and a Direction Signal to input 2 through the digital I/O interface of ServoStudio2 as needed. Pay attention to that the order cannot be reversed.



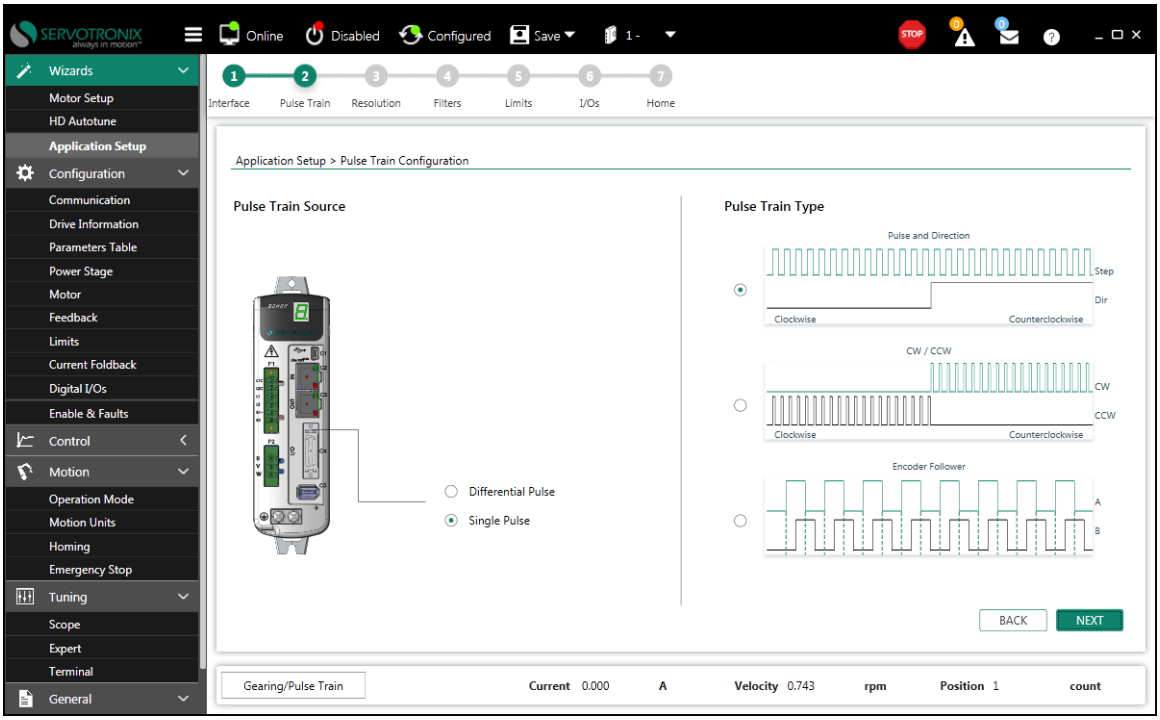

### 12.5.1 ServoStudio Interface Execution Configuration

1) To open the ServoStudio2 software and enter the Application Setup interface. In Application Setup -Interface Mode, select “PulseTrain”. Click "Next".



2) To setting pulse form: On the "Pulse Train Configuration " interface, you can set the received pulse form, with differential pulse or single pulse on the left side and three pulse forms on the right side.

The idle level of the pulse entering the BDHDE driver control chip is low by default. If you need to receive the pulse signal with high idle level, you need to set APINLOGIC to 1. Click "Next".




3) To set the resolution and frequency division output mode. On the "Resolution" interface, you can set the resolution of pulse reception and output. "Input resolution" corresponds to the variable XENCRES, "electronic gearing numerator" corresponds to GEARIN, and "electronic gearing denominator" corresponds to GEAROUT. The conversion relationship between the controller output pulse and theinternal position command is as follows:

$$\text{Internal Position Command} = \text{Controller Output Pulse} \times \frac{\text{MENCRES} * 4}{\text{XENCRES}} \times \frac{\text{GEARIN}}{\text{GEAROUT}}$$

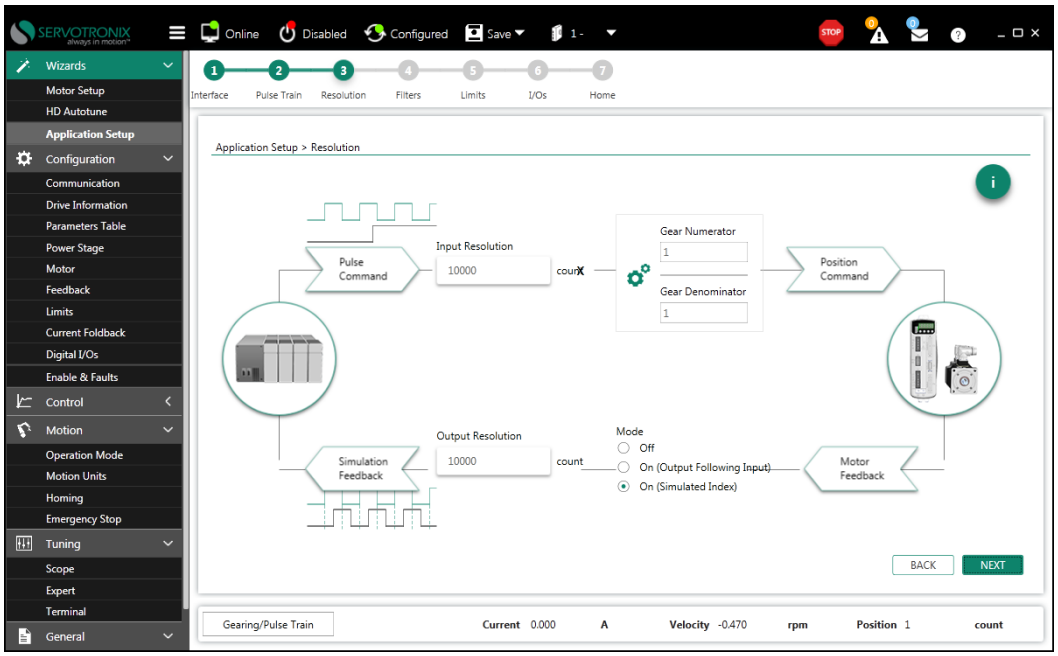
The AP/EC type BDHDE supports pulse division output. The "output resolution" corresponds to ENCOUTRES, which is the resolution before the divide-by-4, i.e. when ENCOUTRES is 10000, and the motor turns 1 revolution, the drive actually feeds 2500 pulses to the controller.

"mode" corresponds to the ENCOUTMODE parameter. select "on (simulate z phase)", and the pulse output will be output according to the resolution set by ENCOUTRES; Select "on (output follows input)", then the driver will forward and output the received 2 pulse inputs as they are; Select "off", then the frequency division output will not be performed. Only when "Mode" is selected as "On (Analogue Index)" can the "Output Resolution" be set on this interface.

