CDHD2S EC Servo Drive

User Manual

Please read this instruction manual carefully before using the product and keep it properly.

Revision History

Document Revision	Date	Remarks
0.1	March 01, 2023	CDHD2S - Initial release. For internal use only.
1.0	Wednesday, April 19, 2023	CDHD2S Version 1.0
1.1	Wednesday, April 26, 2023	CDHD2S Version 1.1
1.2	November 1, 2023	CDHD2S Version 1.2
1.3	October 10, 2024	CDHD2S Version 1.3
1.4	December 26, 2024	CDHD2S Version 1.4

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Trademark

ServoStudio2 is the trademark of Servotronix Motion Control Ltd.
EtherCAT is a registered trademark of Beckhoff Automation GmbH.
Windows is a registered trademark of Microsoft Corporation.

Contact Information

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Technical Support

If you need assistance with the installation and configuration of the CDHD2S drive, contact Servotronix technical support.

Tel: 400-111-8669

Unpacking

The package contains only one CDHD2S drive. Upon arrival, please open the package and remove all packaging materials. Check the product to ensure that there is no visible damage in CDHD2S drive. If damage is found, please inform the carrier immediately.

Contents

1.Introduction

1.1CDHD2S Product Overview

CDHD2S is a high-performance servo drive based on innovative technology and advanced control algorithms. CDHD2S is optimized based on the second generation of this series of servo drives, and has made many improvements and enhancements in terms of functionality and performance.

For CDHD2S drive options, please refer to the ordering information.

The CDHD2S drive using a medium voltage power supply (AC 120–240V) is the medium-voltage model, and the drive using a high voltage power supply (AC 380–480V) is the high-voltage model.

Figure 1-1 CDHD2S- AC 120-240V (medium-voltage) EC model

CDHD2S-003/006 CDHD2S-012 CDHD2S-024/030

Figure 1-2 CDHD2S-AC 380-480V (High Voltage) Model

CDHD2S-040 CDHD2S-060

Figure 1-3 CDHD2S- AC 380-460V (high-voltage) model

1.2CDHD2S model

Different models in the CDHD2S servo drive series use different communication methods and protocols. The table below shows the different models and their features.

Table 1-1 CDHD2S Model - Communication and Protocol

CDHD2S model	Physical layer	Communication protocol	Configuration language
CDHD2S(AP) Standard CDHD2S model	Serial port (RS232)	ASCII commands	VarCom
	Simulation	±10V	
	Pulse train	Pulse and direction, CW/CCW, AB quadrature	
CDHD2SCAN (AF) uses CANopen protocol. Call it as CDHD2SCANopen drive.	Serial port (USB|RS232)	ASCII commands	VarCom
	Simulation	±10V	
	Pulse train	Pulse and direction, CW/CCW, AB quadrature	
	CAN	Communication: CANopen CiA301, CiA402	VarCom CANopen
CDHD2SEtherCAT(EC) uses CANopen(CoE) protocol on EtherCAT.	Serial port (USB|RS232)	ASCII commands	VarCom
	Simulation	±10V	
	Pulse train	Pulse and direction, CW/CCW, AB quadrature	
	EtherCAT	Communication: CANopen(CoE) on the EtherCAT CiA402	VarCom CANopen
CDHD2SEtherCAT(EB) uses CANopen(CoE) protocol on EtherCAT.	Serial port (USB)	ASCII commands	VarCom
	Simulation	±10V	
	EtherCAT	Communication: CANopen(CoE) on the CANopen(CoE) CiA402	VarCom CANopen
CDHD2SPN uses the PROFIdrive protocol on PROFINET.	Serial port (USB)	ASCII commands	VarCom
	Simulation	±10V	
	PROFINET	Communication: PROFIdrive on PROFINET	VarCom PROFINET

Note: VarCom is a dedicated set of parameters and commands for configuring, operating and tuning CDHD2S drives. The CDHD2S *VarCom Reference Manual* and *EtherCAT and CANopen Reference Manual* can be downloaded from the product page of Servotronix website.

1.3Order Information

The ordering options shown below include all drive models in the CDHD2S product line. To inquire about product availability, please contact Servotronix.

Table 1-2 CDHD2S Ordering Plan

							CDHD2S	**–**	**012**	**4D**	**EC2**	**– RO**	**000**

CDHD2S Servo Drive – HD Series

Power specifications

	24VDC		120/240VAC		400/480VAC	
	Cont [Arms]	Peak [Arms]	Cont [Arms]	Peak [Arms]	Cont [Arms]	Peak [Arms]
1D5			1.5	4.5		
003	3	9	3	9	3	9
4D5			4.5	18		
006			6	18	6	18
008			8	28		
010			10	28		
012					12	24
013			13	28		
024					24	72
030					30	90
040					40	120
060					60	180

	Input power supply
1D	MV input power supply •20-90VDC
2A	MV input power supply •Single phase input 120 L-L VAC +10% -15% 50/60 Hz •Single phase input 240 L-L VAC +10% -15% 50/60 Hz •Three phase input 120-240 L-L VAC +10% -15% 50/60 Hz
4D	HV input power supply •Three phase input 400 L-L VAC +10% -15% 50/60 Hz •Three phase input 480 L-L VAC +10% -15% 50/60 Hz 24VDC control board power supply

	Communication interface	**Communication interface**
EC2	EtherCAT, USB,Analog Voltage,Pulse Train Ref.	2
PN2	PROFINET, USB,Analog Voltage,Pulse Train Ref. .	2
	x = 1: One analog input, 16 bit x = 2: Two analog inputs, 14 bit each	* Standard configuration

	Motor type
[*blank*]	Rotary servo motors, linear motors and DD motors
RO	RO models are only suitable for rotary motors

	Special options
[*blank*]	Standard

1.4CDHD2S Product Label

Different models of products may look exactly the same. See the product label on the back panel of the drive for model numbers and specifications. The following picture shows the EtherCAT model label.

Model: CDHD2S-0244DEC2

Serial number: 118B-0000012 Version: XX

CDHD2S

Rating	Input	Output	
AC voltage	380/480 3PH	380/480 3PH	FW: 2.0.0
Frequency Hz	50/60	0-1000Hz	SCCR: 5000A
F.L. current 3PH	24A	24A	IP20 housing protection
Power 380/480V		12.2/15.4kVA	Ambient temperature: 45℃

	Dangerous voltage	Residual voltage. To avoid electric shock, please wait 5 minutes after removing the power supply before performing maintenance.
	Warning	Read the manual and follow the safety instructions. Use proper PE grounding techniques.
	Hot surface	Do not touch the radiator. It may cause burns.

www.servotronix.com Ref:PRD9HCD3MC2-00

Figure1-3 EtherCAT model label

The following picture shows the PROFINET model label.

Model：CDHD2S-0032APN2

Serial number: 118B-0000012 Version：XX

CDHD2S

Rating	Input	Output	
AC voltage	120/240 3PH	0~240 1PH	FW：2.0.0
Frequency Hz	50/60	0-1000Hz	SCCR：5000A
F.L. current 3PH	5A	3A	IP20 housing protection
Power 120/240V		0.44/0.74kVA	Ambient temperature：45℃

	Dangerous voltage	Residual voltage. To avoid electric shock, please wait 5 minutes after removing the power supply before performing maintenance.
	Warning	Read the manual and follow the safety instructions. Use proper PE grounding techniques.
	Hot surface	Do not touch the radiator. It may cause burns.

www.servotronix.com Ref:PRD9HCD3MC2-00

Figure 1-4 CDHD2S product label - sample

1.5CDHD2S File Package

The CDHD2S servo drive’s file package contains the following manuals.

The CDHD2S manual can be downloaded from the product page of the Servotronix website (http://www.servotronix.com/products/cdhd-servo-drives/).

- CDHD2S User Manual: Hardware Setup, Operation and Tuning.
  For use by those qualified to transport, assemble, consign and maintain drives.
- ServoStudio2 Reference Manual: Graphical User Interface (GUI) provided with CDHD2S for configuring, operating and tuning the drive.
- VarCom Reference Manual: Parameters and commands used to configure, operate and tune the drive.
- EtherCAT and CANopen Reference Manual.

The CDHD2S implements the CANopen protocol used by the CDHD2SEtherCAT (EC and EB) and CAN (AF) drives.

Note:	The files can also be found in the online help package included with the ServoStudio2 software.

2.Safety and Standards

2.1Safety Symbols

Safety symbols indicate that personal injury or equipment damage is likely to occur if specified precautions and safe operating practices are not followed. The following safety warning symbols are used on the drive and documentation.

Table 2-1 Safety Warning Symbols

Symbol	Meaning	Description	ISO7000/IEC60417
	Warning	Prompting caution when operating the equipment. Prompting the operator to know the current situation, or the operator needs to take measures to avoid adverse consequences.	0434
	Dangerous voltage	Prompting dangerous voltage.	5036
	Protective grounding	Indicating any terminal, or protective grounding electrode terminal, used for connection to the outer conductor to provide protection in the event of a fault.	5019
	Warning, hot surface	The marked object is hot and you should be careful when touching it.	5041

2.2Safety Guide

The CDHD2S servo drive is used as a component within the machine system.

Machine manufacturers and integrators must ensure personnel safety and machine system integrity.

Machine manufacturers and/or integrators must take into account the intended use of the CDHD2S drive when performing a risk assessment. Based on the results of the assessment, appropriate security measures must be implemented.

CDHD2S drives must be used in compliance with all applicable safety regulations and directives and all technical specifications and requirements.


CDHD2S drives use dangerous voltage. They must be properly grounded.


Machine manufacturers and machine owners are responsible for machine operator safety.


The machine owner and machine operator are responsible for ensuring that access to hazardous areas is prohibited while the machine is energized (unless equipped with appropriate functional safety mechanisms).

Only qualified personnel should perform installation, operation, service and maintenance procedures. These qualified personnel must have sufficient technical training and knowledge 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 entire machine system.

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

2.2.1 Installation safety

Note: Improper handling of the CDHD2S can cause personal injury and/or equipment damage.

⚠ When connecting the CDHD2S to other control devices, be sure to follow two basic guidelines to prevent damage to the drive:

- The CDHD2S must be grounded via the ground wire of the AC mains power supply.
- Any drive controller, PLC or PC connected to the CDHD2S must be connected to the same ground wire as the CDHD2S.

- Before installing or commissioning CDHD2S, review all relevant product information.
- Install the machine in accordance with product specifications and installation instructions.
- All system components must be grounded. Provide electrical safety via a low-resistance ground connection (Category I based on EN/IEC618005-1). The motor shall be connected to the protective earth conductor by a separate earth conductor with a rating no less than that of 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 unexpected activities do not cause physical injury and/or equipment damage.
- The drive complies with IP20 (IEC60529 standard) and Type 1 (UL50) requirements; therefore, the machine builder must select a suitable enclosure. The enclosure must meet at least IP54 ((IEC60529 standard) and Type 2 (UL50) requirements, be composed of metal or 5VA flammability rated materials, and have no openings on the bottom.
- The leakage current of the protective ground wire is greater than 3.5mA; therefore, in order to comply with the requirements of IEC61800-5-1 and UL508C, double PE connections can be used (one is grounded through the main power ground wire, and the other is connected to the grounded equipment base through the heat sink), or use a copper connecting cable with a cross-sectional area greater than $10mm^2$. Use drive mounting screws and PE coupling screws to meet this requirement.
- The yellow wire with/without one or more green stripes may not be used except for protective grounding.
- Power cables should be rated at least 600V, 75°C.

2.2.2 Operational safety

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

- Perform all equipment operations in accordance with product specifications and installation instructions.
- Equipment manufacturers must provide power disconnect devices in compliance with local regulations.
- During operation, all protective covers and cabinet doors remain closed.
- During operation, this equipment has live parts and hot parts. CDHD2S heat sink temperatures can reach 90°C. Even if the motor is not turning, control and power cables can carry high voltage.
- Machine tool axes subjected to suspended loads or unbalanced loads must be provided with additional mechanical safety blocks (such as motor-controlled brakes) to prevent the load from falling out of control. The CDHD2S drive cannot keep the load suspended when the STO function is activated. If the load is not properly protected, serious injury may occur.

2.2.3 Maintenance safety

Note: Improper handling of the CDHD2S can cause injury and/or equipment damage.

- Before performing maintenance on the CDHD2S (or the machine it drives), please review all relevant product information.
- Perform maintenance procedures in accordance with product maintenance requirements and instructions.
- To avoid electric arc and personal injury and damage to electrical contacts, never disconnect or connect the product with power on.
- After the equipment is powered off, wait at least 5 minutes before touching or disconnecting normally live parts (such as capacitors, switch contacts, screw connections).
- Before touching the device, measure the electrical contacts with a meter. Make sure the DC voltage is below 30V before handling the components.

2.3Material Safety Data

CDHD2S is marked in accordance with the SJ/T11364, which applies to electronic and electrical products sold within the territory of the People's Republic of China.

The hazardous substance data in the table below complies with China’s RoHS2.0: *Restriction of the Use of Certain Hazardous Substances in Electronic and Electrical Equipment* issued on January 21, 2016.

CDHD2S contains specific hazardous substances and can be used safely for 20 years, after which it should be recycled.

Table 2-2 Hazardous Substances

Part Name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent chrome (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
Electrical parts	X	O	O	O	O	O
Contacts	O	O	O	O	O	O
Cables and accessories	O	O	O	O	O	O

O indicates that the content of the hazardous substance in all homogeneous materials of this part is below the limit requirements specified in GB/T26572.

X indicates that the content of the hazardous substance in at least one homogeneous material of the component exceeds the limit requirements specified in GB/T26572.

2.4Certifications

Table 2-3 CDHD2S will be tested and certified according to the following standards.

Standard	Directives/Instructions	Certification mark
IEC61800-5-1	Low voltage directive 2014/35/EU Adjustable speed electrical power drive systems	
IEC61800-5-2:2017	Machinery directive 2006/42/EC Adjustable speed electrical power drive systems - safety requirements - functional	
IEC61800-3	Electromagnetic compatibility (EMC) directive 2004/108/E Adjustable speed electrical power drive systems	
IEC61800-3	Electromagnetic compatibility (EMC) directive 2014/30/EU Adjustable speed electrical power drive systems For second environment	
EN50581	European directive 2011/65/EURoHS (Restriction of Hazardous Substances) Declaring compliance with the technical documentation required to comply with substance restriction requirements.	
SJ/T11364	Marking for the restriction of the use of hazardous substances in electronic and electrical products (China RoHS2.0) Hazardous substances in electronic and electrical products; environmentally friendly service life and recyclability.	
EUREACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (EC)1907/2006 The production and use of chemicals and their potential effects on human health and the environment.	

International Electrotechnical Commission (IEC)
European Norm (EN)
Underwriter Laboratories Inc. (UL)
Canadian Standards Association (CSA)
European Parliament and Council of European Union

3.Specifications

3.1Dimensions

Various models of CDHD2S drives are housed in many different enclosures. The appearance dimensions of the enclosure are as shown in the figure below.

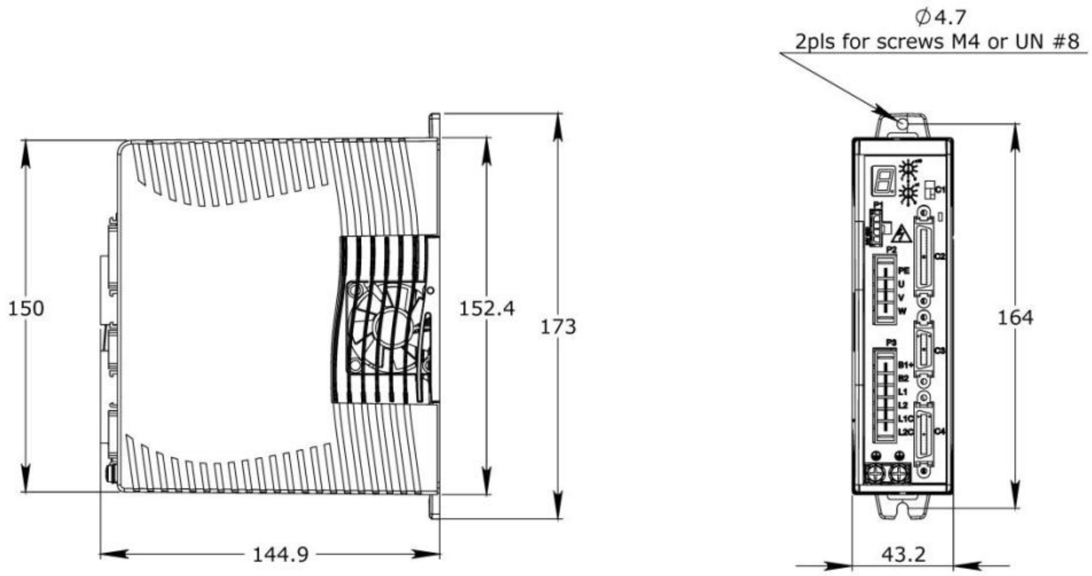


Figure 3 -1 CDHD2S-003(low-voltage),CDHD2S-1D5/CDHD2S-003 (medium-voltage) - dimensions (mm)

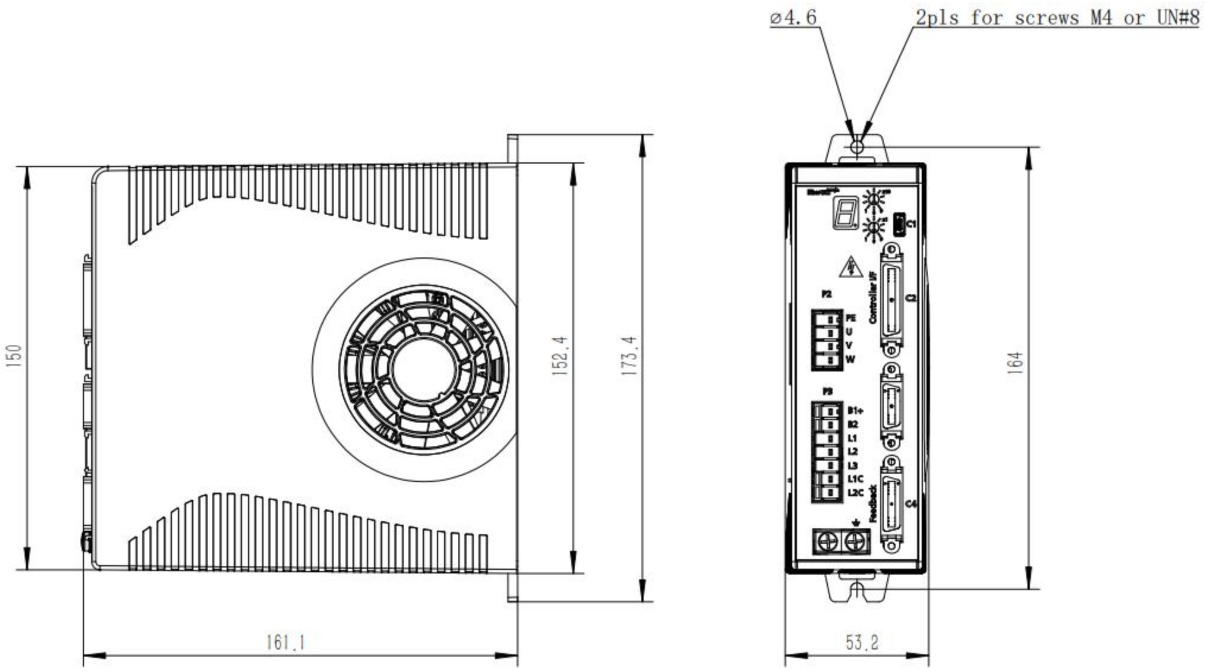


Figure 3 - 2 CDHD2S-4D5/CDHD2S-006 (medium-voltage) - dimensions (mm)

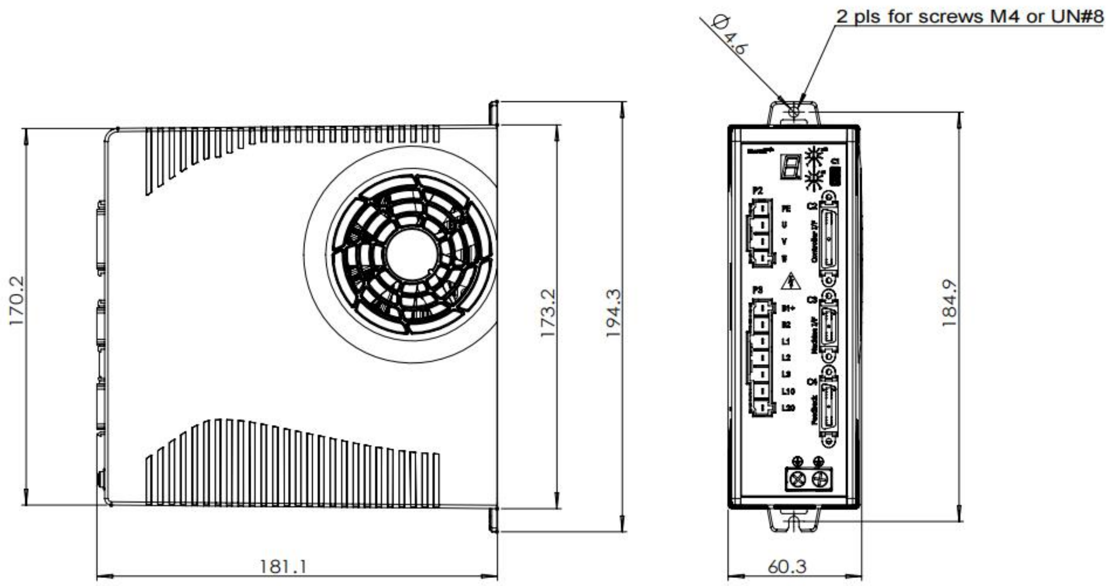


Figure 3 - 3 CDHD2S-008/CDHD2S-010/CDHD2S-013 (medium-voltage) - dimensions (mm)

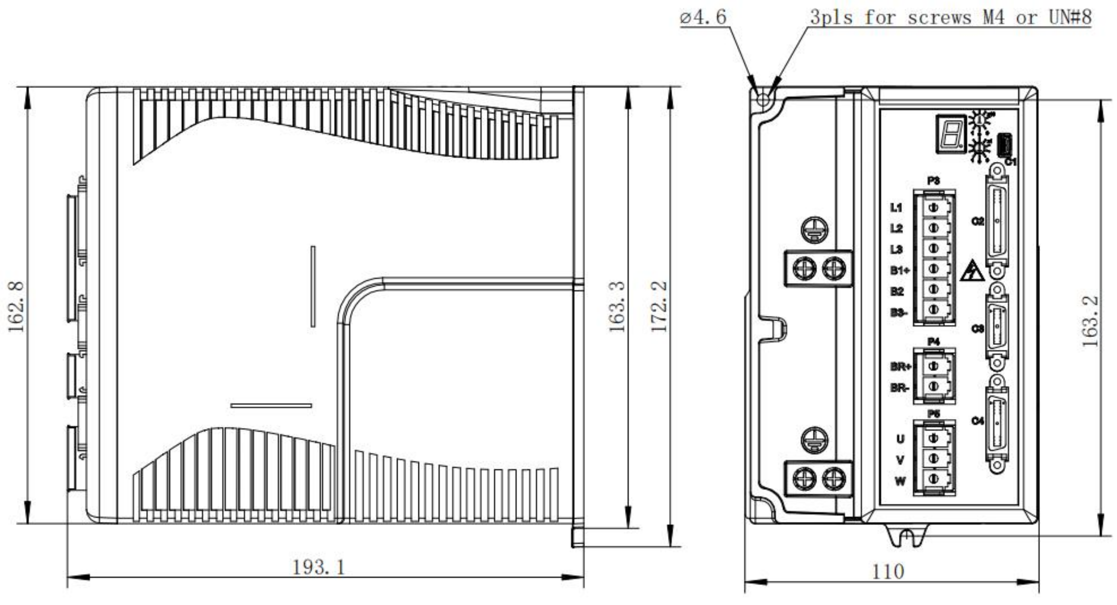


Figure 3 - 3 CDHD2S-003/CDHD2S-006 (high-voltage) - dimensions (mm)

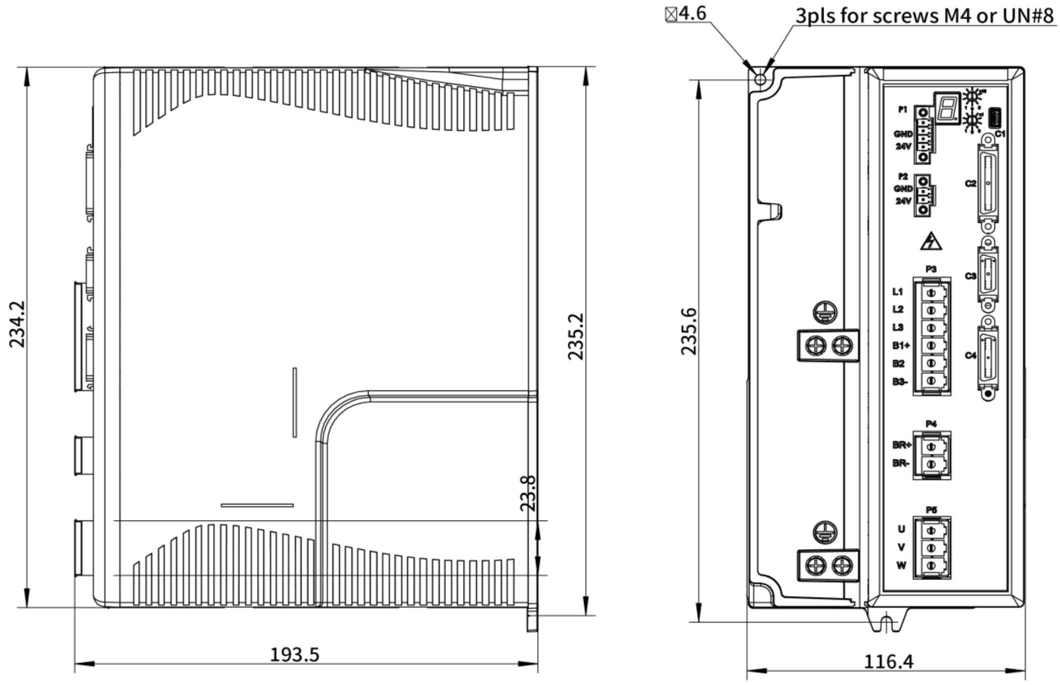


Figure 3-4 CDHD2S-012 (high-voltage) - dimensions (mm)

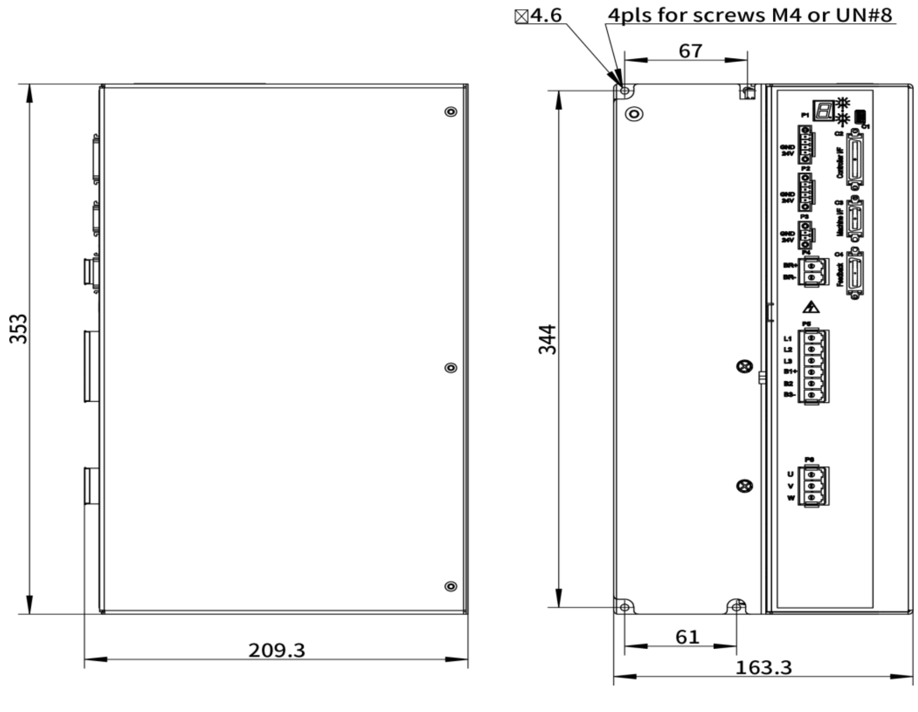


Figure 3-5 CDHD2S-024/CDHD2S-030 (high-voltage) - dimensions (mm)

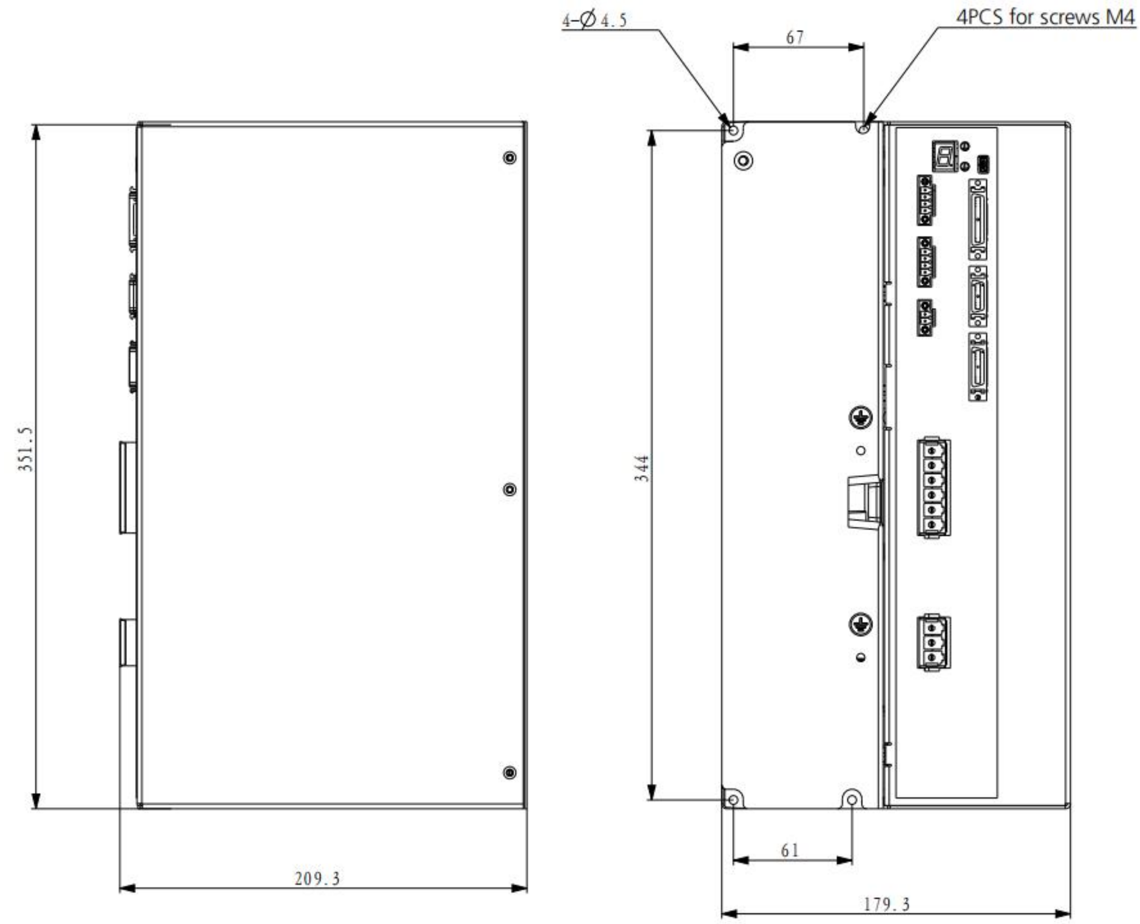


Figure 3-6 CDHD2S-040 (high-voltage) - dimensions (mm)

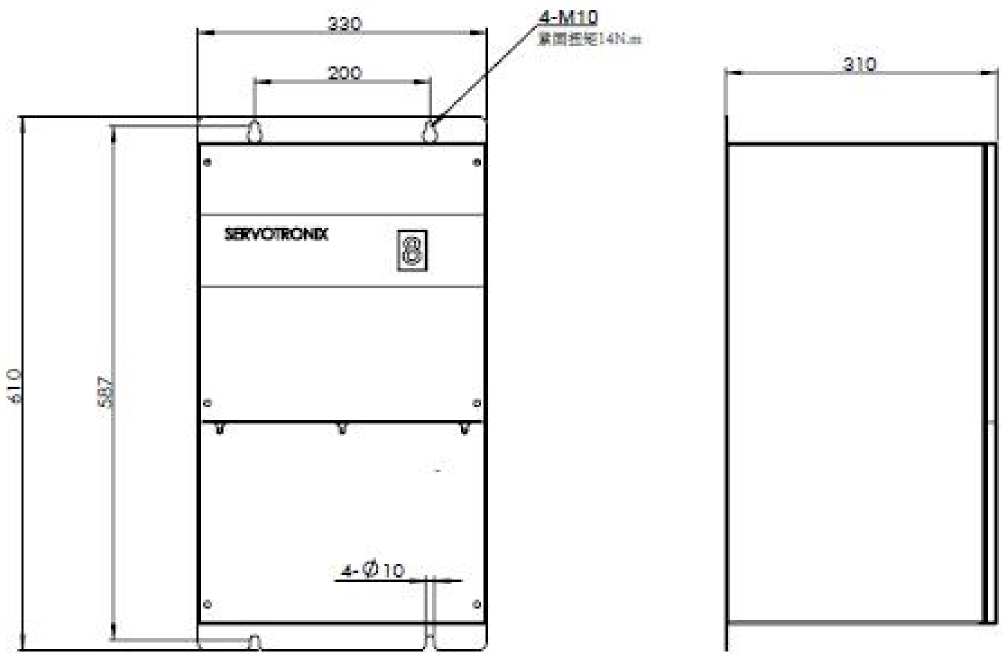


Figure 3-7 CDHD2S-060 (high-voltage) - dimensions (mm)

3.2Electrical and Mechanical Specifications

Table3-1 Mechanical and electrical specifications-CDHD2S-1D5/CDHD2S-003 (120/240 VAC)

Single phase AC 120/240V	Specification	Medium-voltage CDHD2S-1D5	Medium-voltage CDHD2S-003
Rating			
Input power circuit: L1, L2	Rated voltage (AC voltage line-neutral point) ±10%	120/240	120/240
	Line frequency (Hz)	50/60	50/60
	120/240VAC	1Phase	1Phase
	Continuous current (1 phase Arms)	2.5	5
	Line fuse (FWP, or equivalent)	4	6
	Voltage-endurance (primary to ground)	1500VAC (2121VDC)	1500VAC (2121VDC)
Control circuit input power (L1C, L2C)	120±10 or 240±VAC	Single phase	Single phase
STO (safety torque shutdown)	STO power supply (DC voltage)	24±10%	24±10%
STOFuse(TimeDelay)	120 or 240 VAC (A)	1.5	1.5
Drive output	Continuous output current [Arms]	1.5	3
	Continuous output current (Apeak)	2.12	4.24
	Peak output current (Arms) 2s	4.5	9
	Peak output current (Apeak) 2s	6.3	12.72
	kVA, 120V AC voltage	0.28	0.44
	kVA, 240V AC voltage	0.37	0.74
	PWM frequency (kHz)	16	16
Soft start	Maximum soft-start surge current (A)	7	7
	Maximum charging time (ms)	350	350
Circuit power loss	W	5	5
Control circuit loss	W		
Total power loss	W		
Hardware			
Unit weight	kg	0.7	0.75
Connecting hardware	PE grounding screw size/torque	M4/1.35Nm	M4/1.35Nm
Line number	Control circuit (AWG) (under 3 meters)	24-28	24-28
	Main circuit motor circuit (AWG)	18	18
	Main circuit AC input (AWG)	18	18
	PE grounding screw	M4	M4
Installations	Installation of Book		
Net distance	Left and right (mm)	15	15
	Top/bottom (mm)	50	50
Voltage trip			
	Low voltage trip (nominal) (DC voltage)	100	100
	Overvoltage trip (DC voltage)	420	420
Power supply temperature			
Fan	Usually run at a quarter of power; when the temperature exceeds the trigger temperature of the high-speed fan, it works at full power.	No	Yes
	Temperature to trigger high-speed	NA	45

Single phase AC 120/240V	Specification	Medium-voltage CDHD2S-1D5	Medium-voltage CDHD2S-003
	fan (°C)		
Power module	Overheating fault regulation (°C) power module	80±5%	80±5%
	Overheating fault unregulation (°C) power module	NA	45
External regenerative resistor (B1+, B2)			
External regenerative resistor requirements (regenerative resistor is not provided with the drive)	Peak current (A)	6.3	12.7
	Minimum resistance (Ω)	64	31.5
	Power rating (W)	System related	System related
Application information	Internal bus capacitance (μF)	360	660
	VLOW (regenerative circuit off) (DC voltage)	380	380
	VMAX (regenerative circuit on) (DC voltage)	400	400

Table3-2 Mechanical and electrical specifications-CDHD2S-4D5/CDHD2S-006 (120/240 VAC)

Single or three phase AC 120/240V	Specification	Medium-voltage CDHD2S-4D5	Medium-voltage CDHD2S-006
Rating			
Input power circuit: L1, L2, L3	Rated voltage (AC voltage line-neutral point) ±10%	120/240	120/240
	Line frequency (Hz)	50/60	50/60
	120VAC	1 phase or 3 phase	1 phase or 3 phase
	240VAC	1 phase	1 phase
	Continuous current (1 phase/3 phase, Arms)	8.5/4	10/5.8
	Line fuse (FWP, or equivalent)	10	10
	Voltage-endurance (primary to ground)	1500VAC (2121VDC)	1500VAC (2121VDC)
Control circuit input power (L1C, L2C)	120±10 or 240±VAC	Single phase	Single phase
STO (safety torque shutdown)	STO power supply (DC voltage)	24±10%	24±10%
STOFuse(TimeDelay)	120 or 240 VAC (A)	1.5	1.5
Drive output	Continuous output current [Arms]	4.5	6
	Continuous output current (Apeak)	6.63	8.48
	Peak output current (Arms) 2s	18	18
	Peak output current (Apeak) 2s	25.45	25.45
	kVA, 120V AC voltage	0.5	0.7
	kVA, 240V AC voltage	1.1	1.5
	PWM frequency (kHz)	16	16
Soft start	Maximum soft-start surge current (A)	7	7
	Maximum charging time (ms)	250	250
Circuit power loss	W	5	5
Control circuit loss	W		
Total power loss	W		
Hardware			
Unit weight	kg	0.97	0.97
Connecting hardware	PE grounding screw size/torque	M4/1.35Nm	M4/1.35Nm
Line number	Control circuit (AWG) (under 3 meters)	24-28	24-28

Single or three phase AC 120/240V	Specification	Medium-voltage CDHD2S-4D5	Medium-voltage CDHD2S-006
	Main circuit motor circuit (AWG)	16	16
	Main circuit AC input (AWG)	16	16
	PE grounding screw	M4	M4
Installations	Installation of Book		
Net distance	Left and right (mm)	15	15
	Top/bottom (mm)	50	50
Voltage trip			
	Low voltage trip (nominal) (DC voltage)	100	100
	Overvoltage trip (DC voltage)	420	420
Power supply temperature			
Fan	Usually run at a quarter of power; when the temperature exceeds the trigger temperature of the high-speed fan, it works at full power.	Yes	Yes
	Temperature to trigger high-speed fan (°C)	45	45
Power module	Overheating fault regulation (°C) power module	80±5%	80±5%
	Overheating fault unregulation (°C) power module	NA	45
External regenerative resistor(B1+, B2)			
External regenerative resistor requirements (regenerative resistor is not provided with the drive)	Peak current (A)	25.5	25.5
	Minimum resistance (Ω)	16	16
	Power rating (W)	System related	System related
Application information	Internal bus capacitance (μF)	1120	1120
	VLOW (regenerative circuit off) (DC voltage)	380	380
	VMAX (regenerative circuit on) (DC voltage)	400	400

Table3-3 Mechanical and electrical specifications-CDHD2S-008/CDHD2S-010//CDHD2S-013 (120/240 VAC)

Single or three phase AC 120/240V	Specification	Medium-voltage CDHD2S-008	Medium-voltage CDHD2S-010	Medium-voltage CDHD2S-013
Rating				
Input power circuit: L1, L2, L3	Rated voltage (AC voltage line-neutral point) ±10%	120/240	120/240	120/240
	Line frequency (Hz)	50/60	50/60	50/60
	120VAC	1 phase or 3 phase	1 phase or 3 phase	1 phase or 3 phase
	240VAC	1 phase	1 phase	1 phase
	Continuous current (1 phase/3 phase, Arms)	5	8	10
	Line fuse (FWP, or equivalent)	10	10	15
	Voltage-endurance (primary to ground)	1500VAC (2121VDC)	1500VAC (2121VDC)	1500VAC (2121VDC)
Control circuit input power (L1C, L2C)	120±10 or 240±VAC	Single phase	Single phase	Single phase
STO (safety torque shutdown)	STO power supply (DC voltage)	24±10%	24±10%	24±10%
STOFuse(TimeDelay)	120 or 240 VAC (A)	1.5	1.5	1.5
Drive output	Continuous output current [Arms]	8	10	13

Single or three phase AC 120/240V	Specification	Medium-voltage CDHD2S-008	Medium-voltage CDHD2S-010	Medium-voltage CDHD2S-013
	Continuous output current (Apeak)	11.31	14.14	18.38
	Peak output current (Arms) 2s	28	28	28
	Peak output current (Apeak) 2s	39.56	39.56	39.56
	kVA, 120V AC voltage	1.1	1.3	1.7
	kVA, 240V AC voltage	1.7	2.2	2.8
	PWM frequency (kHz)	8	8	8
Soft start	Maximum soft-start surge current (A)	15	15	15
	Maximum charging time (ms)	350	350	350
Circuit power loss	W	5	5	5
Control circuit loss	W			
Total power loss	W			
Hardware				
Unit weight	kg	1.15	1.15	1.15
Connecting hardware	PE grounding screw size/torque	M4/1.35Nm	M4/1.35Nm	M4/1.35Nm
Line number	Control circuit (AWG) (under 3 meters)	24-28	24-28	24-28
	Main circuit motor circuit (AWG)	14	14	14
	Main circuit AC input (AWG)	14	14	14
	PE grounding screw	M4	M4	M4
Installations	Installation of Book			
Net distance	Left and right (mm)	15	15	15
	Top/bottom (mm)	50	50	50
Voltage trip				
	Low voltage trip (nominal) (DC voltage)	100	100	100
	Overvoltage trip (DC voltage)	420	420	420
Power supply temperature				
Fan	Usually run at a quarter of power; when the temperature exceeds the trigger temperature of the high-speed fan, it works at full power.	Yes	Yes	Yes
	Temperature to trigger high-speed fan (°C)	45	45	45
Power module	Overheating fault regulation (°C) power module	80±5%	80±5%	80±5%
	Overheating fault unregulation (°C) power module	100±5%	100±5%	100±5%
External regenerative resistor(B1+, B2)				
External regenerative resistor requirements	Peak current (A)	40	40	40
	Minimum resistance (Ω)	10	10	10

Single or three phase AC 120/240V	Specification	Medium-voltage CDHD2S-008	Medium-voltage CDHD2S-010	Medium-voltage CDHD2S-013
(regenerative resistor is not provided with the drive)	Power rating (W)	System related	System related	System related
Application information	Internal bus capacitance (μF)	2110	2110	2110
	VLOW (regenerative circuit off) (DC voltage)	380	380	380
	VMAX (regenerative circuit on) (DC voltage)	400	400	400

Table3-4 Mechanical and electrical specifications-CDHD2S-003/CDHD2S-006/CDHD2S-012 (400/480 VAC)

Three phase AC 400/480V	Specification	High-voltage CDHD2S-003	High-voltage CDHD2S-006	High-voltage CDHD2S-012
Rating				
Input power circuit: L1, L2, L3	Rated voltage (AC voltage line-neutral point) ±10%	380/480	380/480	380/480
	Line frequency (Hz)	50/60	50/60	50/60
	380/480VAC	3 Phase	3 Phase	3Phase
	Continuous current (3 phase Arms)	2.8@380V 2.3@480V	5.7@380V 4.6@480V	11.0@400V 9.2@480V
	Line fuse (FWP, or equivalent)	10	10	50
	Voltage-endurance (primary to ground)	1800VAC(2520VDC)	1800VAC(2520VDC)	1800VAC(2520VDC)
Control circuit input power (P2)	24VDC±10%	24VDC±10% 1.5Arms	24VDC±10% 1.5Arms	24VDC±10% 1.5Arms
STO(safety torque off)	STO power supply (DC voltage)	24VDC±10% STO 1.0Arms	24VDC±10% STO 1.0Arms	24VDC±10% STO 1.0Arms
STO Fuse(Time Delay)	24VDC±10%	1.5	1.5	1.5
Drive output	Continuous output current [Arms]	3	6	12.0
	Continuous output current (Apeak)	4.24	8.48	16.97
	Peak output current (Arms) 2s	9	18	24
	Peak output current (Apeak) 2s	12.72	25.45	33.84
	kVA, 380V AC voltage	1.63	3.11	6.22
	kVA, 480V AC voltage	1.77	3.68	7.36
	PWM frequency (kHz)	8	8	8
Soft start	Maximum soft-start surge current (A)	7	7	9
	Maximum charging time (ms)	1300	1300	1300
Circuit power loss	W	5	5	5
Control circuit loss	W			
Total power loss	W			
Hardware				
Unit weight	kg	2.1	2.1	3.2
Connecting hardware	PE grounding screw size/torque	M4/1.35Nm	M4/1.35Nm	M4/1.35Nm
Line number	Control circuit (AWG) (under 3 meters)	24-28	24-28	24-28

Three phase AC 400/480V	Specification	High-voltage CDHD2S-003	High-voltage CDHD2S-006	High-voltage CDHD2S-012
	Main circuit motor circuit (AWG)	12-14	12-14	12-14
	Main circuit AC input (AWG)	12-14	12-14	12-14
	PE grounding screw	M4	M4	M4
Installations	Installation of Book			
Net distance	Left and right (mm)	25	25	25
	Top/bottom (mm)	50	50	50
Voltage trip				
	Low voltage trip (nominal) (DC voltage)	320	320	360
	Overvoltage trip (DC voltage)	800	800	800
Power supply temperature				
Fan	Operates at full power	Yes	Yes	Yes
	Temperature to trigger high-speed fan (°C)	50±5%	50±5%	50±5%
Power module	Overheating fault regulation (°C) power module	76±5%	76±5%	76±5%
	Overheating fault unregulation (°C) power module	100±5%	100±5%	100±5%
External regenerative resistor (B1+, B2)				
Internal regenerative resistor (B1+, B2)	Peak current (A)	16.8	16.8	23.9
	Resistance (Ω)	33	33	22
	Power	300	300	300
External regenerative resistor requirements (regenerative resistor is not provided with the drive)	Peak current (A)	16.8	16.8	23.9
	Minimum resistance (Ω)	33	33	22
	Power rating (W)	System related	System related	System related
Application information	Internal bus capacitance (μF)	410	410	820
	VLOW (regenerative circuit off) (DC voltage)	770	770	750
	VMAX (regenerative circuit on) (DC voltage)	780	780	770
Brake output				
	Opening voltage (VDC) at 24VDC logic supply and rated current (minimum)	23.5	23.5	23.5
	Leakage current when closing the gate (mA)	<2	<2	<2
	Maximum current (A)	1.3	1.3	1.3
	Short circuit protection	Yes	Yes	Yes
	Maximum opening time (ms)	20	20	20
	Maximum shutdown time (ms)	20	20	20

Table3-5 Mechanical and electrical specifications-CDHD2S-024/CDHD2S-030 (400/480 VAC)

Three phase AC 400/480V	Specification	High-voltage CDHD2S-024	High-voltage CDHD2S-030
Rating			
Input power circuit: L1, L2, L3	Rated voltage (AC voltage line-neutral point) ±10%	380/480	380/480
	Line frequency (Hz)	50/60	50/60
	380/480VAC	3Phase	3Phase
	Continuous current (3 phase Arms)	24	30
	Line fuse (FWP, or equivalent)	100	125
	Voltage-endurance (primary to ground)	1800VAC (2520VDC)	1800VAC (2520VDC)
Control circuit input power (P2)	24VDC±10%	24VDC±10% 1.5Arms	24VDC±10% 1.5Arms
STO and STO2(safety torque off)	STO power supply (DC voltage)	24VDC±10% STO 1.0Arms STO2 0.5Arms	24VDC±10% STO 1.0Arms STO2 0.5Arms
STO Fuse(Time Delay)	24VDC±10% (Arms)	1.5	1.5
Drive output	Continuous output current [Arms]	24	30
	Continuous output current (Apeak)	33.94	42.3
	Peak output current (Arms) 2s	72	90
	Peak output current (Apeak) 2s	102	126
	kVA, 380V AC voltage	12.2	15.1
	kVA, 480V AC voltage	15.4	19.0
	PWM frequency (kHz)	8	8
Soft start	Maximum soft-start surge current (A)	10	10
	Maximum charging time (ms)	1500	1500
Circuit power loss	W	5	5
Control circuit loss	W		
Total power loss	W		
Hardware			
Unit weight	kg	10.5	10.5
Connecting hardware	PE grounding screw size/torque	M4/1.35Nm	M4/1.35Nm
Line number	Control circuit (AWG) (under 3 meters)	24-28	24-28
	Main circuit motor circuit (AWG)	12	10
	Main circuit AC input (AWG)	12	10
	PE grounding screw	M4	M4
Installations	Installation of Book		
Net distance	Left and right (mm)	30	30
	Top/bottom (mm)	50	50
Voltage trip			
	Low voltage trip (nominal) (DC voltage)	360	360
	Over-voltage trip (DC voltage)	800	800
Power supply temperature			
Fan	Operates at full power	Yes	Yes
	Temperature to trigger high-speed fan (°C)	NA	NA
Power module	Overheating fault regulation (°C) power module	65±5%	65±5%
	Overheating fault unregulation (°C) power module	75±5%	75±5%
External regenerative resistor (B1+, B2)			

Three phase AC 400/480V	Specification	High-voltage CDHD2S-024	High-voltage CDHD2S-030
Internal regenerative resistor (B1+, B2)	Peak current (A)	65	65
	Resistance (Ω)	12	12
	Power	300	300
External regenerative resistor requirements (regenerative resistor is not provided with the drive)	Peak current (A)	100	100
	Minimum resistance (Ω)	8.4	8.4
	Power rating (W)	System related	System related
Application information	Internal bus capacitance (μF)	1640	1640
	VLOW (regenerative circuit off) (DC voltage)	750	750
	VMAX (regenerative circuit on) (DC voltage)	770	770
Brake output			
	Opening voltage (VDC) at 24VDC logic supply and rated current (minimum)	23.5	23.5
	Leakage current when closing the gate (mA)	<2	<2
	Maximum current (A)	<2	<2
	Short circuit protection	Yes	Yes
	Maximum opening time (ms)	20	20
	Maximum shutdown time (ms)	20	20

Table3-6 Mechanical and electrical specifications-CDHD2S-040/CDHD2S-060 (400/480 VAC)

Three phase AC 400/460/480V	Specification	High-voltage CDHD2S-040	High-voltage CDHD2S-060
Rating			
Input power circuit: L1, L2, L3	Rated voltage (AC voltage line-neutral point) ±10%	380/480	380/460
	Line frequency (Hz)	50/60	50/60
	380/480VAC	3Phase	3Phase
	Continuous current (3 phase Arms)	40	65
	Line fuse (FWP, or equivalent)	125	200
	Voltage-endurance (primary to ground)	1800VAC(2520VDC)	1800VAC(2520VDC)
Control circuit input power (P2)	24VDC±10%	24VDC±10% 3.5Arms	NA
STO and STO2(safety torque off)	STO power supply (DC voltage)	24VDC±10% STO 1.0Arms STO2 0.5Arms	
STO Fuse(Time Delay)	24VDC±10% (Arms)	3.5	
Drive output	Continuous output current [Arms]	40	60
	Continuous output current (Apeak)	56.56	85
	Peak output current (Arms) 2s	120	180
	Peak output current (Apeak) 2s	169	254
	kVA, 380V AC voltage	20	39.5
	kVA, 480V AC voltage	25	47.8
	PWM frequency (kHz)	4	4
Soft start	Maximum soft-start surge current (A)	28	25
	Maximum charging time (ms)	1500	1400
Circuit power loss	W	NA	NA
Control circuit loss	W		

Three phase AC 400/460/480V	Specification	High-voltage CDHD2S-040	High-voltage CDHD2S-060
Total power loss	W		
Hardware			
Unit weight	kg	10.32	38
Connecting hardware	PE grounding screw size/torque	M4/1.35Nm	M4.8/6Nm
Line number	Control circuit (AWG) (under 3 meters)	24-28	NA
	Main circuit motor circuit (AWG)	10	2
	Main circuit AC input (AWG)	10	2
	PE grounding screw	M4	M4.8
Installations	Installation of Book		
Net distance	Left and right (mm)	30	50
	Top/bottom (mm)	50	100
Voltage trip			
	Low voltage trip (nominal) (DC voltage)	360	360
	Over-voltage trip (DC voltage)	800	800
Power supply temperature			
Fan	Operates at full power	Yes	Yes
	Temperature to trigger high-speed fan (°C)	NA	NA
Power module	Overheating fault regulation (°C) power module	65±5%	NA
	Overheating fault unregulation (°C) power module	75±5%	80±5%
External regenerative resistor (B1+, B2)			
Internal regenerative resistor (B1+, B2)	Peak current (A)	51.3	NA
	Resistance (Ω)	15	
	Power	800	
External regenerative resistor requirements (regenerative resistor is not provided with the drive)	Peak current (A)	80	102
	Minimum resistance (Ω)	9.6	7.5
	Power rating (W)	System related	System related
Application information	Internal bus capacitance (μF)	2400	4700
	VLOW (regenerative circuit off) (DC voltage)	750	730
	VMAX (regenerative circuit on) (DC voltage)	770	750
Brake output			
	Opening voltage (VDC) at 24VDC logic supply and rated current (minimum)	NA	NA
	Leakage current when closing the gate (mA)		
	Maximum current (A)		
	Short circuit protection		
	Maximum opening time (ms)		
	Maximum shutdown time (ms)		

3.3Control Specifications

Table 3-7 Control specifications

Features		Specification
Motor	Type	DC brushless motor, DC brush motor, voice coil motor, rotary servo motor, linear servo motor
	Automatic motor phasing	Auto-configuration of motor phase, encoder direction and Hall phase sequence.
Operation mode	Optional control mode	Current (torque) control, velocity control, position control, HD control, double-loop control, gantry control
Current (torque) control	Performance	Refresh rate 31.25µs(32KHz), output sine wave
	Step response time	The actual current reaches the command current within two cycles, i.e. 62.5µs
	Control loop	DQ, PI, feedforward
	Reference command*	Analog DC voltage ± 10V, serial port RS232 or USB, CANopen, EtherCAT
	Autotuning	Automatic setting of current control loop parameters
Velocity control	Performance	Refresh rate 125µs (8kHz)
	Optional velocity control loop	PI, PDFF, standard pole placement, advanced pole placement, standard pole placement high-frequency, dump active pole placement
	Filter	First order low pass filter, double first order low pass filter, notch filter, high-pass filter, bandpass filter, user-defined polynomial filter
	Reference command	Analog DC voltage ±10V, serial port RS232 or USB*, CANopen, EtherCAT
Position control	Performance	Refresh rate 250µs (4kHz)
	Control loop	PID and feedforward
	Reference command*	Electronic gearing pulse and direction, serial port RS232 or USB, CANOpen, EtherCAT
HD control	Performance	Refresh rate 125µs (8kHz)
	Control loop	Nonlinear control algorithm provides low tracking error, smooth motion with zero or minimum settling time; it includes an adaptive feedforward feature that is applied at the end of motion to deliver zero or minimum settling time.
	Filter	One second order low pass filter, two notch filters, and other filters for handling flexible and resonant systems
	Reference command*	Velocity: Analog DC voltage ± 10V, serial port RS232 or USB, CANopen, EtherCAT Position: Pulse, serial port RS232 or USB, CANopen, EtherCAT
	Autotuning	Automatic inertia load measurement, automatic setting and optimization of HD control loop parameters.
Gantry control	Control loop	Position control of H-shaped mechanical structure
Brake	Method	Controller braking, dynamic braking, electromechanical braking by the motor.
Seven-segment display	User interface	7-segment LED (green) to display drive status
GUI	User interface	Windows based ServoStudio2 application
	Function	Setup connection, drive information, power information, motor, feedback, input/output selection/configuration, action setting/tuning, fault history/display, setup wizard, expert view
Electronic gearing	Method	User defined input signal ratio
Rotation unit	Position	Velocity, count, degree
	Rate	Rps, rpm, deg/s

Features	Specification	
	Acceleration/Deceleration	Rps/s, rpm/s, deg/s2
Linear device	Position	Count, pitch, mm, μm
	Rate	mm/s, μm/s
	Acceleration/Deceleration	mm/s2, μm2/s

3.4Protection Functions and Environmental Specifications

Table 3-8 Protection functions and environmental specifications - all CDHD2S models

Features	Specification
Protection function	Including but not limited to: low/overvoltage, overcurrent, drive and motor overheating, motor feedback, drive feedback, feedback loss, secondary feedback loss, STO signal not connected, not configured, circuit failure.
Compliance	IEC61800-5-1: Low voltage directive 2006/95/EC. Adjustable speed electrical power drive systems
	EN61800-5-2:2017: Machinery directive 2006/42/EC. Adjustable speed electrical power drive systems - safety requirements - functional
	IEC61800-3: Electromagnetic compatibility (EMC) directive 2004/108/E. Adjustable speed electrical power drive systems
	EN50581: Supporting the basic requirements of the EU RoHS directive 2011/65/EU. Restriction of the Use of Certain Hazardous Substances in Electronic and Electrical Equipment
	UL508C: TÜV Rheinland certification. Power conversion equipment. NOTE: Certification for low voltage models is pending.
	REACH: Regulation (EC) No 1907/2006 Regulations on the chemicals and their safe use.
Environment	Ambient temperature: working temperature 0-45°C, storage temperature 0-70°C
	Humidity: 10-90%
	Height: If the height requirements are specified in accordance with the IEC61800-5-1, the CDHD2S should be used below 2,000 meters.
	Vibration: 1.0g
Working conditions	IP20 rating; IEC60664-1 Degree 2 Please do not use it in places with corrosive or flammable gases, water, oil or chemicals, dust (including iron powder) and salt.

3.5STO/Functional Safety Specification

Note: STO certification for all CDHD2S models is currently pending.

Table 3-9 STO electrical specifications

Features	Parameter	
STO power supply	Rated voltage	24V DC voltage
	Voltage class, based on EN61131-2 Type 2 exception (operating voltage is 15V DC instead of 11V DC)	DC voltage 15-30V: STO function is not activated (action allowed) DC voltage 0-5V: STO function is activated (action suppression) DC voltage 5-15V: STO function is undefined and not guaranteed

	Power supply - external	SELV/PELV required
	Power supply - internal	STO jumper required
Cable	Maximum length	30m
	Line number	22-24AWG
Current loss		Under the condition of DC voltage 15V<300mA; under the condition of DC voltage 24V<200mA; under the condition of DC voltage 30V<150mA
Maximum response time	Movement suppression time range	40ms
Maximum duration of OSSD test pulse	Drive ignoring OSSD test pulse	1ms
OSSD test pulse Maximum frequency of	Absolute maximum frequency of 1ms test pulse successfully filtered by the drive	475Hz

3.6Communication Specifications

Table 3-10 Communication specifications

Features	Specification
CANopen*	CiA301 application layer and CiA402 device profile for drives and motion control
	Baud rate: 0.5M1Mbit/s
	Integrating 120Ω terminal resistor with switch
	Addressing: operation panel (medium-voltage model), rotary switch (low-voltage model)
EtherCAT*	CiA301 application layer and CiA402 device profile for drives and motion control
	Communication cycle: 250μs or less
PROFINET	Application rules: IEC 61800-7-203 (Profidrive) IEC 61784-2 (PROFINET)
	Communication method: RT communication, IRT communication
	Communication cycle: 500μs or more
RS232	Based on ASCII, ServoStudio2, HyperTerminal
	Baud rate: 115200bit/s
	Maximum cable length: 10 meters
USB*	Based on ASCII, ServoStudio2, HyperTerminal
	Baud rate: 115200bit/s
	Maximum cable length: 3 meters
Daisy chain loop	Maximum 8 axes. Axis address setting range 0-99
	Maximum cable length: 1 meters

*Some features are not available on all models. Please refer to the *Ordering Information*.

3.7Input/Output Specification

Table 3-11 Input/output specifications

Features	Specification			
	CDHD2S model	AP/AF	EC	EB
First analog input	Voltage range	Analog DC voltage ±10V difference		
	Input resolution	16-bit (14-bit for versions with two analog inputs)		
	Input impedance	8kΩ (20kΩ when using two analog inputs)		
	Bandwidth (-3db)	8kHz		
	Accuracy	2%		

Features	Specification			
	CDHD2S model	AP/AF	EC	EB
Second analog input*	Voltage range	Analog DC voltage ±10V difference		
	Input resolution	14-bit		
	Input impedance	20kΩ		
	Bandwidth (-3db)	8kHz		
	Accuracy	2%		
Pulse train	Signal	RS422 line receiver		
	Maximum input frequency	5MHz		
Equivalent encoder output	Signal	AB quadrature output and exponential differential output; RS422 line transmitter		
	Maximum output frequency	5MHz		
Digital input	Number	8	8	4
	Signal	Configurable; optical isolation. Sinking type or sourcing type signal input.		
	Voltage	24V (IEC61131)		
	Electromagnetic interference protection	Yes		
	Maximum input current	6mA		
	Transmission delay time	1ms		
	Frequency	1kHz		
Fast digital input	Number	3	3	1
	Signal	Configurable; optical isolation. Sinking type or sourcing type signal input.		
	Voltage	24V (IEC61131)		
	Electromagnetic interference protection	Yes		
	Maximum input current	12.5mA		
	Transmission delay time	1μs		
	Frequency	1MHz		
Digital output	Number	6	6	3
	Signal	Configurable; optical isolation. Open-collector Sinking type or sourcing type signal input.		
	Voltage	24V (IEC61131)		
	Electromagnetic interference protection	Yes		
	Maximum input current	100mA		
	Battery overload protection	Yes		
	Transmission delay time	1ms		
Fast digital input	Number	2	2	1
	Signal	Configurable; optical isolation. Open-collector Sinking type or sourcing type signal input.		–
	Voltage	5 to 24V		–
	Maximum input current	50mA		–
	Transmission delay time	1μs		–
Analog output	Signal	Configurable analog output		–
	Voltage	±10V		–
	Resolution	12-bit		–
	Bandwidth	2kHz		–
	Maximum load	100kΩ		–
Fault output relay	Signal	Configurable analog output		–
	Voltage	24V		–
	Maximum current	1A		–

3.8Motor Feedback Specification

Table 3-12 Motor feedback specifications - all CDHD2S models

Features	Specification	
Power supply	Drive supply voltage	DC voltage 5V (DC voltage 8V*)
	Maximum supply current from drive to main encoder**	320mA@5V 140mA@8V
Cable	Maximum length	50 meters for sensAR encoder. For other feedback devices, refer to the device specifications.
Incremental encoder	Differential RS422 or RS485	AB quadrature, with or without index, 8-channel Tamagawa (Tamagawa) Encoder
	AB quadrature maximum input frequency	5MHz (before quadrature)
	Minimum index pulse width	1μs
Hall sensor	Signal	Open-collector single-ended type (optional differential type)
Sine encoder	Signal	Sine/cosine differential, with or without Hall
	Signal level	1Vpp@2.5V
	Maximum input frequency	300kHz
	Protocol	EnDat2.1, HIPERFACE
	Input impedance	120Ω
	Interpolation	Maximum 16384 (14 bits)
Serial synchronous encoder	Signal	Synchronous encoder differential data and clock Data only for asynchronous encoders
	Protocol	sensAR, EnDat2.2, BiSS-C (up to 26 bits), Nikon, Tamagawa
Motor temperature	Signal	Thermistor PTC or NTC, user-defined fault threshold

*Some features are not available on all models. Please refer to the *Ordering Information*.
**The maximum combined current of the motor and secondary feedback must not exceed 500mA.

3.9Secondary Feedback Specifications

Table 3-13 Secondary feedback specifications - all CDHD2S models

Features	Specifications	
Power supply	Drive supply voltage	5V DC voltage
	Maximum supply current from drive to encoder*	320mA
Incremental encoder	Differential RS422 or RS485	AB quadrature, with or without index
	AB quadrature maximum input frequency	5MHz (before quadrature)
	Minimum index pulse width	1μs
Serial encoder	Signal	Synchronous encoder differential data and clock. Data only for asynchronous encoders.
	Protocol	EnDat2.2, BiSS-C (up to 26 bits)
Analog	Drive supply voltage	5V DC voltage
Function		Dual loop, master/slave unit or handwheel, encoder reader

*The maximum combined current of the motor and secondary feedback must not exceed 500mA.

4.Drive Setup

4.1Setup Overview

Perform the following steps to install and set up the CDHD2S system.

1. Install CDHD2S.
2. Perform all wiring and cabling connections as required by the application:

   Controller input/output and/or mechanical input/output

   - Motor feedback
   - Fieldbus device (if used)
   - CANopen network: Set the 120Ω terminal resistance switch as needed
   - Safe torque shutdown (STO), or bypass using jumpers
   - Motor
   - Regenerative resistor (if required)
   - Motor brake (if required)
   - Medium-voltage type: AC voltage input
   - Low-voltage type: DC voltage input
3. Connect the drive to the host.
4. Power on the drive and the host. Please refer to the *Power Up*.
5. Install ServoStudio2 software. Please refer to the ServoStudio2 manual.
6. If necessary, define the drive communication address. Please refer to the *Drive Addressing*.

4.2Power Up

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

Note: If the logic power and bus AC power are separate, it is recommended to turn on the logic power before turning on the bus AC power.

Check the digital display on the front panel of the CDHD2S.

On initial power-up, the digital display shows that the drive parameters are not saved (e). By configuring the drive and saving the parameters to the drive, this fault can be cleared.

4.3Drive Address

If only one drive is connected to the host, the drive address setting defaults to 0 and no definition is required.

If multiple drives are connected to the host, each drive must be assigned a unique communication address. Address 0 is not available when configuring a daisy chain loop.

- High-voltage type: VarCom variable ADDR sets the drive address. Then enter SAVE and restart the drive.
- High-voltage type: Set the drive address with the rotary address switch on the front panel. Then restart the drive.

The new address only takes effect after (save and) drive restart.

Set drive address

In a CANopen network, each CANopen device must be assigned a unique node address (identification number).

In an EtherCAT network, it is not necessary to assign a physical node address (identification number) to the device; the EtherCAT controller will assign addresses. Two or more drives connected in an EtherCAT network can be set to the same physical address; the EtherCAT controller will automatically set the slave ID.

In a PROFINET network, the PROFINET controller distinguishes the device through the MAC address of the drive. The node name and IP address can be configured, but the node address does not take effect.

4.4Setup Preparation

4.4.1 Hardware and tools

The table below specifies all required hardware and tools.

In addition, you also need:

- ●Except for CDHD2S-033, CDHD2S044, and CDHD2S-055, all models use M4 ring terminals or sector terminals for grounding.
- ●M6 ring terminal for grounding for CDHD2S-033, CDHD2S-044, CDHD2S-055.
- ●M2 sector terminals for CDHD2S-033, CDHD2S-044, CDHD2S-055 logic connectors.
- ●A small slotted screwdrive for setting the switch.

Table 4-1 Required tools (if off-the-shelf cable assemblies are not used)

Medium-voltage type – AC voltage 120/240V		
Item	**Model**	**Interface**
	CDHD2S-1D5 CDHD2S-003	
Crimping tool	Molex0638190000	P1
	YRF-880	P2, P3
Plug-in tool	EJ-JFAJ3	P2, P3
Spring connector tool	J-FAT-OT (prepared)	
Item	**Model**	**Interface**
	CDHD2S-4D5 CDHD2S-006	
Crimping tool	Molex 0638190000	P1
	YRF-1070	P2, P3, P4
Plug-in tool	EJ-JFAJ3	
Spring connector tool	J-FAT-OT (prepared)	

High-voltage type – AC voltage 400/480V		
Item	**Model**	**Interface**
	CDHD2S-012 CDHD2S-024 CDHD2S-030 CDHD2S-040	
Crimping pliers	Molex0638190000(P1,P2) (alsoP3onCDHD2S-024/030)	P1, P2
	CDHD2S-024 CDHD2S-030	
Crimping pliers	Molex0638190000	P3

For other models, no additional tools are required.

4.4.2 Cables and crimping

Please refer to the *Cables* section for details of the various cables required by the CDHD2S system.

Before crimping, strip 2mm off the end of the wire, as shown in Figure 4-1.

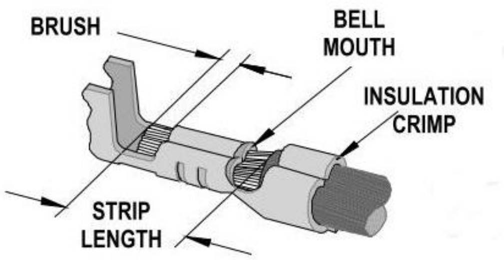


Figure 4-1 Wire insertion into crimp pin

4.4.3 Connector - control board

For more information about cables, Please refer to the *Cables* section.

Table 4-2 Connector for controller interface C2

Interface	Manufacturer	Item	Manufacturer part number	Servotronix part number
C2	3M	Welding plug connector	10136-3000PE	CONr00000036-01
	3M	Welding plug shell	10336-52F0-008	HODr00000036-00

Table 4-3 Connector for machine interface C3

Interface	Manufacturer	Item	Manufacturer part number	Servotronix part number
C3	3M	Welding plug connector	10120-3000PE	CONr00000020-38
	3M	Welding plug shell	10320-52F0-008	HODr00000020-00

Table 4-4 Connector for controller interface C2 Connector for feedback C4

Interface	Manufacturer	Item	Manufacturer part number	Servotronix part number
C4	3M	Welding plug connector	10126-3000PE	CONr00000026-31
	3M	Welding plug shell	10326-52F0-008	HODr00000026-00

Table 4-5 Connector for fieldbus communication (EtherCAT/CAN) C5/C6

Interface	Manufacturer	Item	Manufacturer part number	Servotronix part number
C5/C6	Molex	Connector	44915-0011	

Table 4-6 Connector for RS232 serial communication C7

Interface	Manufacturer	Item	Manufacturer part number	Servotronix part number
C7	AIM-Cambridge	Connector	32-5964UL	

Table 4-7 Connector for RS232 serial communication C8

Interface	Manufacturer	Item	Manufacturer part number	Servotronix part number
C8	TE	Connector	1658527-3	CONr00000010-67

4.4.4 Connector - power board

Note: All connectors for power board are provided with the drive.

Table 4-8 Connector for CDHD-003(low-voltage),CDHD2S-1D5/003 (medium-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	STO	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter：16-28AWG	11201707002095
P2	Motor phase line interface	Housing：SC-T3005004SB0X Wire diameter：12-14AWG	11201707001995
P3	AC power input and regenerative resistor interface	Housing：SC-T3005006SB0X Wire diameter：12-14AWG	11201707001996

Table 4-9 Connector for CDHD2S-4D5/006 (medium-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	STO	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter：16-28AWG	11201707002095
P2	Motor phase line interface	Housing：SC-T3005004SB0X Wire diameter：12-14AWG	11201707001995
P3	AC power input and regenerative resistor interface	Housing：SC-T3005007SB0X Wire diameter：12-14AWG	11201707001997

Table 4-10 Connector for CDHD2S-008/010/013 (high-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	STO	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter：16-28AWG	11201707002095
P2	Motor phase line interface	Housing：F9A-7.5-04P-A-0415 Wire diameter：12-14AWG	11201707002295
P3	AC power input and regenerative resistor interface	Housing：F9A-7.5-07P-A-0403 Wire diameter：12-14AWG	11201707002275

Table 4-11 Connector for CDHD2S-003/006 (high-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	STO	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter：16-28AWG	11201707001435
P2	24V logic power input	Crimp connection 15EDGKNM-3.5-02P-14-1000A(H) Wire diameter：16-28AWG	11201707001436
P3	AC power input and regenerative resistor interface	Housing：SPC5/6-STCL-7,62(1718520) Wire diameter：12-14AWG	11201707000306
P4	Motor brake	Housing：SPC5/2-STCL-7,62(1718481) Wire diameter：14-17AWG	11201707000304
P5	Motor phase line interface	Housing：SPC5/3-STCL-7,62(1718494) Wire diameter：12-14AWG	11201707000305

Table 4-12 Connector for CDHD2S-012 (high-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	STO	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter: 16-28AWG	11201707001435
P2	24V logic power input	Crimp connection 15EDGKNM-3.5-02P-14-1000A(H) Wire diameter: 16-28AWG	11201707001436
P3	AC power input and regenerative resistor interface	Housing: SPC5/6-STCL-7,62(1718520) Wire diameter: 12-14AWG	CONr00000006-78 or 11201707000306
P4	Motor brake	Housing: SPC5/2-STCL-7,62(1718481) Wire diameter: 14-17AWG	CONr10000002-16 or 11201707000304
P5	Motor phase line interface	Housing: SPC5/3-STCL-7,62(1718494) Wire diameter: 12-14AWG	CONr10000003-21 or 11201707000305

Table 4-13 Connector for CDHD2S-024 (high-voltage)/CDHD2S-030 (high-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	STO	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter: 16-28AWG	11201707001435
P2	STO2	Crimp connection 15EDGKNM-3.5-04P-14-1022Z (H) Wire diameter: 16-28AWG	11201707001435
P3	24V logic power input	Crimp connection 15EDGKNM-3.5-02P-14-1000A(H) Wire diameter: 16-28AWG	11201707001436
P4	Motor brake	Housing: SPC5/2-STCL-7,62(1718481) Wire diameter: 14-17AWG	CONr10000002-16 or 11201707000304
P5	AC power input and regenerative resistor interface	Housing: SPC5/6-STCL-7,62(1718520) Wire diameter: 12-14AWG	CONr00000006-78 or 11201707000306
P6	Motor phase line interface	Housing: SPC5/3-STCL-7,62(1718494) Wire diameter: 12-14AWG	CONr10000003-21 or 11201707000305

4.4.5 Host system

The following computer systems and software are required:

- 2GHzCPU
- 1GBRAM
- 1000MB of free hard drive space (after installing .net4)
- Communication interface to the drive; one of the following:
  - USB port
  - USB port and USB-to-RS232 adapter (with ferrite beads)
  - RS232 port
- Operating system: Windows7, Windows8, Windows10, 32-bit or 64-bit.
- For ServoStudio2, the recommended screen resolution is 1280x800; the minimum resolution is 1024x800.
- It is recommended to set your Windows monitor to small - 100% (default).
- Net4 (please refer to the .NET Framework System Requirements for details). If .NET4 is not installed on your computer, ServoStudio2 will guide you through the installation but will not install it automatically.
- ServoStudio2, a graphical software interface for configuring and testing the drive. Download from the Servotronix website or contact technical support.

Please refer to *Software Installation* in the ServoStudio2 manual.

Note: ServoStudio2 provides compatibility with CDHD2S firmware version 2.0 and above.

Install ServoStudio2

1. Download the ServoStudio2 software installation file from the Servotronix website or contact technical support.
2. Install ServoStudio2 software on the host computer.
3. After installation is complete, launch ServoStudio2 from the Windows Start menu or from the shortcut on the desktop.

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

- Copy the installation file to the computer hard disk.
- Right-click the installation file and select "Run as administrator."

Install USB device driver of CDHD2S.

The first time you connect a drive to a host through a USB port, Windows may display the New Hardware Discovery wizard, or a new driver will be added to Windows Device Manager with an error or warning symbol.

1. If Windows activates the "New Hardware" wizard, press "Skip getting drives from the network" when this prompt appears. Open Windows Device Manager.
2. In the Ports or Universal Serial Bus Controllers section, find the device marked "Unknown".
3. Right-click on the unknown device and select "Update Drive".
4. Select "Browse my computer" and browse to the following location:

C:\ProgramFiles(x86)\Servotronix\ServoStudio2\Drivers\

5. Make sure the "Include subfolders" option is checked, then click "Next."
6. When the Windows prompt appears, click "Install."

Note: The USB driver has two layers, and you may need to repeat the "Update Drive" procedure again.

CDHD2S USB drives are digitally signed.

4.4.6 Fieldbus device files

- EDS file of CDHD2S on the host computer or PLC controller (if CAN protocol is used). Download from the Servotronix website or contact technical support.
- XML file of CDHD2S on the host or PLC controller (if EtherCAT protocol is used). Download from the Servotronix website or contact technical support.
- GSD file of CDHD2S on the host computer or PLC controller (if PROFINET protocol is used). Download from the Servotronix website or contact technical support.

4.5System Wiring

4.5.1 CDHD2S-003 (low-voltage) system wiring

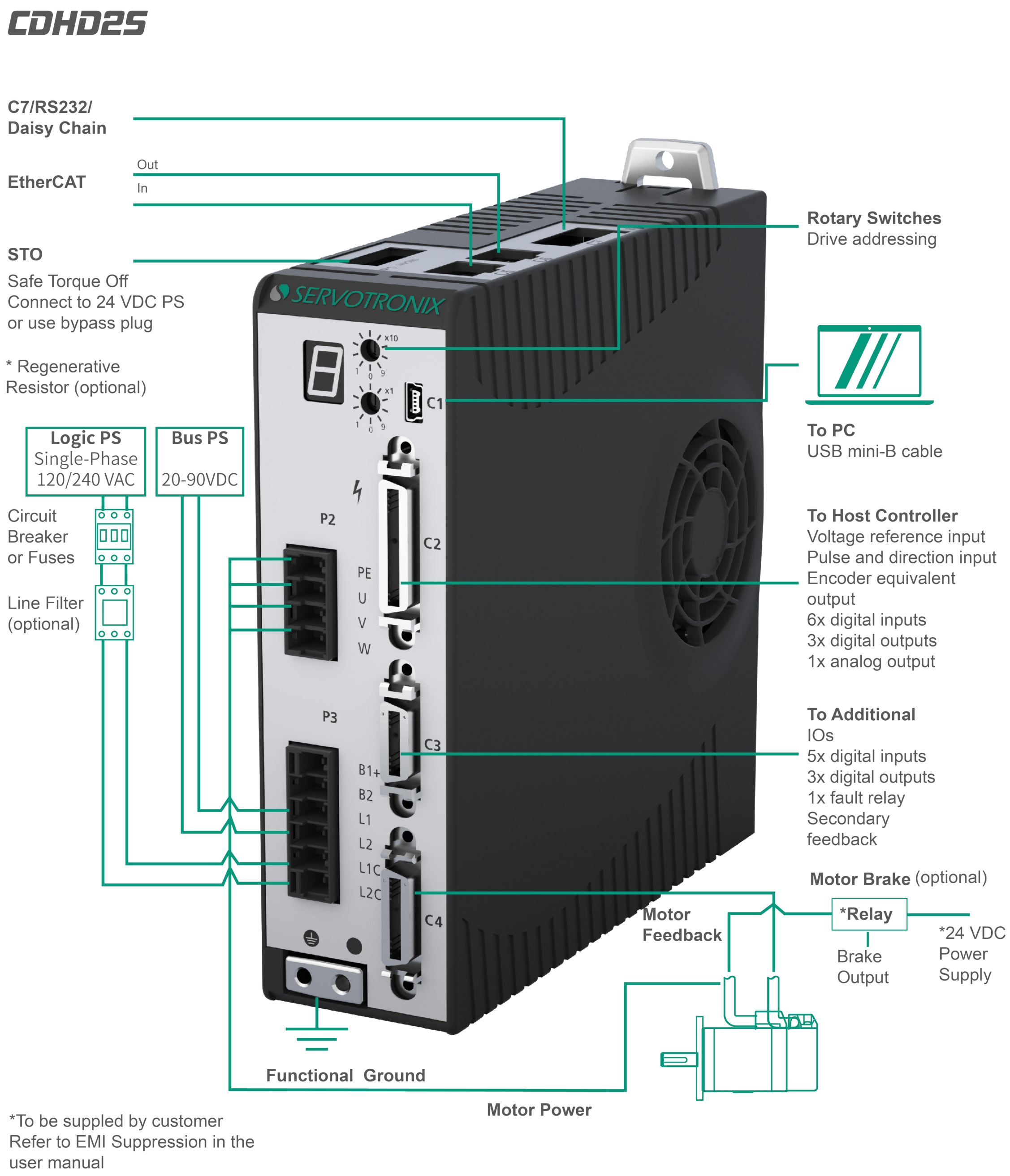


Figure 4-2 CDHD2S-003 DC 20-90V (low-voltage) EC model system wiring

4.5.2CDHD2S-1D5/003 (medium-voltage) system wiring

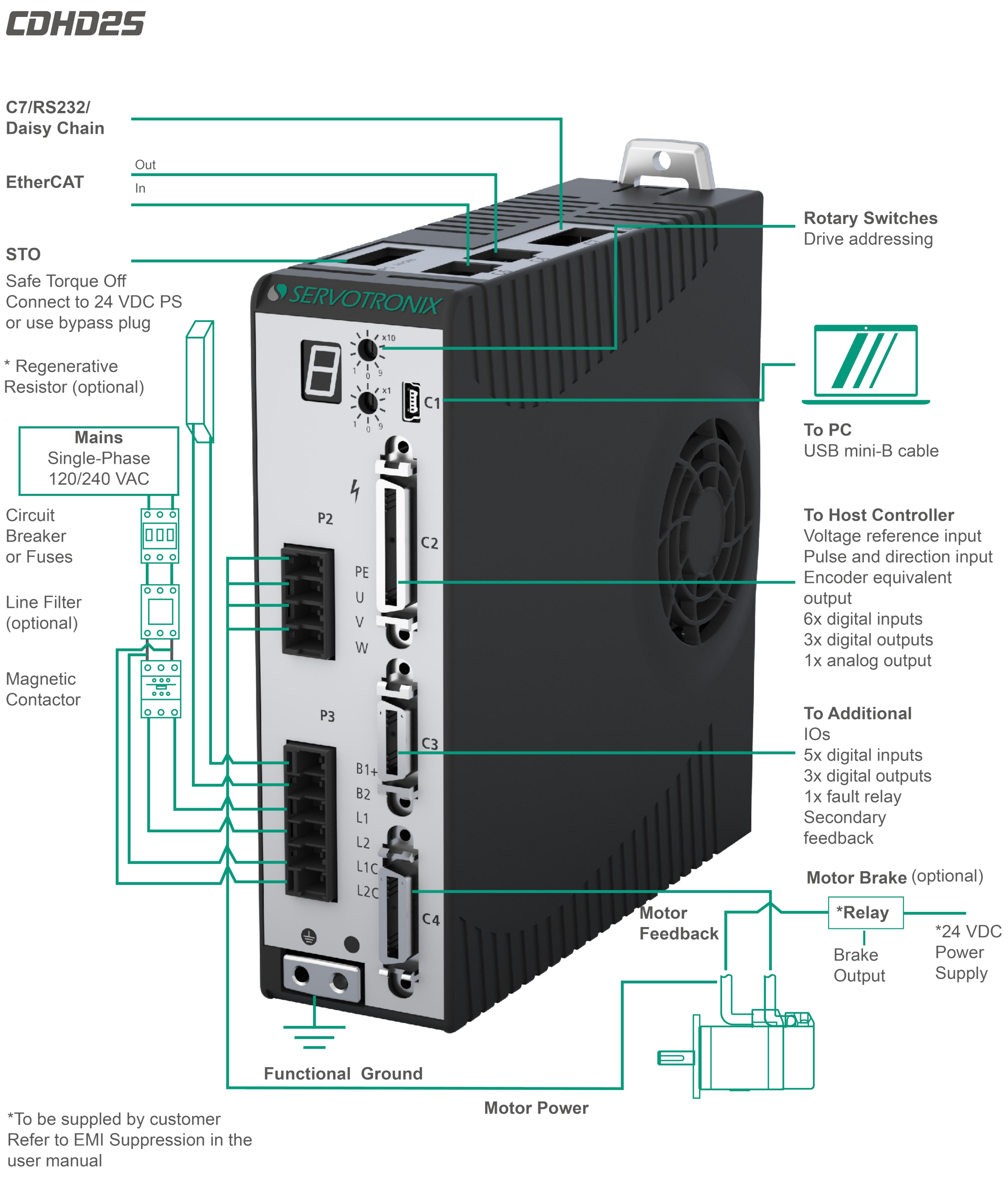


Figure 4-3 CDHD2S-1D5/CDHD2S-003 AC 120-240V (medium-voltage) EC model system wiring

4.5.3 CDHD2S-4D5/006 (medium-voltage) system wiring

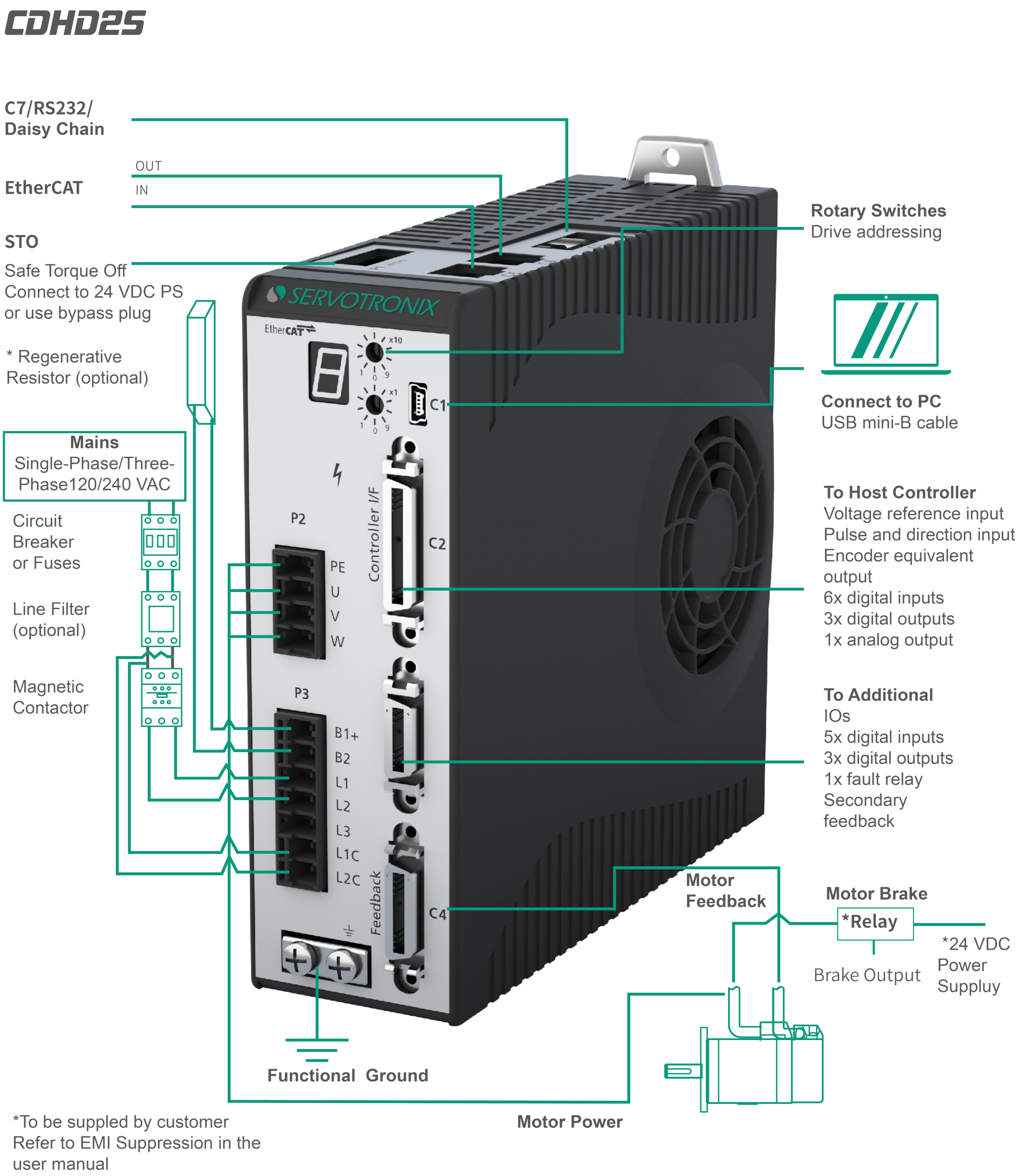
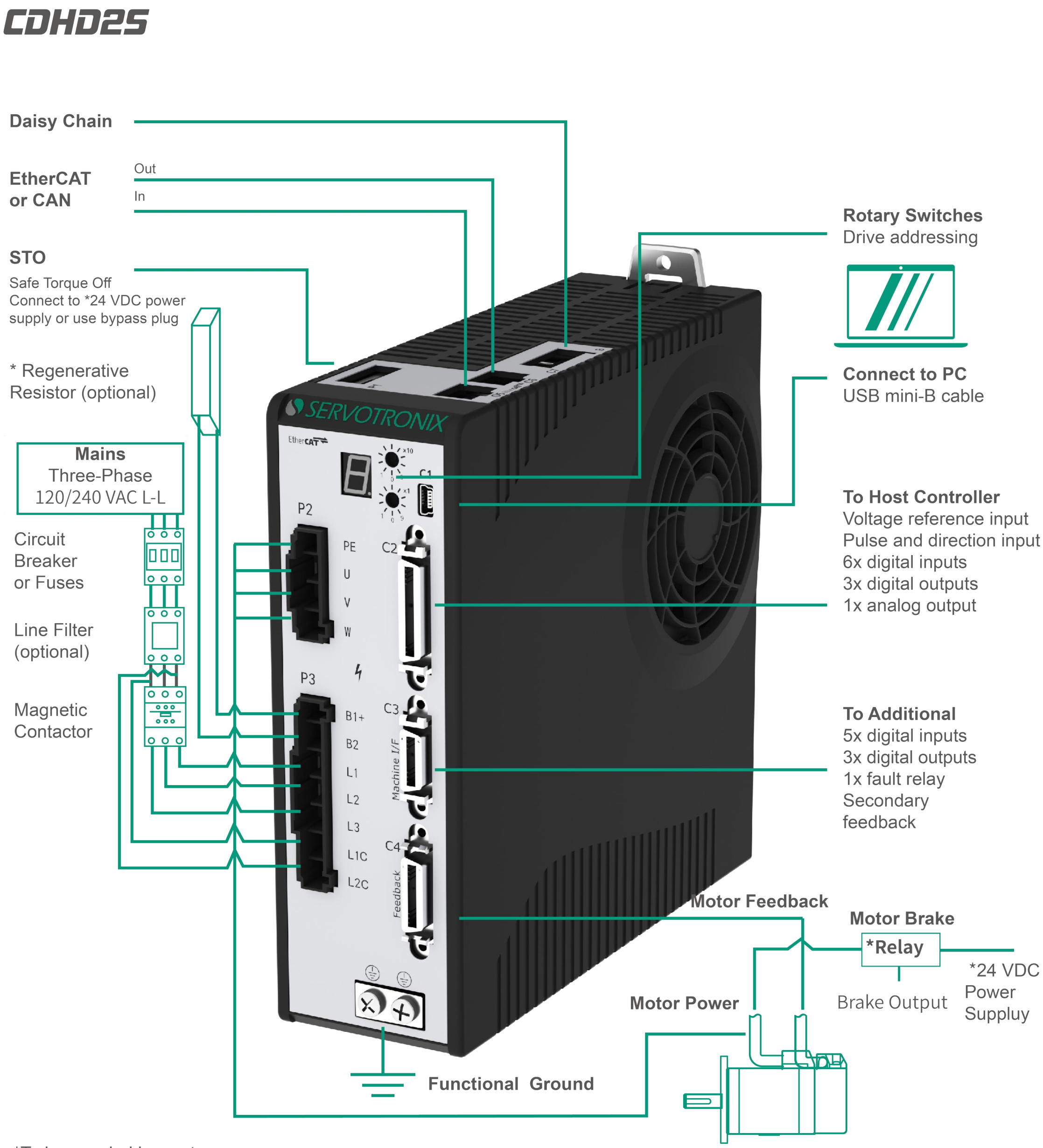


Figure 4-4 CDHD2S-4D5/CDHD2S-006 AC 120-240V (MV) EC model system wiring

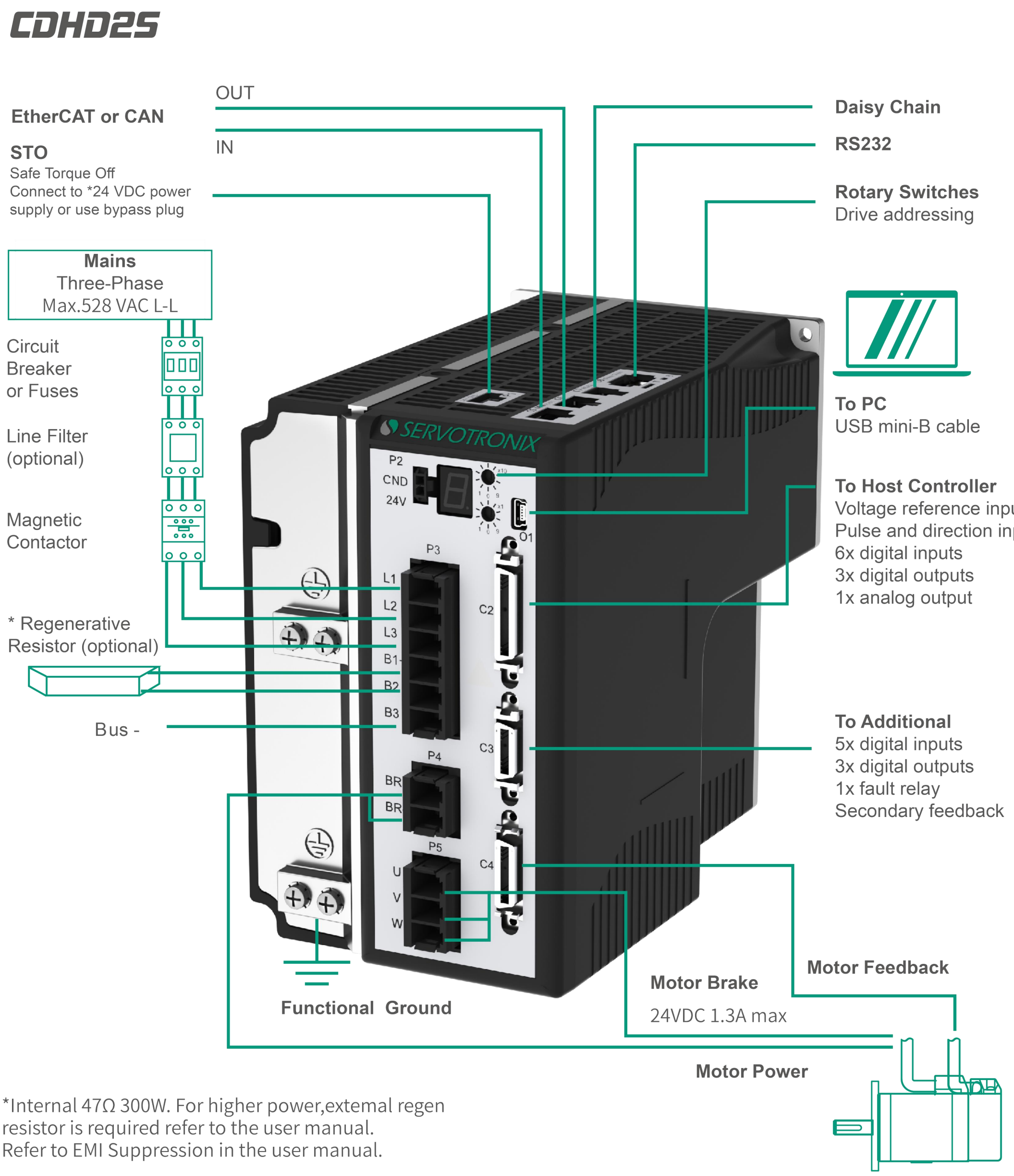
4.5.4 CDHD2S-008/010/013 (medium-voltage) system wiring



*To be suppled by customer
Refer to EMI Suppression in the user manual

Figure 4-5 CDHD2S-008/CDHD2S-010/CDHD2S-013 AC 120-240V (MV) EC model system wiring

4.5.5 CDHD2S-003/006 (high-voltage) system wiring



*Internal 47Ω 300W. For higher power,extemal regen
resistor is required refer to the user manual.
Refer to EMI Suppression in the user manual.