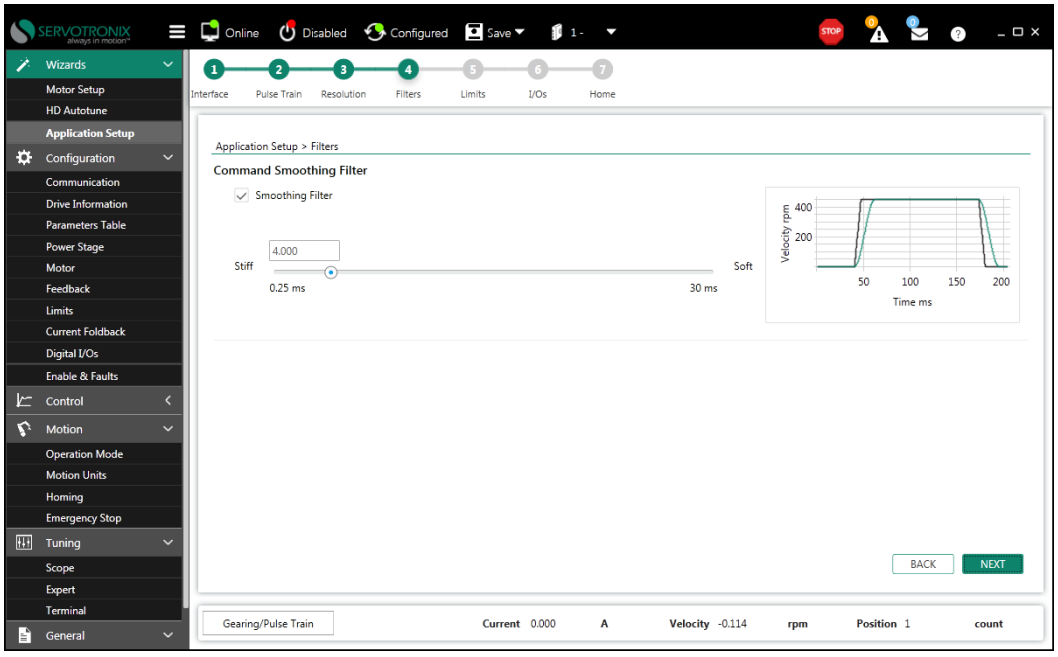
The conversion relationship between the pulse received by the controller and the encoder feedback is:

$$\text{Controller reception} = \text{Encoder Feedback} \times \frac{\text{ENCOUTRES}}{\text{MENCRES} * 4}$$

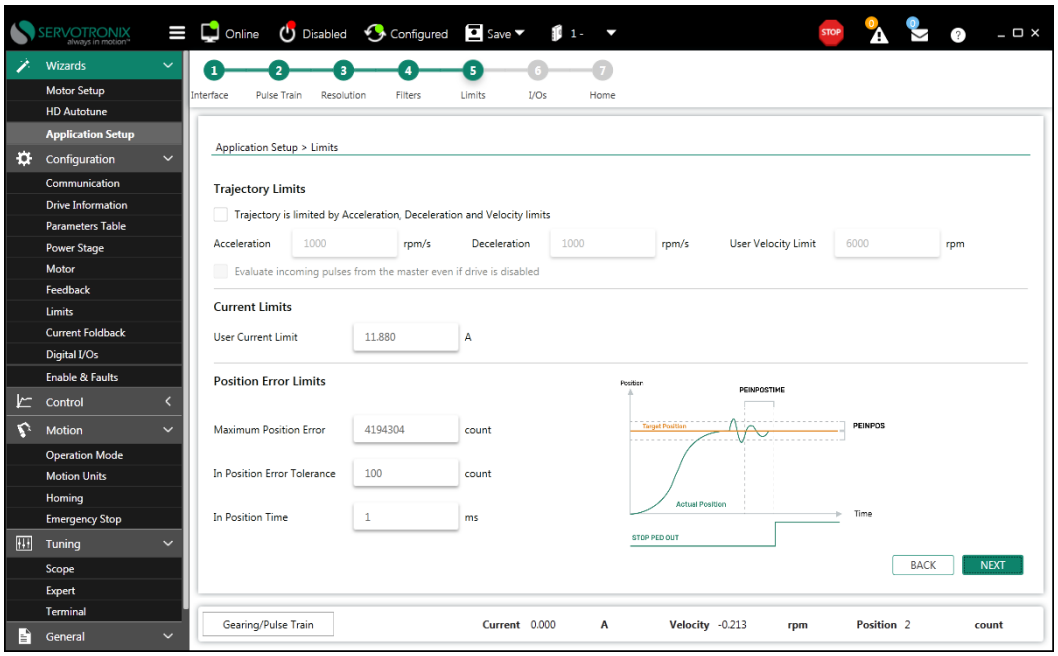
Click "Next".



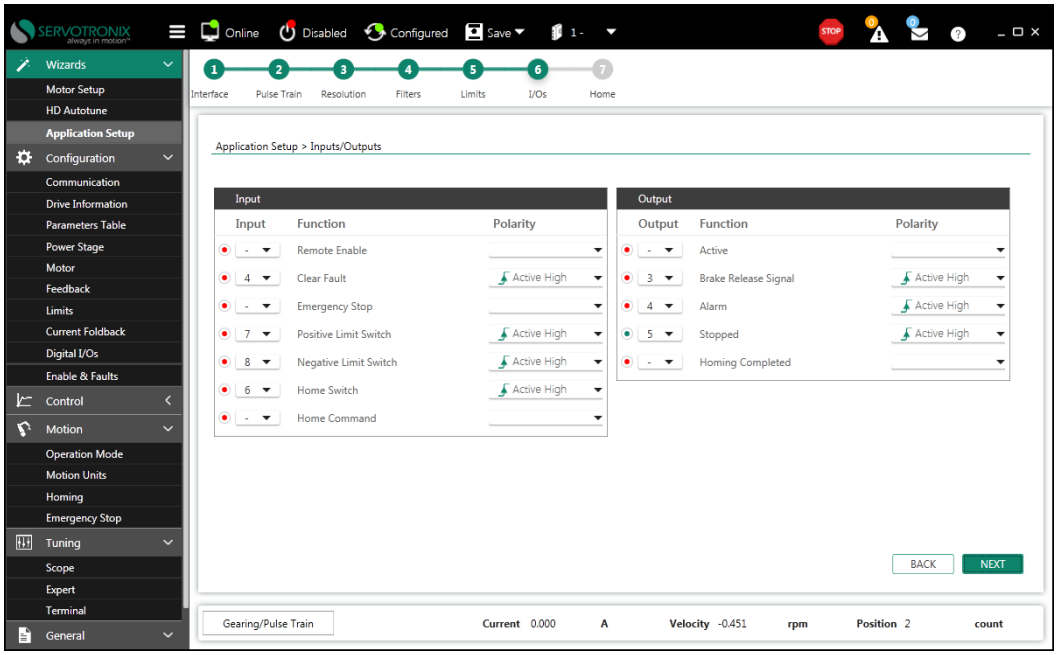

4) To set filter parameters. On the “Filters” interface, you can select and set the command smoothing filter. If Smooth Filter is checked, it will be used. If this option box is not checked, it will not be used. You can set the filtering time constant of the smoothing filter by moving the slider of the filter or setting the filtering time constant in the setting box above the slider, which can only be set to an integer multiple of 0.25, otherwise there will be a pop-up window to remind you of the error, and click "Next".



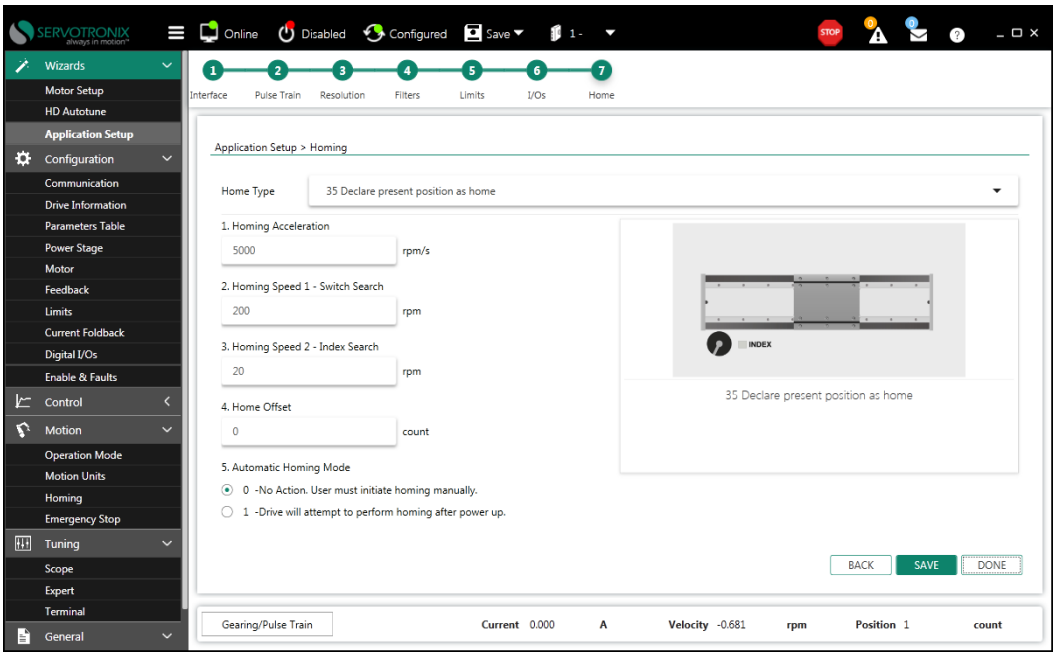

5) To set the limit value. On the "Limits" interface, you can set the limit value of servo system. The setting of trajectory limit is invalid in pulse train mode. Other limit values are similar to the "serial position" mode, so they will not be described again. Click "Next".