Figure 4-6 CDHD2S-003/CDHD2S-006 AC 380V (HV) model system wiring

4.5.6 CDHD2S-012 (high-voltage) system wiring

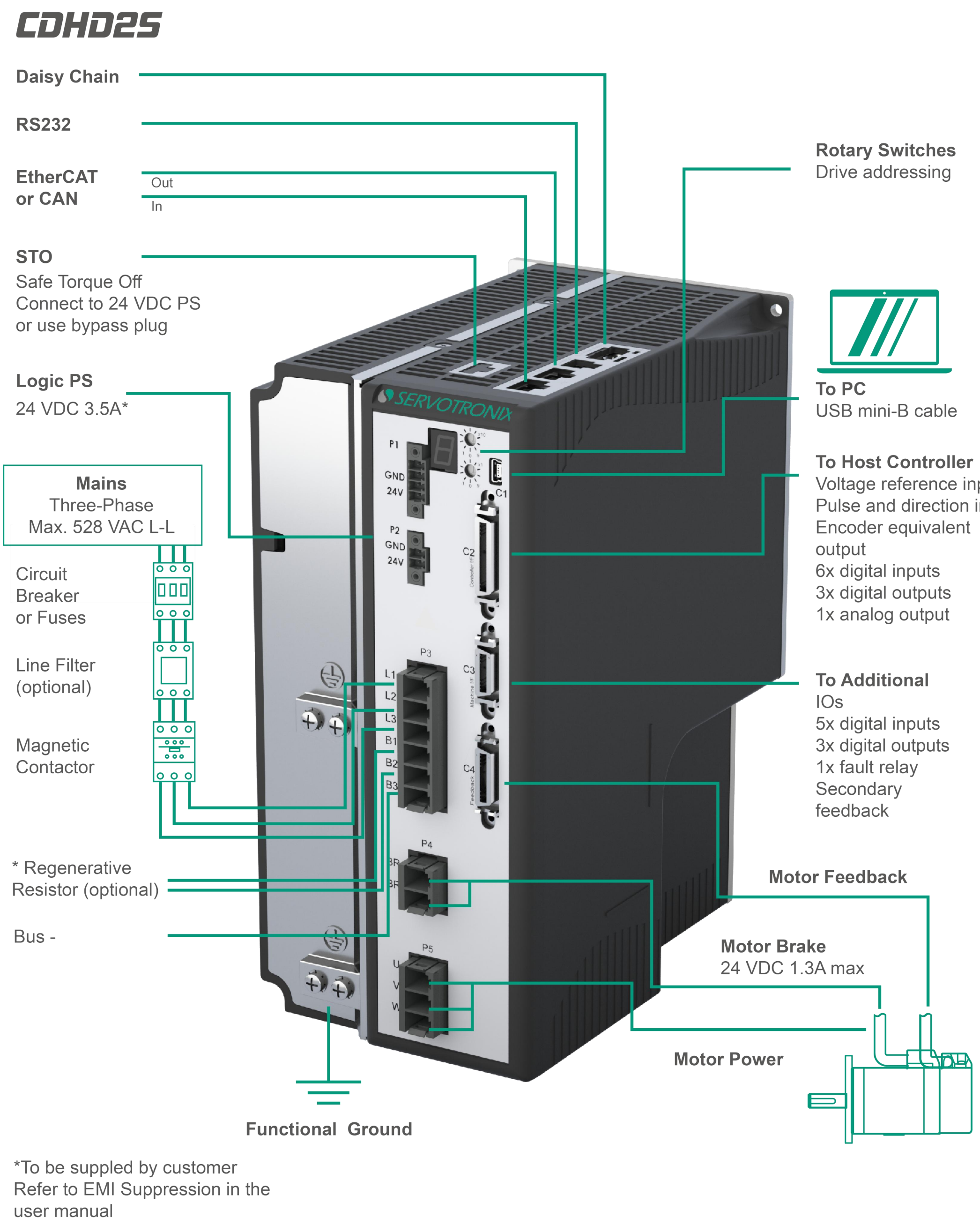


Figure 4-7 CDHD2S-012 AC 380V (HV) model system wiring

4.5.7 CDHD2S-024/CDHD2S-030 (high-voltage) system wiring

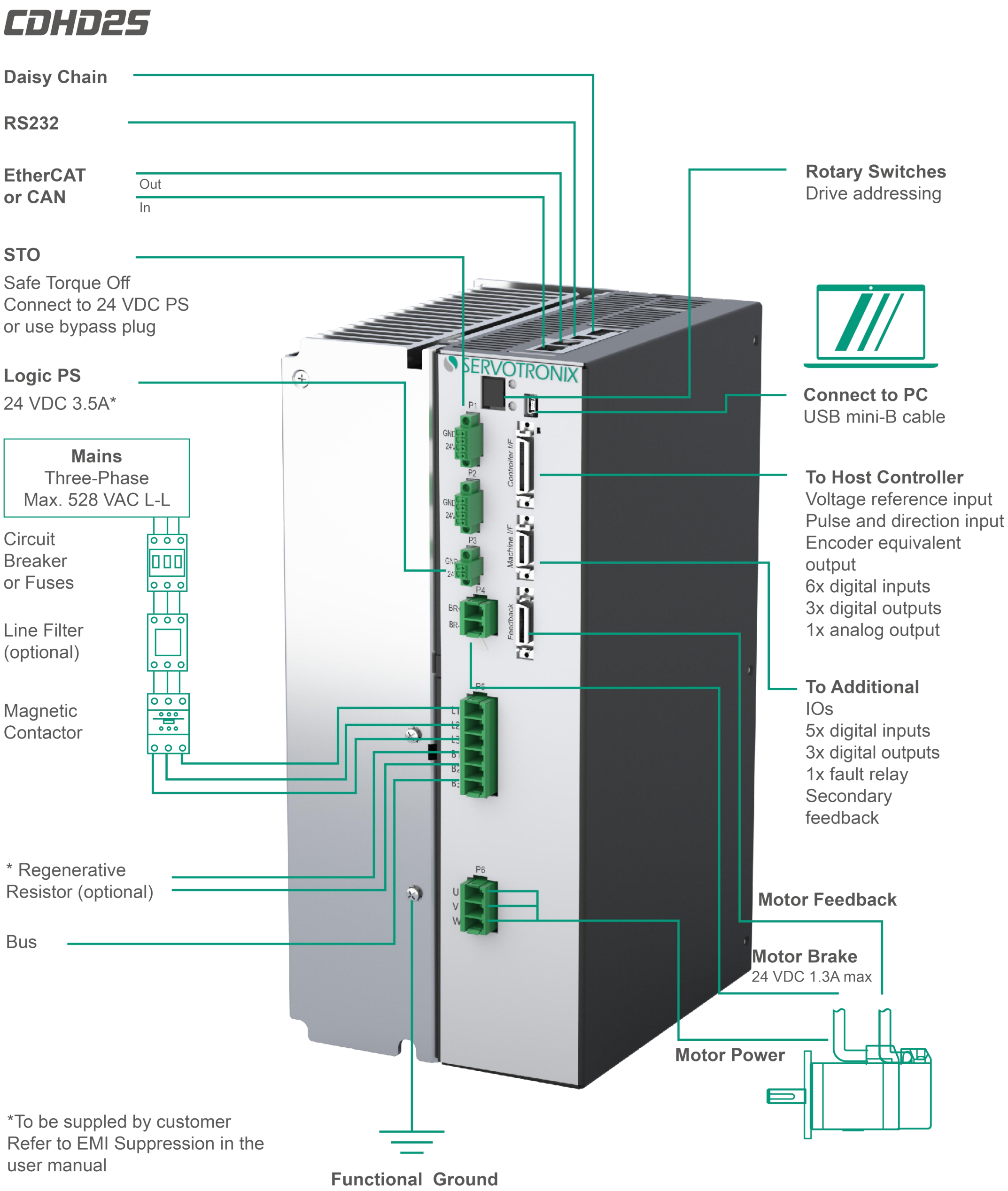


Figure 4-8 CDHD2S-024/CDHD2S-030 AC 380V (HV) model system wiring

4.5.8 CDHD2S-040 (high-voltage) system wiring

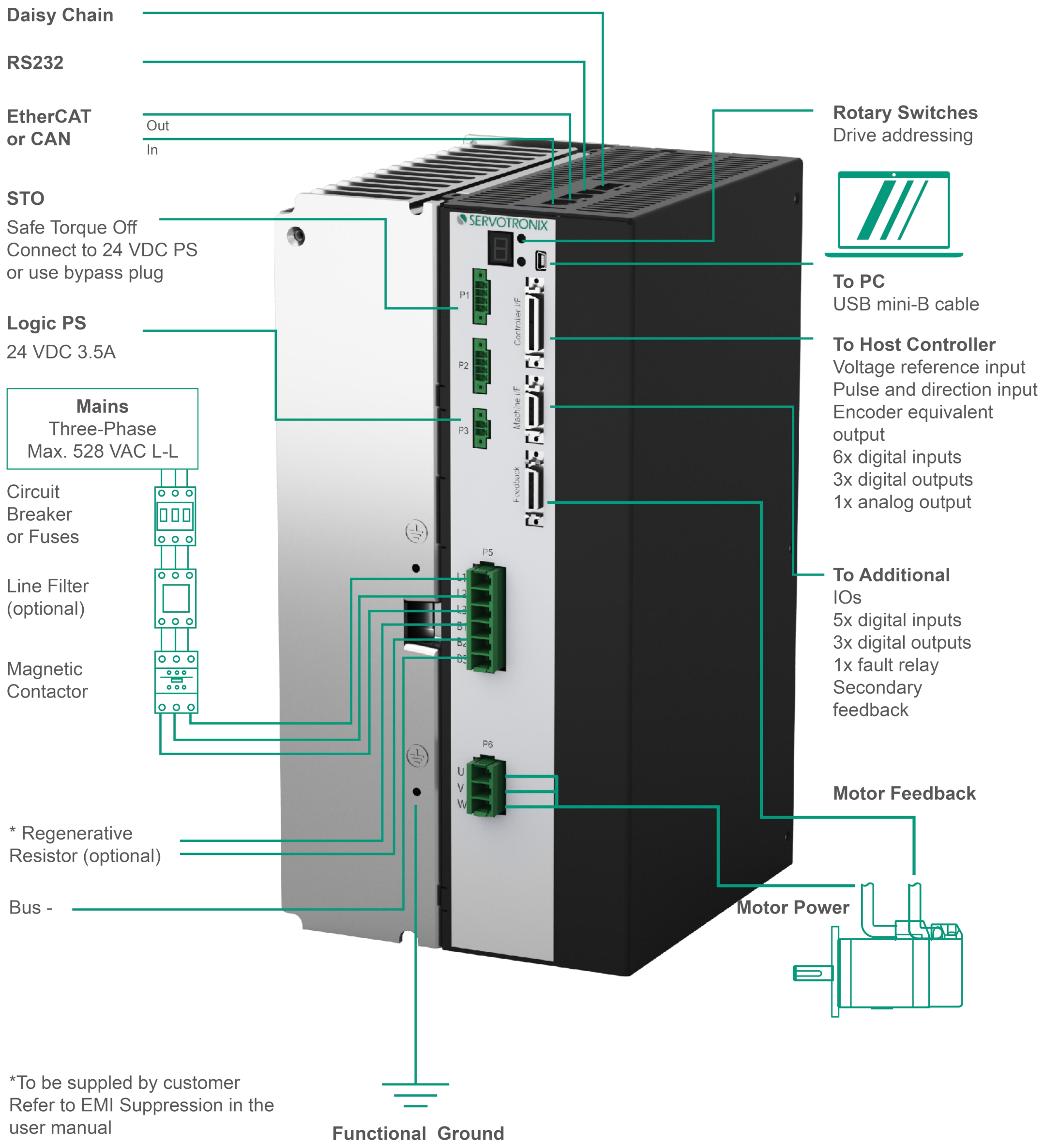


Figure 4-9 CDHD2S-040 AC 380V (HV) model system wiring

4.5.9 CDHD2S-060 (high-voltage) system wiring

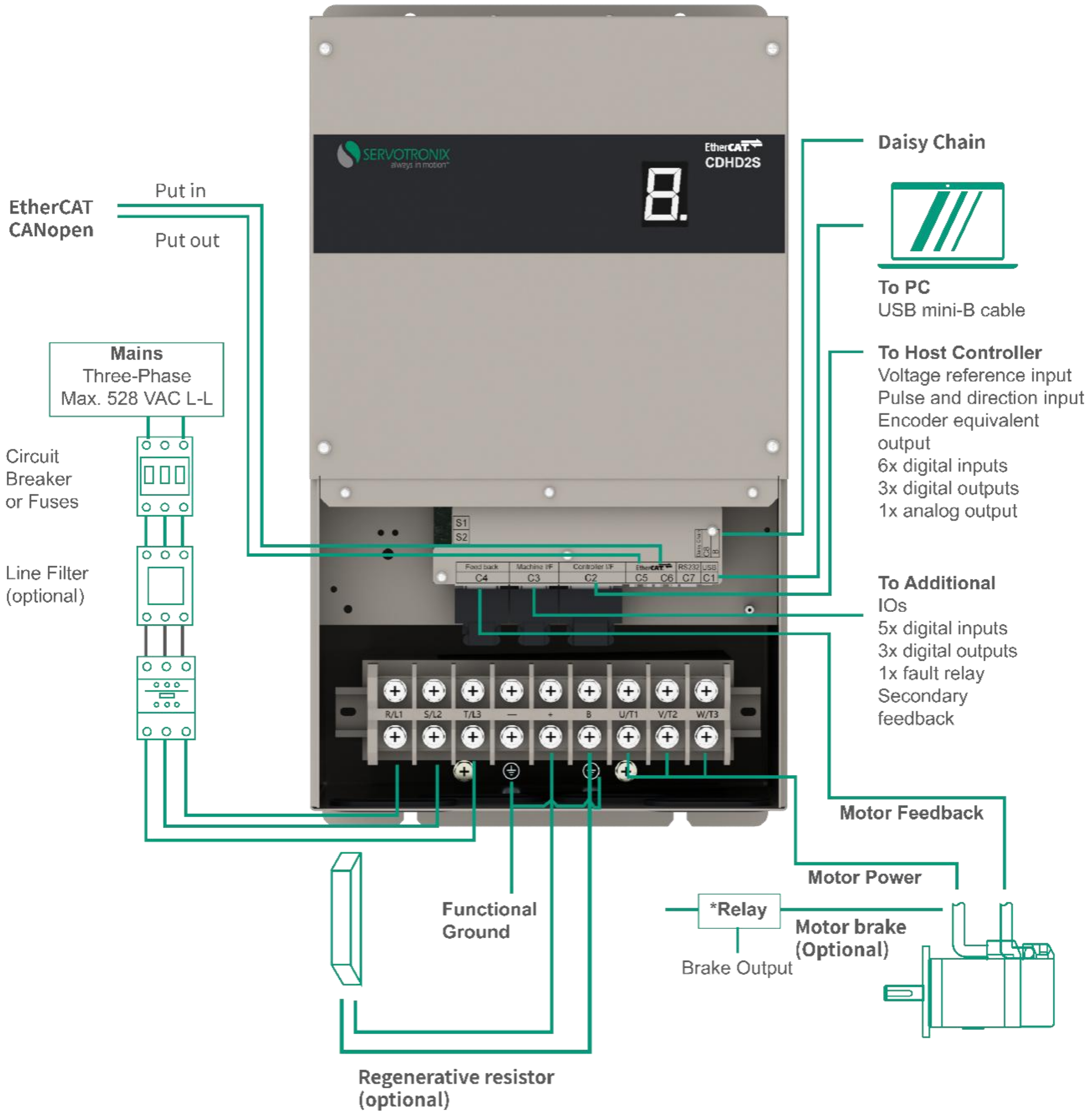


Figure 4-10 CDHD2S-060 (high-voltage) system wiring

4.6 Electromagnetic Interference Suppression

4.6.1 CE filtering technology

The CDHD2S drive complies with the CE standards specified in the *Standard Certification*. Proper bonding, grounding and filtering techniques must be used to meet this standard.

There are usually two types of noise current. The first is conductive noise emission through the ground loop. The quality of the system grounding is inversely proportional to the line noise amplitude. These conducted emissions have a common mode characteristic from line to neutral point (or ground). The second is radiation high-frequency noise emission, which is usually line-to-line capacitive coupling and it is specific in nature.

To properly install an EMI filter, the enclosure should have an unpainted metal surface. This leaves more surface area in contact with the filter housing and provides a lower impedance path between that housing and the backplane. In turn, the backplane has a high-frequency ground bus connection to the enclosure or ground.

4.6.2 Grounding

When connecting the CDHD2S to other control devices, be sure to follow two basic guidelines to prevent damage to the drive:

- The CDHD2S must be grounded via the ground wire of the AC mains power supply.
- Any drive controller, PLC or PC connected to the CDHD2S must be connected to the same ground wire as the CDHD2S.

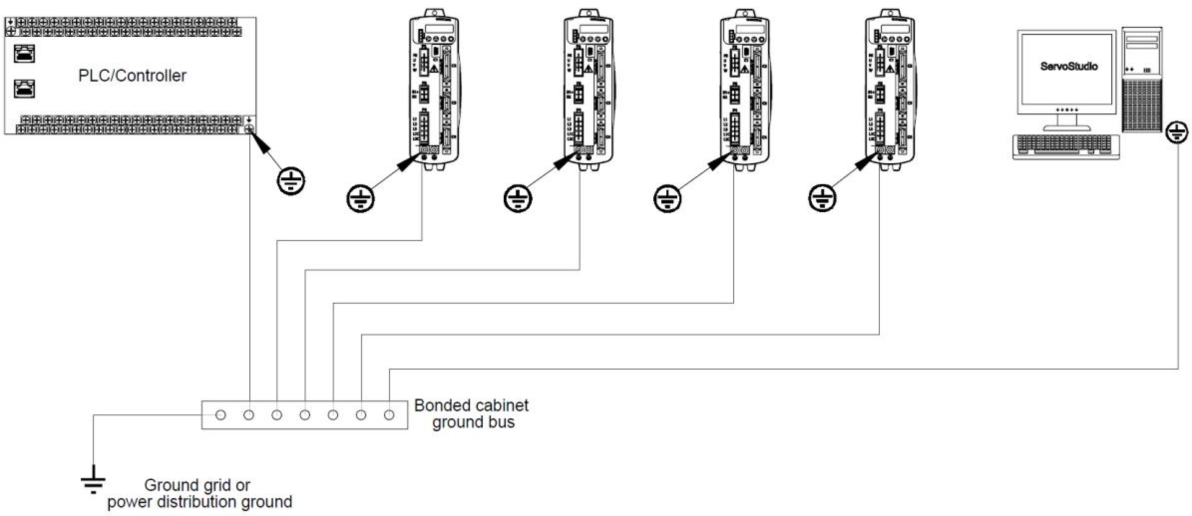


Figure 4-11 CDHD2S system grounding

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

The AC input voltage ground wire must be connected to the PE terminal located on the front panel of the CDHD2S. This is good for safety and reduces electromagnetic interference.

The system uses a single point ground (start wiring) to avoid ground loops.

It is strongly recommended to mount the CDHD2S on a metal backplane and provide a high frequency ground to ground the backplane. Electrical connections are provided throughout the entire back of the drive panel. It is recommended to use current-conducting plate such as aluminum or galvanized steel sheet. For painted and other coated metal panels, remove any coating behind the drive. The goal is to provide a low impedance path between the filter, drive, power supply, and ground for high frequency signals that may cause electromagnetic interference. Use flat braided wire or copper busbar for high frequency grounding. When connecting to high frequency ground, use the shortest braided wire possible.

Ensure good connections between cabinet components. Connect the back panel and cabinet door to the cabinet body with multiple conductive braided wires. The grounding connection must not be made by hinges or mounting bolts. Ensure that the cabinet is well grounded with the right grounding system. The grounding lead shall be the same as or

smaller than the main power lead.

The host computer must also be properly grounded.

4.6.3 Shielding and connection

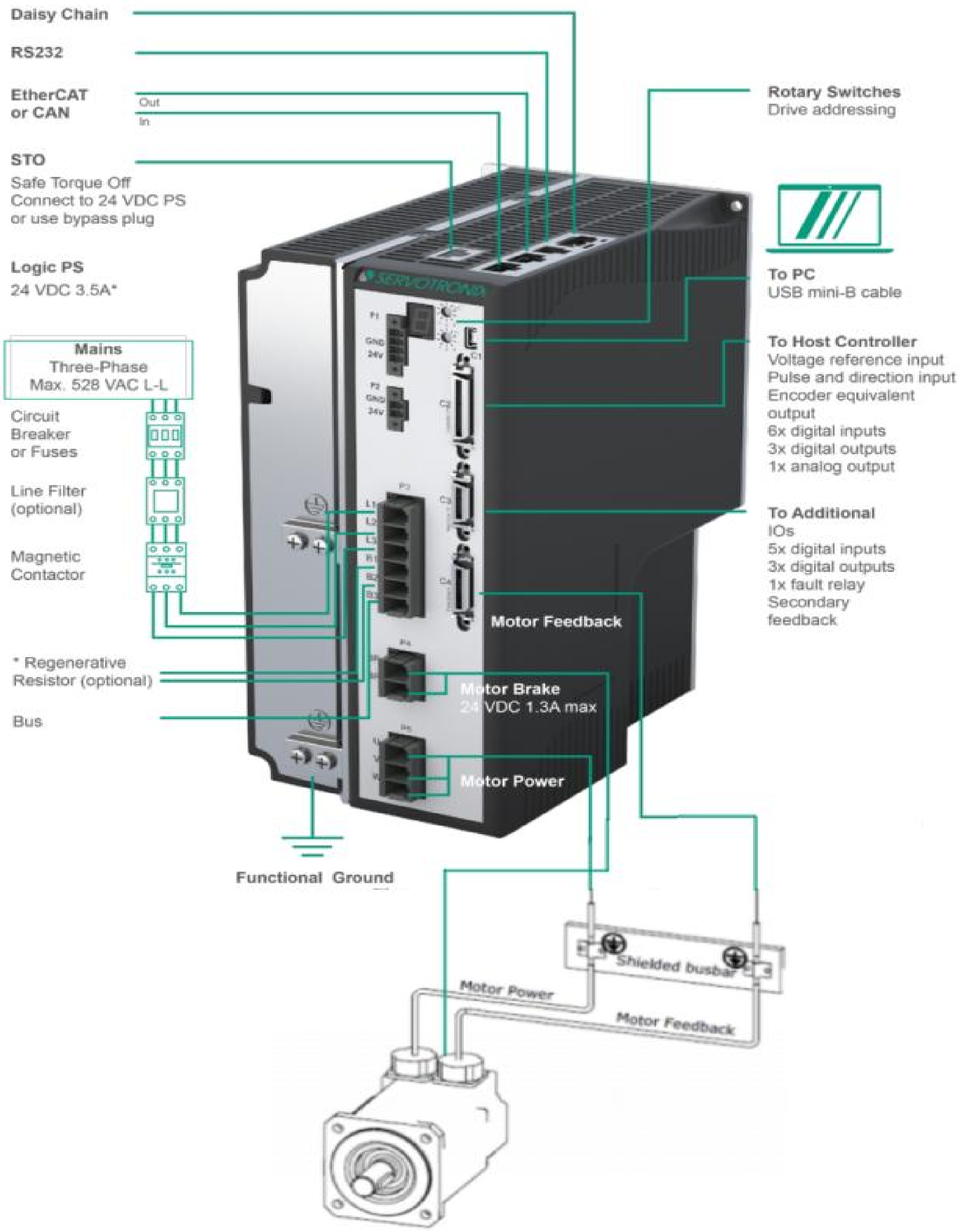


Figure 4-12

To minimize noise emissions and maximize drive system immunity, motor and feedback cables must be shielded and properly connected to a ground surface.

The shield must be connected to ground at both ends of the cable. Its purpose is to reduce the impedance between the cable shield and the rear panel.

It is recommended to connect all shielded cables to the rear panel

Motor and feedback shielded cables should be placed as close to the drive as possible. Connect this exposed cable shield to the rear panel using non-insulated metal cable clamp or connector clamp.

It is recommended to use shielded busbars for star shield connection

4.6.4 Input power supply filtering

CDHD2S electronic system components require EMI AC line filtering in the input power lines to meet CE requirements for industrial environments.

Pay attention to the calibration system size. The filter type is determined based on the rated voltage and current values of the system and the phase of the input line (1 phase or 3 phase). One input line filter is available for multi-axis control application.

For the recommended line filter manufacturer name and part number for the CDHD2S, please refer to the *Line Filters*. The use of the input power filter should follow the following guidelines:

- 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 as possible to the drive to prevent noise from capacitive coupling into other signal lines and cables.
- When installing the filter to the panel, remove any paint or material coating. If possible, use unpainted metal backplane.
- The filter is equipped with a ground terminal and must be grounded.
- Filters can produce high leakage currents. The filter must be grounded before connecting the power supply.
- The filter should not be touched for 10 seconds after power is removed.

4.6.5 Other electromagnetic interference suppression suggestions

Power and control cables should be routed separately. The recommended distance is at least 200mm to improve anti-interference. If the input power supply and wires need to cross, make sure they cross at a 90° angle.

Feedback lines may not be extended as this would cause shielding interruption and may interfere with signal processing.

Connect the cable normally. If you need to tap the cable, please use a connector with a metal back shell. Make sure that the two shells are connected along the periphery of the

sheath. No part of the wiring should be unshielded. Never tap cables through the terminal strip.

For differential input of analog signals, use a twisted pair shielded signal cable, both ends connecting shield.

4.7Matters Needing Attention in Electrical System

4.7.1 Fuse

Circuit protection shall 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 class T, AC 600V200kA, time delay. It must be UL and CSA certified; UR recognition alone is not enough.
- EU fuse: type gRL or gL, 400V/500V, time delay.
- Fuse holder: Standard fuse holder, or finger-safe fuse holder that meets IEC60529. For example:
  - Bussmann: CH series modular fuse holders, fuse size less than 30A, class J, 3-pole: CH30J3.
  - Ferraz: Ultrasonic fuse, fuse size less than 30A, class J, 3-pole: US3J3I.

4.7.2 Leakage current

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

According to experience, based on the PWM frequency of the output stage, the following assumptions can be made about the leakage current on the cable:

- Ileak=nx20mA+Lx1mA/m, output stage 8kHzPWM frequency
- Ileak=nx20mA+Lx2mA/m, output stage 16kHzPWM frequency

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

Since the leakage current of PE is greater than 3.5mA, it meets the requirements of doubling PE connection or using connecting cables with cross-sectional area greater than 10mm² as stipulated in IEC61800-5-1 standard. This requirement is met using PE terminals and PE connecting screws.

4.8Mechanical Installation

4.8.1 Installation of CDHD2S

Mount the CDHD2S on a grounded conductive metal panel using the bracket on the back of the CDHD2S. The metal panel must be strong enough. For installation dimensions, please refer to the *Dimensions*.

4.8.2 Installing multiple units

When multiple CDHD2S units are installed side by side in a cabinet or enclosure, it is recommended that the minimum unit spacing is 10mm. The recommended minimum top and bottom clearance for all CDHD2S models is 50mm.

It is important to keep the ambient temperature within the enclosure not exceeding 45°C. If the CDHD2S unit is installed on a backplane, also ensure that the backplane temperature does not exceed 45°C. It is recommended to install a cooling fan at the bottom of the cabinet for optimal circulation.

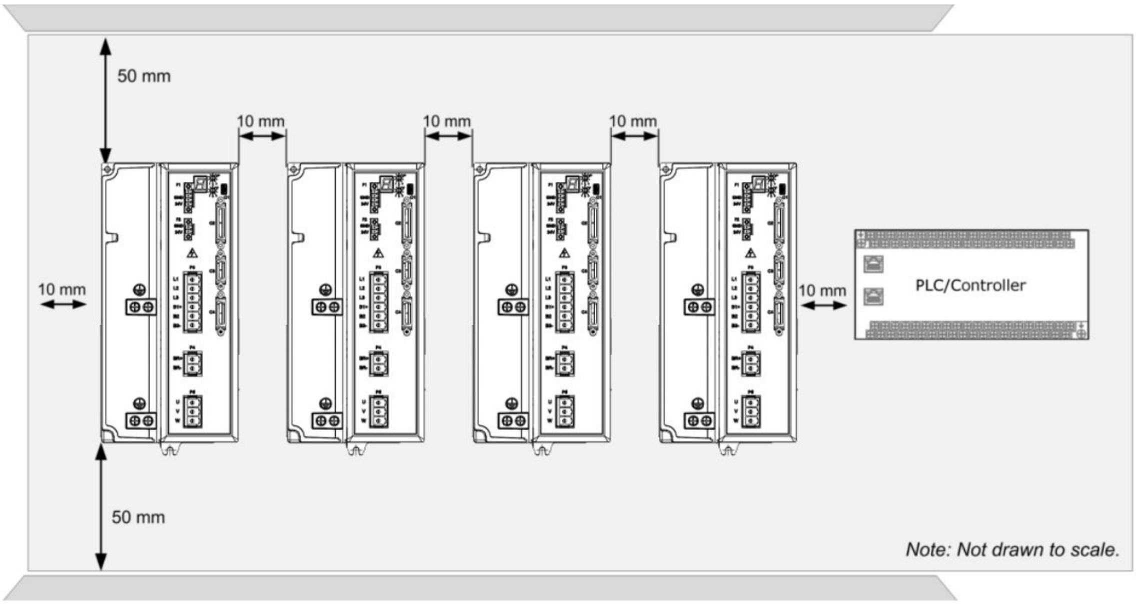


Figure 4-13 Installing multiple CDHD2S units in the cabinet

4.9Control Board Connection

The control board interface varies depending on the specific CDHD2S model. See the table below for details.

Table 4-10 Controller board interface

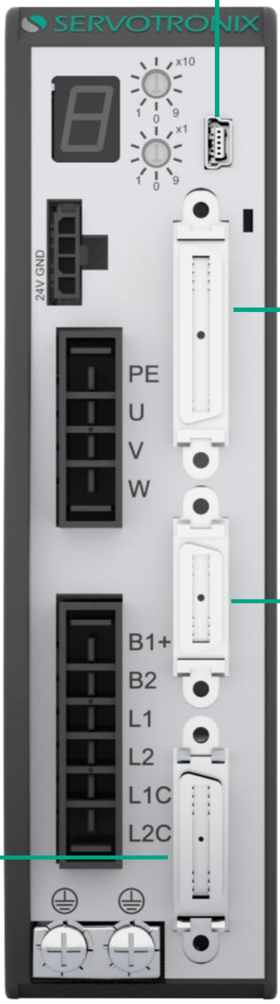
CDHD2S model		AP	AF	EC	EB
Function	Interface				
USB serial communication	C1	–	■	■	■

RS232 serial communication	C7	■	■	■	–
CANopen communication	C5+C6	–	■	–	–
EtherCAT communication		–	–	■	■
Daisy chain communication	C8	■	■	■	■
Controller interface	C2	■	■	■	■
Pulse and direction input		■	■	■	–
Equivalent encoder output		■	■	■	–
Analog input		1or2	1or2	1or2	2
Analog output		1	1	1	0
Digital input	C2|C3	8	8	8	4
Fast digital input		3	3	3	1
Digital output		6	6	6	3
Fast digital input		2	2	2	0
Machine interface	C3	■	■	■	–
Secondary feedback		■	■	■	–
Fault relay		■	■	■	–
Motor feedback interface	C4	■	■	■	■
Sine encoder		■	■	■	■
Motor temperature sensor		■	■	■	■
Motor feedback 8V power supply		–	■	■	–
Motor feedback resolver		■	■	■	–

4.9.1 CDHD2S control board pins

CDHD2S

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



Controller I/F C2: MDR 36 Plug | 24-28 AWG			
1	Common output	19	Common input
2	Digital output 1	20	Digital output 2
3	Digital input 1	21	
4	Equivalent encoder output A-	22	Equivalent encoder output A+
5	Equivalent encoder output B-	23	Equivalent encoder output B+
6	Equivalent encoder output Z-	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input1+	26	Analog input1-
9	Direction input+ Secondary encoder B-	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoderA+
11	Pulse input- Secondary encoderA-	29	Ground
12	Fast digital output 8	30	Fast digital output 7
13	Ground	31	Digital input 3
14	Digital input 4	32	Fast digital input 5
15	Fast digital input 6	33	Digital output 2
16	Digital output 3	34	Fast digital output 24V return
17	Fast digital output 24V	35	* Analog input 2-
18	* Analog input 2+	36	Analog output

* Optional. Refer to Ordering Options.

Feedback C4: MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U+	17	Hall V+
5	Hall W+	18	8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine+	20	Resolver cosine-
8	Resolver reference+	21	Resolver reference-
9	Sine encoder sine+	22	Sine encoder sine-
10	Sine encoder cosine+	23	Sine encoder cosine-
11	5V supply	24	Ground (5V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Machine I/F C3: MDR 20 Plug | 24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A- Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Fast digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	Common input	19	Common output
10	Fault relay 1	20	Fault relay 2

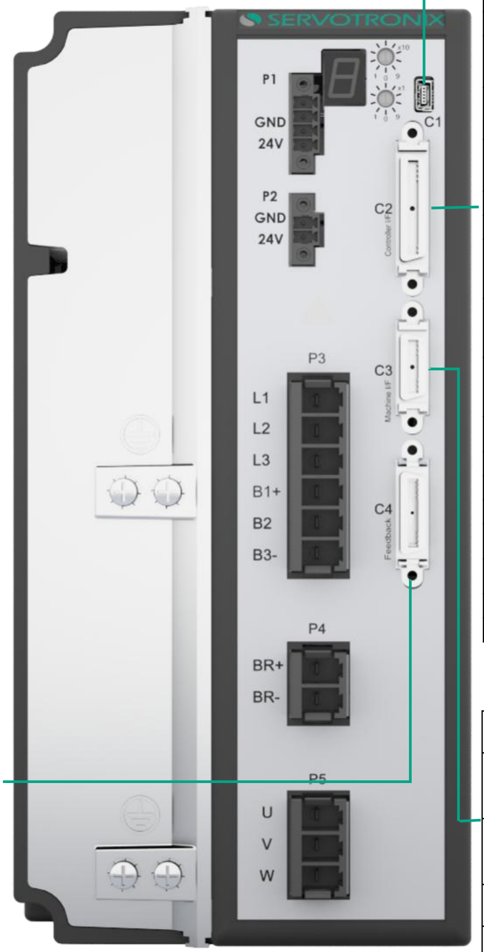
Figure 4-14 CDHD2S-1.5A/3A/4.5A/6A (MV) EC,AP and EC-RO model control board pin assignment

CDHD2S

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

Controller I/F C2: MDR 36 Plug | 24-28 AWG			
1	Common output	19	Common input
2	Digital output 1	20	Digital output 2
3	Digital input 1	21	
4	Equivalent encoder output A-	22	Equivalent encoder output A+
5	Equivalent encoder output B-	23	Equivalent encoder output B+
6	Equivalent encoder output Z-	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input1+	26	Analog input1-
9	Direction input+ Secondary encoder B-	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoderA+
11	Pulse input- Secondary encoderA-	29	Ground
12	Fast digital output 8	30	Fast digital output 7
13	Ground	31	Digital input 3
14	Digital input 4	32	Fast digital input 5
15	Fast digital input 6	33	Digital output 2
16	Digital output 3	34	Fast digital output 24V return
17	Fast digital output 24V	35	* Analog input 2-
18	* Analog input 2+	36	Analog output

* Optional. Refer to Ordering Options.



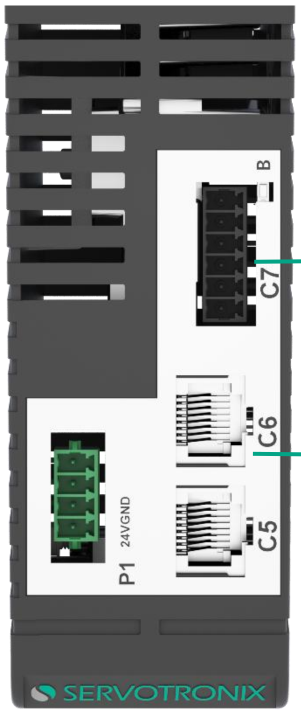
Feedback C4: MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U+	17	Hall V+
5	Hall W+	18	8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine+	20	Resolver cosine-
8	Resolver reference+	21	Resolver reference-
9	Sine encoder sine+	22	Sine encoder sine-
10	Sine encoder cosine+	23	Sine encoder cosine-
11	5V supply	24	Ground (5V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Machine I/F C3: MDR 20 Plug | 24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A- Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Fast digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	Common input	19	Common output
10	Fault relay 1	20	Fault relay 2

Figure 4-15 CDHD2S (HV) EC model control board pin assignment

4.9.2 CDHD2S panel wiring diagram

CDHD2S



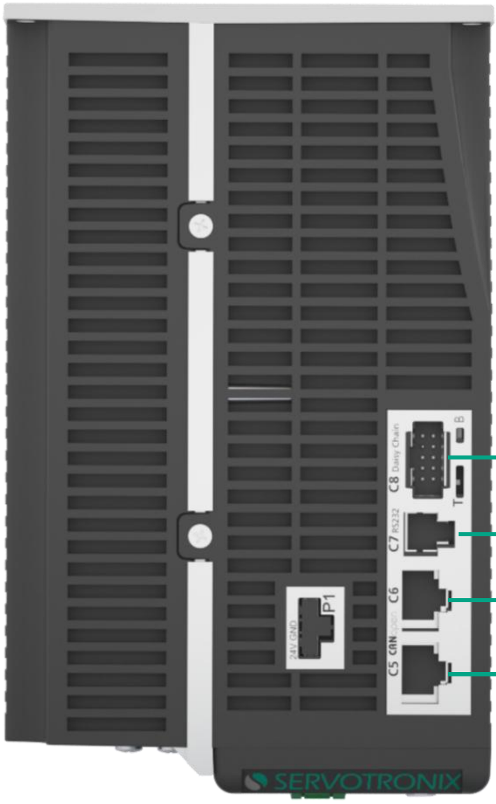
RS232/Daisy Chain C7: 6pin	
1	RX
2	TX
3	FGND
4	GND
5	TD
6	RD

EtherCAT IN / OUT C5 / C6: RJ45	
1	TX+
2	TX-
3	RX+
4	
5	
6	RX-
7	
8	

Figure 4-16 CDHD2S (MV) EtherCAT model panel pin assignment

CDHD2S

I/F	Mfgr	Mating Connector	Manufacturer PN	Servotronix PN
C5	Molex	Connector	44915-0011	
C6	Molex	Connector	44915-0011	
C7	AM-Cambridge	Connector	32-5984UL	
C8	TE	Connector	1658527-3	CoNr00000010-67



Daisy Chain/Gantry C8:01"IDC Female	
1	DC Shield
2	
3	RX
4	GND
5	TX
6	GND
7	GantryA+
8	GantryA-
9	GantryB+
10	GantryB-

RS232 C7:4p4c	
1	RX
2	GND ISO
3	TX
4	Shield

EtherCAT OUT C6:RJ45	
1	CANH
2	CANK
3	FGND
4	
5	
6	
7	FGND
8	

EtherCAT In C5:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

Figure 4-17 CDHD2S (HV) EtherCAT model panel pin assignment

4.9.3 USB serial communication - C7

During debugging, the drive can be connected to the host through interface C7 (RS232 port). Alternatively you can use interface C1 (USB port).

Note: The CDHD2SUSB drive is digitally signed.

4.9.4 USB serial communication - C5 and C6

Interfaces C5 and C6 are RJ45 ports used as transmitter and receiver for drives operating on CAN, EtherCAT or PROFINET networks. The LEDs on interfaces C5 and C6 indicate the fieldbus status. Please refer to the *Fieldbus Status-LED*.

For detailed information on the installation, configuration and operation of drives used on CAN and EtherCAT networks, please refer to the *CDHD2SEtherCAT and CANopen Reference Manual*.

For detailed information on the installation, configuration and operation of drives used on PROFINET networks, please refer to the *CDHD2S PROFINET Reference Manual*.

An adapter can be used to connect the RJ45 port to the D9 interface. Please refer to the *D9-RJ45 Adapter*.

4.9.5 Daisy chain and gantry communication - C8

The CDHD2S can be addressed and controlled via a daisy chain RS232 line.

In a daisy chain RS232 configuration, all drives must be connected in the daisy chain via interface C8. Each drive must have a unique address so that it can be identified on the network.

The daisy chain drive can be assigned an address from 1 to 99 by setting parameter P0003 from the operation panel or the VarCom variable ADDR.

Address 0 is not available when configuring a daisy chain loop.

4.9.6 Controller interface - C2

Connect digital and analog inputs and outputs according to application requirements.

Unused pins must remain unwired.

The common inputs and common outputs at the controller interface (C2) and machine interface (C3) are connected internally.

The DC voltage 24V power supply and loop can be connected at the controller interface (C2) or the machine interface (C3), but not both.

All digital inputs and digital outputs on all CDHD2S models are optoisolated.

Fast output can only be sink type. All other digital inputs and digital outputs can be connected as source or sink.

If both the fast digital output and the regular digital output are configured as sink type, it is usually possible to use one power supply for all outputs.

It is recommended to use fast output (7 or 8) as the motor brake release signal.

The motor brake requires a separate power supply. If the load is inductive (such as a relay), an external flywheel diode must be added.

Table 4-11 Controller interface - AP/AF/EC mode

Pin	Function	Description	Pin	Function	Description
1	Common output		19	Common input	
2	Digital output 1	Optoisolated programmable digital output. Read using OUT1	20	Digital input 2	Optoisolated programmable digital input. Read using IN2
3	Digital input 1	Optoisolated programmable digital input. Read using IN1	21		
4	Equivalent encoder output A-	Equivalent encoder output signal A low (RS422)	22	Equivalent encoder output A+	Equivalent encoder output signal A high (RS422)
5	Equivalent encoder output B-	Equivalent encoder output signal B low (RS422)	23	Equivalent encoder output B+	Equivalent encoder output signal B high (RS422)
6	Equivalent encoder output Z-	Equivalent encoder output index low (RS422)	24	Equivalent encoder output Z+	Equivalent encoder output index high (RS422)
7			25	Grounded	Digital ground
8	Analog input 1+	Differential analog command input high (DC voltage ±10V)	26	Analog input 1-	Differential analog command input low (DC voltage ±10V)
9	Direction input +	Direction signal high (RS422), or down counting signal high	27	Direction input -	Direction signal low (RS422), or down counting signal low
	Secondary encoder B+	Secondary encoder input signal B high (RS422)		Secondary encoder B-	Secondary encoder input signal B low (RS422)
10	Grounded	Digital ground	28	Pulse input +	Pulse signal high (RS422), or main encoder signal A high, or up counting signal high
				Secondary encoder A+	Secondary encoder input signal A high (RS422)

Pin	Function	Description	Pin	Function	Description
11	Pulse input -	Pulse signal low (RS422), or main encoder signal A low, or up counting signal low	29	Grounded	Digital ground
	Secondary encoder A-	Secondary encoder input signal A low (RS422)			
12	Fast digital output 8		30	Fast digital output 7	
13	Grounded	Digital ground	31	Digital input 3	Optoisolated programmable digital input. Read using IN3
14	Digital input 4	Optoisolated programmable digital input. Read using IN4	32	Fast digital input 5	Optoisolated programmable fast digital input. Read using IN5
15	Fast digital input 6	Optoisolated programmable fast digital input. Read using IN6	33	Digital output 2	Optoisolated programmable digital output. Read using OUT2
16	Digital output 3	Optoisolated programmable digital output. Read using OUT3	34	Fast digital output 24V loop	
17	Fast digital input 24V		35	Analog input 2-	Second differential analog input low (DC voltage ±10V)
18	*Analog input 2+	Second differential analog input high (DC voltage ±10V)	36	Analog output	Analog output; please refer to the digital ground (DC voltage 0-10V)

*Optional; please refer to the *Ordering Information*.

Blank cells indicate unused pins; these pins must remain unwired.

Table 4-12 Controller interface - EB model

Pin	Function	Description	Pin	Function	Description
1	Common output		19	Common input	
2	Digital output 1	Optoisolated programmable digital output. Read using OUT1	20	Digital input 2	Optoisolated programmable digital input. Read using IN2
3	Digital input 1	Optoisolated programmable digital input. Read using IN1	21		
4			22		
5			23		

Pin	Function	Description	Pin	Function	Description
6			24		
7			25	Grounded	Digital ground
8	Analog input 1+	Differential analog command input high (DC voltage ±10V)	26	Analog input 1-	Differential analog command input low (DC voltage ±10V)
9			27		
10	Grounded	Digital ground	28		
11			29	Grounded	Digital ground
12			30		
13	Grounded	Digital ground	31	Digital input 3	Optoisolated programmable digital input. Read using IN3
14	Digital input 4	Optoisolated programmable digital input. Read using IN4	32	Fast digital input 5	Optoisolated programmable fast digital input. Read using IN5
			33	Digital output 2	Optoisolated programmable digital output. Read using OUT2
16	Digital output 3	Optoisolated programmable digital output. Read using OUT3	34		
17			35	Analog input 2-	Second differential analog input low (DC voltage ±10V)
18	*Analog input 2+	Second differential analog input high (DC voltage ±10V)	36		

*Blank cells indicate unused pins; these pins must remain unwired.