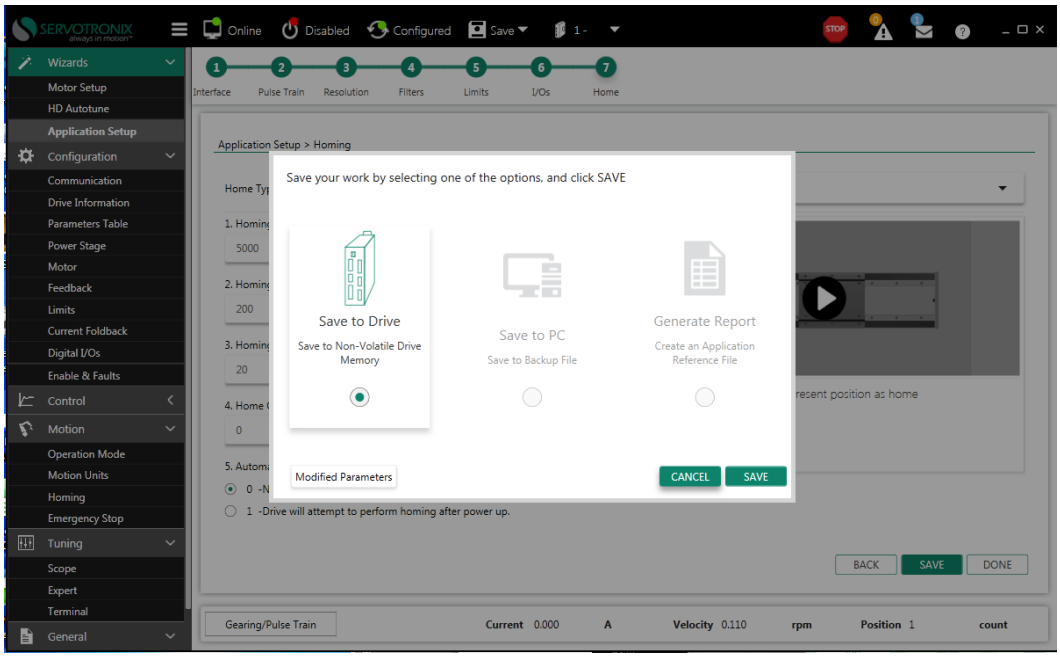

6) To set I/O. On the "I/Os" interface, some commonly used input and output functions are listed, and the user can easily configure the required ports into these functions here. Click "Next".



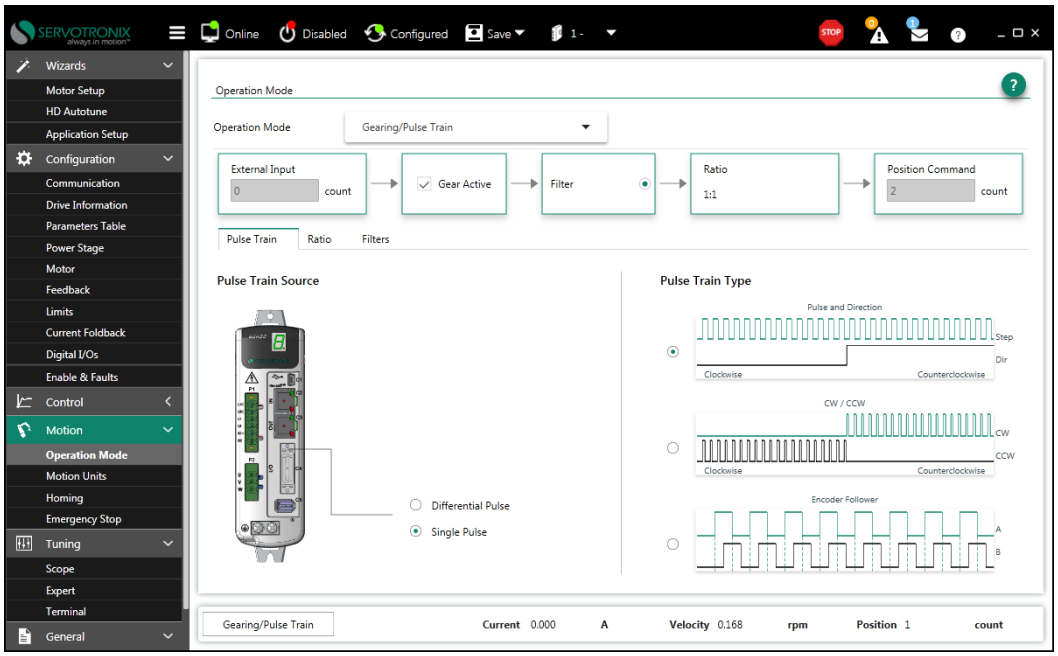

7) To set homing parameters, which can be set in the "Home" interface. Please refer to relevant chapters for details. Click "Save" to save the configured parameters. Click "Done", and the interface will jump to "Motion"-"Operation Mode".




8) To save the parameters.




After that, if "Done" is selected, the interface will automatically jump to "Motion"-"Operation Mode".




9) Operation mode : select "Gearing/Pulse Train" for " operation mode ", and some parameters of pulse train control can be modified.

"**External Input**": displays the pulse count value issued by the controller, which is a cumulative value, 32 bits;

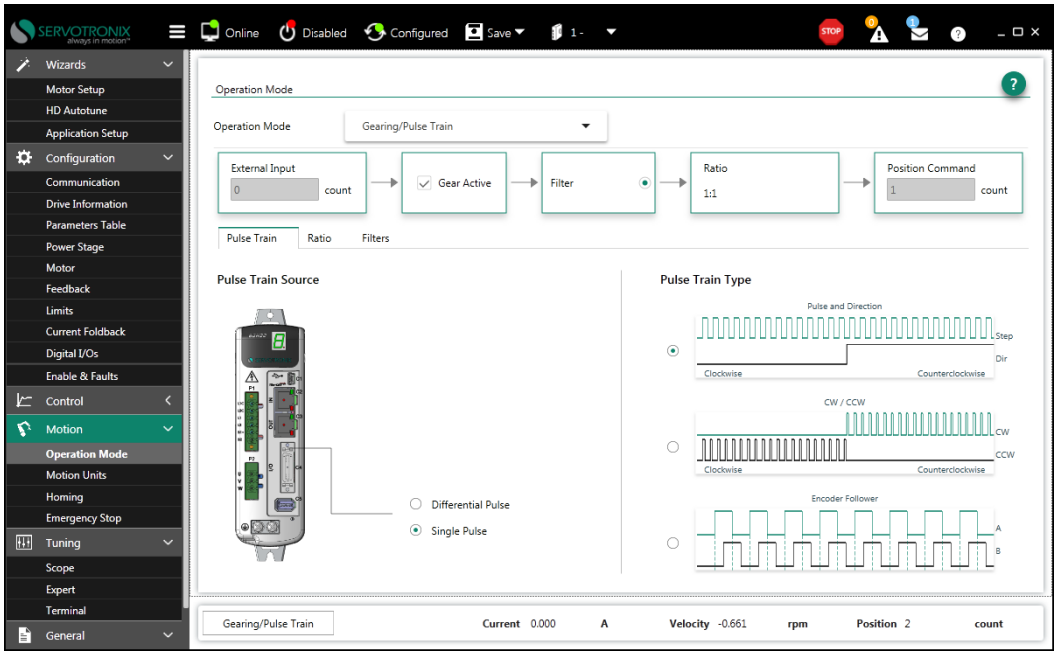
"**Gear Active":** if this option is selected, pulse input is allowed; When unchecked, pulse input is prohibited;