Digital and analog input and output wiring - C2

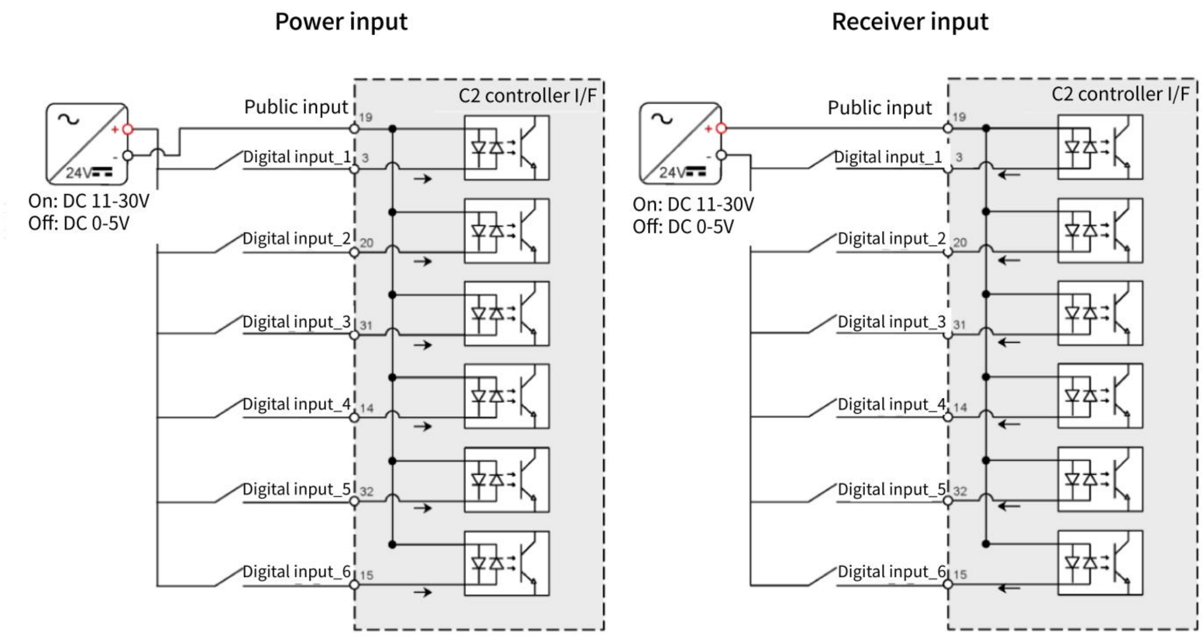


Figure 4-18 Digital input wiring - C2

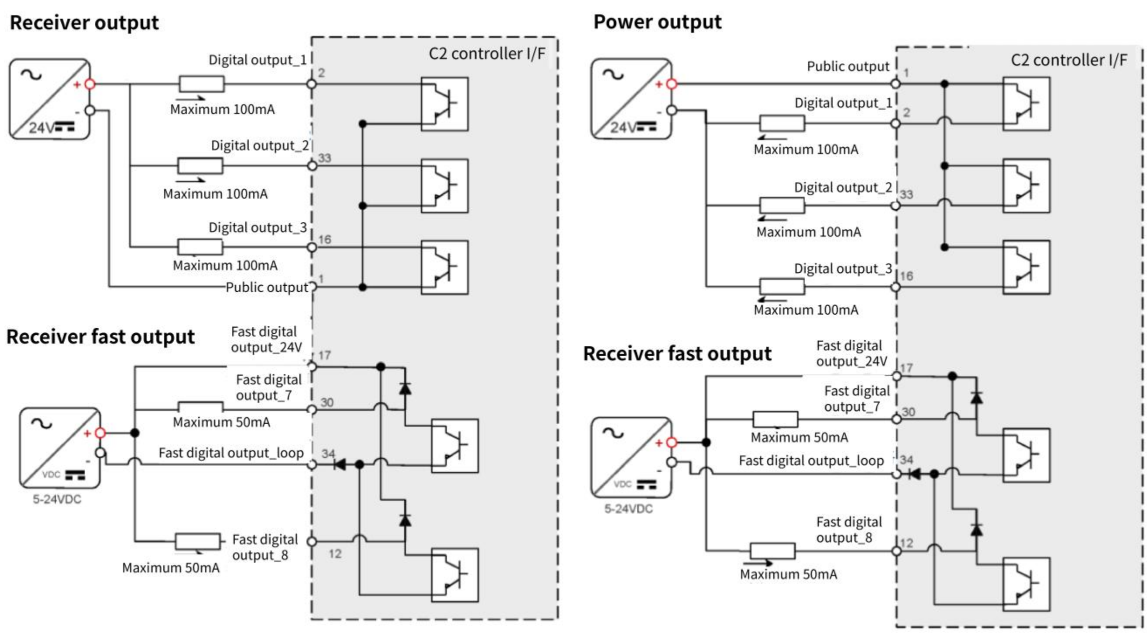


Figure 4-19 Digital output wiring - C2

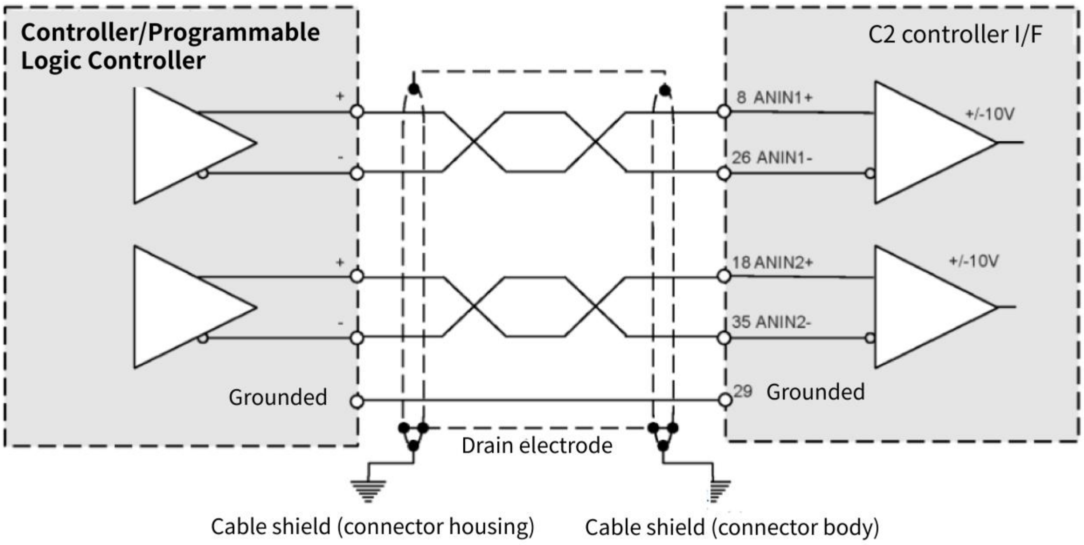


Figure 4-20 Analog input wiring - C

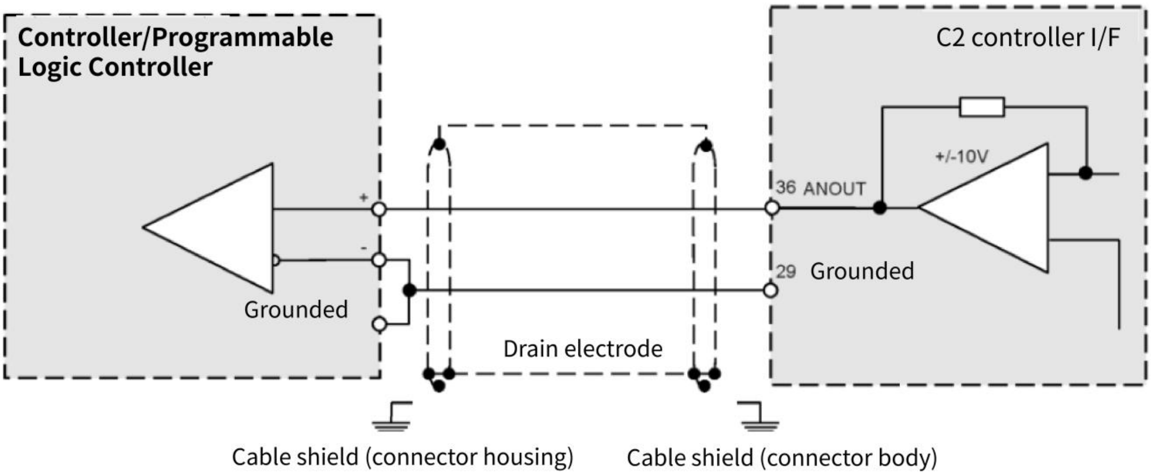


Figure 4-21 Analog output wiring - C2

Pulse and direction optoisolated wiring - C2

CDHD2S can connect DC voltage 24V single-ended signal PLC to the drive.

This type of signaling requires fast digital input on the CDHD2S controller interface (C2).

For this configuration, CDHD2S inputs 5 and 6 must be set to INMODE17 and 18 respectively. (Applicable/approved in GEARMODE0, 1\2).

- The pulse signal is connected to fast digital input 5 on pin 32.
- The direction signal is connected to fast digital input 6 on pin 15.

- The cable shield on the PLC side can be connected to any available shielded connector.
- The cable shield on the CDHD2S side can be connected to the housing of the 36-pin connector.

Note: The user should provide DC voltage 24V power supply.

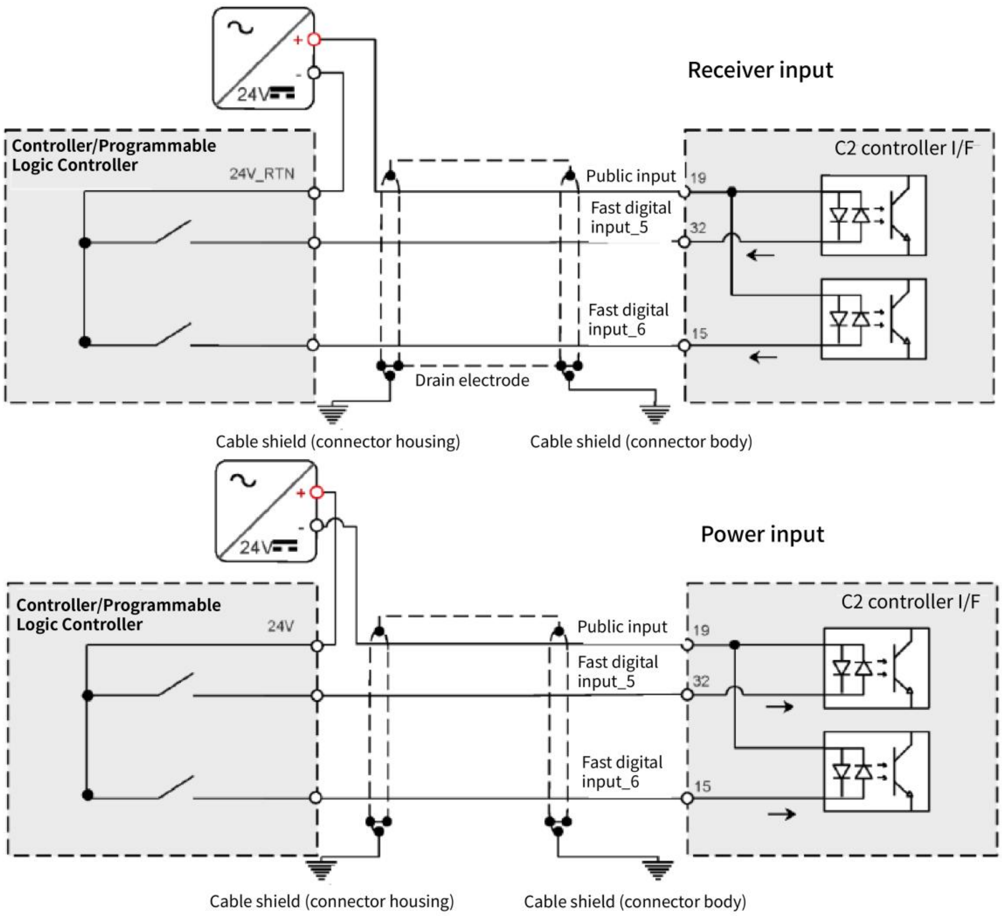


Figure 4-22 Pulse and direction optoisolated input wiring - C2

Pulse and direction optoisolated input wiring - C2

When using the CDHD2 controller interface (C2):

- The pulse signal is received from the controller or PLC on pins 28 and 11.
- The direction signal is received from the controller or PLC on pins 9 and 27.

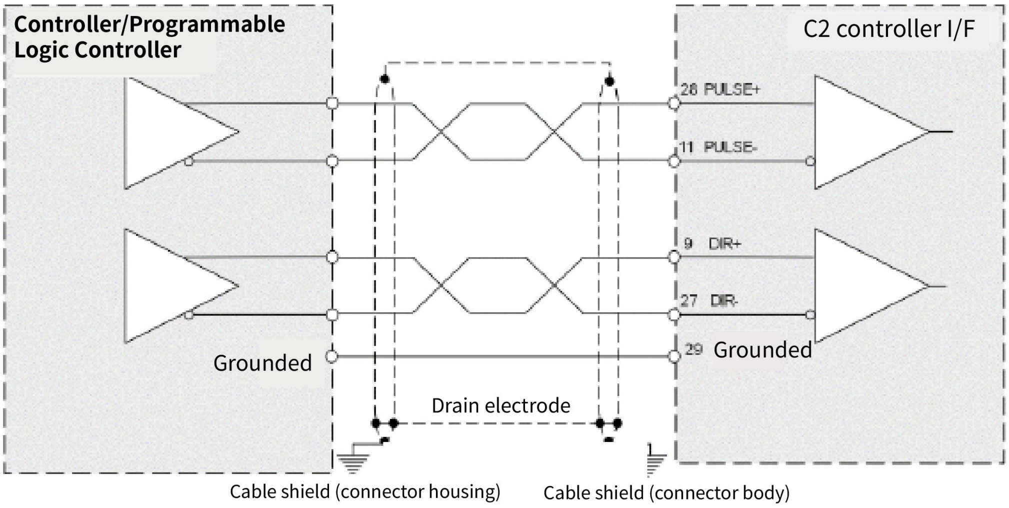


Figure 4-23 Pulse and direction optoisolated input wiring - C2

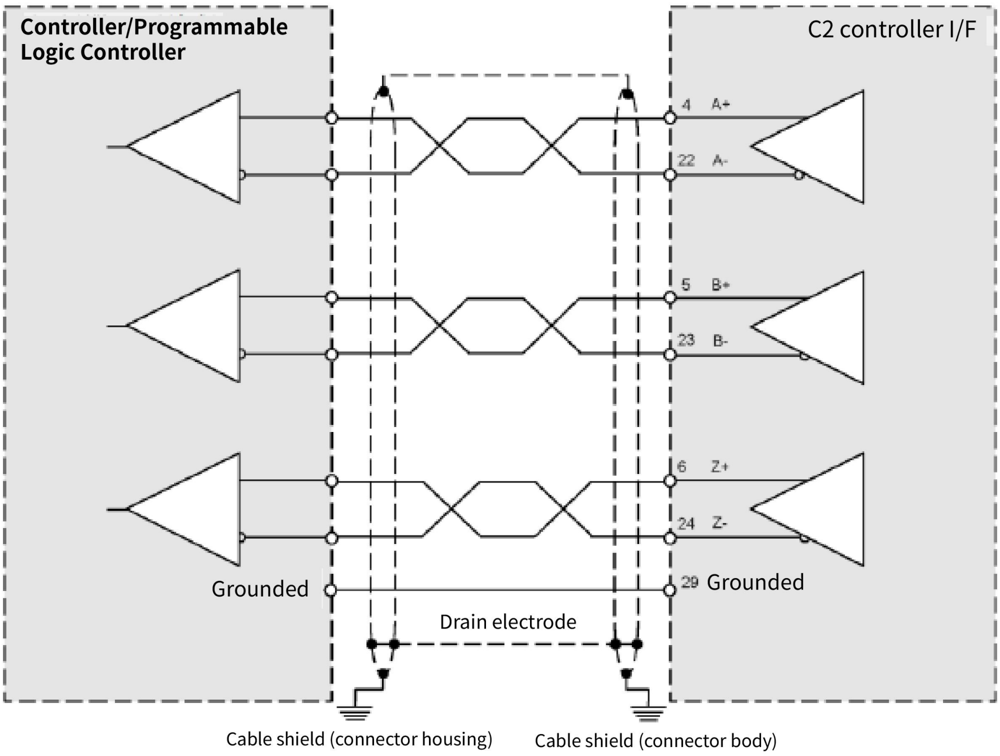


Figure 4-24 Analog encoder equivalent output wiring - C2

4.9.7 Machine interface - C3

Note: EB model - CDHD2SEB model has no machine interface.

Wire machine inputs and outputs according to your application requirements.

Unused pins must remain unwired.

The common inputs and common outputs on the controller interface (C2) and machine interface (C3) are connected internally.

The DC voltage 24V power supply and loop can be connected at the controller interface (C2) or the machine interface (C3), but not both.

All digital inputs and digital outputs on all CDHD2S models are optoisolated.

Fast output can only be sink type. All other digital inputs and digital outputs can be connected as source or sink.

If both the fast digital output and the regular digital output are configured as sink type, it is usually possible to use one power supply for all outputs.

It is recommended to use fast output (7 or 8) as the motor brake release signal.

The motor brake requires a separate power supply. If the load is inductive (such as a relay), an external flywheel diode must be added.

Table 4-13 Machine interface - AP/AF/EC mode

Pin	Function	Description	Pin	Function	Description
1	Secondary encoder A+	Secondary encoder input signal A high (RS422)	11	Secondary encoder A-	Secondary encoder input signal A low (RS422)
	Pulse input+	Pulse signal high		Pulse input-	Pulse signal high
2	Secondary encoder B+	Secondary encoder input signal B high (RS422)	12	Secondary encoder B-	Secondary encoder input signal B low (RS422)
	Direction input +	Direction signal high		Direction input -	Direction signal low
3	secondary encoder Z+	Secondary encoder input index high (RS422)	13	secondary encoder Z-	Secondary encoder input index low (RS422)
4	Secondary encoder 5V	Secondary encoder DC voltage 5V power supply	14	Secondary encoder grounding	The 5V DC voltage power supply of the secondary encoder is grounded.
5	Digital input 7	Optoisolated programmable digital input. Read using IN7	15	Digital input 8	Optoisolated programmable digital input. Read using IN8

6	Digital input 9	Optoisolated programmable digital input. Read using IN9	16	Digital input 10	Optoisolated programmable digital input. Read using IN10

Digital input and output wiring - C3

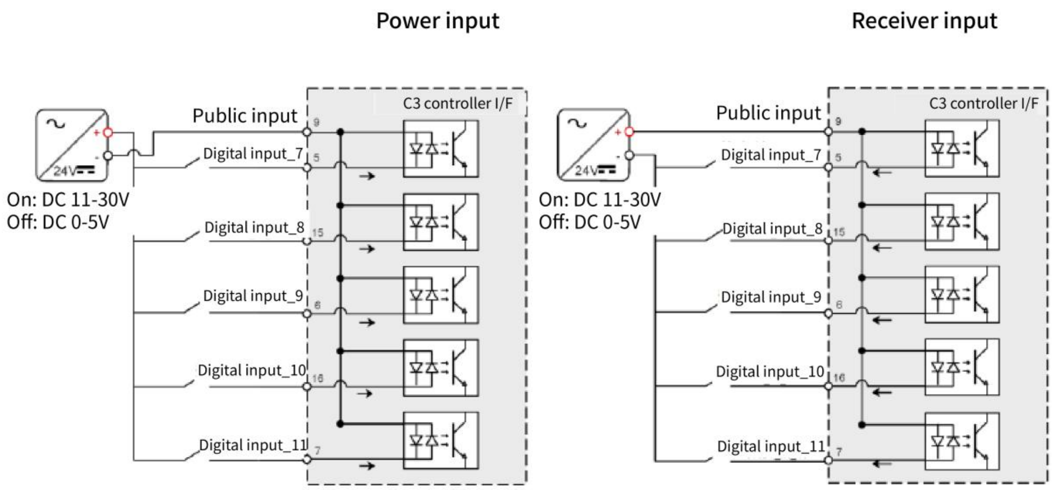


Figure 4-25 Digital input wiring - C3

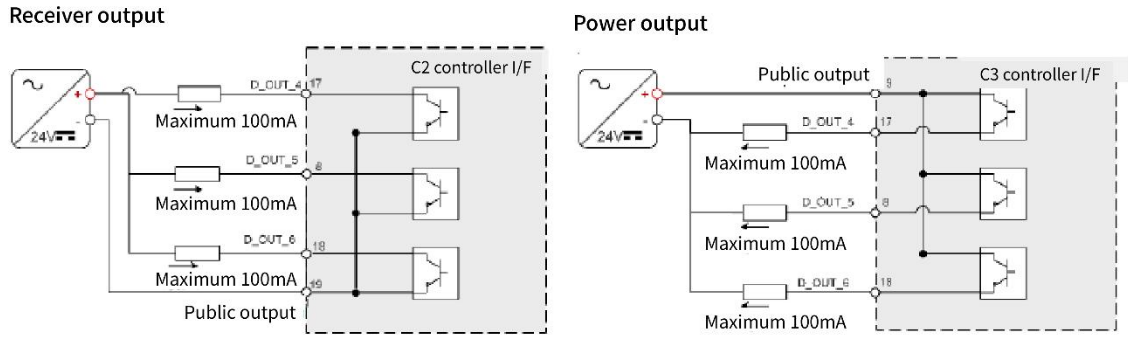


Figure 4-26 Digital output wiring - C3

4.9.8 Motor brake wiring

The CDHD2S medium-voltage does not have enough amperage to activate the motor brake, but the motor brake can be controlled via an external relay. The selection of power supply, relays and diodes depends on the specifications of the motor brake used in the actual application.

You can connect a relay to any digital output on the CDHD2S machine I/F (C3) or controller interface (C2). It is recommended that you connect to the fast digital output connector 7.

The motor brake wiring requirements are as follows:

- Freewheeling diodes: D1 and D2 (for example, PN1N4002)
- Relay: 24V<100mA
- Relay coil: >500W

- External power supply: 24V

When using inductive loads (such as motor brakes), be sure to install the freewheeling diode according to the wiring diagram.

When using DC relays to switch inductive loads, such as relay sequence circuits, motor brakes or DC electromagnets, it is important to absorb surges (e.g. with diodes) to protect the contacts; i.e. the digital inputs and outputs of the drive. Switching these inductive loads generates hundreds to thousands of volts of back-EMF, which can severely damage contacts and shorten product life.

Please refer to the *Motor Brake Control via Relays*.

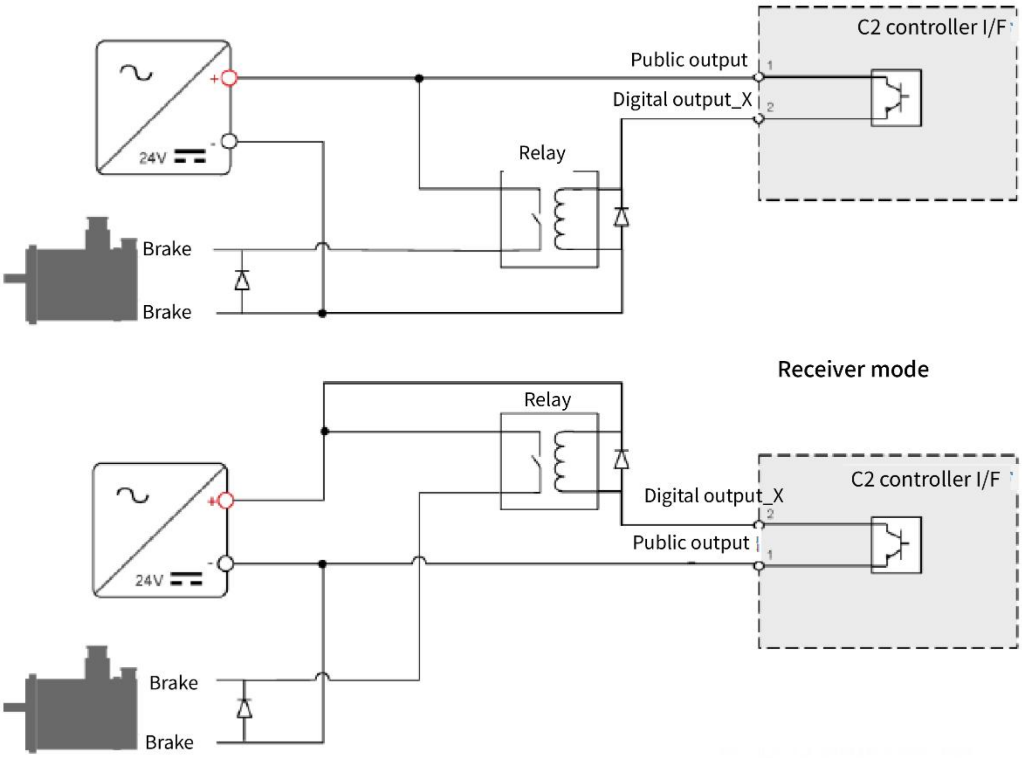


Figure 4-27 Motor brake wiring CDHD2S (medium-voltage model)

4.9.9 Secondary feedback wiring

The table below shows the most common secondary feedback changes. If you require additional information, or if your motor feedback does not match any of the following, please contact technical support.

Use the "User Motor Pin Number" column in these tables to record the pin number of your specific feedback device for future reference.

Wiring - BiSS-C encoder

Table 4-14 BiSS-C encoder

Pin Number	Twisted pair cables	User encoder pin number	Signal declarations
1	Twisted pair cables		Serial data+ (SLO+)
11			Serial data- (SLO-)
2	Twisted pair cables		Serial clock+(MA+)
12			Serial clock-(MA-)
4			+5V DC voltage
14			0V DC voltage

Wiring-HEIDENHAIN (EnDat2.x communication only)

Table 4-15 Feedback wiring - HEIDENHAIN (EnDat2.x communication only)

Pin Number	Twisted pair cables	User encoder pin number	Signal declarations
1	Twisted pair cables		Serial data+
11			Serial data-
2	Twisted pair cables		Serial clock+
12			Serial clock-
4			+5V DC voltage
14			0V DC voltage

Wiring - Incremental encoder AB quadrature, index pulse and Hall

Table 4-16 Feedback wiring - incremental encoder AB quadrature, index pulse and Hall

Pin Number	Twisted pair cables	User encoder pin number	Signal declarations
1	Twisted pair cables		Incremental encoder A+
11			Incremental encoder A-
2	Twisted pair cables		Incremental encoder B+
12			Incremental encoder B-
3	Twisted pair cables		Incremental encoder Z+

13			Incremental encoder Z-
4			+5V DC voltage
14			0V DC voltage

4.9.10 Motor feedback interface - C4

Connect the motor feedback interface according to the type of feedback device used in the application. For common feedback wiring, please refer to the table in *Motor Feedback Wiring*.

Pins 1, 2, 14 and 15 have dual functions.

Pin 25 of the motor temperature sensor is connected internally to the CDHD2S ground within the drive.

Unused pins must remain unwired.

Note:

- Serial encoder data is bidirectional.
- Serial encoder clock output only.
- The low voltage indication comes directly from the encoder; the drive cannot verify the encoder battery voltage.

Table 4-17 Motor feedback interface (C4)

Pin	Function	Pin	Function
1	Incremental encoder A+	14	Incremental encoder A-
	SSI encoder data+		SSI encoder data-
2	Incremental encoder B+	15	Incremental encoder B-
	SSI encoder clock+		SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U+	17	Hall U+
5	Hall W+	18	**AF/EC only:** 8V power supply
6*	Resolver sine+	19*	Resolver sine -
7*	Resolver cosine+	20*	Resolver cosine -
8*	Resolver reference+	21*	Resolver reference-
9	Sine encoder sine+	22*	Sine encoder sine-
10	Sine encoder cosine+	23	Sine encoder cosine-
11	Encoder feedback power supply	24	Grounded
12	Motor temperature sensor	25	Motor temperature sensor
13	Encoder feedback power supply	26	Shielding

*Not available on EB model.

4.9.11 Motor feedback wiring

The table below shows the most common feedback changes. If you require additional information, or if your motor feedback does not match any of the following, please contact technical support.

Use the "User Motor Pin Number" column in these tables to record the pin number of your specific motor for future reference. Use the ServoStudio2 motor setup program and feedback screens to define motor feedback type, resolution and other parameters.

Wiring - sensAR encoder

Table 4-18 Feedback wiring - sensAR encoder

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Wiring - BiSS-C encoder

Table 4-19 Feedback wiring - BiSS-C encoder

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+ (SLO+)
14			Serial data- (SLO-)
2	Twisted pair cables		Serial clock+(MA+)
15			Serial clock-(MA-)
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Wiring - Incremental encoder AB quadrature, index pulse and Hall

Table 4-20 Feedback wiring – incremental encoder AB quadrature, index pulse and Hall

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Incremental encoder A+
14			Incremental encoder A-
2	Twisted pair cables		Incremental encoder B+
15			Incremental encoder B-
3	Twisted pair cables		Incremental encoder Z+
16			Incremental encoder Z-
4			Hall U
17			Hall V
5			Hall W
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.

Wiring – single-ended Hall

Table 4-21 Feedback wiring – single-ended Hall

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
4			Hall U
17			Hall V
5			Hall W
11			+5V DC voltage
24			0V DC voltage
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.
Hall is a single-ended signal. To use differential Hall signals, please refer to the related wiring table.

Wiring - Incremental encoder AB quadrature, index pulse and differential Hall

Table 4-22 Feedback wiring – incremental encoder AB quadrature, index pulse and differential Hall

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Incremental encoder A+
14			Incremental encoder A-
2	Twisted pair cables		Incremental encoder B+
15			Incremental encoder B-
9			Hall U+
22			Hall U-
10			Hall V+
23			Hall V-
3			Hall W+
16			Hall W-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note:

If the motor does not support a temperature sensor, do not connect pins 12 and 25.

To use differential Hall with AB quadrature and index, connect the Hall to the machine interface as follows: Hall U+ to Machine I/F pin 1, Hall U- to Machine I/F pin 11.

Hall V+ to machine I/F pin 2, Hall V- to machine I/F pin 12.

Hall W+ to machine I/F pin 3, Hall W- to machine I/F pin 13.

Connect encoders A, B, I and power to the motor feedback connectors.

Each time power is applied, PHASEFIND must be performed.

Wiring - differential Hall only

Table 4-23 Feedback wiring – differential Hall only

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Incremental encoder A+/Hall U+
14			Incremental encoder A-/Hall U-
2	Twisted pair cables		Incremental encoder B+/Hall V+
15			Incremental encoder B-/Hall V-
3	Twisted pair cables		Incremental encoder Z+/Hall W+
16			Incremental encoder Z-/Hall W-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Wiring – Tamagawa incremental encoder

Table 4-24 Feedback wiring – Tamagawa incremental encoder

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Incremental encoder A+/Hall U+
14			Incremental encoder A-/Hall U-
2	Twisted pair cables		Incremental encoder B+/Hall V+
15			Incremental encoder B-/Hall V-
3	Twisted pair cables		Incremental encoder Z+/Hall W+
16			Incremental encoder Z-/Hall W-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note:

If the motor does not support a temperature sensor, do not connect pins 12 and 25.
Incremental encoder with Hall sensor and index pulse.
The signals A, B and Z use the same wiring as the Hall sensors U, V and W.
When powered on, the feedback will send Hall readings briefly, and then continuously send A, B and Z signals.
Each time power is applied, PHASEFIND must be performed

Table 4-25 Feedback wiring – sine encoder

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.
Each time power is applied, PHASEFIND must be performed.

Wiring - sine encoder with Hall

Table 4-26 Feedback wiring – sine encoder with Hall

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
4			Hall U
17			Hall V
5			Hall W
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.

Wiring - sine encoder with Index

Table 4-27 Feedback wiring – sine encoder with index

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
3	Twisted pair cables		Sine encoder Z+
16			Sine encoder Z-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.

Wiring – sine encoder with index and Hall

Table 4-28 Feedback wiring – sine encoder with index and Hall

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
3	Twisted pair cables		Sine encoder Z+
16			Sine encoder Z-
4			Hall U
17			Hall V
5			Hall W
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.

Wiring – Sick5V (HIPERFACE protocol and sine signal)

Table 4-29 Feedback wiring – Sick5V (HIPERFACE protocol and sine signal)

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.

Wiring – Sick8V (HIPERFACE protocol and sine signal)

Table 4-30 Feedback wiring – Sick8V (HIPERFACE protocol and sine signal)

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
18			+8V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.

Wiring – HEIDENHAIN (EnDat2.x communication only)

Table 4-31 Feedback wiring - HEIDENHAIN (EnDat2.x communication only)

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
2	Twisted pair cables		Serial clock+
15			Serial clock-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.
Please refer to the *EnDat2.x Bidirectional Interface*.

Table 4-32 Feedback wiring - HEIDENHAIN (EnDat2.x with sine/cosine)

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
2	Twisted pair cables		Serial clock+
15			Serial clock-
9	Twisted pair cables		Sine encoder sine+
22			Sine encoder sine-
10	Twisted pair cables		Sine encoder cosine+
23			Sine encoder cosine-
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.
Please refer to the *EnDat2.x Bidirectional Interface*.

Wiring – Nikon/Tamagawa | Incremental 17-bit | single-turn

Table 4-33 Feedback wiring – single-turn: Nikon 17-bit multi-turn | Tamagawa 17-bit incremental single-turn

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Wiring – Nikon/Tamagawa | incremental 17-bit | multi-turn

Table 4-34 Feedback wiring - multi-turn: Nikon 17-bit multi-turn | Tamagawa 17-bit multi-turn | Sankyo multi-turn

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
1	Twisted pair cables		Serial data+
14			Serial data-
11			+5V DC voltage
24			0V DC voltage
26			Shielding

Note: The encoder backup battery is external to the CDHD2S drive.
The recommended battery is 3.6V, 1000mAh lithium battery.
Use backup batteries recommended by the encoder manufacturer.

Wiring - resolver

Table 4-35 Feedback wiring - resolver

Pin Number	Twisted pair cables	User motor pin number	Signal declarations
6	Twisted pair cables		Resolver sine+
19			Resolver sine -
7	Twisted pair cables		Resolver cosine+
20			Resolver cosine -
8	Twisted pair cables		Resolver reference+
21			Resolver reference-
12	Twisted pair cables		Motor temperature sensor
25			Motor temperature sensor
24	Grounded		Optional: Inner shielding for each twisted pair (sine, cosine, reference)
26			Cable shielding

Note: If the motor does not support a temperature sensor, do not connect pins 12 and 25.
Hall is a single-ended signal. To use differential Hall signals, please refer to the related wiring table.

4.9.12 Gantry system wiring

The two drives of the two axes of the CDHD2S gantry system can be connected to each other via the C8 or C3 interface.

To ensure immunity to interference, it is strongly recommended to connect the drive via the C3 shielded interface.

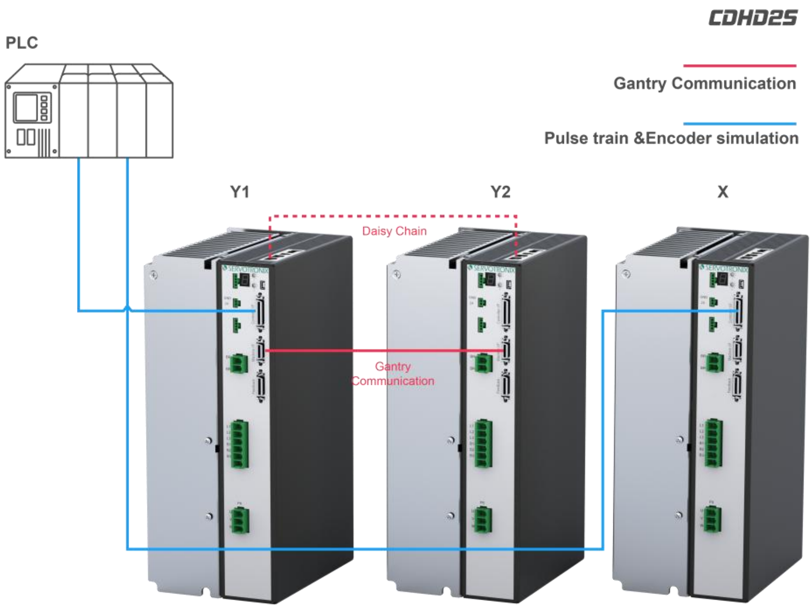


Figure 4-28 Gantry system wiring - pulse train and serial

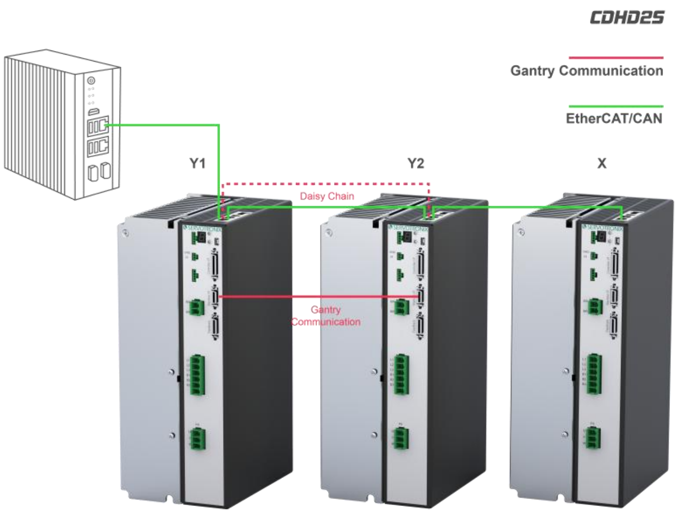


Figure 4-29 Gantry system wiring - EtherCAT/CAN

Table 4-36 Gantry daisy chain C8 wiring

Gantry master (Y1) Drive	Gantry differential (Y2) drive	Twisted pair cables	Signal declarations
7	7	Twisted pair cables	Serial data Tx+
8	8		Serial data Tx-
9	9	Twisted pair cables	Serial data Rx+
10	10		Serial data Rx-

Table 4-37 Gantry daisy chain C3 wiring

Gantry master (Y1) Drive	Gantry differential (Y2) drive	Twisted pair cables	Signal declarations
1	1	Twisted pair cables	Serial data Tx+
11	11		Serial data Tx-
2	2	Twisted pair cables	Serial data Rx+
12	12		Serial data Rx-

4.10Power Board Connection

The power board interface varies with the specific CDHD2S model.

For power board, please refer to the power board pin assignment diagram.

Ensure that the main voltage rating meets the drive requirements. Applying an incorrect voltage may cause the drive to malfunction.

Do not turn on the power supply until all hardware connections are completed.

4.10.1 CDHD2S-003 (low-voltage) power board pin assignment

EtherCAT In C5:RJ45

EtherCAT Out C6:RJ45

RS232/Daisy Chain C7: 6p	
Mating connector: Degson 15EDGKN-3.5-06P or equivalent	
1	RX
2	TX
3	FGND
4	GND
5	TD
6	RD

STO-Safe Torque Off P1: 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	
Mating Connector: refer to 4.4.4	

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector: refer to 4.4.3			

Motor P2: 18 AWG		
1	PE	Functional Ground
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: refer to 4.4.4		

Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC ***Common input	19	24VDC return ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: refer to 4.4.3			

AC Input and Regeneration P3: 18 AWG		
1	B1-	DC Bus +
2	B2	Regen Bus
3	L1	24VDC Phase 1
4	L2	0VDC
5	L1C	Logic AC Phase 1
6	L2C	Logic AC Phase 2
Mating Connector: refer to 4.4.4		

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: refer to 4.4.3			

Functional GroundPE:Terminal M4
M4 ring or spade terminal

★	See ordering options
★★	AF and EC models only
★★★	EC models only
STX	Servotronix
Highlighted PN	Supplied with CDHD2S

Figure 4-30 CDHD2S-003(low-voltage)power board pin assignment

4.10.2 CDHD2S-1D5/003 (medium-voltage) power board pin assignment

RS232/Daisy Chain C7: 6p	
Mating connector: Degson 15EDGKN-3.5-06P or equivalent	
1	RX
2	TX
3	FGND
4	GND
5	TD
6	RD

EtherCAT In C5:RJ45

EtherCAT Out C6:RJ45

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector: refer to 4.4.3			

STO-Safe Torque Off P1: 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	
Mating Connector: refer to 4.4.4	

Motor P2: 18 AWG		
1	PE	Functional Ground
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: refer to 4.4.4		

Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC ***Common input	19	24VDC return ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: refer to 4.4.3			

AC Input and Regeneration P3: 18 AWG		
1	B1-	DC Bus +
2	B2	Regen Bus
3	L1	AC Phase 1
4	L2	AC Phase 2
5	L1C	Logic AC Phase 1
6	L2C	Logic AC Phase 2
Mating Connector: refer to 4.4.4		

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: refer to 4.4.3			

Functional GroundPE:Terminal M4 M4 ring or spade terminal

★	See ordering options
★★	AF and EC models only
★★★	EC models only
STX	Servotronix
Highlighted PN	Supplied with CDHD2S

Figure 4-31 CDHD2S-1D5/003(medium-voltage)power board pin assignment

4.10.3 CDHD2S-4D5/006 (medium-voltage) power board pin assignment

EtherCAT In C5:RJ45

EtherCAT Out C6:RJ45

RS232/Daisy Chain C7: 6p	
Mating connector: Degson 15EDGKN-3.5-06P or equivalent	
1	RX
2	TX
3	FGND
4	GND
5	TD
6	RD

STO-Safe Torque Off P1: 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	
Mating Connector: refer to 4.4.4	

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector: refer to 4.4.3			

Motor P2: 18 AWG		
1	PE	Functional Ground
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: refer to 4.4.4		

Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC ***Common input	19	24VDC return ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: refer to 4.4.3			

AC Input and Regeneration P3: 18 AWG		
1	B1-	DC Bus +
2	B2	Regen Bus
3	L1	AC Phase 1
4	L2	AC Phase 2
5	L3	AC Phase 3
6	L1C	Logic AC Phase 1
7	L2C	Logic AC Phase 2
Mating Connector: refer to 4.4.4		

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: refer to 4.4.3			

Functional GroundPE:Terminal M4
M4 ring or spade terminal

★	See ordering options
★★	AF and EC models only
★★★	EC models only
STX	Servotronix
Highlighted PN	Supplied with CDHD2S

Figure 4-32 CDHD2S-4D5/006(medium-voltage)power board pin assignment

4.10.4 CDHD2S-008/010/013(medium-voltage)power board pin assignment

EtherCAT In
C5:RJ45

EtherCAT Out
C6:RJ45

RS232/Daisy Chain C7: 6p	
Mating connector: Degson 15EDGKN-3.5-06P or equivalent	
1	RX
2	TX
3	FGND
4	GND
5	TD
6	RD

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector: refer to 4.4.3			

STO-Safe Torque Off P1: 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	
Mating Connector: refer to 4.4.4	

Motor P2: 18 AWG		
1	PE	Functional Ground
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: refer to 4.4.4		

Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC ***Common input	19	24VDC return ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: refer to 4.4.3			

AC Input and Regeneration P3: 18 AWG		
1	B1-	DC Bus +
2	B2	Regen Bus
3	L1	AC Phase 1
4	L2	AC Phase 2
5	L3	AC Phase 3
6	L1C	Logic AC Phase 1
7	L2C	Logic AC Phase 2
Mating Connector: refer to 4.4.4		

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: refer to 4.4.3			

Functional GroundPE:Terminal M4
M4 ring or spade terminal

★	See ordering options
★★	AF and EC models only
★★★	EC models only
STX	Servotronix
Highlighted PN	Supplied with CDHD2S

Figure 4-33 CDHD2S-008/010/013(medium-voltage)power board pin assignment

4.10.5 CDHD2S-003/006 (high-voltage) power board pin assignment

CDHD2S

EtherCAT in/ PROFINET port 1 C5:RJ45

OR

EtherCAT in/ PROFINET port 2 C6:RJ45

OR

*CAN In C5:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

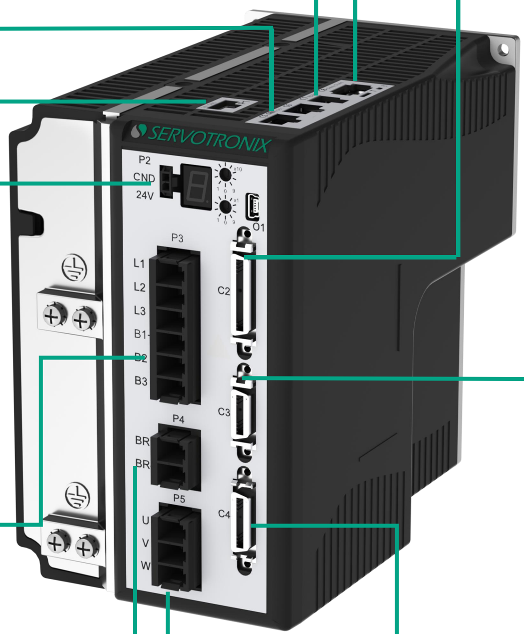
*CAN Out C6:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

RS232 C7:4p4c	
1	RX
2	GND ISO
3	TX
4	

Daisy Chain C8:0.1"IDC Female	
NELTRON 4401-10SR or COXOC 304A-10PSAAA03 STX PN CONr00000010-67	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	FGND
8	
9	
10	

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector:3M Solder Plug ConnectorPN10136-3000PE(STX PN CONr00000036-01)or equiv3M Solder Plug Junction ShellPN 10336-52F0-008 (STX PN HODr00000036-00)or equivMating Cable (STX PN CBL-MDRFL-36-0x,x=1|2|3 meter			

STO-Safe Torque Off P1:Molex|26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	
Mating Connector: Crimp Housing-PN 436450400 or equiv. (STX PN CONr10000004-09) Contacts -PN 0430300001 or equiv (STX PN PINr43030000-00) Wired STO: STX PN CONr00000004-AS	



Logic Power 24V Input P2:Molex|26-28 AWG	
1	24 VDC (Logic in)
2	Ground (24 VDC return)
3	
4	
Mating Connector: Crimp Housing-PN 436450200 or equiv.(STX PN CONr1000002-03) Contacts -PN 0430300001 or equiv. (STX PN PINr43030000-00)	

Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC ***Common input	19	24VDC return ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: 3M Solder Plug Connector PN 10120-3000PE(STX PN CONrO0000020-38)or equiv 3M Solder Plug Junction Shell PN 10320-52F0-008 (STX PN HODr00000020-00)or equiv. Mating Cable(STX PN CBL-MDRFL-20-0x,x=1|2|3 meter			

AC Input and Regeneration P3:Phoenix|12-14 AWG		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3
4	B1+	DC Bus +
5	B2	Regen Bus -
6	B3-	DC Bus -
Mating Connector: PN SPC 5/6-STCL-7,62 (1718520) STX PN CONr00000006-78)		

Brake P4:Phoenix|14-17 AWG		
1	BR+	Motor Brake +
2	BR-	Motor Brake -
Mating Connector: PN SPC 5/2-STCL-7,62(1718481) (STX PN CONr10000002-16)		

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: 3M Solder Plug Connector PN 10126-3000PE(STX PN CONr00000026-31)or equiv 3M Solder Plug Junction Shell PN 10326-52F0-008 (STX PN HODr00000026-00)or equiv. Mating Cable (STX PN CBL-MDRFL-26-0x,x=123 meter			

Motor P5:Phoenix|12-14 AWG		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: PN SPC 5/3-STCL-7,62(1718494) STX PN CONr10000003-21		

Functional GroundPE:Terminal M4
M4 ring or spade terminal

★	See ordering options
★★	AF and EC models only
★★★	EC models only
STX Highlighted PN	Servotronix Supplied with CDHD

Crimping tool	Molex 0638190000(P1) or equivalent
Crimping tool	YRF-880 (P2 P3)
Extraction tool	EJ-JFAJ3 (F2,P3)
Keyfor spring connector	J-FAT-OT
4/40 insert threads on C2,C3,C4	

Figure 4-34 CDHD2S-003/006 (high-voltage) power board pin assignment

4.10.6 CDHD2S-012 (high-voltage) power board pin assignment

CDHD2S

EtherCAT in/ PROFINET port 1 C5:RJ45

OR

*CAN In C5:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

EtherCAT in/ PROFINET port 2 C6:RJ45

OR

*CAN Out C6:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

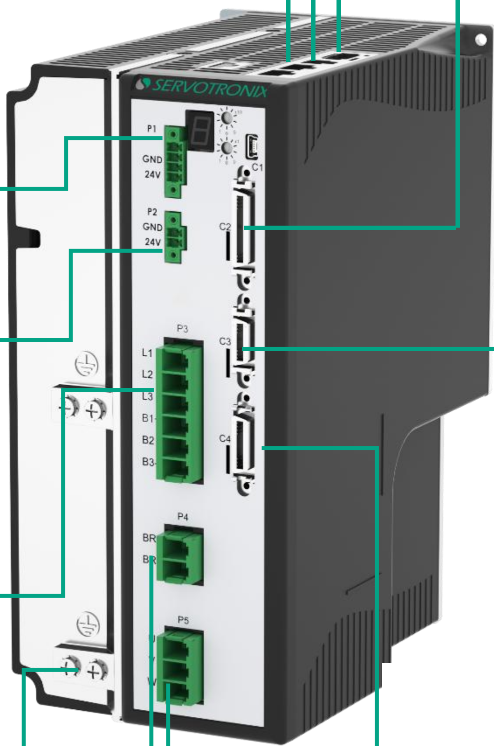
RS232 C7:4p4c	
1	RX
2	GND ISO
3	TX
4	

Daisy Chain C8:0.1"IDC Female	
NELTRON 4401-10SR or COXOC 304A-10PSAAA03 STX PN CONr00000010-67	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	FGND
8	
9	
10	

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return / Common output	19	24VDC / ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ / Secondary encoder B+	27	Direction input- / Secondary encoder B-
10	Ground	28	Pulse input+ / Secondary encoder A+
11	Pulse input- / Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector:3M Solder Plug ConnectorPN10136-3000PE(STX PN CONr00000036-01)or equiv3M Solder Plug Junction ShellPN 10336-52F0-008 (STX PN HODr00000036-00)or equivMating Cable (STX PN CBL-MDRFL-36-0x,x=1|2|3 meter			

STO-Safe Torque Off P1:Molex|26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	
Mating Connector: Crimp Housing-PN 436450400 or equiv. (STX PN CONr10000004-09) Contacts -PN 0430300001 or equiv (STX PN PINr43030000-00) Wired STO: STX PN CONr00000004-AS	

Logic Power 24V Input P2:Molex|26-28 AWG	
1	24 VDC (Logic in)
2	Ground (24 VDC return)
3	
4	
Mating Connector: Crimp Housing-PN 436450200 or equiv.(STX PN CONr1000002-03) Contacts -PN 0430300001 or equiv. (STX PN PINr43030000-00)	



Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ / Pulse input +	11	Secondary encoder A / Pulse input-
2	Secondary encoder B+ / Direction input+	12	Secondary encoder B- / Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC / ***Common input	19	24VDC return / ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: 3M Solder Plug Connector PN 10120-3000PE(STX PN CONrO0000020-38)or equiv 3M Solder Plug Junction Shell PN 10320-52F0-008 (STX PN HODr00000020-00)or equiv. Mating Cable(STX PN CBL-MDRFL-20-0x,x=1|2|3 meter			