"**Filter**": the indicator light is green to indicate that the command smoothing filter is used, and red to indicate that the command smoothing filter is not used;

"**Ratio**": displays the value of GEARIN/GEAROUT at this time;

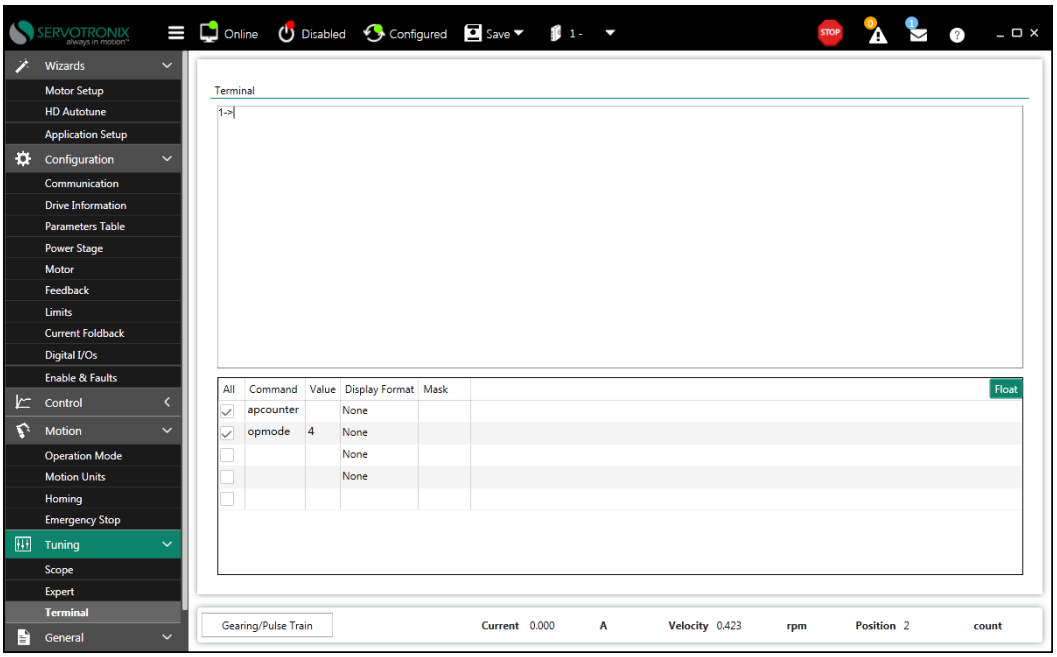
"**Position command**": displays the position command of encoder unit at this time, which is generally offset from "external input".

There are three tabs below, from which **"Pulse Train", "Ratio" and "Filters"** can be selected to conveniently modify the corresponding parameters of pulse control mode.



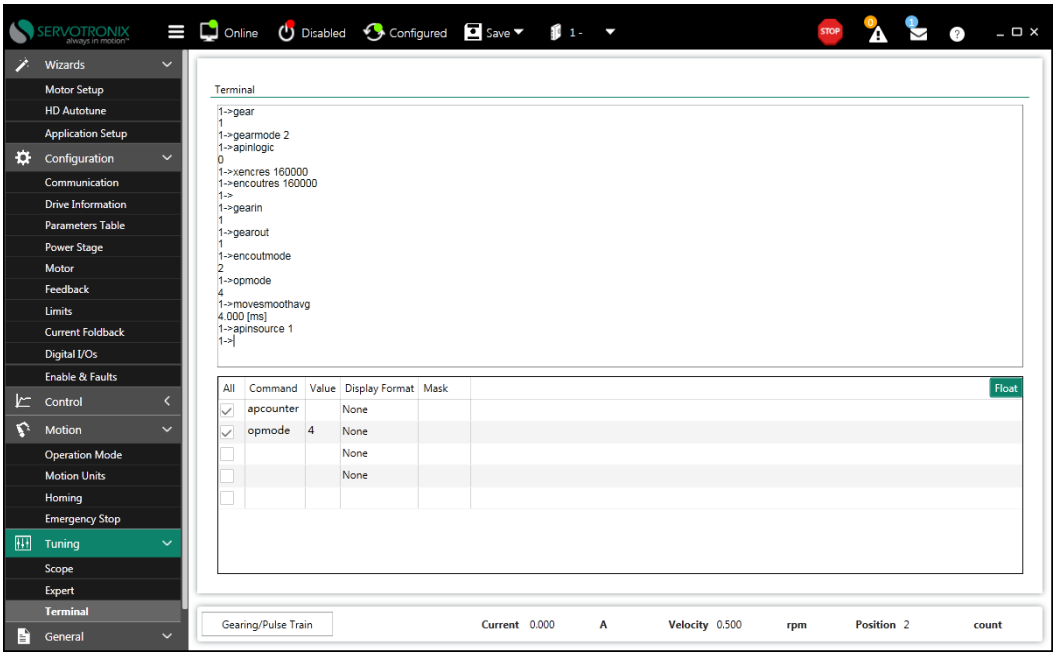
### 12.5.2 ServoStudio Terminal Command Execution Configuration

1) To open ServoStudio2 software and enter Terminal interface.




2) To set the "pulse train" parameter according to the pulse form and wiring output by the controller.

The default value of the " pulse train" control parameter is the common "single pulse+direction" format, and the default resolution is 10000, which is configured as differential CW+CCW according to the needs, with the input and output resolutions all set to 160000, the moving smooth filtering time set to 64ms, and all others use the default values.




3) Enable the motor and the controller sends pulses. The motor runs normally, and observe whether the value of the variable APCOUNTER is correct.

### 12.5.3 Parameter Description:

1) related DI functions:

**Pulse input prohibition: after this function is enabled, its function is the same as the command GEAR.**

**Position command direction:** This function is only for the "pulse train" control mode, and is invalid for other position modes. When this function is enabled and the status is 1, the pulse position command is reversed, and do not change its status during load operation. The function is the same as the direction of GEARIN/GEAROUT, and when the function of "position command direction" is enabled, GEARIN and GEAROUT cannot be set.