AC Input and Regeneration P3:Phoenix|12-14 AWG		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3
4	B1+	DC Bus +
5	B2	Regen Bus -
6	B3-	DC Bus -
Mating Connector: PN SPC 5/6-STCL-7,62 (1718520) STX PN CONr00000006-78)		

Brake P4:Phoenix|14-17 AWG		
1	BR+	Motor Brake +
2	BR-	Motor Brake -
Mating Connector: PN SPC 5/2-STCL-7,62(1718481) (STX PN CONr10000002-16)		

Functional GroundPE:Terminal M4
M4 ring or spade terminal

Motor P5:Phoenix|12-14 AWG		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: PN SPC 5/3-STCL-7,62(1718494) STX PN CONr10000003-21		

★	See ordering options
★★	AF and EC models only
★★★	EC models only
STX Highlighted PN	Servotronix Supplied with CDHD

Crimping tool	Molex 0638190000(P1) or equivalent
4/40 insert threads on C2,C3,C4	

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ / SSI encoder data +	14	Incremental encoder A- / SSI encoder data -
2	Incremental encoder B+ / SSI encoder clock +	15	Incremental encoder B- / SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: 3M Solder Plug Connector PN 10126-3000PE(STX PN CONr00000026-31)or equiv 3M Solder Plug Junction Shell PN 10326-52F0-008 (STX PN HODr00000026-00)or equiv. Mating Cable (STX PN CBL-MDRFL-26-0x,x=123 meter			

Figure 4-35 CDHD2S-012 (high-voltage) power board pin assignment

4.10.7 CDHD2S-024/CDHD2S-030 (high-voltage) power board pin assignment

CDHD2S

*CAN In C5:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

*CAN Out C6:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

Daisy Chain C8:0.1"IDC Female	
NELTRON 4401-10SR or COXOC 304A-10PSAAA03 STX PN CONr00000010-67	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	FGND
8	
9	
10	

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output

Mating Connector:3M Solder Plug ConnectorPN10136-3000PE(STX PN CONr00000036-01)or equiv3M Solder Plug Junction ShellPN 10336-52F0-008 (STX PN HODr00000036-00)or equivMating Cable (STX PN CBL-MDRFL-36-0x,x=12|3 meter

STO-Safe Torque Off P1:16-28 AWG STO2-Safe Torque Off P2:16-28 AWG	
1	24 VDC (STO enable)
2	Ground (24V VDC return)
3	
4	

Mating Connector:
Contacts-PN 15EDGKNM-3.5-04P-14-1022Z(H)
(STX PN 11201707001435)

Logic Power 24V Input P3:16-28 AWG	
1	24 VDC (Logic in)
2	Ground (24V VDC return)

Mating Connector Type Crimp
Crimp-15EDGKNM-3.5-02P-14-1000A(H)
(STX PN 11201707001436)

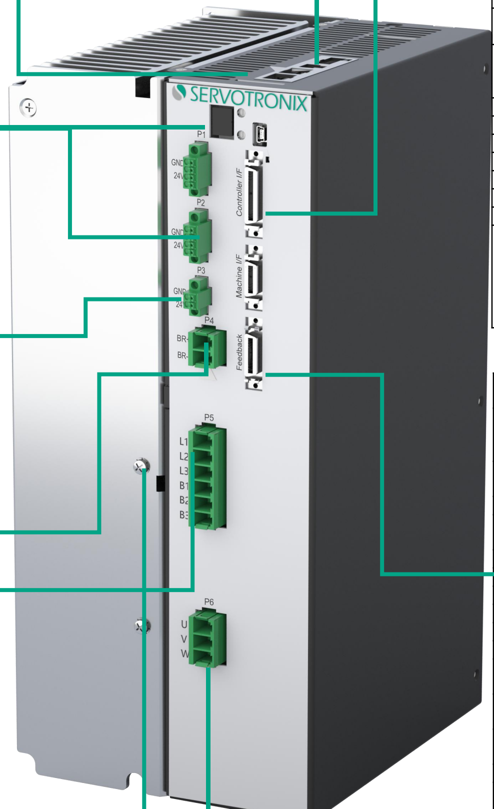
Brake P4:Phoenix|14-17 AWG		
1	BR+	Motor Brake +
2	BR-	Motor Brake -

Mating Connector:
PN SPC 5/2-STCL-7,62(1718481)
(STX PN CONr10000002-16)

AC Input and Regeneration P3:Phoenix|12-14 AWG		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3
4	B1+	DC Bus +
5	B2	Regen Bus -
6	B3-	DC Bus -

Mating Connector:
PN SPC 5/6-STCL-7,62 (1718520)
STX PN CONr00000006-78)

Functional GroundPE:Terminal M4
M4 ring or spade terminal



Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Mating Connector:
3M Solder Plug Connector
PN 10126-3000PE(STX PN CONr00000026-31)or equiv
3M Solder Plug Junction Shell
PN 10326-52F0-008 (STX PN HODr00000026-00)or equiv.
Mating Cable (STX PN CBL-MDRFL-26-0x,x=123 meter

Motor P6:Phoenix | 10-12 AWG		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W

Mating Connector:
PN SPC 5/3-STCL-7,62(1718494)
(STX PN CONr10000003-21)

STX	Servotronix
Highlighted PN	Supplied with CDHD

Crimping tool	Molex 0638190000(P1) or equivalent
4/40 insert threads on C2,C3,C4	

Figure 4-36 CDHD2S-024 (high-voltage) power board pin assignment

4.10.8 CDHD2S-040 (high-voltage) power board pin assignment

*CAN In C5:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

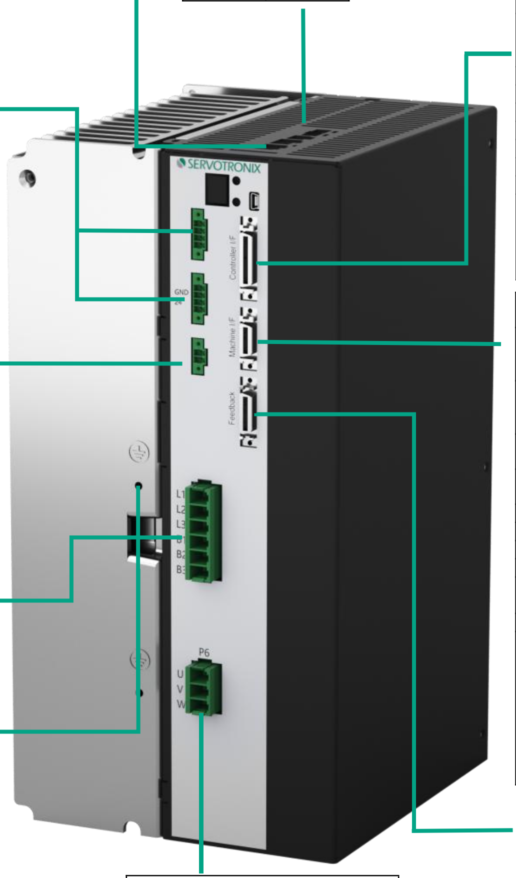
*CAN Out C6:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

Daisy Chain C8:0.1"IDC Female	
NELTRON 4401-10SR or COXOC 304A-10PSAAA03 STX PN CONr00000010-67	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	FGND
8	
9	
10	

Controller I/F C2:MDR 36 Plug|24-28 AWG			
1	24 VDC return Common output	19	24VDC ***Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A	22	Equivalent encoder output A+
5	Equivalent encoder output B	23	Equivalent encoder output B+
6	Equivalent encoder output Z	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
10	Ground	28	Pulse input+ Secondary encoder A+
11	Pulse input- Secondary encoder A-	29	Ground
12		30	
13	Ground	31	Digital input 3
14	Digital input 4	32	Digital input 5
15	Digital input 6	33	Digital output 2
16	Digital output 3	34	
17		35	*Analog input 2-
18	*Analog input 2+	36	Analog output
Mating Connector:3M Solder Plug ConnectorPN10136-3000PE(STX PN CONr00000036-01)or equiv3M Solder Plug Junction ShellPN 10336-52F0-008 (STX PN HODr00000036-00)or equivMating Cable (STX PN CBL-MDRFL-36-0x,x=12|3 meter			

STO-Safe Torque Off P1:16-28 AWG	
STO2-Safe Torque Off P2:16-28 AWG	
1	24 VDC (STO enable)
2	Ground (24V VDC return)
3	
4	
Mating Connector: Contacts-PN 15EDGKNM-3.5-04P-14-1022Z(H) (STX PN 11201707001435)	

Logic Power 24V Input P3:16-28 AWG	
1	24 VDC (Logic in)
2	Ground (24V VDC return)
Mating Connector Type Crimp Crimp-15EDGKNM-3.5-02P-14-1000A(H) (STX PN 11201707001436)	



Machine I/F C3:MDR 20 Plug|24-28 AWG			
1	Secondary encoder A+ Pulse input +	11	Secondary encoder A Pulse input-
2	Secondary encoder B+ Direction input+	12	Secondary encoder B- Direction input-
3	Secondary encoder Z+	13	Secondary encoder Z-
4	Secondary encoder 5V	14	Secondary encoder ground
5	Digital input 7	15	Digital input 8
6	Digital input 9	16	Digital input 10
7	Digital input 11	17	Digital output 4
8	Digital output 5	18	Digital output 6
9	24VDC ***Common input	19	24VDC return ***Common output
10	Fault relay 1	20	Fault relay 2
Mating Connector: 3M Solder Plug Connector PN 10120-3000PE(STX PN CONrO0000020-38)or equiv 3M Solder Plug Junction Shell PN 10320-52F0-008 (STX PN HODr00000020-00)or equiv. Mating Cable(STX PN CBL-MDRFL-20-0x,x=1|2|3 meter			

AC Input and Regeneration P3:Phoenix|12-14 AWG		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3
4	B1+	DC Bus +
5	B2	Regen Bus -
6	B3-	DC Bus -
Mating Connector: PN SPC 5/6-STCL-7,62 (1718520) STX PN CONr00000006-78)		

Functional GroundPE:Terminal M4
M4 ring or spade terminal

Motor P6:Phoenix | 10-12 AWG		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W
Mating Connector: PN SPC 5/3-STCL-7,62(1718494) (STX PN CONr10000003-21)		

STX	Servotronix
Highlighted PN	Supplied with CDHD

Crimping tool	Molex 0638190000(P1) or equivalent
4/40 insert threads on C2,C3,C4	

Feedback C4:MDR 26 Plug | 24-28 AWG			
1	Incremental encoder A+ SSI encoder data +	14	Incremental encoder A- SSI encoder data -
2	Incremental encoder B+ SSI encoder clock +	15	Incremental encoder B- SSI encoder clock -
3	Incremental encoder Z+	16	Incremental encoder Z-
4	Hall U +	17	Hall V+
5	Hall W+	18	**8V supply
6	Resolver sine+	19	Resolver sine-
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine+	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield
Mating Connector: 3M Solder Plug Connector PN 10126-3000PE(STX PN CONr00000026-31)or equiv 3M Solder Plug Junction Shell PN 10326-52F0-008 (STX PN HODr00000026-00)or equiv. Mating Cable (STX PN CBL-MDRFL-26-0x,x=123 meter			

Figure 4-37 CDHD2S-040 (high-voltage) power board pin assignment

4.10.9 CDHD2S-060 (high-voltage) power board pin assignment

ControllerI/F C2:MDR36Plug24-28AWG			
1	24VDCreturn ***Commonoutput	19	24VDC ***Commoninput
2	Digitaloutput1	20	Digitalinput2
3	Digitalinput1	21	
4	4EquivalentencoderoutputA-	22	Equivalentencoder outputA+
5	Equivalentencoder outputB-	23	Equivalentencoder outputB+
6	Equivalent encoder output Z-	24	Equivalent encoder output Z+
7		25	Ground
8	Analog input 1+	26	Analog input 1-
9	Direction input+ Secondary encoder B+	27	Direction input- Secondary encoder B-
	Ground	28	Pulse input+
	Pulse input-		Secondary encoder A+
	Secondary encoder A-	29	Ground
		30	
	Ground	31	Digital input 3
	Digital input 4	32	Digital input 5
	Digital input 6	33	Digital output 2
	Digital output 3	34	
		35	*Analog input 2-
	*Analog input 2+	36	Analog output

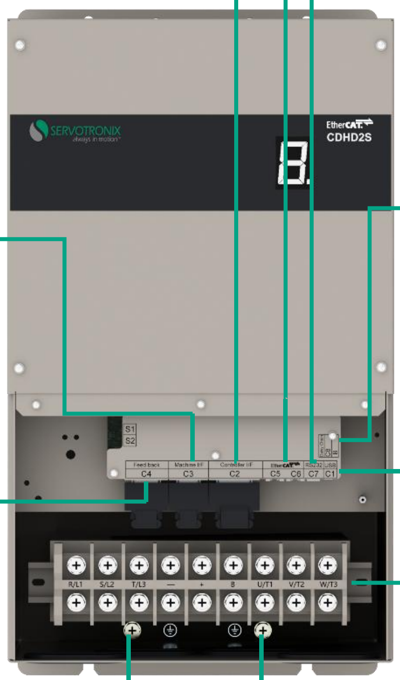
MatingConnector:
3MSolderPlugConnector
PN10136-3000PE(STXPNCONr00000036-01)orequiv
3MSolderPlugJunctionShell
PN10336-52F0-008(STXPNHODr00000036-00)orequiv.
MatingCable(STXPNCBL-MDRFL-36-0x,x=123meter)

MachineI/F C3:MDR20Plug24-28AWG			
1	SecondaryencoderA+ Pulseinput+	11	SecondaryencoderA Pulseinput-
2	SecondaryencoderB+ Directioninput+	12	SecondaryencoderB- Directioninput-
3	SecondaryencoderZ+	13	SecondaryencoderZ-
4	Secondaryencoder5V	14	Secondaryencoderground
5	Digitalinput7	15	Digitalinput8
6	Digitalinput9	16	Digitalinput10
7	Digitalinput11	17	Digitaloutput4
8	Digitaloutput5	18	Digitaloutput6
9	24VDC ***Common input	19	24VDCreturn ***Common output
10	Faultrelay1	20	Faultrelay2

Mating Connector:
3MSolderPlugConnector
PN10120-3000PE(STXPNCONr00000020-38)or equiv.
3MSolderPlugJunctionShell
PN10320-52F0-008(STXPNHODr00000020-00)orequiv.
MatingCable(STXPNCBL-MDRFL-20-0x,x=123meter)

Feedback C4:MDR26Plug24-28AWG			
1	IncrementalencoderA+ ***Commonoutput	14	IncrementalencoderA- SSlencoderdata-
2	IncrementalencoderB+	15	IncrementalencoderB-
	SSlencoderclock+		SSlencoderclock-
3	IncrementalencoderZ+	16	IncrementalencoderZ-
4	HallU+	17	HallV+
5	HallW+	18	**8Vsupply
6	Resolversine+	19	Resolversine-
7	Resolvercosine+	20	Resolvercosine-
8	Resolverreference+	21	Resolverreference-
9	Sineencodersine+	22	Sineencodersine-
10	Sineencodercosine+	23	Sineencodercosine-
11	5Vsupply	24	Ground(5V/8Vreturn)
10 LZ	Motortemperature sensor	25	Motortemperature sensor
13	5Vsupply	26	Shield

MatingConnector:
3MSolderPlugConnector
PN10126-3000PE(STXPNCONr00000026-31)orequiv.
3MSolderPlugJunctionShell
PN10326-52F0-008(STXPNHODr00000026-00)orequiv.
MatingCable(STXPNCBL-MDRFL-26-0x,x=123meter



EtherCAT in/ PROFINET port 1 C5:RJ45

OR

*CAN In C5:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

EtherCAT in/ PROFINET port 2 C6:RJ45

OR

*CAN Out C6:RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

RS232 C7:4P4C	
1	PX
2	GND ISO
3	TX
4	

Daisy Chain C8:0.1"IDC Female	
NELTRON 4401-10SR or COXOC 304A-10PSAAA03 STX PN CONr00000010-67	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	FGND
8	
9	
10	

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

AC Input and Regeneration 2-4 AWG		
1	R/L1	AC Phase 1
2	S/L2	AC Phase 2
3	T/L3	AC Phase 3
4		Ground
5	+	DC BuS +
6	B	Regen Bus-/ground
7	U/T1	Motor Phase U
8	V/T2	Motor Phase V
9	W/T3	Motor Phase W

Functional GroundPE:Terminal M4
M4 ring or spade terminal

*	See ordering options
* *	AF and EC models only
* * *	EC models only
STX Highlighted PN	Servotronix Supplied with CDHD

Figure 4-38 CDHD2S-060 (high-voltage) power board pin assignment

4.10.10 STO-P1

Safe Torque Off (STO) is a safety feature that prevents the drive from supplying power to the motor, thereby producing torque. For complete installation and operating details, please refer to the *Safe Torque Off (STO) Overview*

Table 4-38 STOP Interface

Pin	Pin tag	Function
1	24V	STO power supply
2	GND	STO loop
3		24V loop, provided by STO bypass drive
4		24V power supply, provided by STO bypass drive

Note: Ensure that the main voltage rating meets the drive requirements. Applying an incorrect voltage may cause the drive to malfunction. Do not turn on the power supply until all hardware connections are completed.

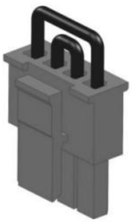


Figure 4-39 STO bypass plug (medium-voltage model)

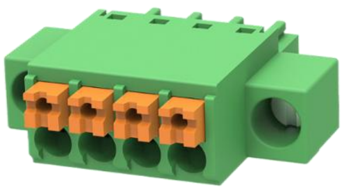


Figure 4-40 STO bypass plug

The STO system configuration is shown in the figure below.

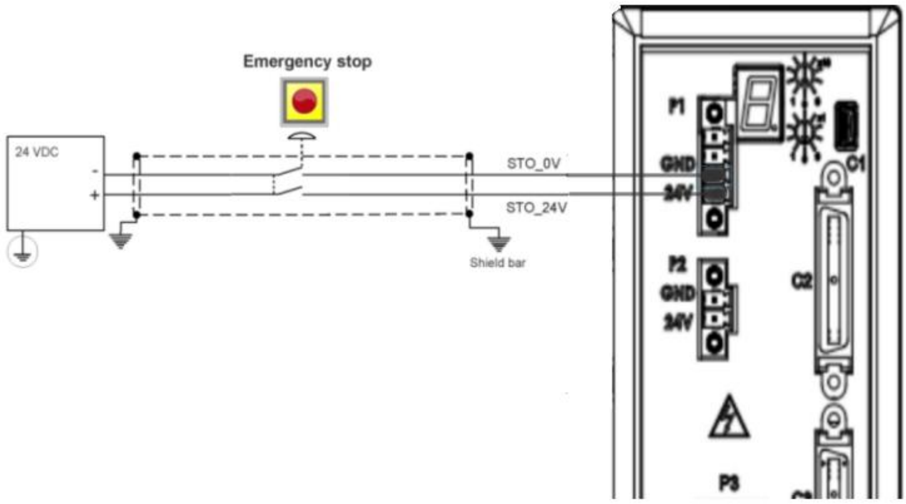


Figure 4-41 STO-emergency stop circuit wiring - example

4.10.11 Motor power - P2, P4

The motor power interface and connector vary with CDHD2S model.

Please refer to the power board pin assignment diagram.

4.10.12 Regenerative Resistors - P3, P5

The regenerative resistance interfaces and connectors of CDHD2S models are different.

Please refer to the power board pin assignment diagram.

If the application requires a regenerative resistor, connect the regenerative resistor between terminals B1+ and B2.

4.10.13 AC input - bus power and logic power - P3, P4, P5

The AC input interface and connector vary with CDHD2S model.

On the CDHD2S-1D5 and CDHD2S-003, the regeneration and AC input voltages are combined on one connector. Since these models only support single-phase AC, they do not have an L3 terminal for bus power.

Please refer to the power board pin assignment diagram.

Ensure that the main voltage rating meets the drive requirements. Applying an incorrect voltage may cause the drive to malfunction. Do not turn on the power supply until all hardware connections are completed.

Protect against impact surges:

Bus power (L1-L2-L3): When the bus is powered on, wait for 1 minute before turning it on, whether it is off or not.

Logic power supply (L1C-L2C): After turning off the logic power supply, wait for 1 minute before turning it on again.

Procedure: Connect power

1. Connect the AC input voltage ground wire to the PE terminal located on the front panel of the CDHD2S. Use M4 ring terminal or sector terminal.

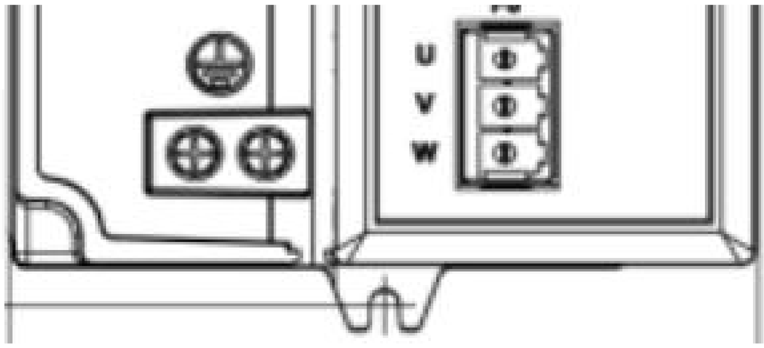


Figure 4-42 Ground terminal

2. Connect L1, L2 and L3 (for bus power).
   - If the main voltage comes from a single-phase supply, connect the line and neutral line to L1 and L3.
   - If the main voltage comes from a three-phase supply, connect the phases to L1, L2 and L3.
3. Connect L1C and L2C (for logic power).
   - If the main voltage comes from a single-phase supply, connect the line and neutral line to L1C and L2C.
   - If the main voltage comes from a three-phase supply, connect any two phases to L1C and L2C.

4.11Regeneration

4.11.1 Overview of regenerative energy

When the motor and load decelerate rapidly, the kinetic energy of the load drives the motor shaft energy back into the drive; this is called regenerative energy, or regeneration. This energy must be dissipated or absorbed.

The undissipated regenerated energy is added to the electrical energy already stored in the bus module capacitors. If the capacitor can store this energy, the system does not require a regenerative resistor.

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

To determine whether the system requires a regenerative resistor and determine the capacity level (if required), please refer to the "calculation of regenerative resistance" to calculate the performance of the system.

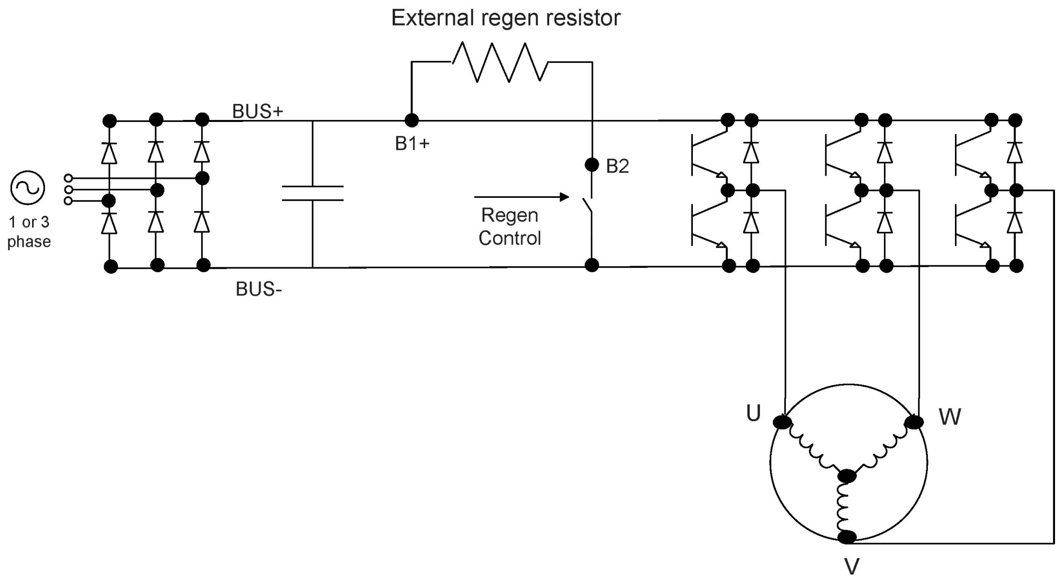


Figure 4-43 Regenerative resistor working circuit

4.11.2 Calculation of regenerative resistance

CDHD2S busbar specifications

Table 4-39 Busbar specifications - two-phase AC voltage 120/240V

Drive model	Rated voltage (DC voltage)	Low-voltage (DC voltage)	High-voltage (DC voltage)	Maximum voltage (DC voltage)
CDHD2S-1D5	170/340	380	400	420
CDHD2S-003	170/340	380	400	420
CDHD2S-4D5	170/340	380	400	420
CDHD2S-006	170/340	380	400	420

Table 4-39 Busbar specifications – three-phase AC voltage 380/480V

Drive model	Rated voltage (DC voltage)	Low-voltage (DC voltage)	High-voltage (DC voltage)	Maximum voltage (DC voltage)
CDHD2S-012	540/680	750	770	800
CDHD2S-024	540/680	750	770	800
CDHD2S-030	540/680	750	770	800

Calculate the return energy for each deceleration

$$E_{dec} = \frac{1}{2}(J_M + J_L)(\omega_1^2 - \omega_2^2)$$

Where:
E_{dec}= Energy returned during deceleration (J or ft·lb)
J_M= Rotor inertia (kg·m2 or lb·ft·sec2)
J_L = Load inertia (kg·m2 or lb·ft·sec2)
ω_1 = Velocity at the beginning of deceleration (rad/s)
ω_2 = Velocity at the end of deceleration (rad/s)

Determine the energy consumed by the motor

As the current passes through the motor winding resistance, part of the energy is dissipated by the motor:

$$E_{motor} = 3I_M^2 \cdot (R_M/2) \cdot t_d$$

Where:
E_{motor} = Energy consumed by motor (J)
R_M = Motor resistance (ΩL-L)
I_M = Current during deceleration (ARMS/phase)
t_d = Deceleration time (s)

Determine the energy consumed by the friction

$$E_{friction} = \frac{1}{2}T_f(\omega_1 - \omega_2)t_d$$

Where:
$E_{friction}$ = Energy consumed by friction (J or ft·lb)
T_f = Friction torque (N·m or lb·ft)
ω_1 = Velocity at the beginning of deceleration (rad/s)
ω_2 = Velocity at the end of deceleration (rad/s)
t_d = Deceleration time (s)

Determine the energy consumed by the amplifier

$$E_M = E_{dec} - E_{motor} - E_{friction}$$

Where:

E_M = Total energy consumed by the amplifier (J or ft·lb)

If the energy is less than the energy that the bus module can store, the regenerative resistor is not needed.

E_M should be expressed in joule. The conversion rate from ft·lb to joule is:

1ft·lb=1.356J

Determine the energy that the bus module can absorb

$$E_{BUS} = \frac{1}{2}C(V_M^2 - (V_{NOM})^2)$$

Where:

E_{BUS}= Energy that the bus module can absorb (J)

C=Bus module capacitance (F); please refer to the *Bus Specifications* section

V_M = Maximum bus voltage (v); please refer to the *Bus Specifications* section.

V_{NOM}=Bus nominal voltage=$\sqrt{2}V_{mains}$（V）

Determine whether the regenerative resistor is needed.

If $E_{BUS} > E_M$, the regenerative resistor is not needed.

If $E_{BUS} < E_M$, the regenerative resistor is needed.

Determine the resistor value

The procedure for calculating regeneration requirements is twofold. The regenerative resistor value and resistor power must be determined.

Determine the resistance value

$$R_{Max} = \frac{V_M^2}{V_B I_M \sqrt{3}}$$

Where:

V_B = Motor back-EMF - motor loss.

$$V_B = K_B N - \sqrt{3} IM (R_M/2)$$

V_M = Maximum bus voltage (v); please refer to the *Bus Specifications* section.

K_B=Back-EMF constant (VL-L/rpm)

N=Motor velocity before deceleration (rpm)

I_M = Current during deceleration (ARMS/phase)

R_M = Motor resistance (ΩL-L)

Determine the average power dissipated

$$P_{AV} = \frac{E_M - \frac{1}{2}C(V_{High}^2 - V_{Low}^2)}{t_{cycle}}$$

Where:

E_M = Total energy consumed by the amplifier (J)

C=Bus module capacitance (F); please refer to the *Bus Specifications* section

V_{High} = Hysteresis point: the regenerative circuit is turned on (V); please refer to the *Bus Specifications* section.

V_{Low} = Hysteresis point: the regenerative circuit is closed (V); please refer to the *Bus Specifications* section.

t_{cycle} = Deceleration interval+deceleration time (s)

Determine the resistor power for peak

$$P_{PK} = \frac{V_M^2}{R_{Regen}}$$

R_{Regen} = Regenerative resistor resistance (ΩL-L)

V_M = Maximum bus voltage (v); please refer to the *Bus Specifications* section.

Example for the calculation of regenerative resistor resistance (in US standard units)

Motor and drive specifications

CDHD2S-006 drive, using single-phase AC voltage 240V input

J_{motor}=0.000484lb·ft·sec2

R_M=1.32Ω

I_{peak}=18A

T_M=19.8lb·ft

C=0.001120F

V_M=420V

K_B=81.2V/krpm=0.0812V/rpm

k_t=1.188lb·ft/A

System specifications

T_f=1.5lb·ft

J_{Load}=0.0015lb·ft·sec2

V_{Max}=2,500rpm=>ω_M=261rad/s

V_{NOM}=240Vrms=340VDC

Deceleration interval=5s

Calculation of deceleration time

$$t_d = \frac{(J_{Motor} + J_{Load}) \cdot (\omega_M)}{(T_M + T_f)} = (0.000484 + 0.001) \cdot (261) / (19.8 + 1.5) = 0.0181\text{s}$$

Calculation of current during deceleration

$$I_M = \frac{(J_{Motor} + J_{Load})}{k_t} \cdot \frac{\omega_1 - \omega_2}{t_d} = \frac{0.001 + 0.000484}{1.188} \cdot \frac{261}{0.0181} = 18A$$

Calculation of energy

$$E_{dec} = \frac{1}{2}(J_M + J_L)(\omega_1^2 - \omega_2^2) = \frac{1}{2}(0.0015 + 0.000484)(261^2 - 0) = 67.57 ft \cdot lb = 91.63 J$$

$$E_{motor} = 3I_M^2 \cdot (R_M / 2) \cdot t_d = 3 \cdot 18^2 \cdot (\frac{1.32}{2}) \cdot 0.0181 = 11.61 J$$

$$E_{friction} = \frac{1}{2} T_f (\omega_1 - \omega_2) t_d = \frac{1}{2} \cdot 1.5 \cdot (261 - 0) \cdot 0.0181 = 3.54 ft \cdot lb = 4.8 J$$

$$E_M = E_{dec} - E_{motor} - E_{friction} = 91.633 - 11.611 - 4.8 = 75.22 J$$

$$E_{BUS} = \frac{1}{2} C (V_M^2 - V_{NOM}^2) = \frac{1}{2} \cdot 0.001120 (420^2 - 340^2) = 34.05 J$$

Since $E_M > E_{BUS}$, a regenerative resistor is needed.

Calculation of resistor specification

$$V_B = K_B N - \sqrt{3} I_M (\frac{R_M}{2}) = 0.0812 \cdot 2500 - \sqrt{3} \cdot 18 \cdot (\frac{1.32}{2}) = 182.423 V$$

$$R_{MAX} = \frac{V_M^2}{V_B I_M \sqrt{3}} = \frac{420^2}{182.423 \cdot 18 \cdot \sqrt{3}} = 31.02 \Omega$$

$$P_{AV} = \frac{E_M - \frac{1}{2} C (V_{High}^2 - V_{LOW}^2}{t_{cycle}} = \frac{44.42 - \frac{1}{2} \cdot 0.001120 \cdot (400^2 - 380^2)}{5.03} = 7.1 W$$

$$P_{PK} = \frac{V_M^2}{R_{Regen}} = \frac{420^2}{132} = 5686.65 W$$

4.11.3 Regenerative resistor overload protection

Motor energy regeneration in CDHD2S is always active.

The motor energy regeneration function has two modes:

- Regeneration with resistor overload protection.

  The regenerative resistor circuit requires overload protection to ensure reliable operation of the resistor. In this mode, you can configure the CDHD2S regenerative resistor parameters for protection.
- Regeneration without resistor overload protection. This mode is also called bang-bang mode.

In bang-bang mode, the drive will activate the regenerative resistor when the upper threshold is exceeded (400V for medium-voltage drives, 770V for high-voltage drives); when the bus voltage drops to the lower threshold (400V for medium-voltage drives) 380V,

770V for high-voltage drives), the regenerative resistor will be disabled.

⚠ Please use regenerative resistor protection with caution.
If the motor increases the bus voltage and the protection mechanism is activated, it may lead to overvoltage condition.

4.11.4 Regenerative resistor parameters

The regenerative resistor capacity is defined by several parameters.

To activate the regenerative resistor protection function in CDHD2S, parameter REGENRES and/or parameter REGENPOW must be set to a value other than -1, and this is the default value.

VarCom	Description
REGENRES	Regenerative resistor resistance, in ohms.
REGENPOW	Regenerative resistor power , in watts.
REGENMAXONTIME	Maximum time that regenerative resistor can be continuously activated (turned on), in milliseconds.
REGENMAXPOW	Maximum power of regenerative resistor, in watts.

Note: If the system does not have a regenerative resistor, set REGENRES=-1 and REGENPOW=-1
If the system has a regenerative resistor, the "-1" value of REGENRES or REGENPOW will disable the regenerative resistor overload protection algorithm.

4.12Firmware Update

4.12.1 Firmware update preparation

IMPORTANT: Before updating firmware, make sure to do the following:

- Please refer to the release notes and any other documentation provided with the new firmware.
- Since the parameter settings may be lost during the update, please back up the parameters of each drive in the system and keep these files safe. When the update is completed, the parameters can be reloaded/restored.

To back up parameters, go to the ServoStudio2 Backup and Restore screen and press the Save to Backup button.

4.12.2 Firmware update options

Click the Firmware Download button in the ServoStudio2 drive information screen to open the firmware download dialog box.

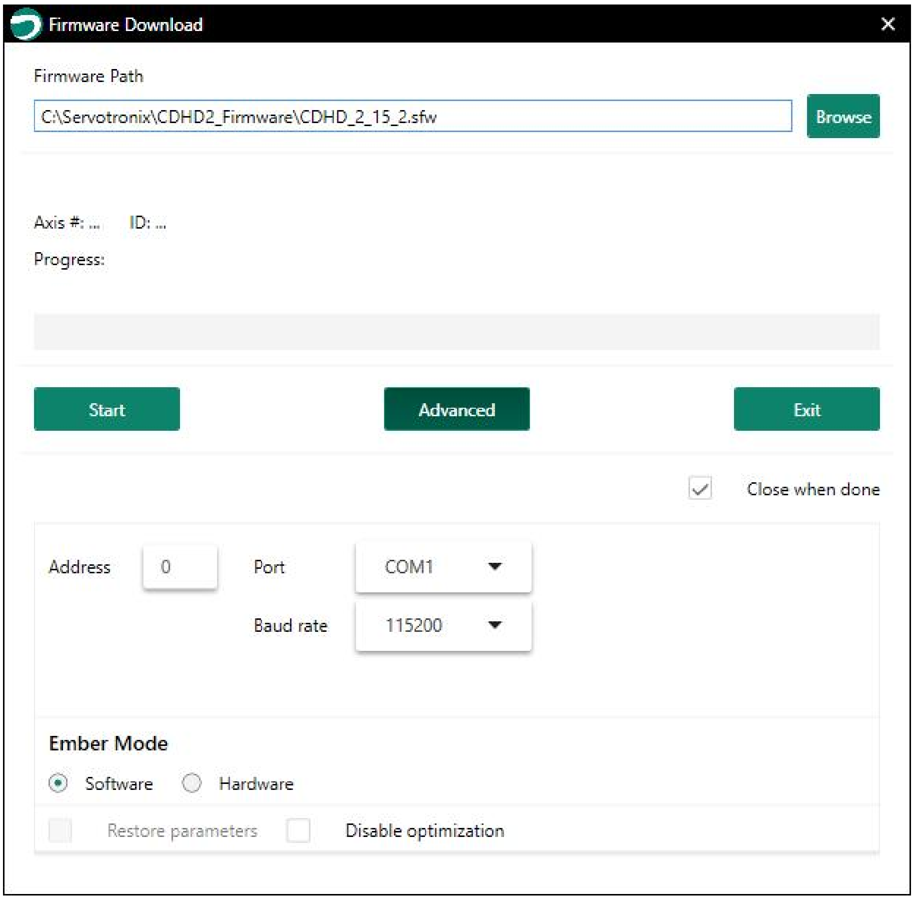


Figure 4-44 Firmware download

Table 4-41

Firmware path	Containing the path and name of the firmware update file. The file name represents the firmware version; for example: 2_00_0*.sfw represents firmware version 2.0.x. The default path is \My Documents\ServoStudio2. Click **Browse** to choose a different path.
Start	Activate firmware update.
Advanced	Expanding the dialog to show additional options
Close when done	When selected, the firmware download dialog box will automatically close after the program is completed.
Address	● When only one drive is connected to the host, the drive address is not required. Before activating the firmware download process, the software attempts to communicate with the drive that is communicating with the host. Therefore, if the drive responds to serial communication, the firmware download process will continue. ● When multiple drives are connected to the host in daisy chain, the drive address must be specified. After specifying the drive address, the software will be started by sending the command \\, which will stop all drives connected to the selected serial port from responding to serial communications. It then issues the command *nn*, instructing only the drive with address with *nn* to respond.
Port	The COM port of the host to which the drive is connected. Make sure this COM port is not in use by any other application.
Baud rate	The baud rate must be set to 115200.
Ember mode	Ember is a process for burning new firmware on the flash memory of the drive. ● **Software** Usually using default software options. ● **Hardware** Using this option if the firmware loading process is interrupted and you cannot establish communication with the drive.
Disable optimization	The firmware update process uses optimization methods to improve performance. In rare cases, this optimization may cause the program to fail. In this case, please disable optimization and restart the firmware update.
Restore parameters	When selected, the firmware update process will store all user parameters in memory before downloading the firmware, and restore the parameters after the update. This option can be disabled. This option is not available if the host and the drive are not communicating. **Note:** Regardless of the setting of this option, it is strongly recommended that you use the **Save to Backup** option in the Backup and Restore screen to preserve existing drive parameters before updating firmware.

4.12.3 Updating firmware via serial connection

Procedure: Updating drive firmware via serial connection

1. Download the firmware file (*.sfw) of the drive from the product webpage to the host.
2. In the ServoStudio2 drive information screen, click "Download Firmware".

The Firmware Download dialog box opens, allowing you to send a firmware file to the drive via the serial communication link.

3. Browse and select the firmware file.
4. Click "Start" to download the firmware file to the drive.

   During the firmware update process, the digital display shows E:

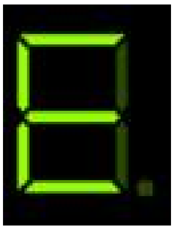


Figure 4-45

This process takes several minutes.

When the process is completed, the new firmware will start running.

5. Download the drive parameter file to the drive.
6. Perform "Save" to save the parameters in the non-volatile drive memory.
7. Restart the power and run the machine.

   If machine behavior has changed, please contact technical support.

8. Retrieve the parameter file from the drive and save the file for future reference and backup.
9. Repeat the firmware update procedure for each drive in the machine.

4.12.4 Updating firmware on EtherCAT

The firmware update can be performed using the FileoverEtherCAT (FoE) download protocol. The CDHD2S runs in a bootloader state, allowing firmware to be downloaded to the host controller over the EtherCAT network. Therefore, standardized firmware can be downloaded to the device even without TCP/IP support.

Note:	The drive resident (bootloader) must be version 1.3.1 or above.

The version can be checked in the ServoStudio2 Terminal screen via command VER. If the system has a regenerative resistor, the “-1” value of REGENRES or REGENPOW will disable the regenerative resistor overload protection algorithm.

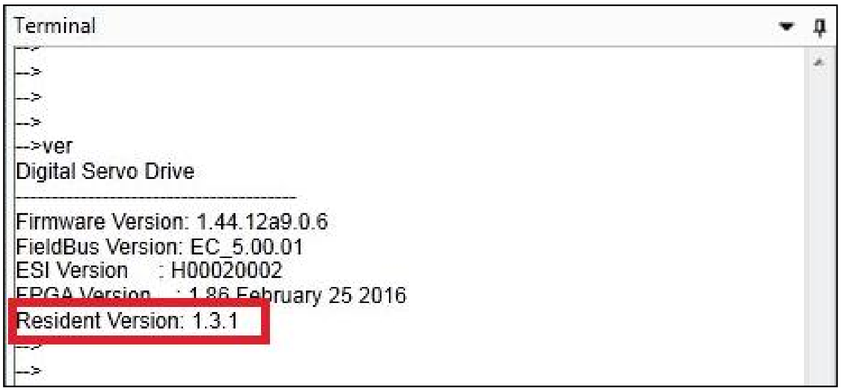


Figure 4-46

Procedure: Update drive firmware via EtherCAT

1. Install TwinCAT3.0 on the host.
   Follow the instructions provided by Beckhoff.

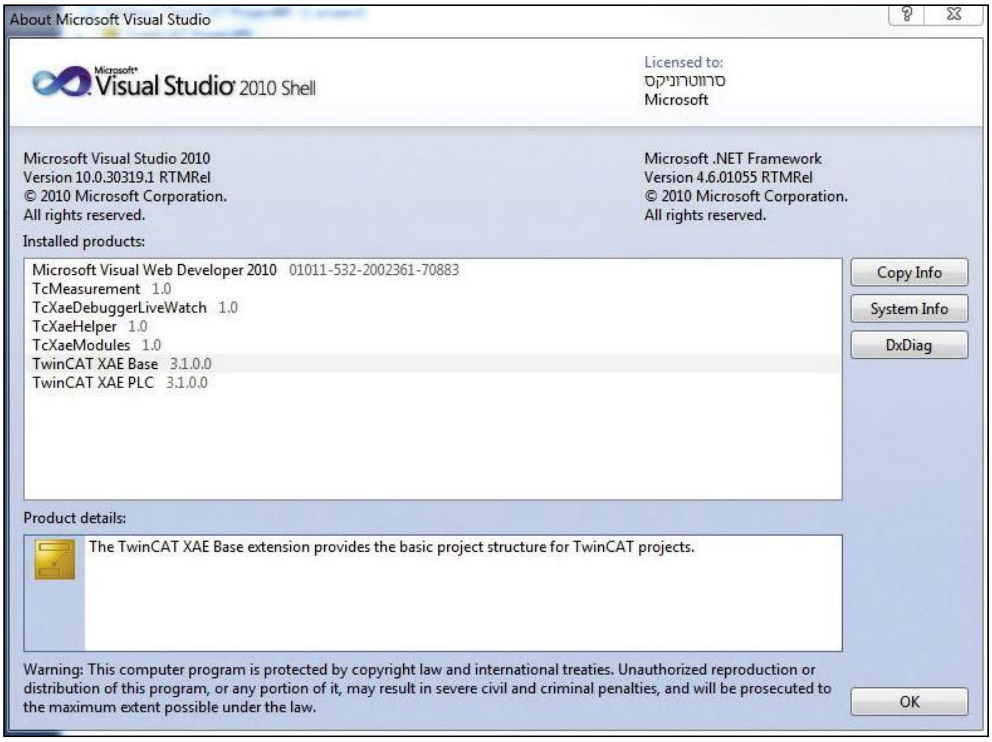


Figure 4-47

2. Connect to CDHD2S drive in TwinCAT.
3. In the TwinCAT navigation menu, select I/O>Devices...CDHD2S Drive.

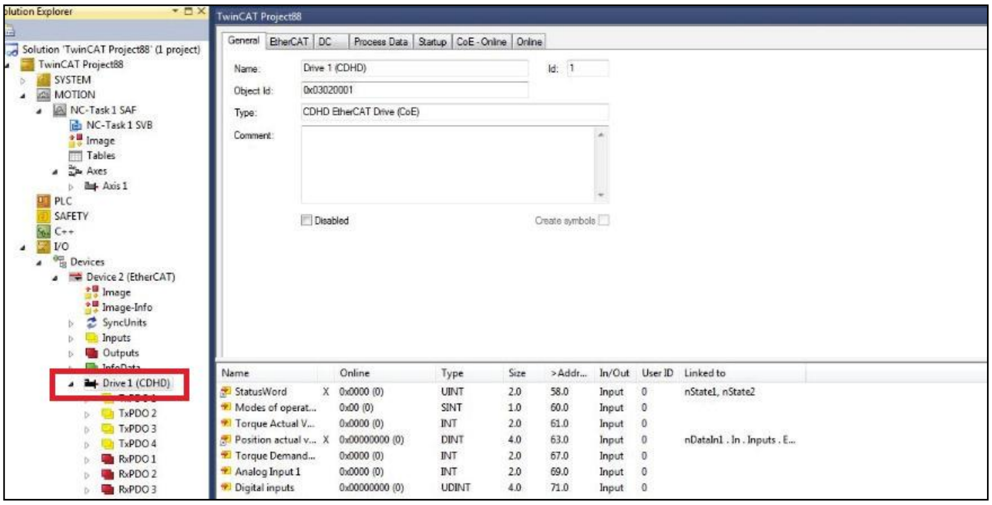


Figure 4-48

4. Go to the "Online" tab. Click "Bootstrap".
Wait for the "Current State" to change to BOOT.

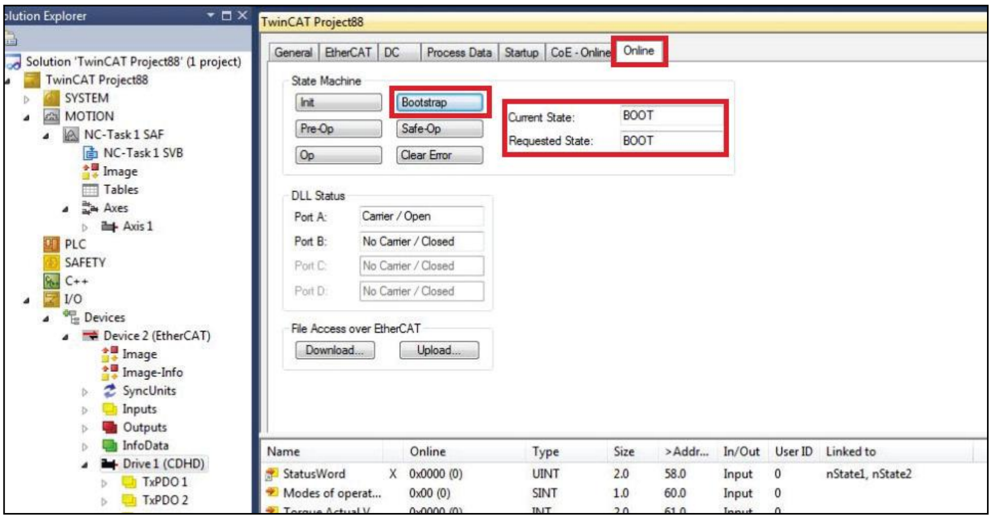


Figure 4-49

5. Click “Download".
6. The File Manager dialog box will open.
   Browse and select the CDHD2S firmware file (extension *.i00).
Click "Open".