**Clear pulse input count:** when this function is enabled, its function is the same as the command APCOUNTERCLR.

2) The definition of pulse Sequence # #configuration parameters is as follows:

| VarCom | Description |
|---|---|
| OPMODE | For OPMODE 4:<br>The drive system is controlled by pulse train. |
| GEAR | Pulse input enabled.<br>GEAR = 0: pulse input disabled.<br>GEAR = 1: pulse input enabled. |
| APINSOURCE | Pulse input source.<br>APINSOURCE = 0: single-ended signal input. When set to single-ended input, DI should be configured as 17- pulse signal and DI 2 as 18- direction signal. The default DI 1 function of AP BDHDE driver is 17- pulse signal, and DI 2 is 18- direction signal.<br>APINSOURCE = 1: differential signal input. |
| GEARMODE | Pulse input shape.<br>Gear mode = 0: AB orthogonal signal.<br>GEARMODE = 1: pulse + direction.<br>GEARMODE = 2:CW+CCW. |
| APINLOGIC | Pulse input logic.<br>APINLOGIC = 0: Positive logic, i.e. idle time pulse low.<br>APINLOGIC = 1: inverse logic, i.e. idle time pulse high. |
| XENCRES | Pulse input resolution. |
| GEARIN | Numerator of the gear ratio.<br>GEARIN/GEAROUT>0 means that the direction of input rotation is positive.<br>GEARIN/GEAROUT< 0 means that the direction of input rotation is negative. |
| GEAROUT | Denominator of the gear ratio.<br>GEARIN/GEAROUT>0 means that the direction of input rotation is positive.<br>GEARIN/GEAROUT< 0 means that the direction of input rotation is negative. |
| APCOUNTER<br>HWPEXT | The 2 variables both represent the cumulative value of the number of pulses received by the drive. |
| APCOUNTERCLR | The pulse count value is cleared to zero.<br>Clear the number of pulses received by the driver. after the terminal inputs APCOUNTERCLR, APCOUNTER and HWPEXT = 0. |
| INFLTTIME2 | Pulse filter time constant, in 10ns.<br>APINSOURCE = 0: default INFLTTIME2 = 80.<br>APINSOURCE = 1: default INFLTTIME2 = 5. |

| VarCom | Description |
|---|---|
| ENCOUTMODE | Frequency division pulse output mode.<br>ENCOUTMODE = 0: no output.<br>ENCOUTMODE = 1: output the input pulse directly.<br>ENCOUTMODE = 2: Outputs pulses according to ENCOUTRES frequency division. |
| ENCOUTRES | Pulse output resolution.<br>A positive number means that phase A leads phase B by 90 degrees.<br>A negative number means that phase B leads phase A by 90 degrees. |

### 12.5.4 Possible Problems and Solutions

1) The pulse control of the old firmware is normal. after updating the firmware and restoring the parameters stored in batches under the old firmware, the pulse control motor does not run and the APCOUNTER remains at 0.

**Cause Analysis**

Only firmwares of DI1 and DI2 have default functions which versions are previous of AP-MCU 2.1.4, the function of the other port is not configured by default. For AP - MCU2.1.4 and later versions, DI6 defaults to "Pulse Input Disable(AP Only)" function, so from the AP - MCU2.1.4 before the firmware update to AP - MCU2.1.4 and MCU version later, DI6 is configured to " Pulse Input Disable(AP Only)" function by restoring factory settings. If DI6 is configured for other functions after restoring old firmware parameter, the GEAR signal enabled by pulse signals will be set to 0.

**Solution:**

Set GEAR 1.

2) After the pulse is set, under the pulse control, the controller sends forward and reverse commands, the motors do not run, and the APCOUNTER remains at 0.

**Solution:**

Please run the "serial position" mode first to see if it is normal. If the "serial position" mode is not normal, solve the problem of the "serial position" mode first. If the "Serial Position" mode is normal, please check:

- Whether the pulse wiring is loose;
- Whether the pulse wiring is correct, connected in the wrong place, and connected in the opposite direction;
- IO interface power supply is normal;
- XENCRES, GEARIN, GEAROUT correspond to the controller settings;
- GEARMODE is consistent with the pulse sent by the controller;
- GEAR is 0, " Pulse Input Disable(AP Only)" DI function is configured and status is 1;
- In case of single pulse, please check whether DI1 and DI2 are configured with "pulse signal" and "direction signal" respectively.

3) After the pulse is set, under the pulse control, the controller sends forward and reverse commands, and the motor can only run in one direction.

**Solution:** Check whether the pulse form sent by the upper computer is consistent with GEARMODE.

4) In pulse+direction mode, the controller sends forward rotation instruction, but the motor reverses; otherwise, the controller sends reverse rotation instruction, and the motor rotates forward.

**Cause Analysis**

The pulse or wiring sent by the controller causes the idle level of the pulse finally sent to FPGA to become high level.

**Solution:**

Set APINLOGIC 1.

5) In CW/CCW mode, if the controller can only send the signal that the idle signal is high, or if there is a problem with the wiring but the connected cable cannot be modified, the controller will send the pulse position command in this mode, and the motor will not move or rotate in the reverse direction.

**Solution:**

If the motor only moves in the reverse direction, change the sign of GEARIN or GEAROUT so that GEARIN/GEAROUT is negative.

If the motor does not move, first modify APINLOGIC 1; if the motor changes to reverse motion after modification, change the sign of GEARIN or GEAROUT to make GEARIN/GEAROUT negative.

If the motor moves only in one direction, or if the motor moves only in one direction after modifying APINLOGIC 1, it can only be solved by checking the wiring.

6) The controller does not send a pulse, but the APCOUNTER has a value.

**Cause Analysis**

Switch the pulse form on the controller. If the level changes, it will be mistaken for a pulse by the driver.

**Solution:**

The pulse count can be cleared by APCOUNTERCLR. It can also be cleared by configuring DI port as "Pulse Input Counter Clear(AP only)".

## 12.6 Collision Detection Application

This application instruction describes how to perform the collision detection function, and assumes that you are familiar with the use of ServoStudio software.

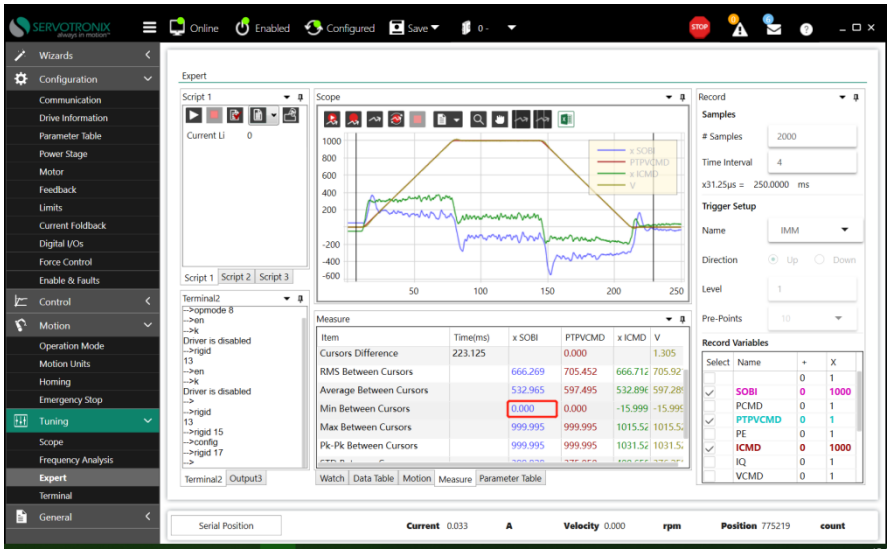
Please understand the relevant contents before testing:

Collision detection can only be used under position control, and COLDETTYPE must be set to 0 when switching to other loops.

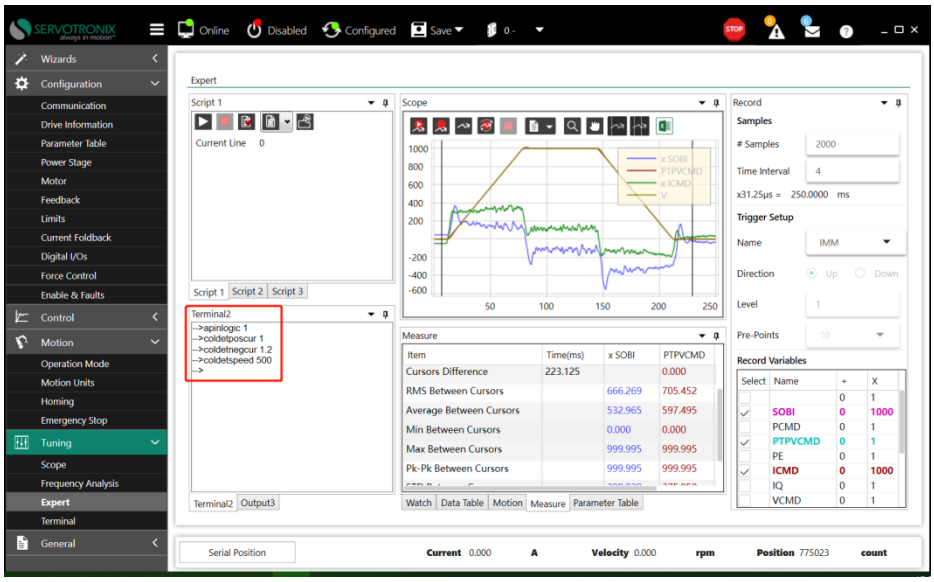
It is necessary to set appropriate parameters for collision detection, which are related to running speed and load, so it is necessary to determine the motion trajectory parameters before setting collision detection parameters.

### 12.6.1 Steps of Operation

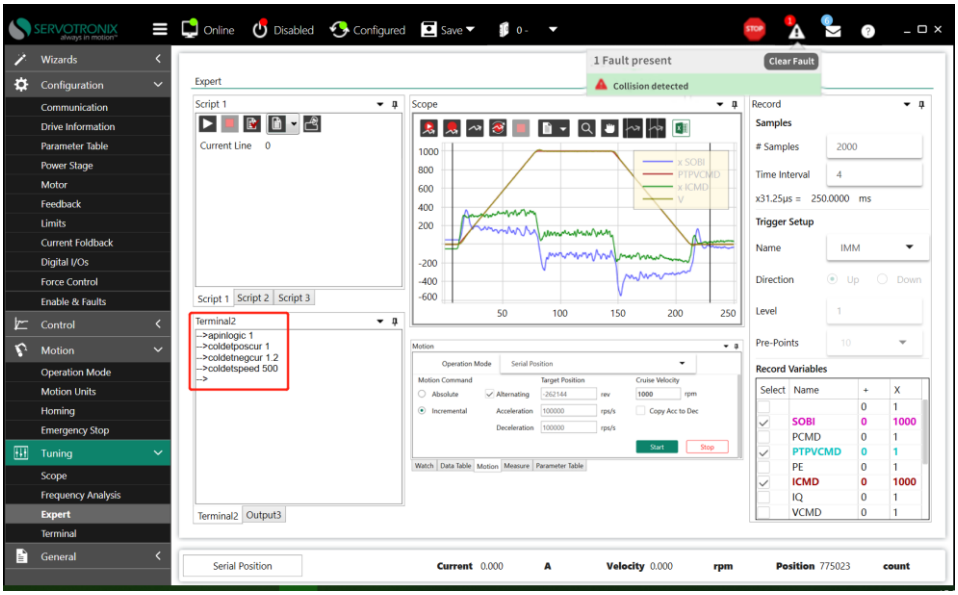
1) To open ServoStudio2 software and enter the "expert" interface. After the motion trajectory is determined, observe the variable SOBI with oscilloscope, reverse and forward several times, and record the maximum absolute value of SOBI as a reference for collision detection parameters.




2) At the "terminal", select the collision detection mode by command "COLDETTYPE", set the collision current threshold by command "COLDETPOSCUR" and "COLDETNEGCUR", set the detection speed threshold by command "COLDETSPEED", set the maintenance current value after collision by “COLDETPOSHOLDCUR ”、 “COLDETNEGHOLDCUR ”, set the start position of collision detection by“COLDETPOSPFB ”、 “COLDETNEGPFB ”.




3) Taking COLDETTYPE 1, negative direction collision as an example, after the servo is enabled, the motor runs in the negative direction on the Motion tab, and after hitting an obstacle, an error of "collision detected" is reported, and the motor is disabled.




## 12.6.2 Parameter Description:

1) The definition of collision detection parameters is as follows:

| VarCom | Description |
|---|---|

| VarCom | Description |
|---|---|
| COLDETTYPE | Type of collision detection.<br>0: Do not detect.<br>1: When the rotational speed meets the speed threshold, the motor rotates forward and backward, and the absolute value of the load current is greater than the set value of COLDETPOSCUR, the driver reports a "Collision Detected" error, and the driver is disabled.<br>2. When the rotational speed meets the speed threshold, the motor rotates forward, the load current is greater than the set value of COLDETPOSCUR, the motor reverses, and the load current is less than the set value of COLDETNEGCUR, the driver reports a "Collision detected" error, and the driver is disabled.<br>3: When the rotational speed meets the speed threshold, the motor rotates forward and backward, and the value of the load current is greater than the set value of COLDETPOSCUR, the driver reports a "Collision Detected" warning, and the output current of driver maintains the set value of COLDETPOSCUR.<br>4. When the rotational speed meets the speed threshold, the motor rotates forward, the load current is greater than the set value of COLDETPOSCUR, the driver reports a "Collision detected" warning, and the output current of driver maintains the set value of COLDETPOSCUR. The motor rotates backward, and the load current is less than the set value of COLDETNEGCUR, the driver reports a "Collision detected" warning, and the output current of driver maintains the set value of COLDETPOSCUR.<br>7: When the rotational speed meets the speed threshold, the motor rotates forward and backward, and the value of the load current is greater than the set value of COLDETPOSCUR, and the current position feedback is greater than COLDETPOSPFB, the driver reports a "Collision Detected" warning, and the output current of driver maintains the set value of COLDETPOSCUR.<br>8. When the rotational speed meets the speed threshold, the motor rotates forward and backward, and the value of the load current is greater than the set value of COLDETPOSCUR, and the current position feedback is greater than COLDETPOSPFB, the driver reports a "Collision Detected" warning, and the output current of driver maintains the set value of COLDETPOSCUR; The motor rotates backward, and the value of the load current is less than the set value of COLDETPOSCUR, and the current position feedback is less than COLDETPOSPFB, the driver reports a "Collision Detected" warning, and the output current of driver maintains the set value of COLDETPOSCUR |
| COLDETPOSCUR | Collision detection forward current threshold (A). |
| COLDETNEGCUR | Collision detection negative direction current threshold (A). |
| COLDETSPEED | Collision detection speed threshold (rpm), when this value is 0, collision detection will be performed at any speed; when this value is not 0, collision detection will only be performed when the absolute value of speed is less than this value. |
| COLDETPOSHOLDCUR | The maintenance current value after positive collision (A). |
| COLDETNEGHOLDCUR | The maintenance current value after negative collision (A). |
| COLDETPOSPFB | The start position of positive collision detection (count). |
| COLDETNEGPFB | The start position of negative collision detection (count). |

2) More Instructions:

**SOBI:** observed value of load current (A). As the basis for judging the collision, the value in the uniform speed section is affected by the trajectory parameters and load.

### 12.6.3 Possible Problems and Solutions

1) false positives

Collision detection false alarm may occur when the parameters are not set properly. Because the friction force and load force need to be overcome when the motor is running, the SOBI itself has a certain range. When setting the collision current threshold, it is set to be greater than the maximum value of SOBI when the motor works normally, which can prevent false alarms; You can also prevent false positives by setting COLDETSPEED to a value less than cruise speed.

The load current threshold and the speed detection threshold need to weigh the allowable collision current of the workpiece and the stress that can be received after collision, and should be carefully tested.

## 12.7 Belt Application

This application note describes how to debug the belt system to achieve the desired performance, and assumes that you are familiar with the use of ServoStudio software.

### 12.7.1 Steps of Operation

First of all, please roughly estimate the approximate range of load inertia ratio of belt system for targeted debugging path:

1. If the load inertia is relatively small (less than 5 times), please refer to the first part of this section;

2. If the load inertia ratio is large (more than 20 times expected), or the system speed is unbalanced or has obvious oscillation during the off-line inertia identification process, please refer to the second part of this section;

3. If the application requirement is point-to-point operation, the positioning requirement is not too high, and the estimated load inertia ratio is less than 20 times, please refer to the simple debugging method in Part III of this section.