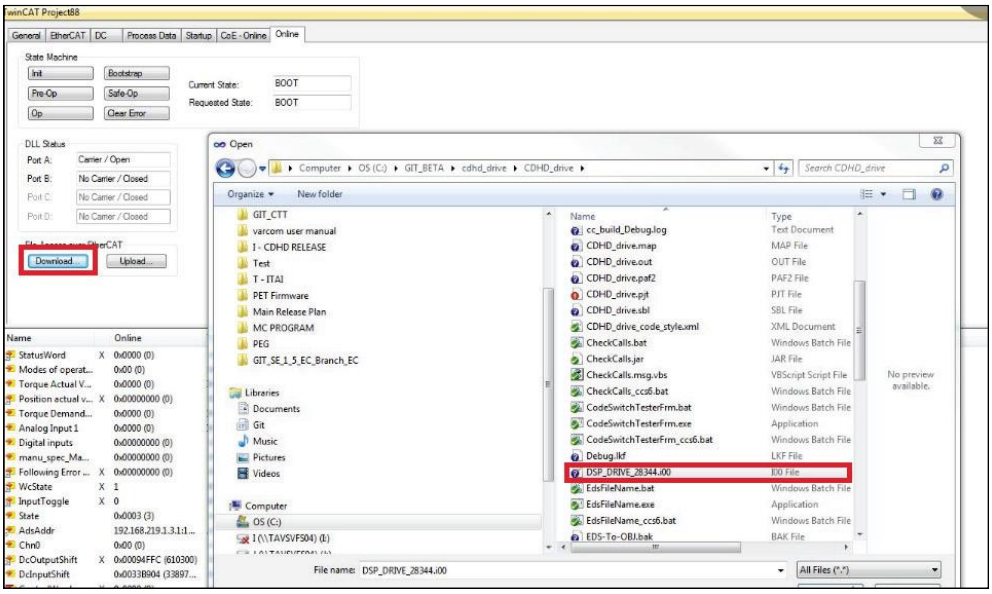


Figure 4-50

7. The Edit FoE Name dialog box will open.
8. Do not change anything in this dialog box. Click “OK”.

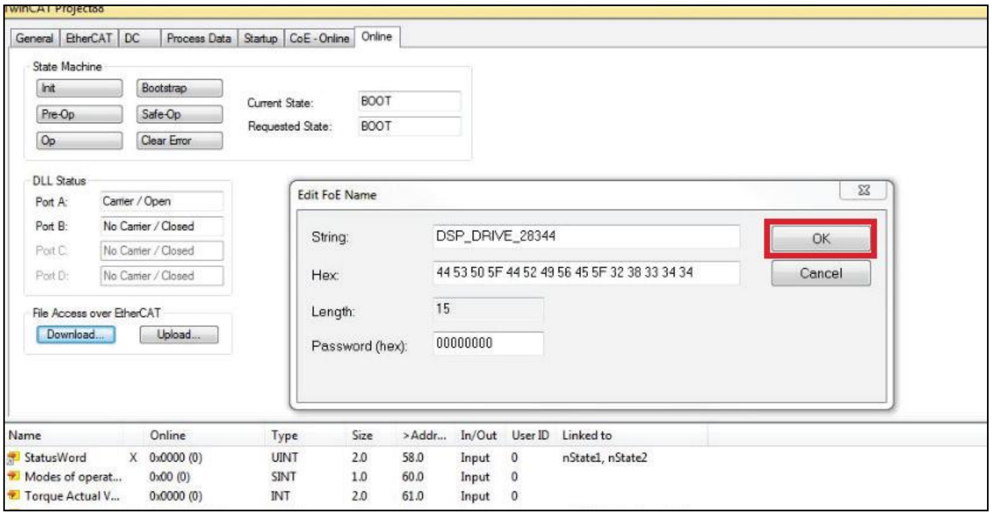


Figure 4-51

9. The firmware update process begins.

Digital display screen shows:

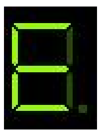


Figure 4-52

In the TwinCAT status bar at the bottom of the screen, "Downloading" is displayed on the left and a progress bar is displayed on the right.

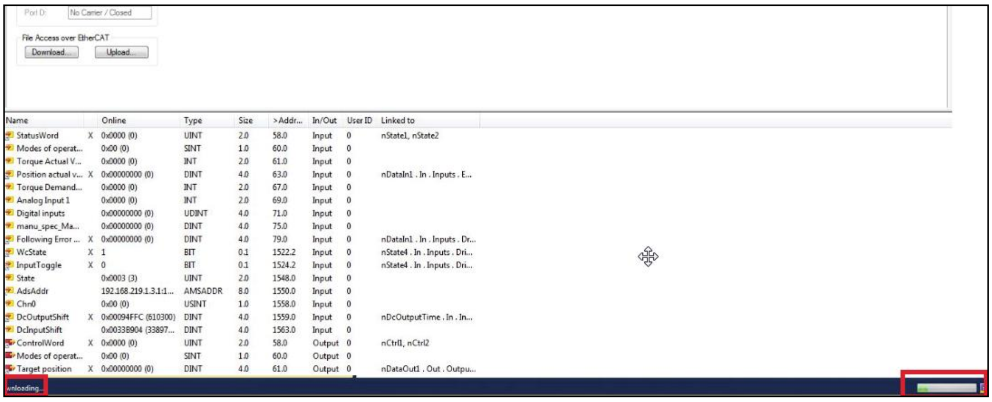


Figure 4-53

10. When the firmware update is completed, the "Current State" switches from BOOT to PREOP.

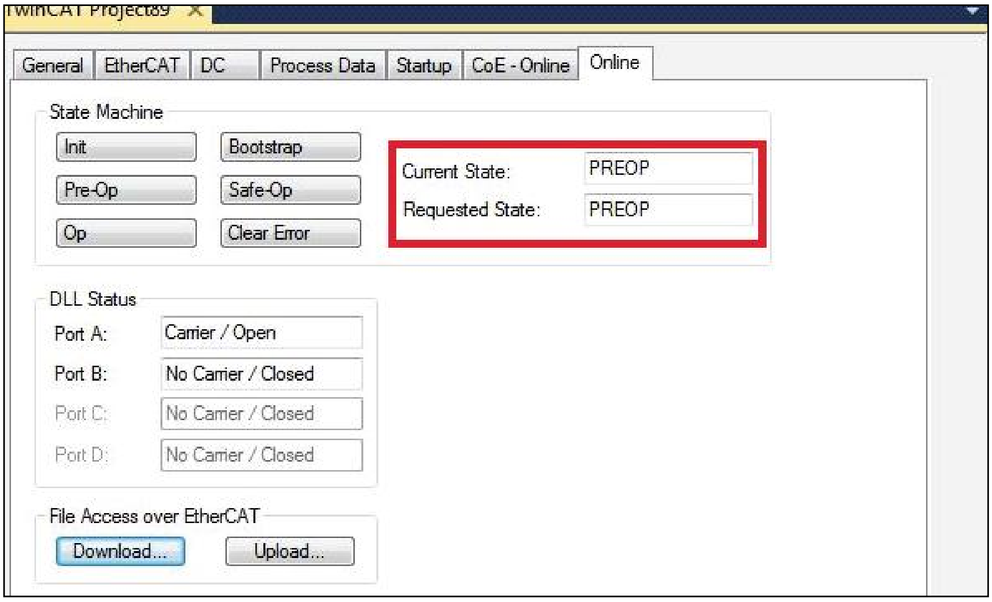


Figure 4-54

4.12.5 Restoration operation after firmware update

Procedure: Restoration operation after firmware update

1. Go to the ServoStudio2 Drive Information screen in ServoStudio2 and check the drive firmware version to verify that the new firmware has been loaded.

2. Open the Backup and Restore screen and click the "Restore" button to reload the previously backed up drive parameters

3. Check the version release notes and set all parameters that may have been added to the new version.

4. Save parameters to non volatile parameter memory: execute the serial command "Save", or click the "Save" button on the ServoStudio2 toolbar, or use the command C0006 on the operation panel; and wait for the display to show completion.

5. Restart the power and run the machine. If machine behavior has changed, please contact technical support.

4.12.6 Ember mode

Ember is a process for burning new firmware on the flash memory of the drive. The drive must be in Ember mode to load firmware. The drive has two Ember modes, software and hardware.

Generally, you can and should communicate with the drive in software Ember mode to load new firmware.

However, if the firmware loading process is interrupted and you cannot establish communication with the drive, you need to use Ember hardware mode.

To activate hardware Ember mode, use a small screwdrive or similar tool to gently press the hardware Ember switch. This switch is located on the top of the drive next to the daisy chain connector (C8).

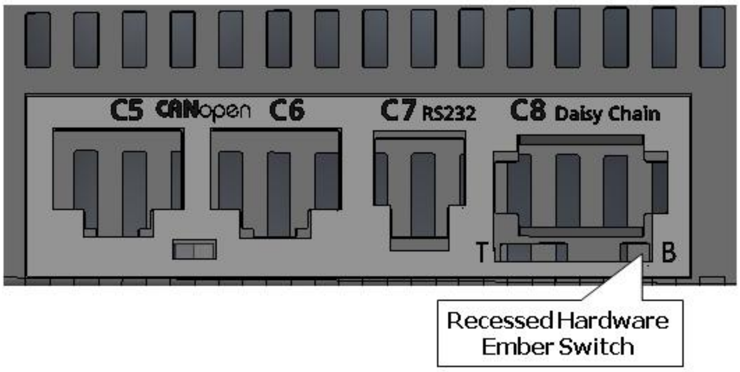


Figure 4-55 Location of hardware Ember switch

Press the switch to set the drive to the serial communication "Boot-Up" mode.

If the drive has a fan, the fan spins at maximum speed. When the firmware is successfully downloaded and the drive is rebooted, the fan speed will return to normal.

In Boot-Up mode, the 5-digit display shows e.

4.12.7 Download parameters via EtherCAT

To automate and simplify the process of downloading parameters to multiple drives, FileoverEtherCAT (FoE) can be used to download parameters.

Procedure: Download parameters via EtherCAT

1. By using ServoStudio2, you can back up the parameters in the drive to an SSV file.

For example, save to a file named CDHD2S_parameters.SSV.

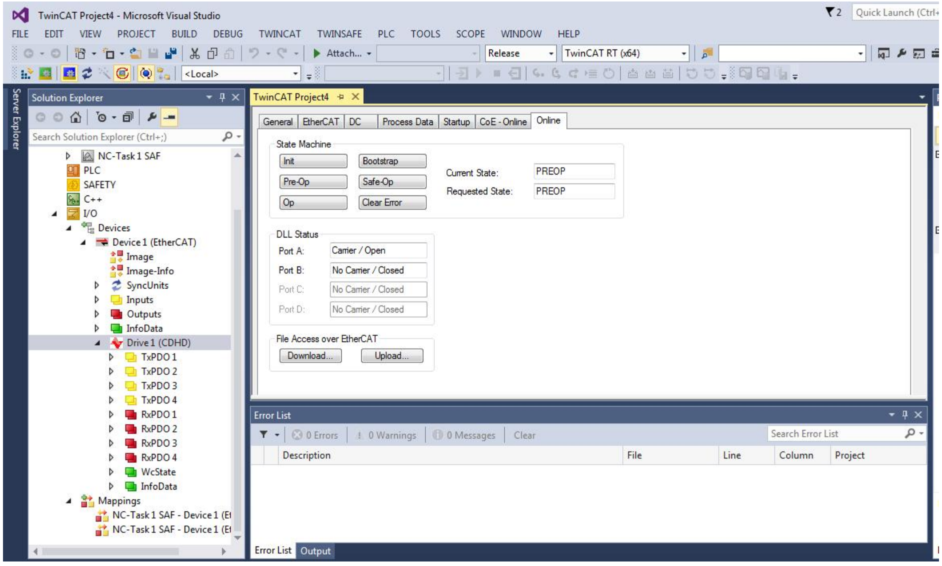


Figure 4-56

2. Using TwinCAT, connect to the CDHD2S drive.

Make sure the drive is in Init or Pre-Op state.

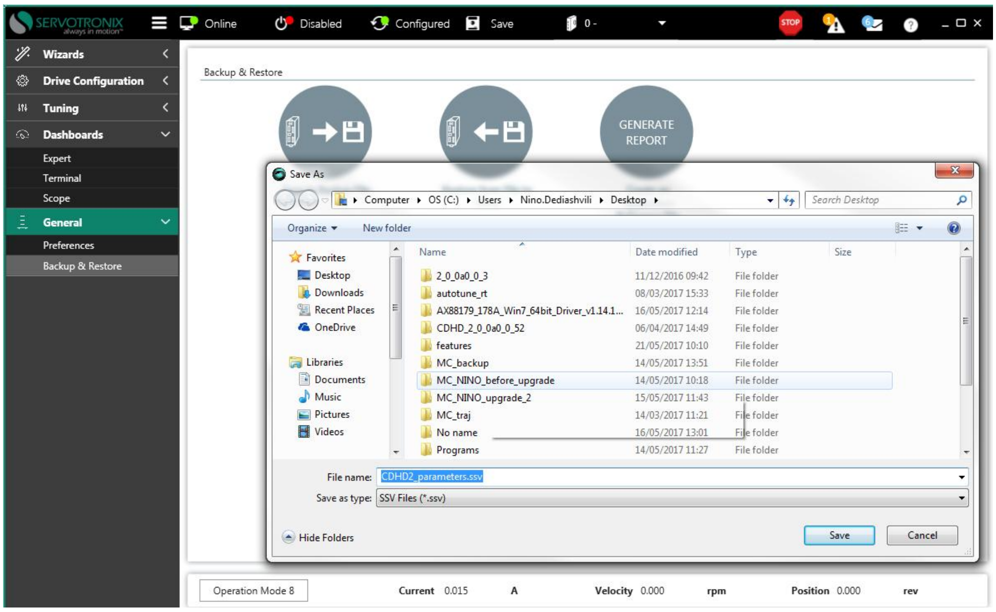


Figure 4-57

3. Click the "Download" button and select the SSV parameter file saved in step 1.

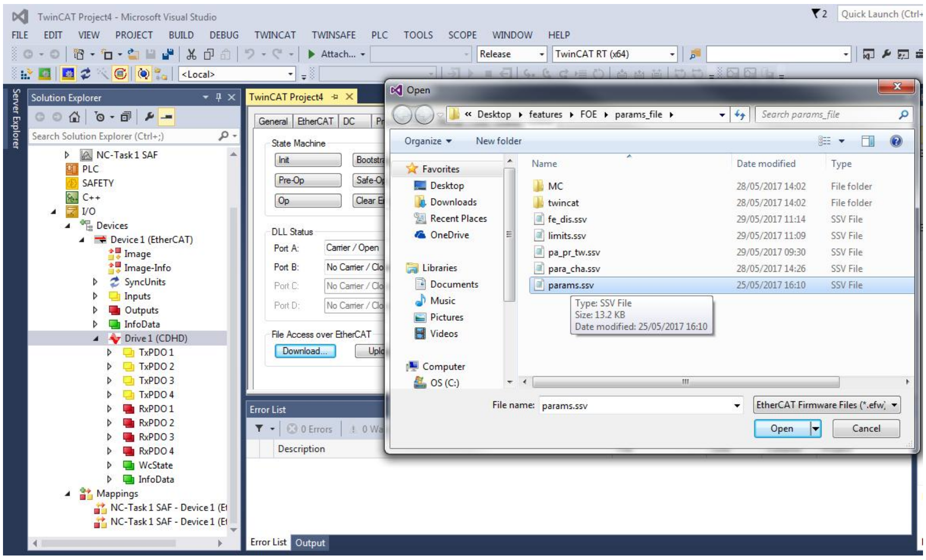


Figure 4-58

4. Ensure that The File Name Contains the Extension .SSV

(By default, TwinCAT does not add extensions.)

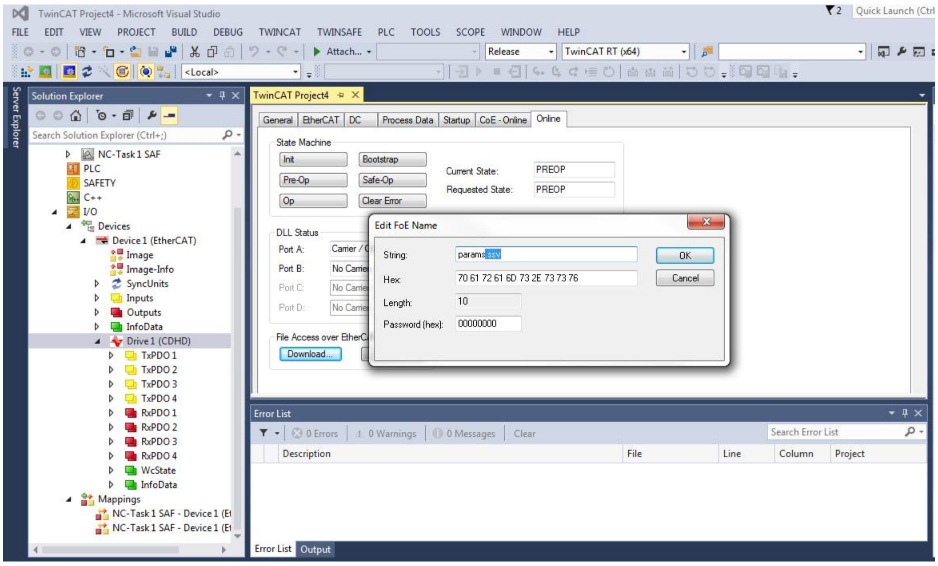


Figure 4-59

5. Click “OK”.

Observe the drive. When downloading parameters, the digital display shows oR.

6. Wait about 10 seconds. When the download is completed, the digital display will be restored to its previous settings.

5.Motor Setup

From firmware version 1.40.0, the drive will attempt to detect the motor feedback device and electronic motor nameplate (MTP) upon power-up. If the electronic motor nameplate (MTP) is detected, some motors and feedback parameters will be directly transmitted to the drive and cannot be operated. Therefore, the electronic nameplate makes debugging simple and reliable.

If the electronic motor nameplate is not detected at power-up, you can use the Motor screen or the Motor Setup Wizard to select a motor from the ServoStudio2 database (Motor Library). You only need to select the motor series and motor part number, and ServoStudio2 can prepare the corresponding motor and feedback parameters. This screen allows you to modify and send parameters to the drive, read parameters from the drive and save parameters.

Note:	Disable the drive before operating the motor and feedback parameters. When the drive is enabled, many parameters can be modified. However, proceed with caution as movement behavior will change. If parameters cannot be modified while the drive is enabled, ServoStudio2 will prompt you to disable the drive.

5.1Motor Setup Wizard

The ServoStudio2 Motor Setup wizard provide a quick and easy way to get your drive and motor up and running. This wizard configures basic parameters and current control loops for an unloaded motor.

It is recommended that you use the "Motor Setup" wizard when connecting the host, drive and motor for the first time.

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

Motor Setup - Connection

Usually, the first step in the wizard is to establish communication between the drive and the ServoStudio2 software.

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

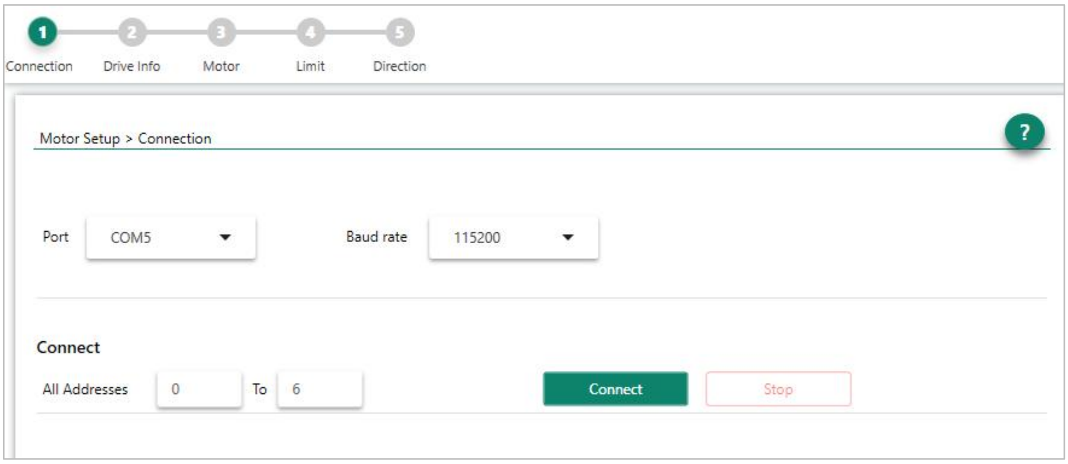


Figure 5-1 Motor setup wizard - connection

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

Please refer to the *Communication*.

Motor Setup - Drive Information

If ServoStudio2 has already communicated with the drive, the wizard will start with the **Drive Information**.

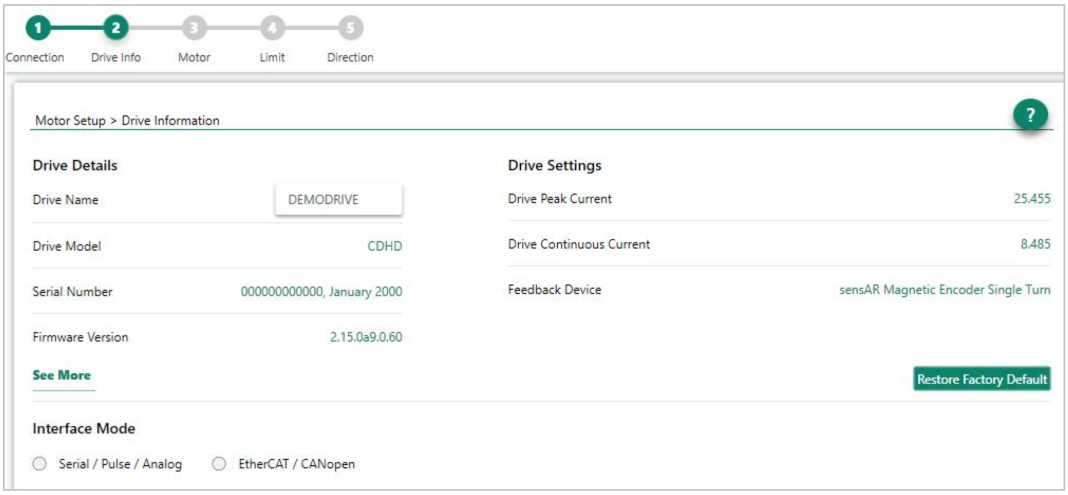


Figure 5-2 Motor setup wizard - drive information

1. View drive information.
2. Enter a name for the drive and press Enter.

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 "Interface Mode".

- Serial/Pulse/Analog means the drive is active (servo on) and drive commands are transmitted via the serial, pulse or analog interface. COMMODE 0.
- EtherCAT/CANopen or PROFINET means that the drive is active (servo on) and drive commands are transmitted through the EtherCAT, CANopen or PROFINET interface. COMMODE 1.

Note: For CDHD2S, there are only EC and PN models at present.

Motor - Setup - Motor identification and initialization

If the drive detects the electronic motor nameplate, the parameters in this screen will be set automatically and cannot be operated. Just click Next to proceed to the next step.

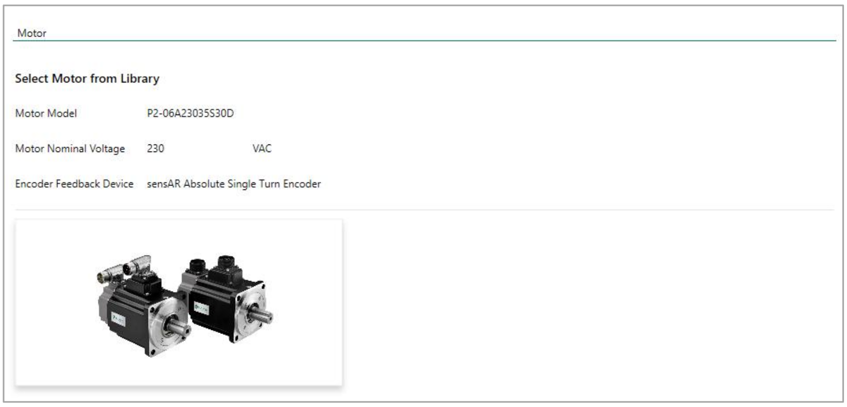


Figure 5-3 Motor setup wizard - automatic motor detection

If the drive does not detect the electronic nameplate (or the software does not communicate with the drive), you can select the motor from the ServoStudio2 motor library.

If the motor is not listed in the default motor library, click **Define New Motor** and enter the parameters for the specific motor by following the new motor wizard.

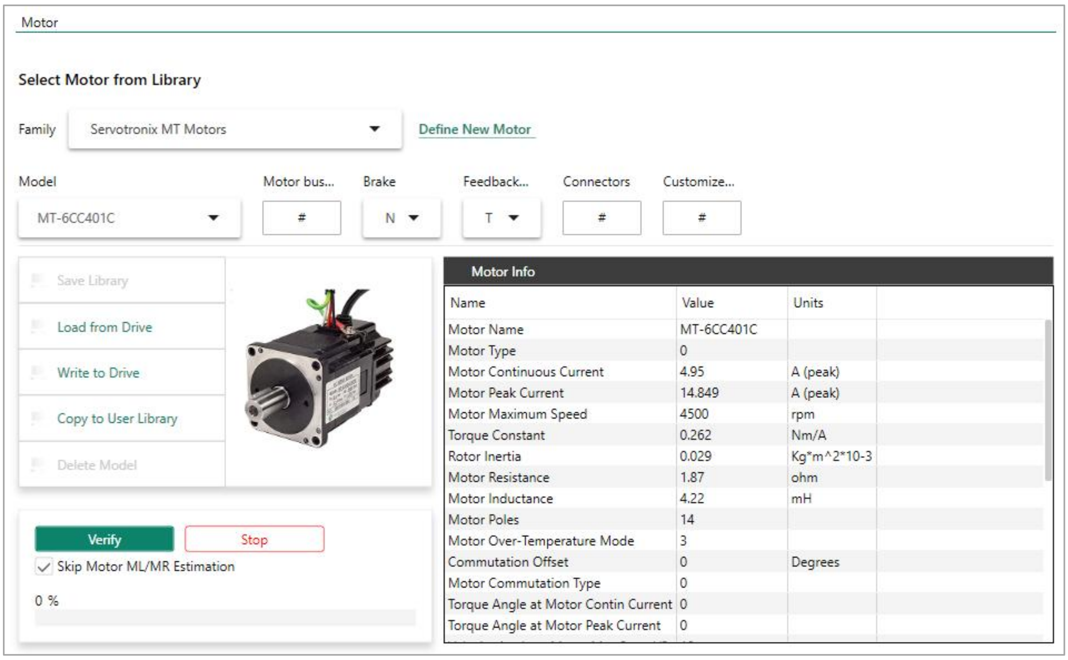


Figure 5-4 Motor setup wizard - motor selection

1. Select motor series.
2. Select the motor model.
3. Select the characters that match the label on the motor (# means the field can be ignored).
4. Click Verify to send parameters to the drive and test the motor configuration.

⚠ Verification will start the drive and drive the motor!

Motor setup - current, velocity limit and position limit

The wizard provides suggestions for low, medium, or high limits for current and velocity. These values correspond to 25%, 50% and 100% of the maximum respectively.

Please refer to the *Current Limit and Velocity Limit* and *Velocity Limit*.

The wizard also allows setting the position error limit, i.e. the maximum value that will not cause a failure.

Please refer to the VarComPEMAX.

Note: If the limit is set too low, the Autotuning wizard may not produce optimal results.

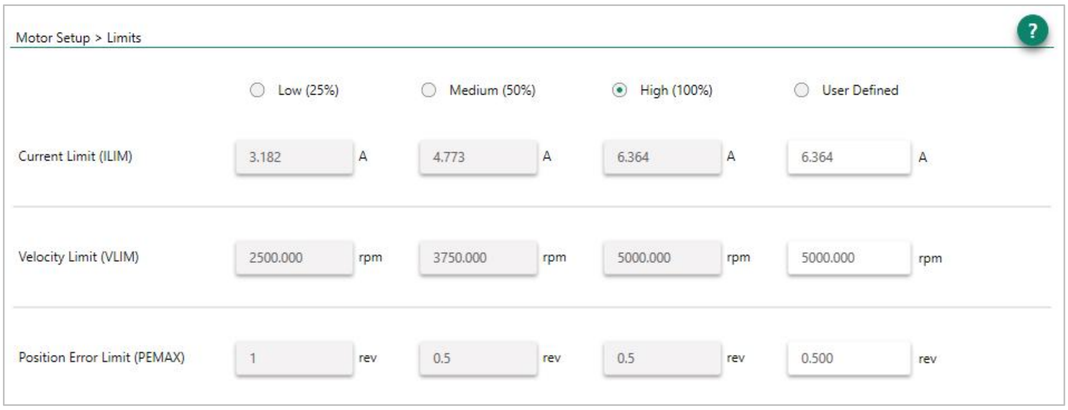


Figure 5-5 Motor setup wizard - limit

1. Set the velocity and current limit and the position error limit by doing any of the following:
   - Select the recommended low, medium or high value.
   - Select User Defined and enter your preferred values.
2. Click "Agree" to send the values to the drive.

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

If the position error limit is set to 0 for user defined value, the position error limit is not set and no fault will occur.

Motor setup - motor direction

This wizard simplifies the process of defining the rotation direction of motion command. Otherwise, the VarCom command is required.

Please refer to the VarComMPHASE and DIR.

To visually test the direction of motion, click and hold the direction button. The test velocity is defined as the percentage of motor continuous current. Use a low value to see the direction of motor movement. The default setting is 5.

The motor setup wizard simplifies the process of defining the rotation direction for positive command. Otherwise, the VarCom command is required.

Figure 5-6 Motor setup wizard - motor direction

1. To verify the direction of motor movement, click "Negative" or "Positive".

"Negative" and "Positive" start the drive and run the motor!

2. To reverse the direction to match the system, enable the Inverse Direction option. Please refer to the VarComMPHASE and DIR.

3. To complete the process, click Save or Done.

Motor Setup - Save

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

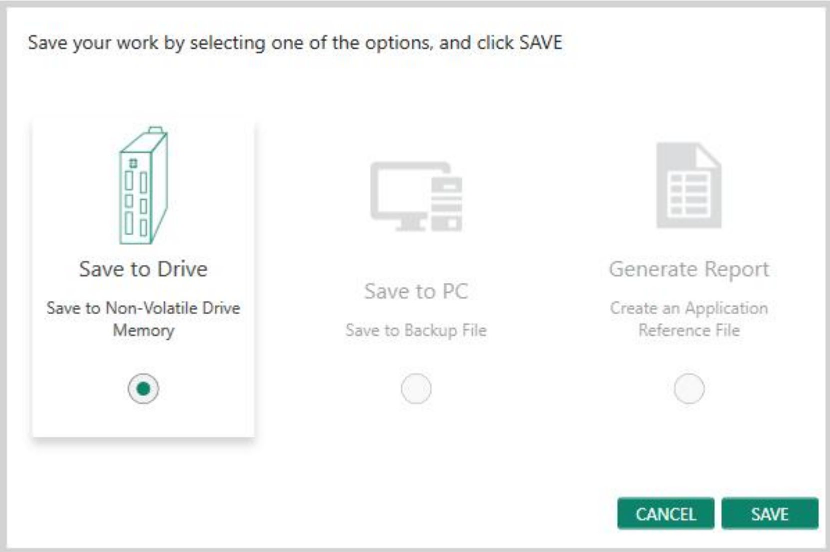


Figure 5-7 Motor setup wizard - save

Do both of the following:

- Click Save to Drive to save the parameters in the drive RAM to its permanent memory.
- Click Save to PC to save the parameters in the drive RAM to a backup file on your computer. Parameters are saved in text files 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 Generate Report.

When activated, Report Generator will open a dialog box that allows you to enter application and user information. Then generate a set of CSV and TXT files in the compressed file. This file can be attached to an email automatically sent to technical support. You can change the address and send it to other recipients.

Please refer to the *Report Generator* in the ServoStudio2 manual.

5.2Drive Identification

You can see and confirm drive information in the Motor Setup wizard.

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:

Table 5-1

VarCom	Description
INFO	Defined by hardware. Return to the drive model and serial number, as well as the version numbers of firmware, control board, power board and FPGA.
DRIVENAME	User-defined parameters. Used when an application has multiple drives. It is recommended to provide the drive with a name that reflects the function it performs, such as Axis-1.

5.3Motor Installation

Motor selection and properties can be displayed and confirmed in the "Motor Setup" wizard.

If the drive does not detect an electronic motor nameplate (MTP), the motor screen allows you to define and initialize the motor.

You can select the motor series and motor part number from the ServoStudio2 database (motor library), and ServoStudio2 can prepare the corresponding motor and feedback parameters.

If your motor is not listed in the default motor library, use the New Motor wizard to define a new motor.

The following parameters are used to view and configure motor identification:

Table 5-2

VarCom	Description
MOTORNAME	If you select a motor from the motor library in the ServoStudio 2 database, the name will be assigned automatically. Users can also assign and modify motor names. The motor name always begins with a quotation mark ("). For example: "MT-6CC401C"

5.4Motor Initialization

Motor commutation is performed in the "Motor Setup" wizard.

If the drive does not detect the electronic motor nameplate (MTP), the Motor screen provides verify and stop buttons to start and stop the MOTORSETUP process.

The MOTORSETUP command starts the quick debugging program, which is used to set and define motor commutation parameters.

During the initialization process, the rotating motor mechanically rotates forward/backward for about two turns in forced commutation, and this information does not need to be fed back. MOTORSETUP detects Hall switch status, index position and polarity, electrical phase sequence, direction of motor motion, and feedback resolution per electrical revolution.

Based on the collected data, the drive updates parameters MFBDIR, MPHASE, MPOLES, MENCRES, and MENCZPOS, so that the motors and wiring connected to the drive can be used.

If the program fails, the original values of MFBDIR, MPHASE, MPOLES, MENCRES, and MENCZPOS will be restored.

Note:	Not all parameters are updated during this process. It depends on the parameters in use determined by MENCTYPE. The MICONT value is very important because this value sets the current limit used in this program.

Program: MOTORSETUP

To perform the "Motor Initialization" process, do the following:

1. Disable drive.
2. Clear any faults in the drive.
3. Enter the command MOTORSETUP (motor setup).
4. Enable the drive (otherwise the process will stop at stage 5/51). The process follows a series of steps.

After the "Motor Initialization" procedure is started (even if the drive is disabled), the digital display shows At1. After the setting is successful, the display returns to normal; if the setting fails, the display shows -5.

To cancel the motor setup process, enter the command MOTORSETUP0

Any parameters modified by the MOTORSETUP program will be restored to their previous values.

To view the status of the program, enter the command MOTORSETUPST.

5.5Current limit

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

The Current Limit tab in the ServoStudio2 Limit screen allows you to define position limit.

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

Table 5-3

VarCom	Description
DIPEAK	Rated peak current of the drive. Defined by hardware. Read only.
MIPEAK	Rated peak current of the motor. This value can be modified.
IMAX	This value is the maximum current of the combination of drive and motor calculated by software. Read only.
ILIM	Current limit of the application. This parameter allows you to limit the peak current of the drive to a value lower than DIPEAK.
ILIMACT	Actual drive current limit. Read only.

5.6Velocity limit

Modify and/or confirm the velocity limits in the "Motor Setup" wizard.

The Velocity Limit tab in the ServoStudio2 Limit screen allows you to define position limit.

The hardware defines the maximum velocity the drive can calculate.

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

Table 5-4

VarCom	Description
MSPEED	The maximum motor velocity defined in the motor data sheet.
VMAX	This value is the maximum velocity of the combination of drive and motor. VMAX is based on the maximum motor velocity. Read only.
VLIM	Maximum velocity. This parameter allows you to limit the maximum velocity of the motor to a value lower than VMAX.

5.7Position limit

Modify and/or confirm the position limit during the Motor Setup wizard.

The Position Limit tab in the ServoStudio 2 Limit screen allows you to define position limit. The following parameters are used to define the position limit mechanism and error tolerance.

Table 5-5

VarCom	Description
PEMAX	Maximum allowable position error without fault, in the unit of count.
PEINPOS	Tolerance window that declares "in position" status.
INMODE#5	The digital input number is defined as a signal indicating whether the position limit has been reached in the positive direction.
INMODE#6	The digital input number is defined as a signal indicating whether the position limit has been reached in the negative direction.
LIMSWITCHPOS LIMSWITCHNEG	Indicating the status of all positive and negative limit events. Read only.
POSLIMMODE	Enable and disable software position limit and/or transient position limit and/or homing limit.
POSLIMPOS POSLIMNEG	Maximum and minimum of the software position limit.

5.8Motor Direction

When the motion command is positive, the direction of motion can be reversed. For example, the positive direction of a rotating motor can be clockwise or counterclockwise, depending on the application requirements.

Test and/or inverse and/or confirm the direction of motion in the Motor Setup wizard.

The following parameters are used ot define the motor direction:

Table 5-6

VarCom	Description
DIR	Motor direction. DIR can be used to inverse the values of position feedback (PFB), velocity (V) and current (ICMD), thus reversing the direction of motor movement.
MPHASE	Resolver/encoder phase related to standard commutation table. To inverse the rotation direction, the value of MPHASE will be increased by 180 degrees.
MFBDIR	Define multiple direction and polarity settings. The value of MFBDIR is set by MOTORSETUP.

Warning!
The values of DIR and MPHASE must be changed simultaneously before the drive is enabled, otherwise commutation failure (motor runaway) may occur.

5.9New Motor Wizard

Note: If the drive detects the electronic motor nameplate, the New Motor Wizard cannot be used during online operation.

If the motor parameters you use are not available in the default motor library series of ServoStudio2, you can use the "New Motor" wizard to define your motor. Once defined, the new motor will be added to the "User Motor" series in the motor library.

The wizard can be activated from the Motor screen or from the Motor Selection step in the Motor Setup wizard.

Click Define New Motor Activation wizard.

Note: It is recommended that you activate the "New Motor" wizard from the "Motor" screen, as parameters cannot be saved to the "User Motor" library when activating the wizard from "Motor Setup".

A series of dialog boxes will prompt you to provide motor parameters, which you can extract from the motor data table.

The New Motor wizard allows you to select unit and enter the value based on the information in the motor data table. In addition, the wizard includes

unit conversion function. After entering all the data in the wizard, ServoStudio2 will convert the unit to the equivalent value used by the drive. These conversion value will be retained in the motor library and the drive.

New Motor - Motor Specifications

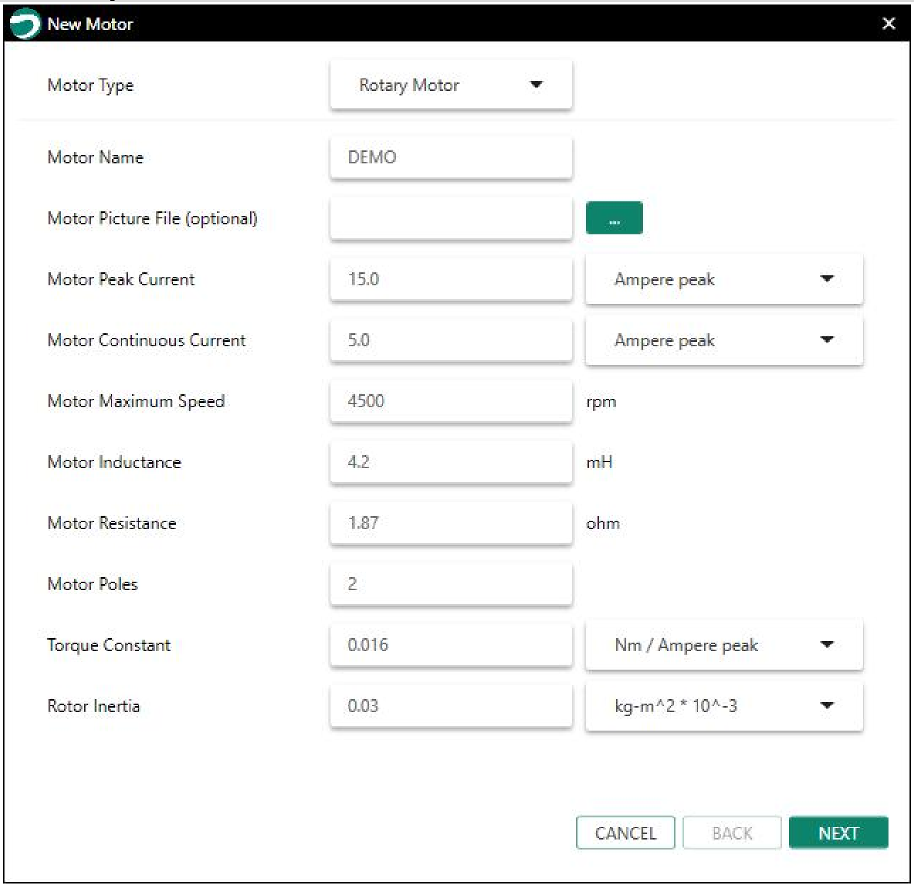


Figure 5-8 New motor definition

Table 5-7

VarCom	Description
MOTORTYPE	Rotary motor/Linear motor
MIPEAK	Motor peak current
MICONT	Motor continuous current
MSPEED	Maximum motor speed
ML	Motor inductance
MR	Motor resistance
MPOLES	Motor poles
MKT	Torque constant (rotatory motor)
MJ	Rotor inertia (rotatory motor)
MKF	Torque constant (linear motor)
MMASS	No-load motor mass (linear motor)
MPITCH	Motor pitch (linear motor)

New Motor - Motor Feedback Selection

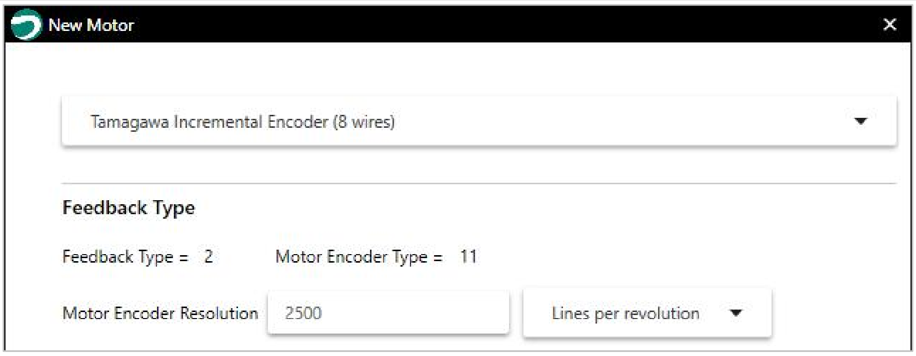


Figure 5-9 New motor - feedback

Table 5-8

VarCom	Description
FEEDBACKTYPE	Feedback type
MENCTYPE	Motor encoder type
MENCRES	Motor encoder resolution

New Motor - Thermal Protection Definition

Figure 5-10 New motor—thermal protection

Table 5-9

VarCom	Description
THERMODE	Motor over-temperature mode

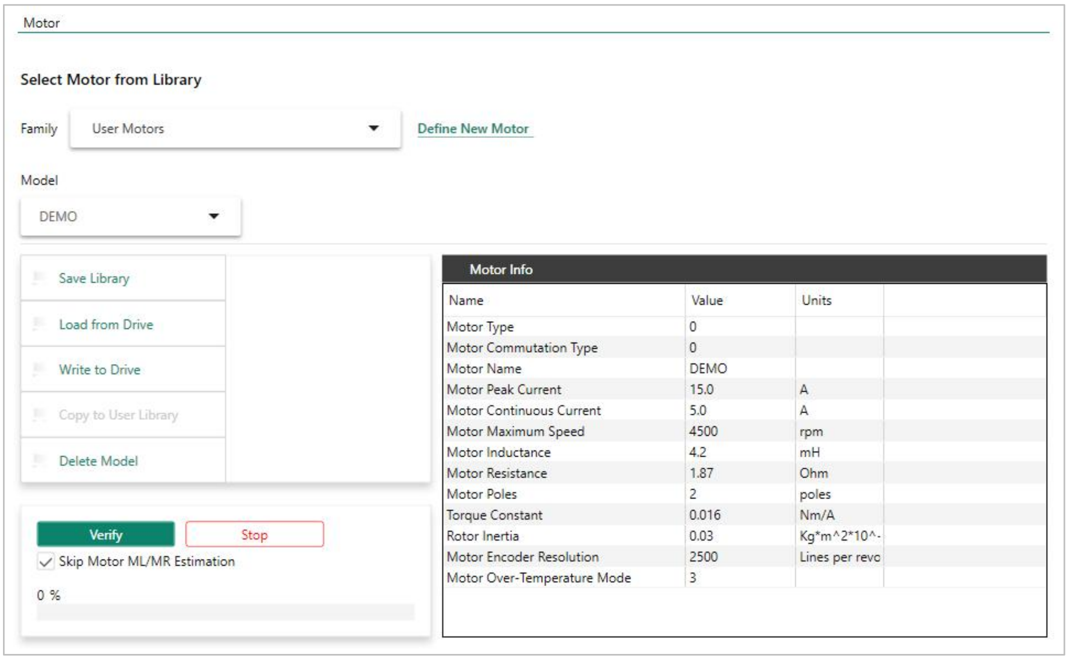


Figure 5-11 New motor - verification

⚠ Verification will start the drive and drive the motor!

Complete the program according to the location activated by the New Motor wizard.

- If the New Motor wizard is activated from the Motor screen, click these buttons in the following order:

a. Save library, to save the motor parameter set to the "User Motor" library.

b. Write to the drive, to send parameters to the drive.

c. Verify, to test motor configuration.

d. Wait for the message "Motor Setup Successfully" to appear.

- If you have activated the "New Motor" wizard from the "Motor Setup" wizard, click Verify to send the parameters to the drive

and test the motor configuration. Wait for the message "Motor Setup Successfully" (failing to save the motor to "User Motor" library

.

6.Application Setup

6.1Parameters

6.1.1 Configuration of parameters

VarCom is a set of proprietary commands and variables or parameters used to configure drive functions when the host and the drive communicate through a serial connection.

VarCom parameters can be accessed and controlled through the ServoStudio2 software on the graphical interface screen or the command line terminal screen.

When setting parameters, please pay close attention to any alarm or error messages appearing on ServoStudio2 and any flashing codes on the digital display of the drive.

Disable the drive before setting motor and feedback parameters.

Many parameters can be modified while the drive is enabled.

However, special attention should still be paid because the motor behavior may change.

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

6.1.2 Management of parameters - drive memory

The CDHD2S drive has two memory types used to store drive parameters:

- Flash memory: Non-volatile memory. Save drive default parameter values (contained in the drive firmware) and save parameter sets.
- RAM: Volatile memory. Drive working memory. Parameter values are saved in RAM as you configure and test the drive and adjust parameters. If the drive is powered off, any unsaved parameter changes will be lost.

During power-up, the CDHD2S loads parameter values from non-volatile memory into RAM and calculates a checksum of these parameter values. If the checksum is invalid, the default parameter value (hard-coded into the drive firmware) will be loaded into RAM and set as "parameter memory checksum failure" fault.

Specific parameters can be stored on the electronic motor nameplate (MTP), such as those used in the sensAR magnetic encoder. When detected during power-on conditions, these parameter values are loaded directly from the encoder memory into the drive RAM.

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

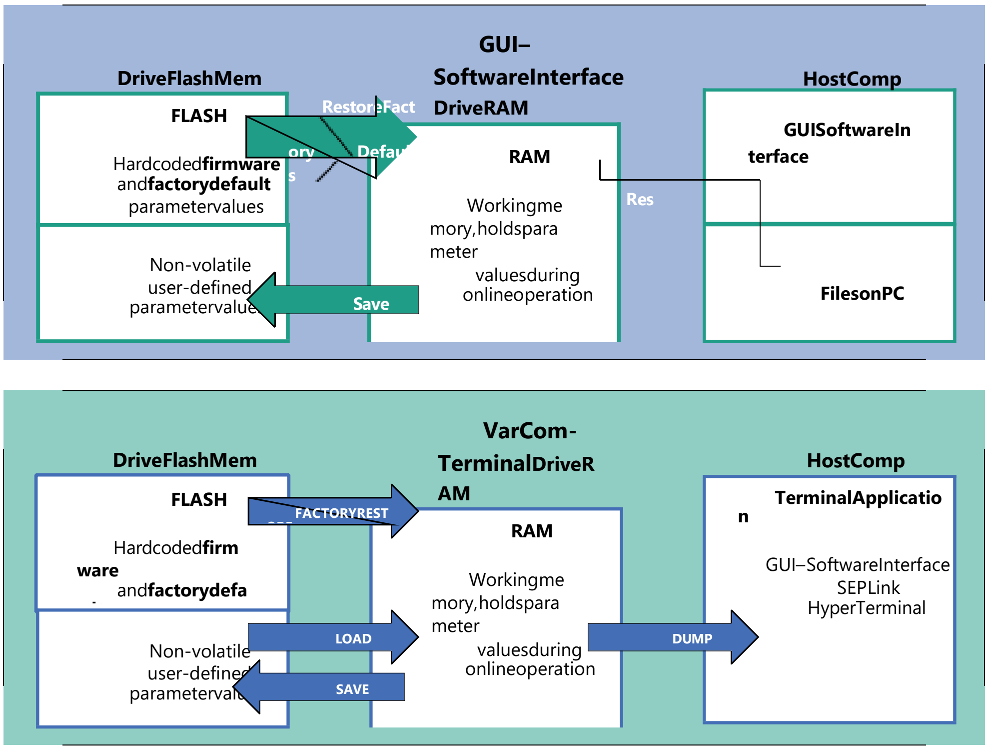


Figure 6-1 Memory and parameter management commands

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

6.2Application Setup Wizard

The Application Setup wizard will guide you through the drive parameter setting procedure according to the special application.

In the first step, the specific "Application Setup" procedure is defined via the selected "Interface Mode". Subsequent steps may include PDO drawing, position unit definition, gear ratio, limit, return and input and output functions.

Note: When the software is offline, all “Interface Mode” will be displayed.
When the software is communicating with the drive, only relevant modes are displayed.

Application Setup - Communication

Figure 6-2 ServoStudio2 - application setup - communication

This will be displayed when the interface mode is CANopen.

It defines the communication settings for the drive system operating in the CANopen network.

Please refer to the section *Communication*.

Application Setup - Operation Mode

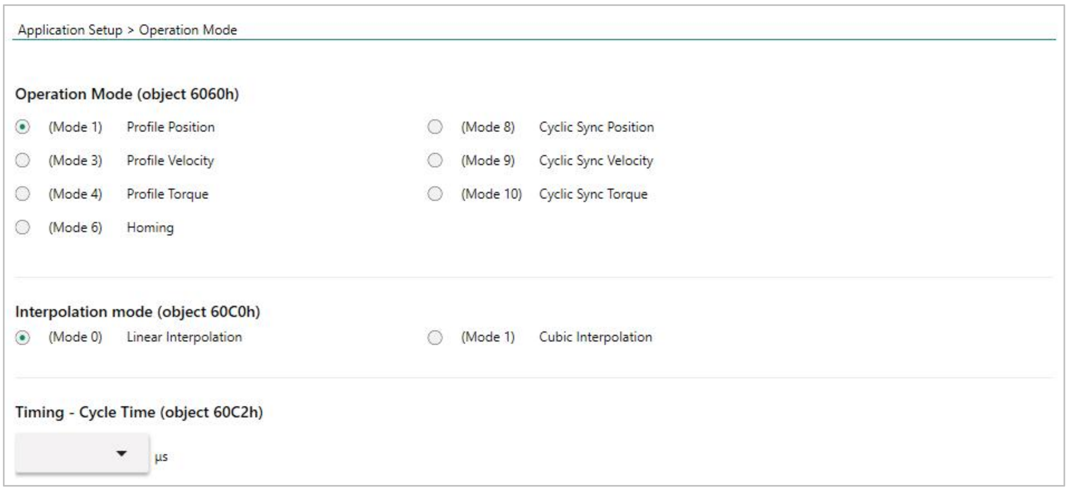


Figure 6-3 ServoStudio2 - application setup - operation mode (CANopen/EtherCAT)

It defines the operation mode of the drive system working in a CANopen or EtherCAT network.

Please refer to the *EtherCAT/CANopen Reference Manual*.

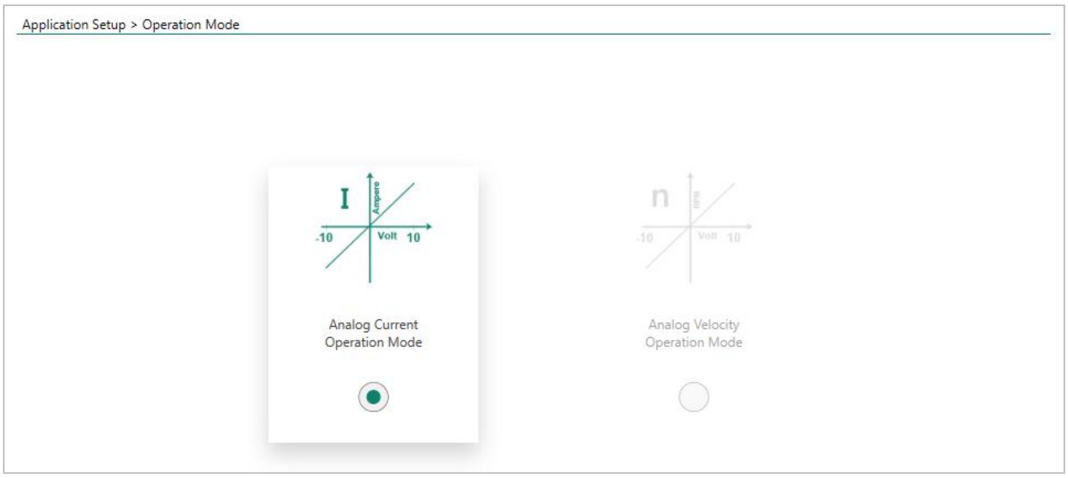


Figure 6-4 ServoStudio2 application setup operation mode (analog command)

It defines the operation mode of the drive system based on the analog command. Please refer to the *Analog Current Operation Mode* and *Analog Velocity Operation Mode*.

Application Setup - Pulse Train

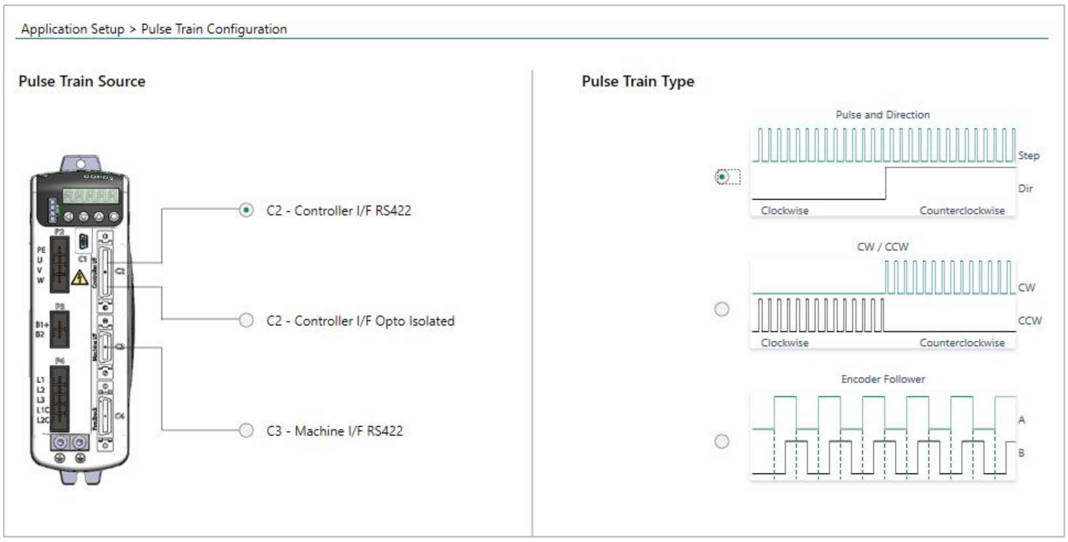


Figure 6-5 ServoStudio2 - application setup - pulse train

It defines the driving method of the drive system working according to a gearing (pulse train). Please refer to the *Gearing/Pulse Train Operation*

Application Setup - Resolution

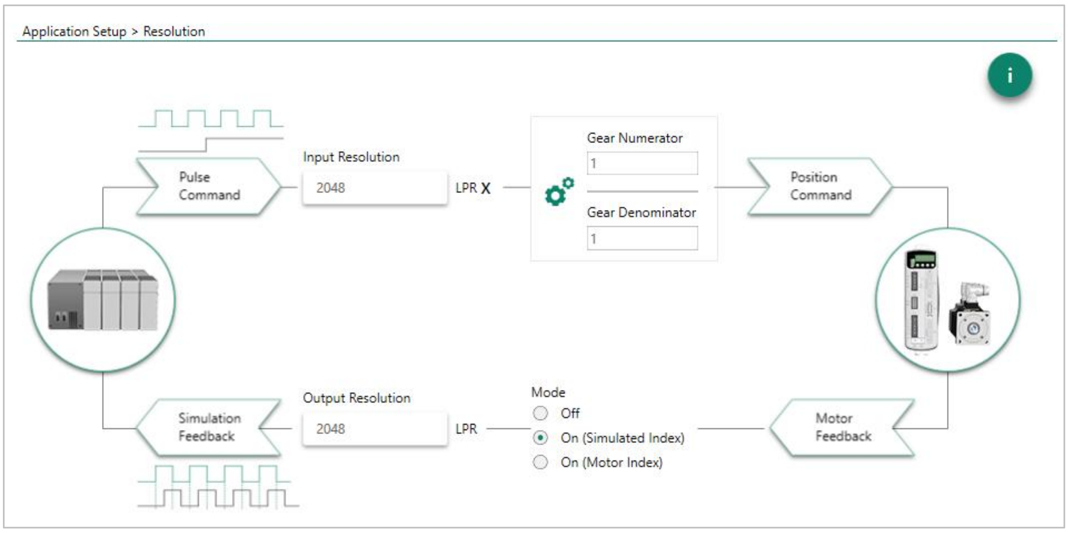


Figure 6-6 ServoStudio2 - application setup - resolution (pulse train)

It defines the resolution, gear ratio and feedback parameters of the drive system working according to a gearing (pulse train).

Please refer to the *Gearing/Pulse Train Operation*

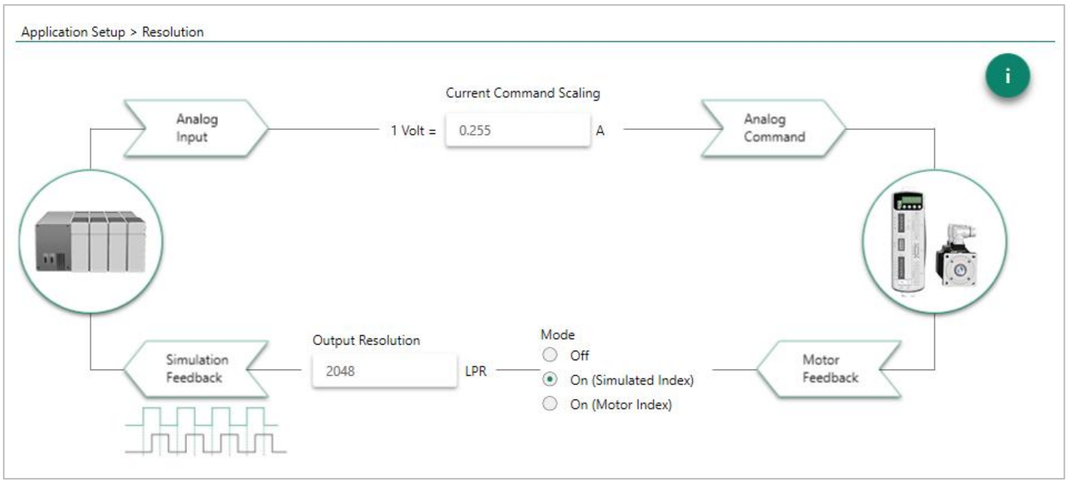


Figure 6-7 ServoStudio2 - application setup - resolution (analog command)

It defines the resolution, gear ratio and feedback parameters of the drive system working according to the analog command.

Application Setup - Filter

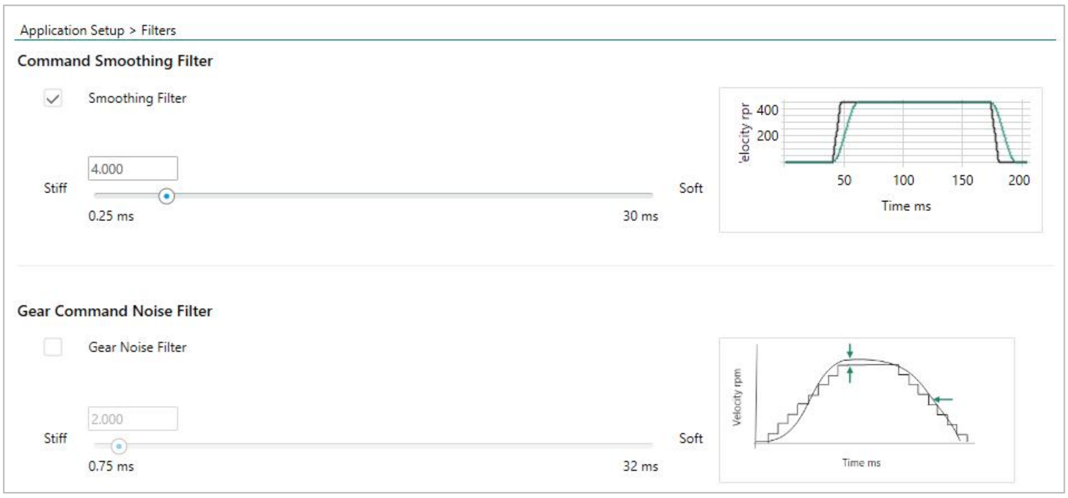


Figure 6-8 ServoStudio2 - application setup – filter (pulse train)

It defines the resolution, gear ratio and feedback parameters of the drive system working according to a gearing (pulse train).

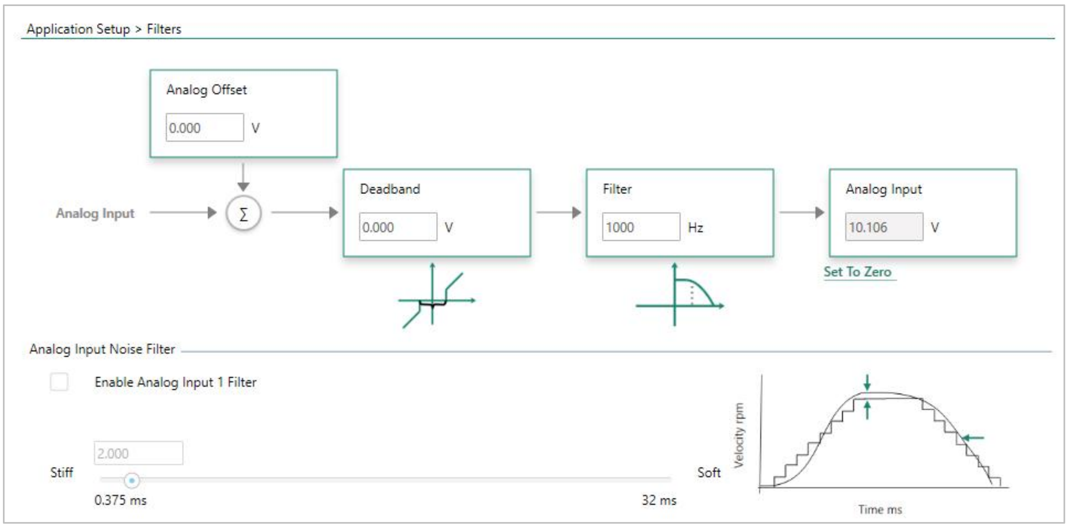


Figure 6-9 ServoStudio2 - application setup - filter (analog command)

It defines the filtering parameters of the drive system working according to the analog command.

Application Setup - Limit

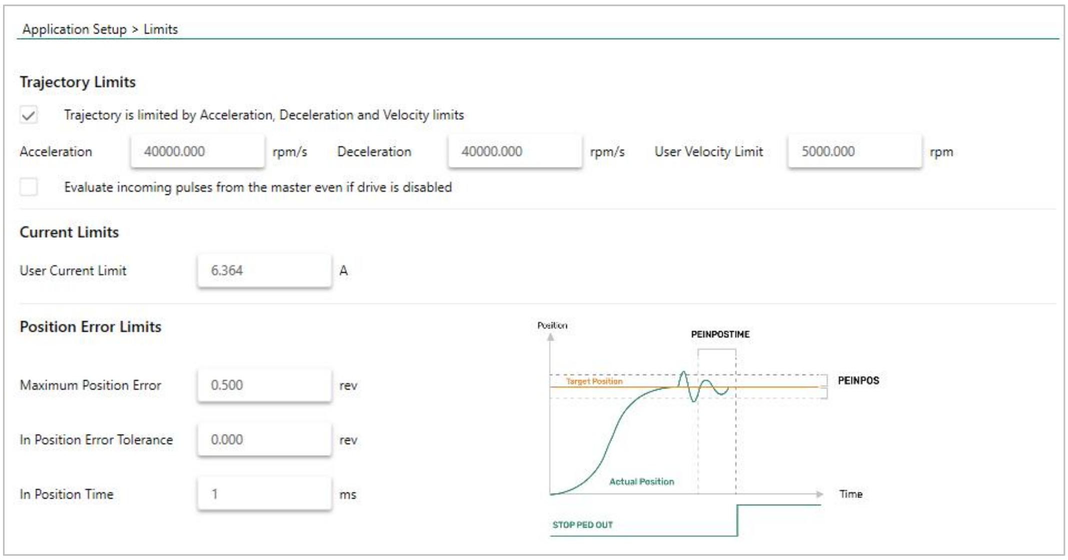


Figure 6-10 ServoStudio2 - application setup - limit (pulse train)

It defines the limit parameters of the drive system working according to a gearing (pulse train).

Figure 6-11 ServoStudio2 - application setup - limit (analog command)

It defines the limit parameters of the drive system working according to the analog command.

Application Setup - PDO Drawing

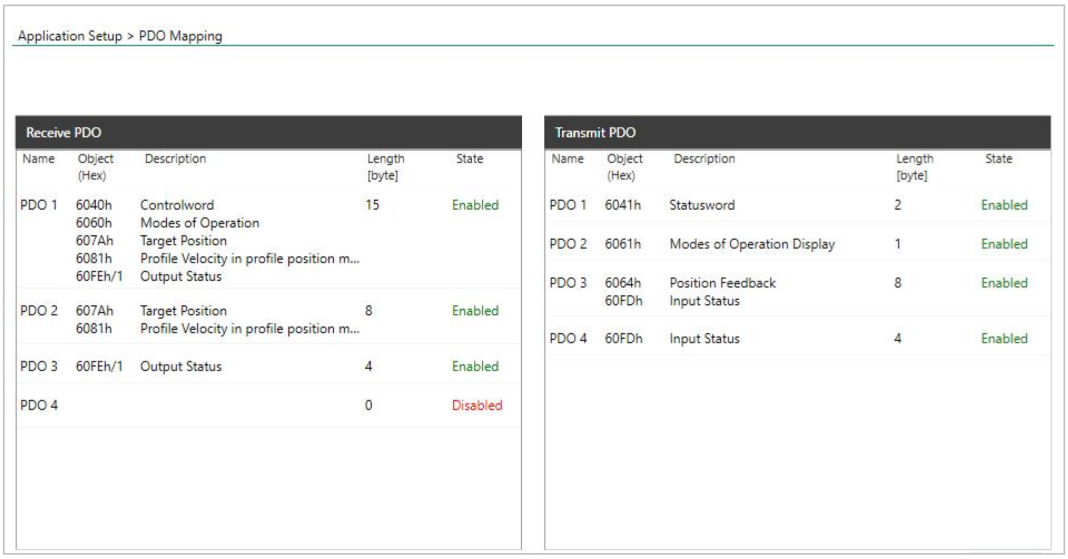
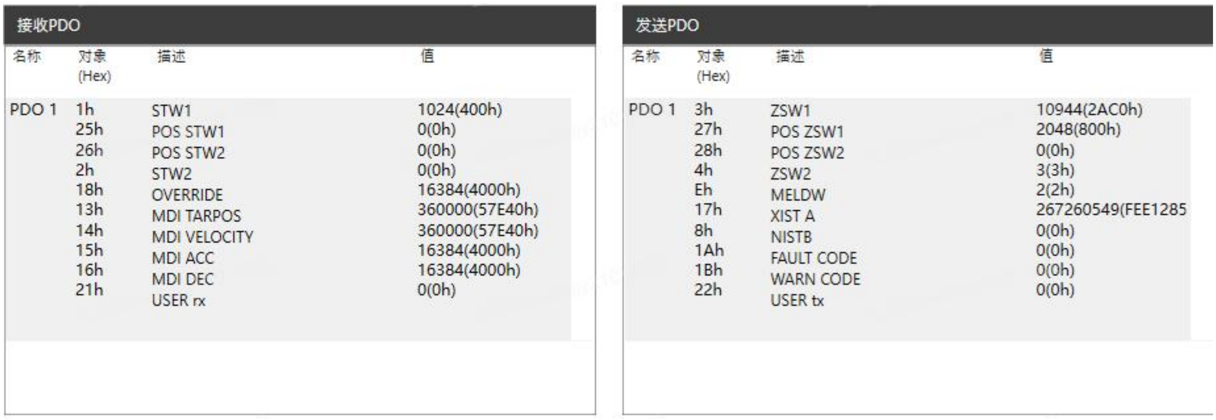


Figure 6-12 ServoStudio2 - application setup - PDO drawing (CANopen/EtherCAT)



接收PDO

名称	对象 (Hex)	描述	值
PDO 1	1h	STW1	1024(400h)
	25h	POS STW1	0(0h)
	26h	POS STW2	0(0h)
	2h	STW2	0(0h)
	18h	OVERRIDE	16384(4000h)
	13h	MDI TARPOS	360000(57E40h)
	14h	MDI VELOCITY	360000(57E40h)
	15h	MDI ACC	16384(4000h)
	16h	MDI DEC	16384(4000h)
	21h	USER rx	0(0h)

发送PDO

名称	对象 (Hex)	描述	值
PDO 1	3h	ZSW1	10944(2AC0h)
	27h	POS ZSW1	2048(800h)
	28h	POS ZSW2	0(0h)
	4h	ZSW2	3(3h)
	Eh	MELDW	2(2h)
	17h	XIST A	267260549(FEE1285
	8h	NISTB	0(0h)
	1Ah	FAULT CODE	0(0h)
	1Bh	WARN CODE	0(0h)
	22h	USER tx	0(0h)

Figure 6-13

It will be displayed when "Interface Mode" is the following mode:

- EtherCAT
- CANopen
- PROFINET

Application Setup - Position Unit

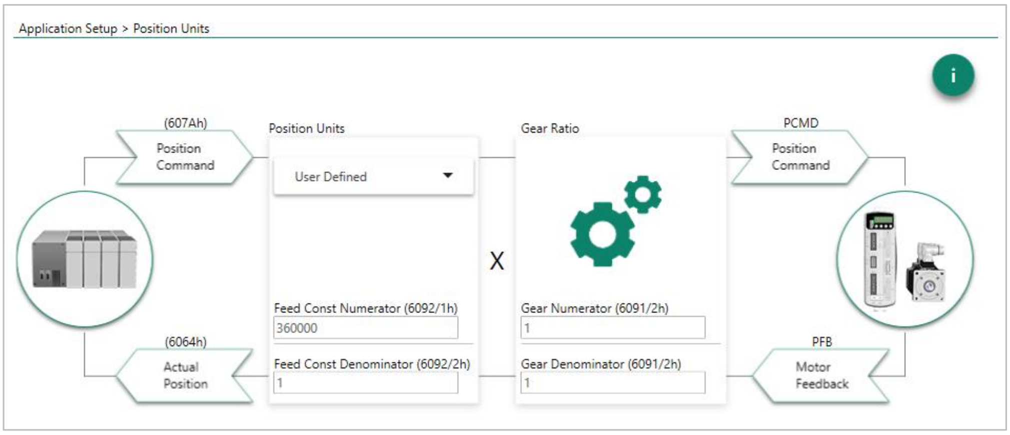


Figure 6-14 ServoStudio2 - application setup - position unit

It will be displayed when "Interface Mode" is the following mode:

- EtherCAT
- CANopen
- PROFINET
  -

Application Setup - Input/Output

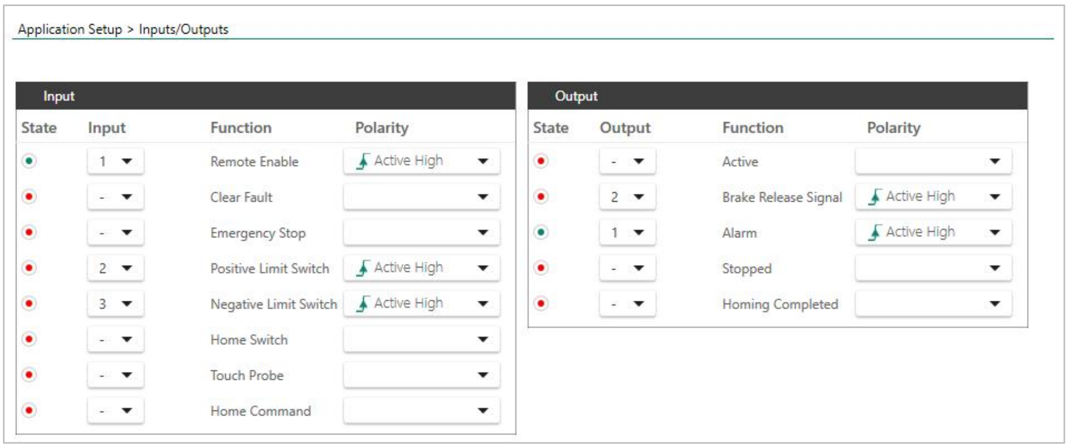


Figure 6-15 ServoStudio2 - application setup - input/output

It will be displayed when "Interface Mode" is the following mode:

- EtherCAT
- CANopen
- Pulse train
- Analog command
- USB/RS232

Application Setup - Return

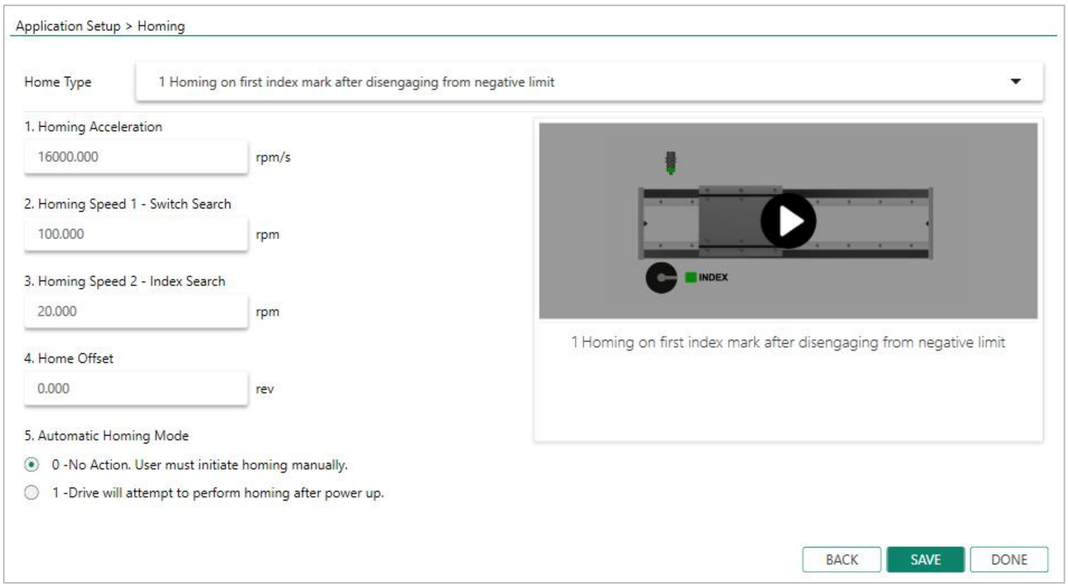


Figure 6-16 ServoStudio2 - application setup - return

It will be displayed when "Interface Mode" is the following mode:

- EtherCAT
- CANopen
- Pulsetrain
- USB/RS232

Application Setup - Save

This option appears in the Application Setup - Return step when the software is communicating with the drive.

6.3Communication

Commissioning the drive via PositionUnits requires serial RS232 or USB connection. After configuring the drive, you can connect the drive to a PLC or controller via an EtherCAT or CANopen network.

When communicating via serial RS232/USB connection and pulse train/analog interface, the drive must be set to COMMODE0.

Note: When communicating via EtherCAT or CANopen networks, the drive must be set to COMMODE1. COMMODE1 is the factory default setting of the drive.

The following parameters are used to configure and monitor communication:

VarCom	Description

COMMODE0	When COMMODE0 is in effect: ● Enable serial RS232/USB communication. ● Disable EtherCAT/CANopen communication. ● PROFINET communication accepts parameter reading and writing, real-time data reading, and cannot be enabled. ● Reference commands are received only through the serial/pulse/analog port. ● Drive can be fully controlled through operation panel and ServoStudio 2 (enabling, motor action, parameter modification). **Note**: The operation panel and ServoStudio 2 are not given priority.
COMMODE1	Only applicable to CDHD2SAF, EC and EB models. When COMMODE1 is in effect: ● Enable EtherCAT/CANopen communication. ● Serial RS232/USB communication can be used as a tool for monitoring and modifying parameters. ● Reference commands can be received through the serial/pulse/analog port. ● Drive can be fully controlled by the field bus device. ● The drive or motor cannot be enabled through ServoStudio 2 or the operation panel **Note**:Certain functions must be performed through ServoStudio 2 or the operation panel. These functions are limited to parameters that do not interfere with the operation of the fieldbus. If you want to set parameters that will interfere with the operation of the fieldbus, the drive will issue an error code on the digital display and/or issue an error message on ServoStudio 2.
BAUDRATE	Set the bit rate of serial communication between the drive and the host.
CANBITRATE	Set the bit rate of CAN bus communication between the drive and the host.

You can establish communication between the host and the drive through the ServoStudio2 communication screen. In addition, the first step in the Motor Setup wizard is to configure communication between the host and the drive.

6.3.1 Serial baud rate

The default baud rate of CDHD2S is 115200. If the settings are changed and saved in the non-volatile drive memory, the saved baud rate will be used when the drive is powered on.

For example, when there is a connection problem, you can try to use a lower baud rate.

Procedure: Modify serial baud rate

To modify the baud rate settings, changes must be made both in the drive and in the ServoStudio2 software.

1. Changing the baud rate in the drive:
   - Enter the terminal screen.
   - Issue a command to change the baud rate; for example: BAUDRATE19200
   - Press enter.

When the enter key is pressed, communication is instantly lost and ServoStudio2 goes offline.

2. Changing the baud rate in ServoStudio2.

- Enter the communication screen.
- Select the same baud rate specified in the drive terminal.

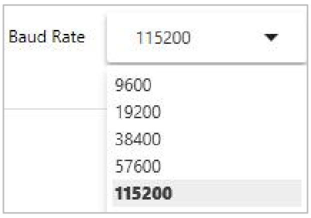


Figure 6-17 Serial baud rate

- Press Connect.

If the operation is successful, ServoStudio2 will reconnect the drive and return to online status.

6.3.2 CANopen baud rate

Program: establish CANopen communication

Establish, verify and modify CANopen communication using ServoStudio2 over serial connections.

1. Make sure to install the CANopen interface according to the manufacturer's instructions.
2. In the ServoStudio2 "Drive Information" screen, select the "Interface Mode" option: EtherCAT/CANopen.
3. In the EtherCAT/CANopen Terminal screen, ensure that the following settings are in effect:

COMMODE1

CANBITRATE3 (or 4, if your system requires it)

To make the CANBITRATE setting takes effect, you must execute the SAVE command and restart.

6.4Power Rating

When a motor is selected from the ServoStudio2 motor library, the rated power parameters are preset and written to the drive. These parameters are defined by the manufacturer and cannot be modified by the user; if you want to modify these parameters, please contact technical support.

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

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

VarCom	Description
DICONT	Drive continuous current. Defined by hardware. Read only.
DIPEAK	Drive peak current. Defined by hardware. Read only.
OVTHRESH	Bus over-voltage protection level Defined by hardware. Read only.
UVMODE	Define how the drive will respond to an under-voltage fault.
UVRECOVER	Define how the drive will return to normal after an under-voltage fault.

UVTHRESH	Bus under-voltage protection level.
UVTIME	Duration of under-voltage fault before it is blocked.
VBUS	Bus voltage (DC).
VBUSREADOUT	Actual bus voltage of the drive. Defined by hardware. Read only.

6.5Feedback

When the CDHD2S drive system contains an electronic motor nameplate, the specific feedback parameters will be directly transmitted to the drive after power-on, and it is impossible to operate.

When a motor is selected from the ServoStudio2 motor library, the motor feedback parameters are preset and written to the drive. These parameters are defined by the manufacturer and cannot be modified by the user; if you want to modify these parameters, please contact technical support.

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

CDHD2S supports a variety of motor feedback devices, including:

- BiSS-C encoder
- EnDat encoder
- HIPERFACE encoder
- Incremental A-quadrature-B encoder, available,without Hall sensor (or reversal tracking)
- Nikon encoder
- Resolver
- sensAR encoder
- Sine encoder
- Tamagawa encoder

6.5.1 Incremental encoder

Type and resolution

CDHD2S supports multiple types of incremental encoders.

The following parameters are used to configure and monitor the incremental encoder.

Table 6-3

VarCom	Description
MENCTYPE	Encoder type used by the motor.
MENCRES	Encoder resolution, number of lines per revolution of motor. For incremental encoders, MENCRES×4 is equal to the encoder count per revolution.

CDHD2S monitors all encoder signal lines. If any wire is damaged, an A/B disconnection fault will be generated (digital display: r4|Fr4)

Hall signal

The CDHD2S supports single-ended (or open collector) and differential Hall signals.

The following parameters are used to configure and monitor the Hall commutation sensor.

Table 6-4

VarCom	Description
HALLSTYPE	Hall signal type.
HALLS	Read the Hall signal status.
HALLSINV	Convert the polarity of a single Hall signal related to the motor phase UVW.

CDHD2S monitors the Hall signal status. If status 000 or 111 is detected, an illegal Hall fault will be generated (digital display: **r6|Fr6**).

If the differential Hall signal cannot be detected, a differential Hall disconnection fault will be generated (**r38|Fr38**).

Note: The differential Hall signal can be used simultaneously with the incremental A and B signals, or as a Hall only using the standard motor feedback C4 connector. If your application requires differential Hall signals as well as incremental A, B, and index signals, please contact technical support.

Encoder index

The encoders usually has an additional channel called marker channel, zero pulse, or index channel. The channel outputs a pulse every revolution, usually a very narrow pulse, which is about a quarter of the pulse width of channel A or B, but it may be wider. The encoder index can be used for return (absolute position reference) and commutation alignment.

You can also use the "Find Index" command in the "Motor Feedback" screen of ServoStudio2 to determine the index signal position.

The following parameters are used to configure and monitor the encoder index.

Table 6-5

VarCom	Description
MENCZPOS	Encoder index position.

CDHD2S monitors the index signal line. If any wire is damaged, an index disconnection fault will be generated (digital display: r5|Fr5).

Phase Find

The Phase Find program is used to initialize the commutation of the incremental encoder system.

Note: The "Phase Find" program can only be used on balanced axes; it cannot be used on unbalanced mechanisms such as the vertical Z axis. Additionally, it cannot be used when gantry mode is in effect.

You can also use the "Phase Find" command in the "Motor Feedback" screen of ServoStudio2 to determine the correct commutation.

The following parameters are used to configure phase find.

Table 6-6

VarCom	Description
PHASEFINDMODE	Method used in commutation phase find.
PHASEFIND	Start the incremental encoder system commutation initialization program.
PHASEFINDGAIN	Adjust the gain of the phase find mechanism.
PHASEFINDI	Adjust the current of the phase find mechanism.
PHASEFINDTIME	Duration of phase find mechanism in soft start.

6.5.2 Sine encoder

Sine encoders are very similar to incremental encoders. The difference is that sine encoder sends A and B channels to the drive in the form of 1V peak-to-peak sine wave, and incremental encoder generates digital pulses at the same time.

6.5.3 sensAR absolute magnetic encoder

The sensAR series absolute magnetic encoders are developed by Servotronix.

SensAR encoder has an electronic motor nameplate (MTP), which refers to a set of motor parameters embedded in the encoder's non-volatile memory.

CDHD2S attempts to detect the electronic motor nameplate when powered on. If detected, the motor and feedback parameters will be transmitted directly to the drive, and the user cannot operate them.

ServotronixPRO2 and PRHD2 motors are often equipped with sensAR encoders.

There are two different types of sensAR encoders:

- Single-turn absolute encoder (FEEDBACKTYPE=12): After restarting, the encoder retains its absolute position within one mechanical rotation. The multi-turn absolute position is 0.
- Multi-turn absolute encoder (FEEDBACKTYPE=19): After restarting, the encoder retains its absolute position within one mechanical revolution, as well as the total number of motor revolutions since the last restart. The multi-turn encoder does not need to return to the original point after each restart.

The multi-turn encoder can store up to 65535 revolutions if it has an external backup battery. The encoder battery is inserted into the battery box on the cable between the motor and the drive. If the cable between the motor and battery box is disconnected, or if the encoder cannot receive battery or drive voltage, the encoder will lose multi-turn revolutions; but the single-turn absolute position will be retained.

The following commands are used to configure and enable a multi-turn absolute encoder.

Table 6-7

VarCom	Description
MTTURNRESET	Reset the counter position of absolute value multi-turn encoder and clear the voltage fault of the battery.
IGNOREBATTFLT	IGNOREBATTFLT=1 is to prevent the multi-turn absolute encoder from issuing faults caused by dead, disconnected or missing spare batteries, so that the encoder is used as a single-turn absolute encoder.

Replacement of battery of multi-turn encoder

The battery voltage level is measured only during the power-up sequence. If the battery voltage drops below the specified value during operation, no warning or fault will be issued before restarting.

- If the battery power drops below 3.15V, the encoder will issue a low battery warning. The battery should be replaced as soon as possible.

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

- If the battery power drops below 3.0V, the encoder will issue a battery dead fault (r40); the drive detects the fault and disables the motor. Multi-turn data is no longer reliable.

To replace the battery: power off the drive. Remove the old battery and insert the new battery. Power on the drive. Issue the MTTURNRESET command to reset the multi-turn encoder position counter. The MTTURNRESET command will also clear the fault.

6.5.4 BiSS-C interface

BiSS is an open interface for sensors and actuators. The BiSS-C standard allows suppliers of such feedback devices to define a small set of commands that require the feedback devices to perform specific functions. BiSS-C execution in the drive is bidirectional.

The following commands are used to configure and monitor the BiSS-C feedback device.

Table 6-8

VarCom	Description
BISSCFIELDS	Set the number of bits of the position information transmission configuration in the BiSS-C packet and the effective number of bits. It is suitable for both rotary and linear encoders. The value used by the command variable comes from the data table information provided by the encoder manufacturer.
BISSCINFO	Return to the related information about BiSS-C device.

6.5.5 EnDat2.x bidirectional interface

The EnDat interface is a digital bidirectional interface for encoders. This interface can not only transmit the position values of the incremental and absolute encoders, but also transmit or update the data stored in the encoders or save new information. The data is transmitted synchronously via the clock signal of the subsequent electronic device. The data type (e.g. position value, parameters, diagnostics) is selected by the mode command sent by the subsequent electronics to the encoder.

CDHD2S supports EnDat2.1 communication protocol, which is a subset of EnDat2.2 protocol. All EnDat2.2 enabled devices support the 2.1 protocol, including commands and queries related to CDHD2S; therefore, all EnDat2.2 enabled devices can be used with CDHD2S.

EnDat2.x can be used with CDHD2S in the following ways:

- EnDat2.x communication only: Suitable for the setting that the drive only depends on the serial data provided by the feedback device (position information source).
- EnDat2.x with Sine/Cosine: Suitable for the following settings (a) the drive performs encoder initialization and uses serial data for position initialization; (b) position update during operation is derived from the sine/cosine signal.

Note: CDHD2S does not support querying and setting parameters during position feedback operation.

The CDHD2S communication rate is 2MHz (to modify the communication rate, please refer to VarComFEEDBACKBR).

EnDat2.x encoder with sine signals: The position feedback (PFB) value is calculated from the HWPOS value and sine/cosine signals during EnDat initialization after power-on and after clearing feedback-related faults. It may take several seconds for initialization to complete. During this time, the position feedback (PFB) value is undefined and therefore the drive cannot be enabled.

EnDat encoder initialization takes approximately 2.5 seconds; during this process, if the drive status is interrogated (using the ST command), the message "ENDAT initialization not completed" will be displayed.

The EnDat encoder +5V DC supply must be switched off during (re)initialization. During EnDat initialization, CDHD2S turns off the DC voltage +5V provided to the encoder. However, if the encoder receives DC voltage +5V from a different source and is not switched off, initialization may fail.

6.5.6 Encoder analog output

The encoder analog output, also known as equivalent encoder output (EEO) or buffer encoder output, is available at the controller interface (C2).

The following parameters are used to configure the analog.

Table 6-9

VarCom	Description
ENCOUTMODE	Turn on or turn off encoder simulation and set functions.

ENCOUTRES	Encoder analog output resolution is expressed by equivalent lines per revolution.
ENCOUTZPOS	Encoder analog output index offset value.

6.5.7 Resolver

It is a resolver used to measure the position of the motor shaft.

The resolver has a primary winding and two secondary windings - sine and cosine synchronous with motor rotation. The voltage level on the sine and cosine waves is related to the axis position in one magnetic cycle (one pole pair) of resolver.

The resolver usually enables dynamic tracking that is slower than the encoder.

The following parameters are used to configure and monitor resolver feedback.

Table 6-10

VarCom	Description
RESAMPLRANGE	Acceptable range of sine/cosine signal of resolver is expressed as a percentage of its nominal value (plus and minus percentage)
MRESPOLES	Number of electrodes of single resolver feedback device.
RESFILTMODE	Define whether to perform feedback position interpolation on resolver feedback to generate a continuous data stream.
RESBW	Resolver conversion bandwidth. High bandwidth can obtain better dynamic tracking, and the high frequency phase lag is small. Low bandwidth generates low noise. RESBW sets the optimal balance value according to the specific application requirements.

Note: After the drive is powered on, the autotuning of the resolver reference amplitude takes about 3-5 seconds. During this time, the drive cannot be enabled.

6.5.8 Calibration of resolver and sine encoder

Resolver and sine encoder calibration overview

When the CDHD2S is connected to a motor equipped with a resolver or sine encoder for the first time, the CDHD2S parameters must be calibrated. Calibration is required during system assembly. Since the analog component values may change at any time, it is required to repeat the calibration procedure every two years. After completing the calibration procedure, the calibration parameters will be saved to the CDHD2S.

When calibrating, the CDHD2S needs to read 128 sine signals in one direction or back and forth.

Typically, the 128 sine signals required for resolver generation will require the motor to rotate 128 times. Therefore, it is necessary to make the motor move at a limited velocity through motion commands.

The sine encoder is typically capable of generating 128 sine signals in one rotation of the motor. Therefore, the motor can be operated manually for calibration.

Resolver and sine encoder parameters

The following parameters are used to configure and monitor resolver/sine encoder calibration.

Table 6-11

VarCom	Description
SININITMODE	Enable/disable the automatic calibration of sine and cosine signals of sine encoder or resolver when it is powered on.
SININIT	Activate the program for calibrating sine and cosine signals of sine encoder or resolver. This calibration is to reduce harmonic errors in sine encoder or resolver readings. The program obtains the average value of sine encoder or resolver singal for multi-turn motor rotation, and determines the gain and offset correction.
SININITST	Report the status of the calibration program of the sine encoder or resolver.
SINPARAM	Return to the parameters used to calibrate sine and cosine signals of a sine encoder or resolver. Parameters are expressed in hexadecimal.

Number of motor revolutions required for calibration

If your application has limited stroke, you can run the motor back and forth 128 times. The length of each of these 128 movements must be at least 1.5 sine cycles. If the motor is operated in one direction, the number of revolutions required for calibration is calculated as follows:

Resolver: $128 \div \frac{\text{MRESPOLES}}{2}$

Where, MENRESPOLES refers to the number of individual electrodes in the resolver feedback device.

For example, if MRESPOLES=4, the motor calibration requires 64 revolutions.

Sine encoder: $\frac{\text{MENCRES}}{128}$

Where, MENCRES refers to the number of sine cycles per revolution or per motor pitch.

Motor velocity limit during calibration

During the calibration procedure, the motor velocity should not exceed the following values:

Resolver: $\frac{3750 \bullet 2}{\text{MENCRES}}\text{rpm}$

Sine encoder: $\frac{3750}{MENCRES}$ rpm

Calibrating resolver and sine encoder

Procedure: Calibrate resolver using terminal

1. In the terminal interface, enter the sine/cosine calibration command:

SININIT<Enter>

2. According to your application operation mode, enter a command to run the motor at low speed (e.g., about 800rpm) for about 10 seconds.

3. Enter the sine/cosine calibration status command:

SININITST<Enter>

4. Wait for SININITST to change to 1, then return to 0.

Example: The motor is running in a velocity control loop at 600rpm and a calibration procedure is performed.

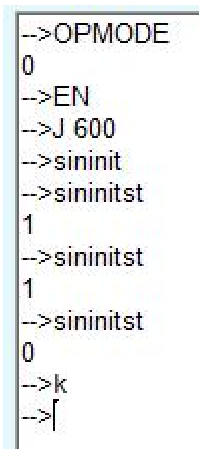


Figure 6-17

Procedure: Calibrate resolver using ServoStudio2

1. In the Feedback screen, select Feedback > Resolver.

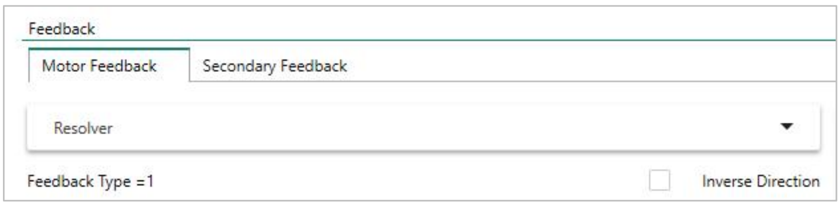


Figure 6-18

2. In the Motion screen, set parameters such as:

- Select "Operation Mode > Serial Velocity".

- Set the velocity to 600rpm.

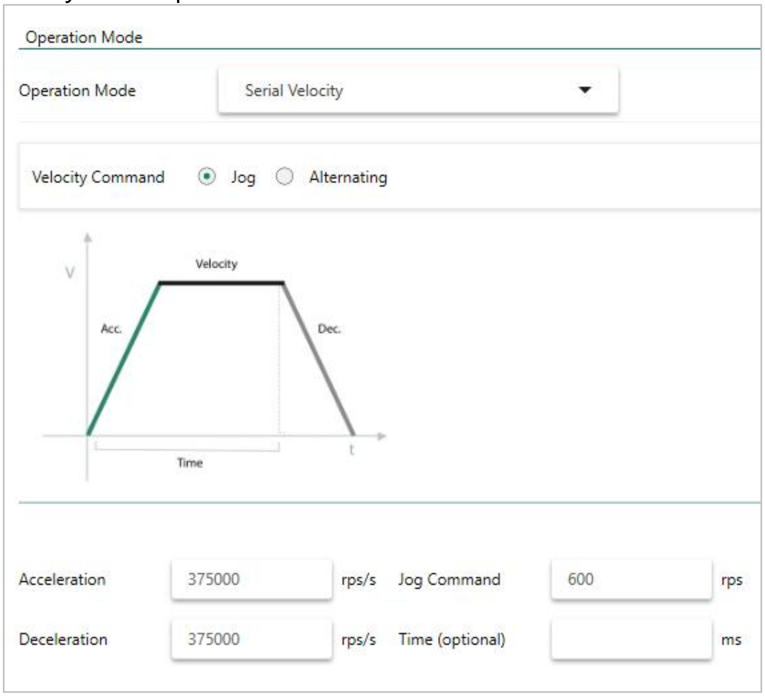


Figure 6-19

3. In the Feedback screen, make the following settings:

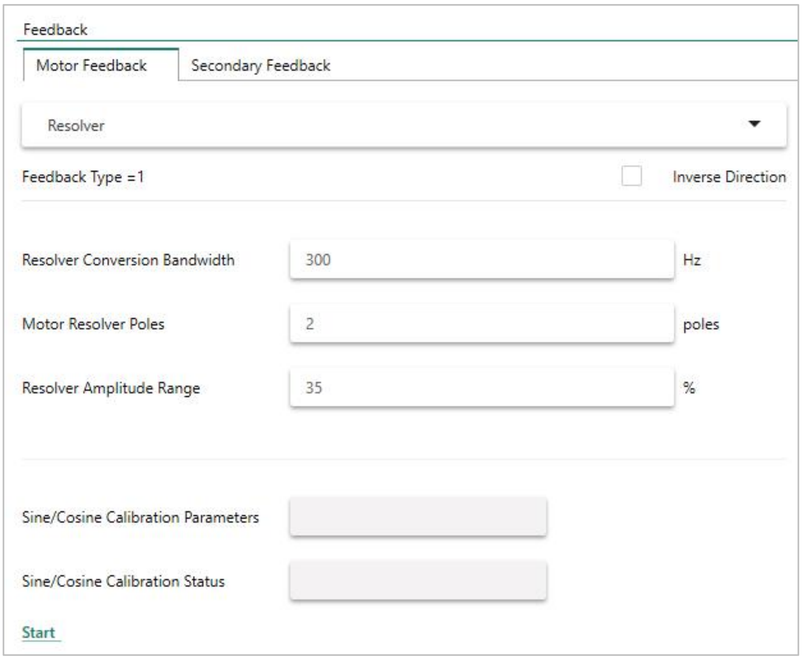


Figure 6-20

a. Notice that the sine/cosine calibration status is 0.

b. Press the "Start" button to begin the calibration procedure.

c. Notice that the sine/cosine calibration status changes to 1.

d. Wait for the sine/cosine calibration status to return to 0.