1) **Belt system under small load inertia ratio**

- Make sure TUNINGAUTOEN is 0;
- Inertia identification is carried out, and LMJR parameters are modified after success;
- If the system does not allow any overshoot, it is necessary to change KPVFR to 0;
- Adjust NOTCH2DEP to 50~60 and NOTCH2BW to about 150;
- Adjust VELFILTFRQ to 800Hz;
- Change RIGID to 13, ICMDLPF to 800Hz, and start trial operation from level 13;

■RIGID is debugged up step by step. after modifying RIGID every time, you need to check ICMDLPF. if the value of ICMDLPF is less than 800Hz, modify ICMDLPF to 800Hz until the requirements are met or the system is unstable. If the system oscillates, you can try to set the center frequency of the trap manually, which can be obtained by analyzing the oscillogram of ServoStudio, and set the bandwidth parameter of the trap (100 ~ 200 Hz);

■Repeat the above steps until the system application performance requirements are met.

**2) Belt system with large load inertia ratio**

- Make sure TUNINGAUTOEN is 0;

■Make inertia identification and modify LMJR; If the identification fails or the identification process is unstable, it is necessary to manually estimate LMJR and write it into the driver through ServoStudio2 or the controller master station;

- If the system does not allow any overshoot, it is necessary to change KPVFR to 0;
- Change ANFEN to 0;
- Adjust NOTCH2DEP to 50~60 and NOTCHDEP to 50 ~ 60;
- Adjust VELFILTFRQ to 800Hz;
- Change RIGID to 8, ICMDLPF to 800Hz, and start trial operation from Grade 8;

■RIGID is debugged up step by step, and the ICMDLPF needs to be changed to 800Hz every time RIGID is modified. If the system oscillates, you can try to set the center frequency of the trap manually, which can be obtained by analyzing the oscillogram of ServoStudio, and set the bandwidth parameter of the trap (100 ~ 200 Hz);

■Repeat the above steps until the system application performance requirements are met.

**3) Simple debugging method of belt system**

■TUNINGAUTOEN is 1, which is a simple debugging method. At this time, RIGID doesn't work, and the response performance level of the system can only be changed through TUNINGLEVEL. The greater the TUNINGLEVEL, the stronger the rigidity of the system. TUNINGLEVEL ranges from 0 to 6.
■If the requirement is point-to-point operation, the positioning requirement is not too high, and the load inertia ratio is within 20 times, this debugging method can be used to reduce the debugging difficulty and improve the efficiency;
- Change TUNINGAUTOEN to 1;
- Change ANFEN to 0;
- If the system does not allow any overshoot, it is necessary to change KPVFR to 0;

■Start the trial run. If the system is absolutely slow, increase the TUNINGLEVEL and continue the test. Until the requirements are met or the system is unstable.
■If a trap is used, please set the trap manually. The center frequency of the trap can be obtained by analyzing the oscillogram of ServoStudio, and the bandwidth parameter of the trap (100~200Hz) To should be set. Pay attention to the trap depth (NOTCHDEP and NOTCH2DEP) above 50;
■Repeat the above steps until the system application performance requirements are met.

## 12.8 Low Frequency Vibration Suppression Application

**Notes** Availability of this function is subject to change depending on driver model and firmware version. Please contact technical support for further information.

This application description describes how to use the low-frequency vibration suppression function to suppress low-frequency vibration and assumes that you are familiar with ServoStudio software.

### 12.8.1 Steps of Operation

■Close low-frequency vibration suppression function, INSHAPEREN 0;

■Sample the variable PE;

■Calculate low-frequency vibration frequency and damping;

■Enable the driver;

■Set ANTIVIBTYPE to 0 or 1;

■Set frequency INSHAPERFREQ and damping INSHAPERDAMP;

■Start low-frequency vibration suppression function, INSHAPEREN 1;

OR

■Close low-frequency vibration suppression function, INSHAPEREN 0;

■Sample the variable PE;

■Calculate low-frequency vibration frequency;

■Enable the driver;

■Set ANTIVIBTYPE to 2;

■Set low-frequency vibration frequency PNOTCHCENTER;

■Set low-frequency vibration bandwidth PNOTCHBW;

■Set low-frequency vibration suppression depth PNOTCHDEP;

■Start low-frequency vibration suppression function, PNOTCHMODE 1.

### 12.8.2 Parameter Description

| VarCom | Description |
|---|---|
| ANTIVIBTYPE | Type of low-frequency vibration suppression.<br>0: Monopulse input integer.<br>1: Two pulse input integer.<br>2. Position command notch filter. |
| INSHAPEREN | Low-frequency vibration suppression function enabled, only valid when ANTIVIBTYPE is 0 or 1. |
| INSHAPERFREQ | Low-frequency vibration suppression frequency (Hz), only valid when ANTIVIBTYPE is 0 or 1. |
| INSHAPERDAMP | Low-frequency vibration suppression damping, only valid when ANTIVIBTYPE is 0 or 1. |
| PNOTCHMODE | Position command notch filter 1 enabled, only valid when ANTIVIBTYPE is 2. |
| PNOTCHBW | Position command notch filter 1 bandwidth, only valid when ANTIVIBTYPE is 2. |

| VarCom | Description |
|---|---|
| PNOTCHCENTER | Position command notch filter 1 center frequency (Hz), only valid when ANTIVIBTYPE is 2. |
| PNOTCHDEP | Position command notch filter 1 depth, only valid when ANTIVIBTYPE is 2. |
| PNOTCH2MODE | Position command notch filter 2 enabled, only valid when ANTIVIBTYPE is 2. |
| PNOTCH2BW | Position command notch filter 2 bandwidth, only valid when ANTIVIBTYPE is 2. |
| PNOTCH2CENTER | Position command notch filter 2 center frequency (Hz), only valid when ANTIVIBTYPE is 2. |
| PNOTCH2DEP | Position command notch filter 2 depth, only valid when ANTIVIBTYPE is 2. |
| PNOTCH3MODE | Position command notch filter 3 enabled, only valid when ANTIVIBTYPE is 2. |
| PNOTCH3BW | Position command notch filter 3 bandwidth, only valid when ANTIVIBTYPE is 2. |
| PNOTCH3CENTER | Position command notch filter 3 center frequency (Hz), only valid when ANTIVIBTYPE is 2. |
| PNOTCH3DEP | Position command notch filter 3 depth, only valid when ANTIVIBTYPE is 2. |

# 13 Serial Communication

Through serial communication connection, BDHDE digital driver and host (terminal, PC or high-end controller) can communicate through asynchronous transmission of ASCII code information.

When the host and BDHDE communicate through serial communication, a series of instructions and variables (called VarCom) are used to configure, control and monitor the drive.

Communication interface can be image software interface, such as ServoStudio, application program designed by user, or basic terminal.

## 13.1 Basic Information

### 13.1.1 Specifications

| Communication Interface | USB, RS-485 |
|---|---|
| Baud rate | 115200 bits/second (bps) |
| Start bit | 1 |
| Data bit | 8 |
| End bit | 1 |
| Check | None |
| Hardware signal exchange | None |
| Software signal exchange | None |
| Character | ASCII encoding |
| data check | 8- bit checksum |

### 13.1.2 Control Code Definition

| Name | Symbol | Hexadecimal |
|---|---|---|
| Implementation | <LF> | 04Ah |
| Enter | <CR> | 0Dh |
| Space | <SP> | 20h |
| Time delay | <DLY> | To explain the delay caused by internal drive information processing |

### 13.1.3 Communication Summary

| Drive to terminal transmission | Terminal to drive transmission | Protocol flag (variable) |
|---|---|---|
| ■ Character echo<br>■ Prompt<br>■ Variable value<br>■ Error/fault messages | ■ Command<br>■ Variable value<br>■ Variable query | ECHO<br>MSGPROMPT<br>CHECKSUM |

## 13.2 Data Transmission Format

To realize normal serial communication between BDHDE and host, they must use the same data transmission format:

- Full-duplex
- 8 bits/character
- No parity
- 1 Start bit
- 1 End bit
- Baud rate: 115200bps
- Hardware: RS-485 or USB serial interface

## 13.3 Drive Addressing

BDHDE is controlled by USB(C1) or RS-485(C2), and only BDHDE AP type drivers support RS-485 connection.

### 13.3.1 Multi-node Configuration (AP type only)

In RS-485 networking configuration, all drivers must be daisy-chained through C2 and C3 connectors with network cables. Each drive must have a unique address for identification in the network.

Chain drives can be assigned addresses from 1 to 99. Address 0 is unavailable when configured as daisy chain.

- To communicate with a single drive in the daisy chain, enter the following statement at the command prompt:

\x <CR>

Where x = 1 to 99 is the address setting of the drive.

## 13.4 Variables and Commands

Serial communication of BDHDE is realized through VarCom. VarCom is a proprietary command string and variable that configures, controls and monitors drivers.

- The command instructs the driver to perform an operation.
- Read-only variables are calculated and/or set by the drive, and are used to monitor the running state of the drive machine.
- To read a variable, enter < CR > after the name. The driver will return the variable value.
- Read/write variables for configuring and monitoring drives.

To set a variable, enter a variable name (VarCom mnemonic), a space (or =), a variable value, and then < CR > (enter key).

## 13.5 Information Format

Information format is the structure used by BDHDE to process ASCII encoded information. Information sent by the host to the drive to send commands, set variables, or query the drive. The information from the drive to the host contains the query reply.

Information format has two main elements: Information Unit and information termination, as shown in the following figure.

The checksum function is optional.

**Note: There is no practical significance at first; It just means that the drive is waiting for the host to send information**

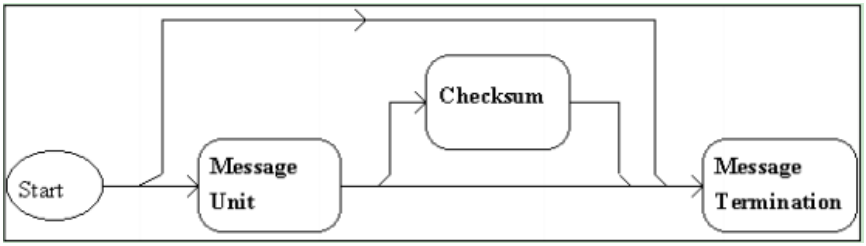



**Figure 13-1.**

### 13.5.1 Information Unit

An Information Unit is a piece of information transmitted over a communication chain. The basic Information Unit is shown in the following figure.

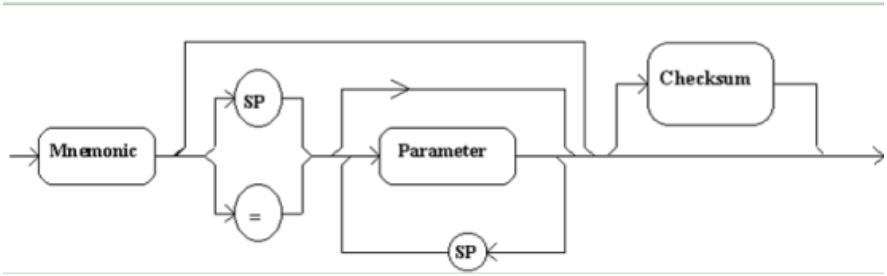



**Figure 13-2.**

The Information Unit includes a title (VarCom mnemonic code) with or without parameters. The title defines the context of the following parameters. Information from the drive to the host generally has no header.

When using titles, parameters and mnemonics are separated by spaces or assignment operators. Parameters must be separated by spaces.

In an information format, BDHDE can only receive one Information Unit.

### 13.5.2 Information Termination

Information termination refers to the end of transmitting information.

The message transmitted by the host is terminated by the Enter key (CR)–the ASCII character is 0DH.




**Figure 13-3.**

The information transmitted by the drive is terminated by the Enter key/Line Feed (CR/LF) combination–ASCII characters are 0DH/0AH.

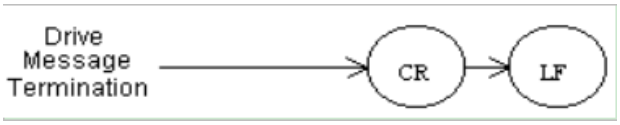



**Figure 13-4**

The drive can also receive an information termination without any additional information.

### 13.5.3 Unit

In a message or command, the unit is indicated in square brackets []. For example:

- Message to drive: mpoles
- Information from drive: 4 [poles]

When the information from the host has units, the drive ignores the unit information.

## 13.6 Example of BDHDE Serial Protocol

The following example shows the serial protocol between BDHDE and host.

### 13.6.1 Issuing Commands or Variables

**Example 1:Command**

EN (Drive enable)

| Sequence # #No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| User input | E | | N | | <CR> | | | | | | |
| Drive returns | | E | | N | | <CR> | <LF> | <DLY> | - | - | > |

Terminal display:

-->EN

-->

**Example 2:Command/variable–multiline return of value**

Because there is a large amount of data output to the screen, such commands generally have a longer delay.

DUMP (Returning the drive parameter value)

| Sequence # #No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | D | | U | | M | | P | | <CR> | |
| Drive returns | | D | | U | | M | | P | | <CR> |

| Sequence # #No. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | | | | | | | | | | |
| Drive returns | <LF> | <DLY> | <VAR1> | <SP> | <VAL1> | <CR> | <LF> | <VAR2> | <SP> | <VAL2> |

| Sequence # #No. | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | | | | | | | | | | |
| Drive returns | <CR> | <LF> | <VARn> | <SP> | <VALn> | <LF> | <CR> | - | - | > |

Terminal display:

-->DUMP

-->var1 val1

-->var2 val2

-->varn valn

**Example 3:Command/variable–return multiple values**

J (jog)

| Sequence # #No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | J | | <CR> | | | | | | | |
| Drive returns | | J | | <CR> | <LF> | <DLY> | <VAL1> | <SP> | <VAL2> | <CR> |

| Sequence # #No. | 11 | 12 | 13 | 14 |
|---|---|---|---|---|
| User input | | | | |
| Drive returns | <LF> | - | - | > |

Terminal display:

-->J

-->nnnnn nnnnn

-->

**Example 4: Reading a variable value**

MPOLES (Unipolar motor with value 2)

| Sequence # #No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | M | | P | | O | | L | | E | |
| Drive returns | | M | | P | | O | | L | | E |

| Sequence # #No. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | S | | <CR> | | | | | | | |
| Drive returns | | S | | <CR> | <LF> | <DLY> | 2 | <SP> | [ | p |

| Sequence # #No. | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | | | | | | | | | | |
| Drive returns | o | l | e | s | ] | <CR> | <LF> | - | - | > |

Terminal display:

-->MPOLES

2 [poles]

-->

**Example 5: Define a variable value**

ACC (accelerated with a value of 50000)

| Sequence # #No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | A | | C | | C | | = | | 5 | |
| Drive returns | | A | | C | | C | | = | | 5 |

| Sequence # #No. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| User input | 0 | | 0 | | 0 | | 0 | | <CR> | |
| Drive returns | | 0 | | 0 | | 0 | | 0 | | <CR> |

| Sequence # #No. | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|
| User input | | | | | |
| Drive returns | <LF> | <DLY> | - | - | > |

Terminal display:

-->ACC=50000

-->

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