Calibration completed.

1. In the terminal interface, enter the sine/cosine calibration command:

SININIT<Enter>

2. According to your application operation mode (current, velocity, or position mode), enter a command to run the motor at a low speed (e.g., 100 rpm). Alternatively, the motor can be run manually.

3. Enter the sine/cosine calibration status command:

SININITST<Enter>

4. Wait for SININITST to change to 1, then return to 0.

Example: The motor is running in a velocity control loop at 6rpm and a calibration procedure is performed.

```
-->OPMODE
0
-->EN
-->J 6
-->sininit
-->sininitst
1
-->sininitst
1
-->sininitst
0
-->sininitst
0
-->sininitst
0
-->MENCRES
128 [LPR]
-->
```

Figure 6-21

Procedure: Calibrate sine encoder using ServoStudio2

Currently, ServoStudio2 does not support sine encoder calibration.

Sine encoder and resolver diagnosis

Overview of sine encoder and resolver diagnosis

When working with a sine encoder or resolver, the CDHD2S measures the sine and cosine signal levels and checks if they are within the specific range. When the signal is out of range, two faults may occur: r4 and r8.

If these faults occur, sine and cosine signals should be recorded to determine whether they are valid.

Record signal

Sine and cosine signals can be recorded by special recording drive - internal data. A typical RECORD (record) command is as follows:

record11000"@ENCSINE"@ENCCOSINE

This command records 1000 samples of sine and cosine values at 31.25μs intervals (based on the drive rate).

A typical sine encoder recording might look like the figure below.

Recorded data is expressed in internal drive unit (analog-to-digital converter counts).

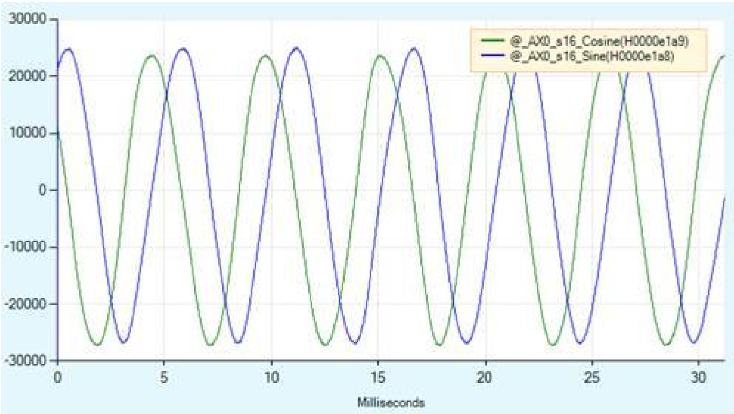


Figure 6-22 Sine encoder recording - example

A typical resolver record might look like the figure below.

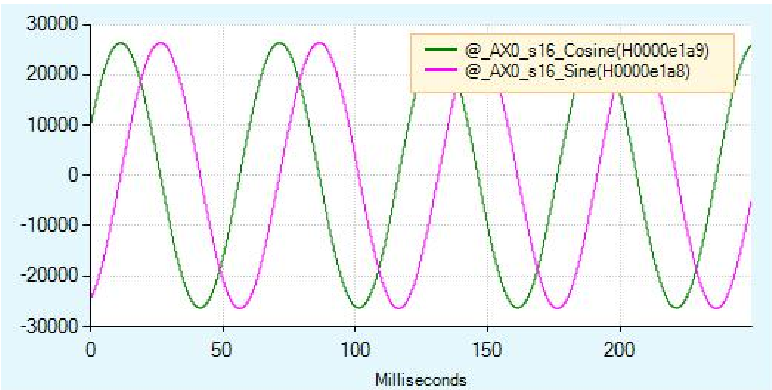


Figure 6-23 Resolver recording - example

Converting to physical value

The recorded data is expressed in internal drive unit and needs to be converted to physical unit; i.e. drive input voltage.

Since the physical sine and cosine signal scales of the sine encoder and resolver are different, the following equation is used to convert the recorded data:

Sine encoder: input voltage $= \frac{\text{recorded value}}{32768} \times \frac{10}{162}$

Resolver: input voltage $= \frac{\text{recorded value}}{32768} \times \frac{10}{325}$

Check the data diagram

Recorded data can be converted in the ServoStudio2 "Range" screen.

When checking the sine and cosine signals of the sine encoder, you need to calculate as: signal ×0.00001883 (1/32768 x 10/16.2).

The resulting data diagram in the Rang screen will look similar to the figure below. This diagram shows the signal level (expressed in volts) of the actual input signal. As expected, the sine encoder signal is close to 1V peak-to-peak.

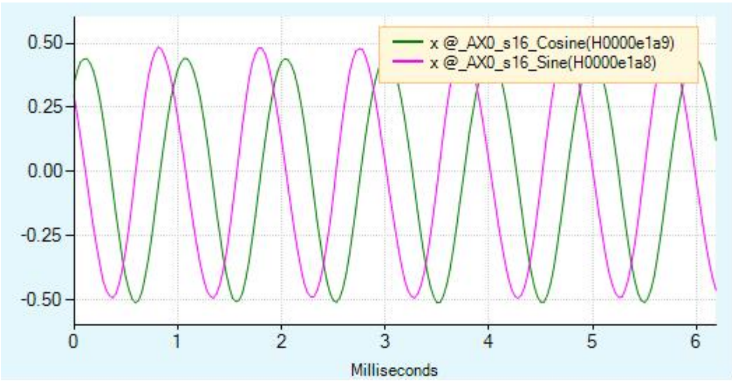


Figure 6-24 Sine encoder signal - example

When checking the sine and cosine signals of the resolver, you need to calculate as: signal ×0.0000939 (1/32768 x 10/3.25).

The resulting diagram in the Rang screen will look similar to the figure below. This diagram shows the signal level (expressed in volts) of the actual input signal.

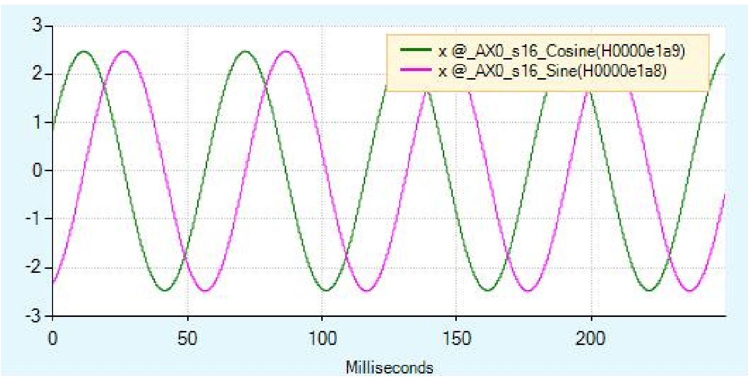


Figure 6-25 Resolver signal - example

6.6Secondary feedback

Please also refer to *Dual Feedback Position Control Loop Tuning*.

6.6.1 Overview of secondary feedback (dual loop control)

CDHD2S can correct positioning error through secondary feedback device and dual-loop control.

In dual-loop control, two feedback devices (usually encoders) are connected to one axis: one feedback device is mounted on the motor and the other is connected to the load. The load feedback device controls the positioning, while the motor feedback device controls the velocity and current.

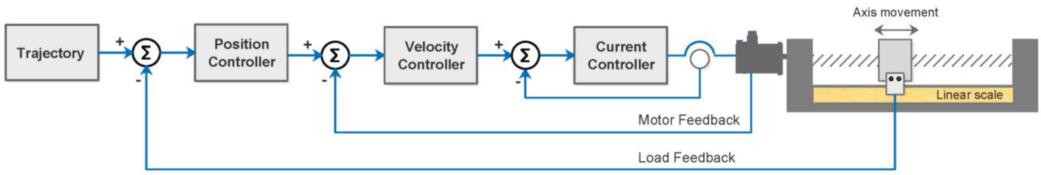


Figure 6-26 Dual loop control using secondary feedback

In dual loop control, the secondary (load) encoder acts as primary positioning feedback. Therefore, the following functions are performed on the load feedback:

- Homing, including index homing. Please refer to the *Homing*.
- Encoder analog output. Please refer to *Encoder Analog Output*.
- AB quadrature encoder interpolation.
- Contact probe capture.

Dual loop control is available in the following operation modes:

- OPMODE4 (gearing/pulse train)
- OPMODE8 (serial position)
- CiA402 mode 1 (profile position)
- CiA402 mode 8 (periodic synchronization position)

For dual loop control, the motor feedback device is connected to the CDHD2S feedback connector (C4) and the load feedback device is connected to the secondary encoder pin on the CDHD2S connector (C3).

When using dual loop control, the gearing input must through the controller interface (C2); GEARMODE0, 1 and 2.

Note: When the CDHD2S error correction function is used in a dual control loop system, the secondary (load) encoder value is corrected.

6.6.2 Secondary feedback device

CDHD2S dual loop control can be implemented by using either a rotary motor (MOTORTYPE=0) or a linear motor (MOTORTYPE=2).

In addition, the double loop control secondary feedback device can be AB quadrature, BiSS-C interface or EnDat2.2.

For a stable dual loop control, the effective resolution of the motor encoder must be higher than the effective resolution of the load feedback device. The low resolution of the motor encoder will cause the position loop to issue VCMD (its resolution is too high), and it cannot be executed by the velocity loop. If the load encoder servos closed position and velocity control loop and the motor encoder servos current control loop, a load encoder with high resolution can be used.

6.6.3 Secondary feedback bus

In EtherCAT and CANopen, the drive reports position feedback (object 6064h), velocity feedback (object 606Ch) and position error (object 60F4h).

In PROFINET, the drive reports position feedback (PZD G1_XIST1 and XIST_A), velocity feedback (PZD NSOLL_A and NSOLL_B)

- When dual loop is activated, the above objects will be reported based on the load feedback.
- When dual loop is not activated (default), the above objects will be reported based on the motor feedback.

6.6.4 Secondary feedback unit

User unit

Secondary feedback uses the same parameters as motor feedback.

- If the load feedback is a rotary encoder: SFB and SFBVEL are expressed in rotation units: UNITSROTPOS, UNITSROTACC and UNITSROTVEL.
- If the load feedback is a linear encoder: SFB and SFBVEL are expressed in linear units: UNITSLINACC, UNITSLINVEL, UNITSLINPOS.

Secondary feedback motor to load ratio

[LMUNITSNUM/LMUNITSDEN] is the mechanical ratio, defined as follows:

- For a rotating system: the motor rotates once for every n turns of the load.

- For a linear system: the motor rotates once per n millimeter of linear motion.

Load rotating motor and linear encoder - example

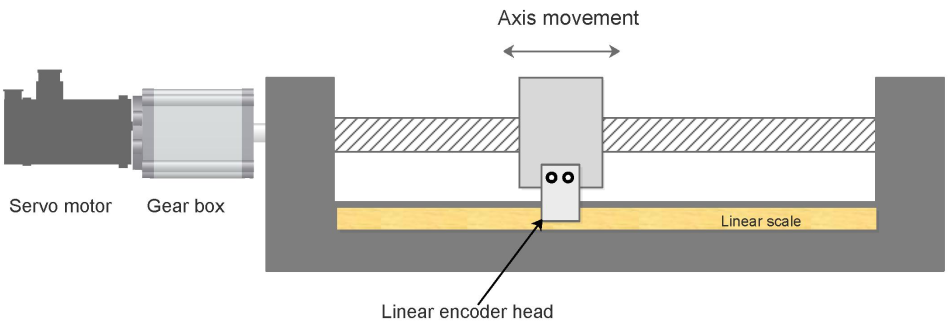


Figure 6-27 Load rotating motor (with gear box and ball screw) and linear encoder

Motor reducer speed ratio: 1:11

Ball screw pitch: 20mm

$$\frac{\text{LMUNITSNUM}}{\text{LMUNITSDEN}} = \frac{1}{11} * \frac{1}{20} = \frac{1}{220}$$

Load rotating motor and rotary encoder - example

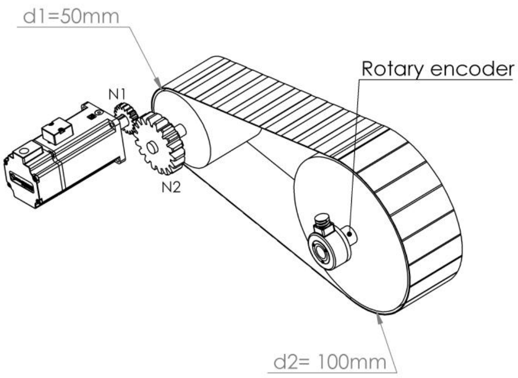


Figure 6-28 Load rotating motor and rotary encoder

Motor side pulley diameter: 50mm

Load side pulley diameter: 100mm

N1: Number of teeth of N1 gear (10)

N2: Number of teeth of N2 gear (60)

$$\frac{\text{LMUNITSNUM}}{\text{LMUNITSDEN}} = \frac{10 \times 100}{60 \times 50} = \frac{1}{3}$$

6.6.5 Secondary feedback parameters

The following parameters are used to configure and monitor dual feedback applications.

Table 6-12

VarCom	Description	Description
SFBMODE	Secondary feedback mode	Activate/deactivate the dual feedback control mode.
SFBTYPE	Secondary feedback type	Feedback device type (rotary or linear) and communication interface.
SFBENCTYPE	AB quadrature encoder secondary feedback type	Load AB quadrature encoder type.
SFBDIR	Secondary feedback direction	Positive feedback from the load.
SFBOFFSET	Secondary feedback offset	Increased offset value of SFB.
SFBRES	Secondary feedback resolution	Resolution of the load feedback device, expressed by the number of lines per revolution or the number of lines per millimeter.
LMUNITSDEN	Denominator of motor and load mechanical ratio	Denominator of conversion factor for motor feedback and load feedback.
LMUNITSNUM	Numerator of motor and load mechanical ratio	Numerator of conversion factor for motor feedback and load feedback.
MFB	Motor feedback position (Read only)	Based on the position of the motor feedback device.
SFB	Secondary feedback position (Read only)	Based on the position of the load feedback device.
PFB	Feedback position (read only)	Position of (motor or load) based on SFBMODE.
MVEL	Motor velocity (read only)	Motor velocity.
SFBVEL	Secondary feedback velocity (Read only)	Load velocity.
SFBVLIM	Secondary feedback velocity limits	Define the maximum load velocity.
V	Velocity (read only)	Velocity of (motor or load) based on SFBMODE.
MACC	Motor acceleration	Acceleration value based on the motor feedback device.
SFBACC	Secondary feedback acceleration	Based on the acceleration value of the load feedback device.
ACC	Acceleration	Acceleration value of (motor or load) based on SFBMODE.
MDEC	Motor deceleration	Deceleration value based on the motor feedback device.
SFBDEC	Secondary feedback deceleration	Deceleration value based on the load feedback device.

DEC	Deceleration	Deceleration value of (motor or load) based on SFBMODE.

6.7Motor Unit

CDHD2S provides configurable acceleration, velocity and position units for both linear and rotary motor systems. The unit is defined as the user's preference or the specific motor performance being used.

Use the ServoStudio2 Motion Unit screen to view and define motion unit.

The following parameters are used to monitor and configure the motion unit.

Table 6-13

VarCom	Description
UNITSROTPOS	Rotatory system position variable unit.
UNITSROTVEL	Rotatory system velocity variable unit.
UNITSROTACC	Rotatory system acceleration and deceleration variables unit.
UNITSLINPOS	Linear system position variable unit.
UNITSLINVEL	Linear system velocity variable unit.
UNITSLINACC	Linear system acceleration and deceleration variables unit.
PNUM PDEN	User-defined conversion factor for units. Used to multiply the motor revolution (rotary motor) or motor pitch (linear motor) according to the motor type (MOTORTYPE).
FBGDS	Conversion coefficient of velocity of fieldbus driving shaft.
FBGMS	Conversion coefficient of velocity of fieldbus gearing shaft.

6.8Foldback current

Foldback current is a mechanism used by CDHD2S to protect the drive and motor from overheating due to excess current. Set the foldback current of the drive and motor independently.

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

When a motor is selected from the ServoStudio2 motor library, the foldback current parameters are preset and written to the drive. These parameters are defined by the manufacturer and cannot be modified by the user; if you want to modify these parameters, please contact technical support.

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

The following parameters are used to monitor and configure the foldback performance.

Table 6-14

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

6.9Digital Input

The CDHD2S features both regular and fast optoisolated digital inputs. The number of inputs varies with the model. Please refer to the *Input/Output Specifications* table.

- The transmission delay of conventional digital input is less than 1 millisecond.
- The transmission delay of fast digital input is less than 1 microsecond.

Use the ServoStudio2 Digital IO screen to configure and view digital input status.

The following parameters are used to configure and monitor digital inputs.

Table 6-14

VarCom	Description
IN	Read the specified digital input status.
INPUTS	Read all digital input status.
INMODE	Define the digital input function.
ININV	Convert the specified input polarity.

ServoStudio2 includes a drive script tool for compiling digital input instructions. These scripts can modify the drive behavior while the machine is working, such as increasing or decreasing acceleration, starting the action, setting variables, or switching the operation mode. Please refer to the *Digital Input Drive Script Activation* in the ServoStudio2 manual.

6.10Digital output

The CDHD2S features both regular and fast optoisolated digital outputs. The number of outputs varies with the model. Please refer to the *Input/Output Specifications* table.

- The transmission delay of conventional digital output is less than 1 millisecond.
- The transmission delay of fast digital output is less than 1 microsecond.

Use the ServoStudio2 Digital IO screen to configure and view digital output status.

The following parameters are used to configure and monitor digital outputs.

Table 6-15

VarCom	Description
OUT	Read the specified digital output status.
OUTPUTS	Read all digital output status.
OUTMODE	Define the digital output function.

6.11Digital Output Control Using Comparison Matching (PCOM)

Note: Only CDHD2SAF (CANopen) and EC (EtherCAT) models have this function.

The drive includes two PCOM modules (PCOM1 and PCOM2) for comparison matching based on position feedback or timer triggering output.

The output is used to activate an external event or device - such as a camera, pick-and-place machine, or measurement device - when the CDHD2S moves through a predefined position or position range.

The two PCOM modules have the same function and can be used to configure pulse or level switching output.

The PCOM module allows three different trigger output configurations.

- Cycle configuration: Trigger output based on the fixed feedback count between positions.
- Table configuration: Trigger output based on the predefined position group.
- Timing configuration: trigger output when there is a time offset with the SYNC0 signal. The controller updates the time offset every cycle.

Note: When using the incremental feedback device, it must be homing before setting any PCOM module parameters.

The following parameters are used to configure and monitor the PCOM module.

Table 6-16

VarCom	CANopen/CoE object		PROFINET parameters	Description
PCOMCNTRL{1|2}	2191h, 2192h,	Sub-Index 0 Sub-Index 0		Configure and match comparison trigger output (PCOM) module.
PCOMDIR{1|2}	2195h, 2196h,	Sub-Index 0 Sub-Index 0		Define whether the motor triggers the output when it moves in negative, positive or any direction.
PCOMEND{1|2}	219Dh, 219Eh,	Sub-Index 0 Sub-Index 0		Position of PCOM module to stop triggering output.
PCOMN{1|2}	219Fh, 21A0h,	Sub-Index 0 Sub-Index 0		Fixed number of feedback counts between each output trigger position.
PCOMSTART{1|2}	219Bh, 219Ch,	Sub-Index 0 Sub-Index 0		Position of PCOM module to start triggering output.
PCOMSTATUS{1|2}	2193h, 2194h,	Sub-Index 0 Sub-Index 0		Actual state of PCOM module.
PCOMTABLE{1|2}	21A1h, 21A2h,	Sub-Index 0 Sub-Index 0		A set of positions to be triggered for output.
PCOMTABLELEN{1|2}	2197h, 2198h,	Sub-Index 0 Sub-Index 0		Number of positions in the PCOM table
PCOMWIDTH{1|2}	2199h, 219Ah,	Sub-Index 0 Sub-Index 0		Pulse output signal width.
DIFPORTMODE	21A3h, sub-index0			Differential (RS422) digital port hardware and output function.
OUTMODEn27|28	209Ch			Output triggered by PCOM module 1|2

6.11.1 PCOM fixed cycle configuration

The cycle configuration is used to output pulses or switch output states at fixed intervals (defined as a set of position feedback counts (PCOMN)). In this mode, the PCOM module continuously compares the actual position with the defined value in PCOMN (or equivalent EtherCAT/CANopen

object). When the feedback counter equals PCOMN, the PCOM module triggers the output.

- Two user-defined positions (PCOMSTART and PCOMEND) define the position range within which the position comparison function takes effect and triggers the output.
- The user-defined constant (PCOMN) defines the number of encoder counts (interval) between each output trigger.
- Define the pulse width based on PCOMWIDTH.

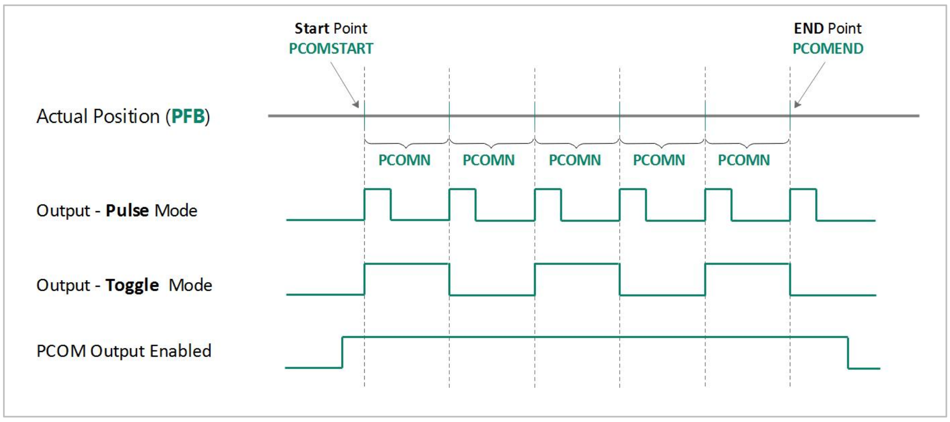


Figure 6-28 Position comparison trigger output - cycle configuration

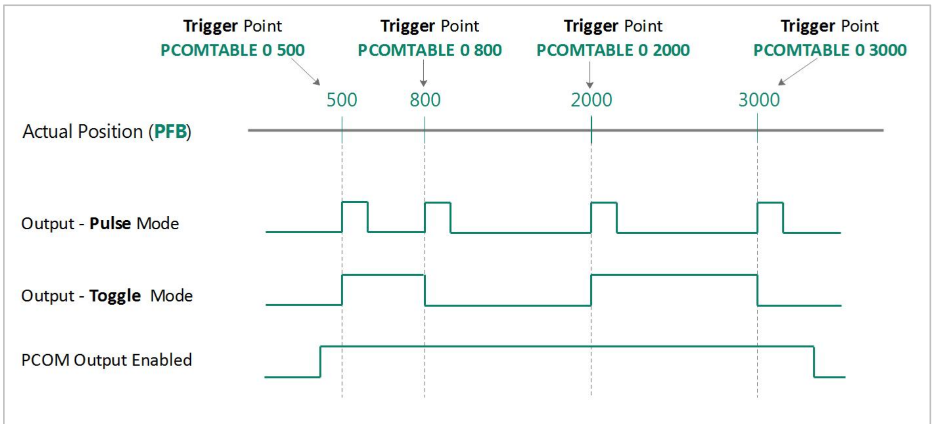
6.11.2 PCOM table configuration

The position table is configured to output pulses at specific positions or switch output states. In this mode, the PCOM module continuously compares the actual position with the position defined by PCOMTABLE. When the feedback counter equals the position in the table, the PCOM module triggers the output.

- For cycle configuration, the pulse width is the defined (PCOMWIDTH)
- The user-defined constant (PCOMN) defines the number of encoder counts (interval) between each output trigger.

Up to 32 user-defined positions (PCOMTABLE) define the specific positions that will trigger output.

Define the number of trigger positions in the table according to the parameter PCOMTABLELEN.



Index	0	1	2	3	....
Position	500	800	2000	3000	

Figure 6-30 Position comparison trigger output - table configuration

6.11.3 PCOM timing configuration

Note: PCOM timing configuration is only valid in EtherCAT cyclic synchronous operation mode.

Timing configuration is used to set the output state when there is time offset from the SYNC0 signal.

There are at most four time offsets (TM1, TM2, TM3, TM4) that can be used to trigger the output in an EtherCAT cycle. The offset and output states are defined via four sub-indexes of objects 2205h (PCOM1 module) and 2206h (PCOM2 module).

TM1 must be the minimum value, and the values of TM2, TM3 and TM4 must be gradually increased.

If the required transition (TR) of a cycle is less than four - for example, if there are only two TRs, the controller will set it to 2, and the drive will only process TM1 and TM2, and ignore TM3 and TM4.

The controller increases the counter value, indicating that the time offset PDO takes effect. If the controller does not increment the counter value, the time offset PDO will be ignored, meaning the output state will not change.

Timing resolution is 0.1μs.

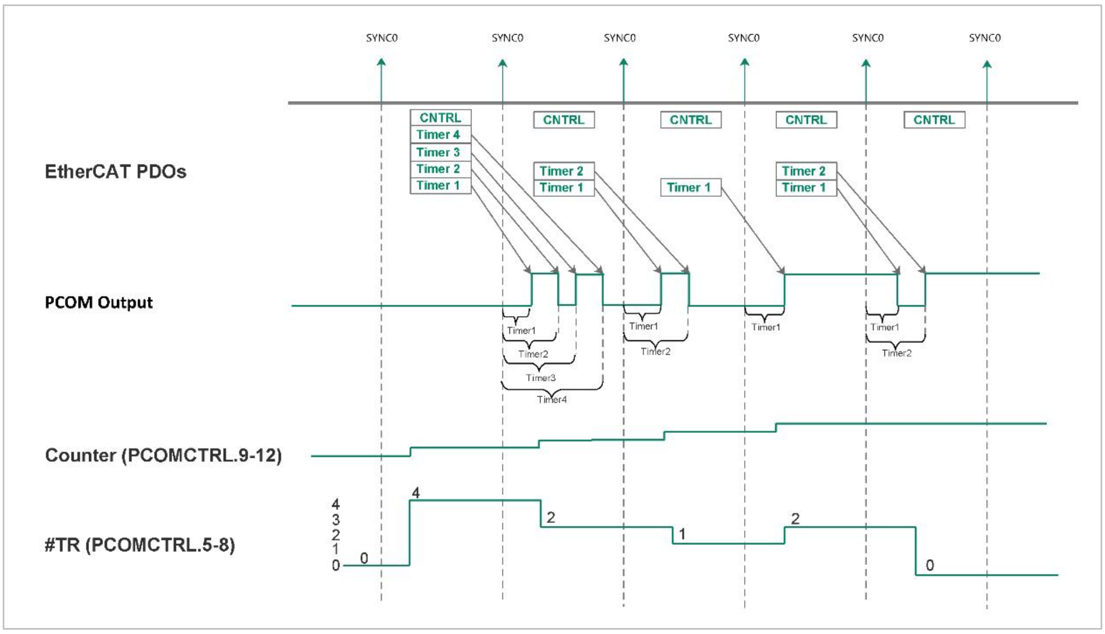


Figure 6-31 Comparison matching trigger output - timing configuration

6.12Analog input

The CDHD2S supports both one 16-bit analog input and two 14-bit analog inputs. There are differences between these two input types.

Note The number in the CDHD2S part number indicates that the drive supports one or two analog inputs.

Analog input is used to send commands to the drive through analog voltage. Analog command can control motor velocity or the current supplied to the motor. Analog command can be used when the CDHD2S is operating in "Analog Velocity" mode (OPMODE1) or "Analog Current" mode (OPMODE3).

Use the ServoStudio2 Analog Input 1 panel (and Analog Input 2, if available) in the Analog IO screen to set analog input properties and monitor input values.

6.12.1 Analog input 1

Analog input 1 acts as an analog command for analog velocity (OPMODE1) and analog current (OPMODE3) operation modes. This function cannot be changed.

The following parameters are used to configure and monitor analog input 1.

Table 6-17

VarCom	Description
ANIN1OFFSET	DC voltage offset on analog input.

ANIN1DB	Dead band range of analog input 1.
ANIN1LPFHZ	Low pass filter for analog input.
ANIN1	Analog input voltage. Read only.
ANIN1ZERO	By modifying the analog offset value, the value of analog input 1 signal becomes 0.

6.12.2 Analog input 2

Note Not all drive models have analog input 2.

When a drive has a second analog input, analog input 2 can be used as the analog current limit. In this configuration, parameter ANIN2SCALE is used to set the current limit range in Amperes/Volts.

The following parameters are used to configure and monitor analog input 2.

Table 6-18

VarCom	Description
ANIN2MODE	Define the secondary input function.
ANIN2LPFHZ	This value is the low pass filter used by the analog input. Used to filter the high-frequency noise generated by the output or limit the signal change rate.
ANIN2OFFSET	DC voltage offset on analog input.
ANIN2	Dead band range of analog input 2. Used to prevent the drive from responding to voltage noise near the analog input zero.
ANIN2	Analog input voltage. Read only.
ANIN2ZERO	By modifying the analog offset value, the value of analog input 2 signal becomes 0.

6.12.3 Using analog input as velocity command and current limit

Procedure: Using analog input as velocity command and current limit

Use the following program from ServoStudio2 to configure the CDHD2S. Use analog input 1 as the velocity command and analog input 2 as the current limit.

1. Define the operation mode.

Activate the Movement screen and select operation mode: Analog Velocity (OPMODE1).

When operating in "Analog velocity" mode, a signal is applied to Analog Input 1 and the drive converts the signal into a velocity command.

2. Define velocity scaling.

Velocity Scaling is a user-defined ratio used by the drive to convert analog input into a velocity command. In the example here, the scaling is set up to a velocity command of 100 rpm/V

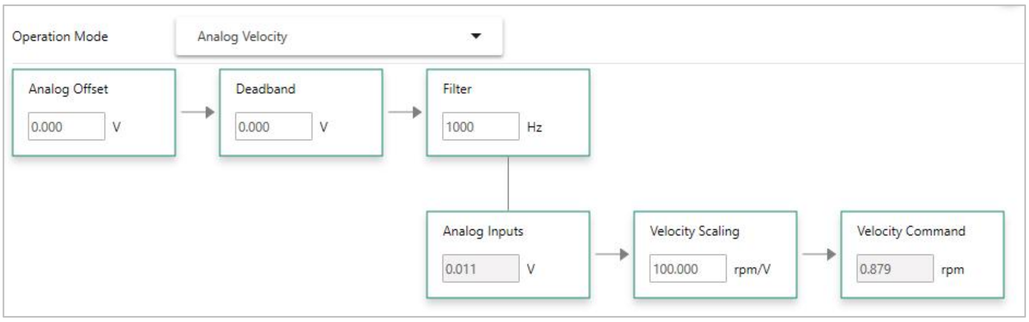


Figure 6-32 Velocity scaling

3. Define analog input 2 function.
Open a terminal.
Define analog input 2 as current limiter by setting the parameter ANIN2MODE value to 2:
4. Define analog current scaling.
Set the analog current scaling from input 2 by setting the parameter ANIN2ISCALE value.
In the example here, the scaling is 0.5A per volt. The drive will calculate the current limit accordingly.

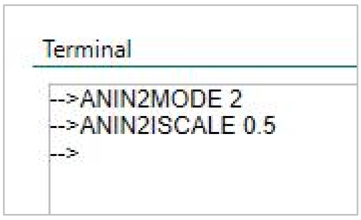


Figure 6-33 Analog input 2 parameter settings

Note: Since both drive parameter ILIM and analog input 2 define current limit, the drive will recognize the smaller of the two as the current limit at any given time. Use ILIMACT to read actual limit.

The drive parameters ACC and DEC provide acceleration and deceleration limit respectively. If analog input 1 (when used as a velocity command) generates a rate greater than ACC or DEC, the drive will not exceed the ACC and DEC values.

6.13Analog output

The CDHD2S also has an analog output that can be set to output a voltage equivalent to a specific parameter value.

Use the ServoStudio2 Analog Output panel in the Analog IO screen to set analog output properties and monitor output values.

The following parameters are used to configure and monitor the analog output.

Table 6-19

VarCom	Description

ANOUTMODE	Define analog output function.
ANOUT	Display the analog output value (in volts) set by ANOUTMODE. Read only.
ANOUTCMD	Analog output command (in volt) set by the user in ANOUTMODE0.
ANOUTISCALE	Analog output voltage scaling representing motor current (I) or current command (ICMD).
ANOUTLIM	Analog output command voltage limit for all modes.
ANOUTVSCALE	Analog output voltage scaling representing velocity (V) or velocity error (VE).
OUTMODE	Define the condition that will activate the specified digital output.

6.14Disabled Mode

The drive may be disabled because the motion controller issues an explicit command or the drive itself responds to a fault condition. When the drive is disabled, the "disabled mode" function can be used under special circumstances to make the motor stop running quickly before turning off the power supply. This can reduce the amount of motor coasting.

Use the ServoStudio2 Emergency Stop screen to select the method and parameters for stopping the motor when the drive is disabled. The disabled mode consists of two mechanisms:

- Active Disable stops the motor by controlling deceleration to zero velocity and then disables the drive. Active Disable cannot be implemented when the drive is operating in current control mode (OPMODE2 or OPMODE3).
- Dynamic braking controls the motor when the drive is disabled by applying the motor back-EMF to the stop current; therefore, it can also be used in the case of feedback loss.

Table 6-20

VarCom	Description
DISMODE	Define how the drive will respond when disabled.
DISMODE0	Non-active disable, non-dynamic braking.
DISMODE1	Non-active disable, dynamic braking on fault only.
DISMODE2	Non-active disable; disable dynamic braking arbitrarily
DISMODE3	Active disable on fault*; non-dynamic braking.
DISMODE4	Active disable on fault*; dynamic braking on fault only.
DISMODE5	Active disable on fault*; disable dynamic braking arbitrarily.

Note: Faults that require immediate disable (to prevent drive damage) and feedback faults that may cause communication errors (motor runaway conditions) cannot issue an active disable.

There are three parameters that affect disable and braking.

Table 6-21

VarCom	Description
DISSPEED	Define the velocity threshold below which the motor is considered stopped and the active disable timer starts the countdown to disable. For a motor to be considered stopped, the motor velocity must be at least 50 ms below this threshold.
DISTIME	Define the continuous time that the motor must remain below DISSPEED before the drive is disabled. DISTIME counter only starts counting after the motor velocity has been lower than DISSPEED for at least 50 ms.
DECSTOP	Define the ramp down deceleration rate.

6.14.1 Active disable

Active disable prevents the motor from coasting when the axis is disabled.

The active disable mechanism stops the motor by controlling the speed to slow down to zero and then disables the drive.

Note: Active disable cannot be implemented when the drive is in current control mode (OPMODE2 or OPMODE3); it is valid in all other operation modes.

Figure 6-34 shows how motor coasting occurs when active disable is not used. The velocity command will be set to zero immediately after the drive is disabled. The actual velocity will then be decreased as a function of inertia and friction.

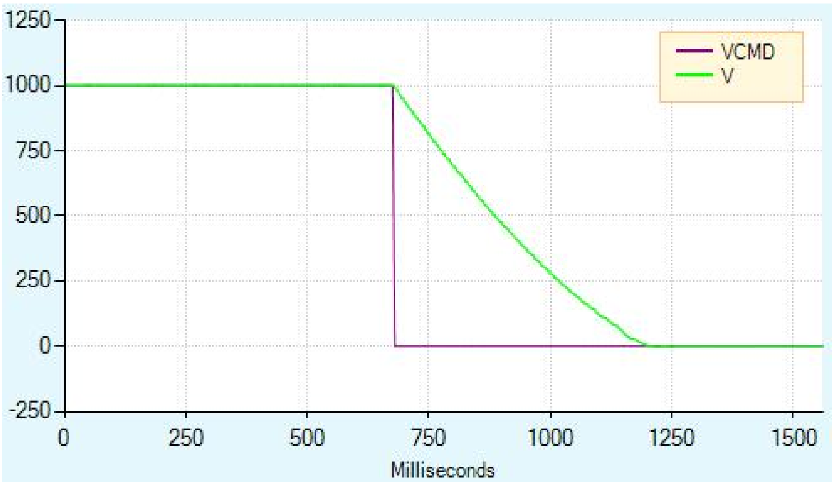


Figure 6-34 Disable (do not use active disable)

Figure 6-35 shows what happens when active disable is in effect. After the drive receives the disable command, the velocity command will immediately slow down the velocity to zero and then the drive is disabled.

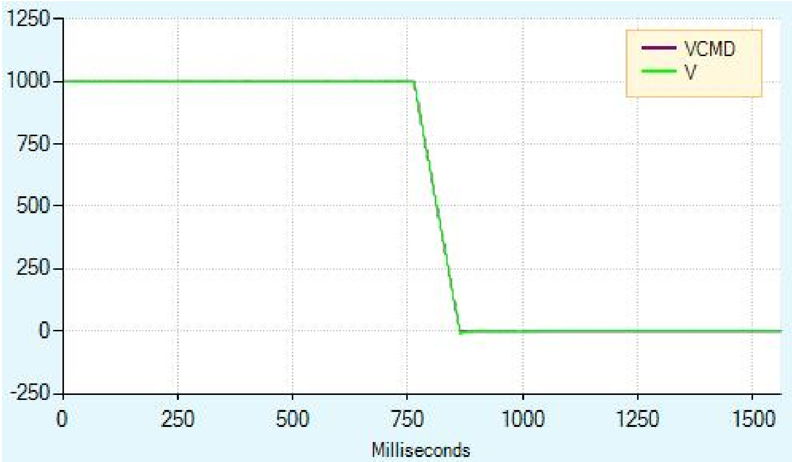


Figure 6-35 Disable (use active disable)

Figure 6-36 shows the effects of DISSPEED and DISTIME. In this example, DISSPEED is set to 1000 and DISTIME is set to 1ms. The motor velocity remains below 1000 for 50ms and after the time defined by DISTIME has elapsed, the drive will be disabled and the motor coasts to a stop.

In this example, it takes approximately 110ms from the time the motor velocity drops below 1000 and the drive is disabled.

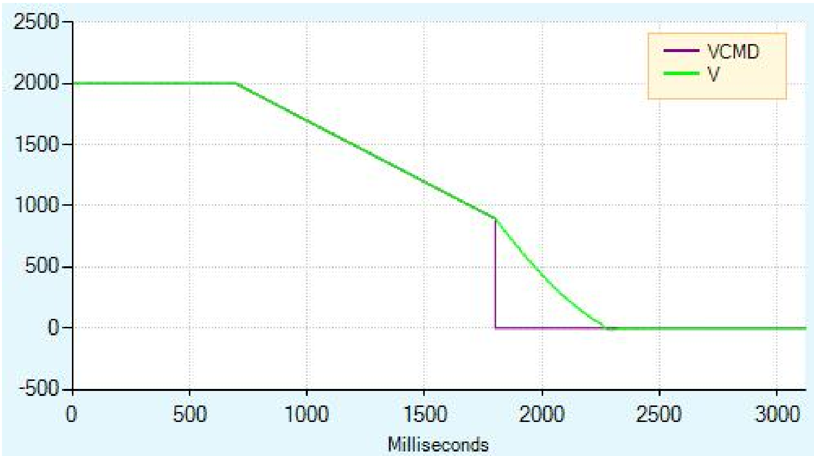


Figure 6-36 Impact of DISSPEED and DISTIME on active disable

During the descent process in the active disable mode, the drive will ignore any new motion commands.

If an additional disable command (VarComK) is issued during the descent process, the descent process will be stopped and the drive will be disabled immediately.

Figure 6-37 shows the impact of the second disable command. In this example, DISSPEED is set to 1000 and the second disable command is issued before the motor velocity descend to this level.

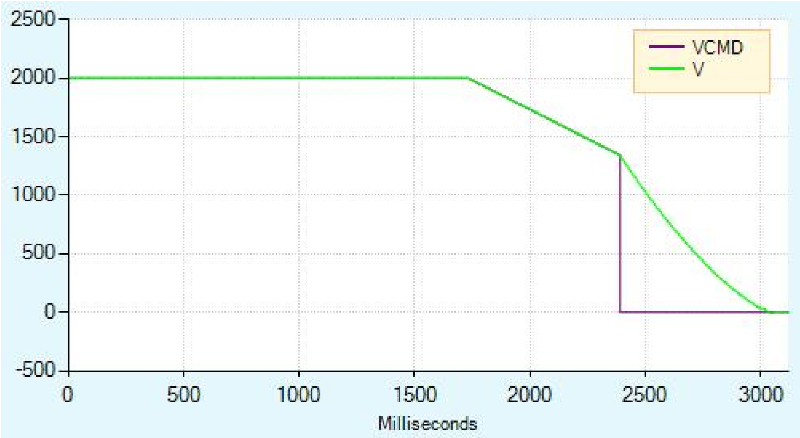


Figure 6-37 Impact of the second disable command on active disable

The legend in the "ServoStudio2 Emergency Stop" screen shows active disable behavior.

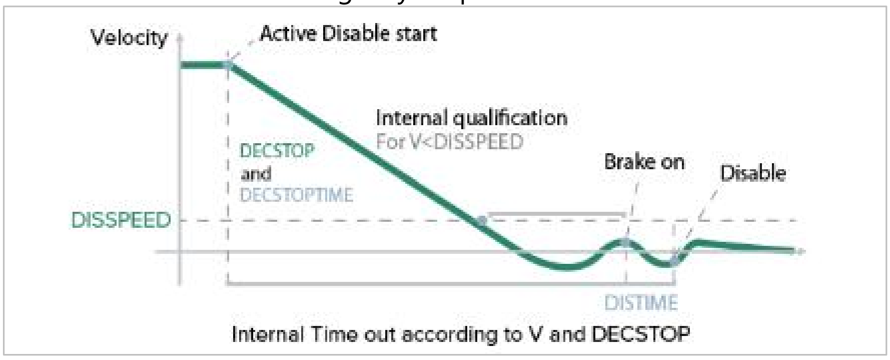


Figure 6-38 Disable stop

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

If the internal timeout (calculated based on the actual velocity and DECSTOP) runs out, the descent mechanism will also be suspended, such as the 1 in disable stop figure.

6.14.2 Dynamic braking

The dynamic braking mechanism can disable the drive to control the motor. Only the motor back EMF is used to apply the stopping current. The variable ISTOP is used to set the maximum allowable current during dynamic braking.

Figure 6-39 shows the motor coasting, i.e. without dynamic braking (and without active disable). The velocity command will be set to zero immediately after the drive is disabled. The actual velocity will be decreased due to system inertia and friction.

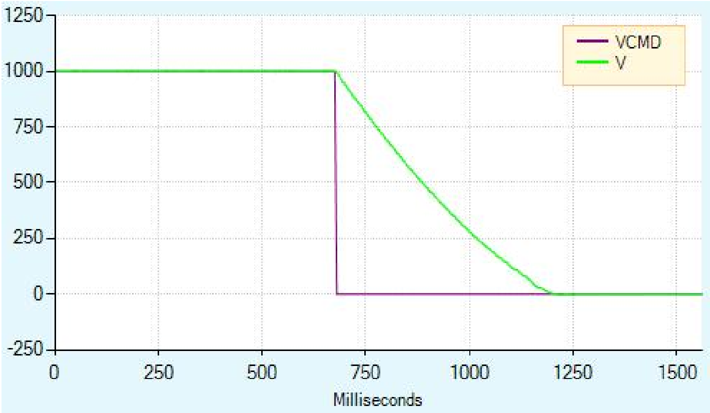


Figure 6-39 Motor coasting (without dynamic braking)

Figure 6-40 shows what happens when dynamic braking is in effect. As shown in the picture above, the velocity command will be set to zero immediately after the drive is disabled. However, the actual velocity will descend gradually after the brake is applied.

Unlike active disable, velocity does not descend along the motion trajectory. The descend rate is a function of the maximum allowable current (variable ISTOP) and the system inertia and friction.

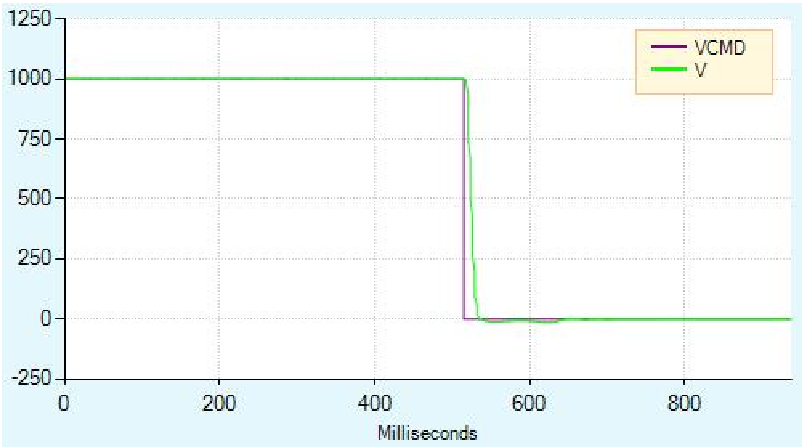


Figure 6-40 Dynamic braking

Figure 6-41 shows dynamic braking with extremely low ISTOP value. In this case, it takes longer for the motor to stop.

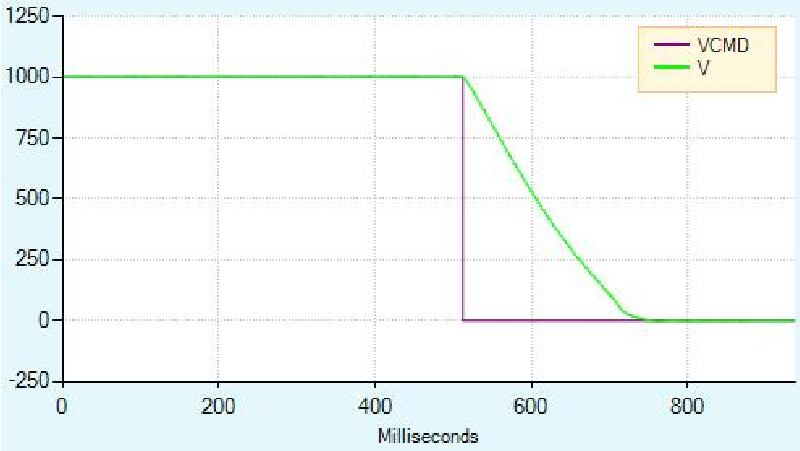


Figure 6-41 Dynamic braking (low ISTOP value)

In both DISMODE4 and DISMODE5 modes, active disable and dynamic braking are supported. In this case, active disable is used to stop the motor and dynamic braking is activated after DISTIME.

6.15Motor Brake Control Via Relay

The CDHD2S can control the motor brake via an external relay. The relay can be connected to any digital output on the CDHD2S machine I/F (C3) or controller interface (C2). It is recommended to connect digital output 7.

Please refer to the *Motor Brake Wiring* and the following procedures.

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

The CDHD2S disable time can be set through the DISTIME parameter. When the drive receives a disable command, it will turn off the brake output first, then wait for the brake disengagement time to end before actually disabling it.

The brake engagement time cannot be set. When the drive receives the enable command, the brake output is turned on at the same time to complete the enabling. It takes at most 1.5 milliseconds for the drive to complete enabling, while it usually takes tens of milliseconds for the brake to disengage.

Procedure: Configuring the digital output to control the brake

When configuring digital output, please perform the following procedure in ServoStudio2.

1. Define the output.

Go to the Digital Inputs/Outputs screen and set the output (example: Output 1) to Mode "2 - Brake Release Signal".

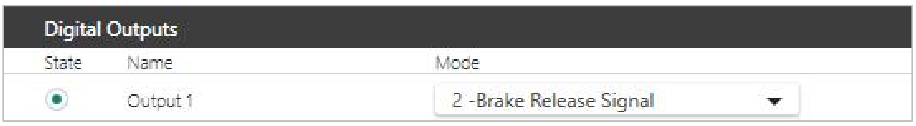


Figure 6-42 Digital output setup for motor brake control

Default:

- When CDHD2S is enabled, the brake output is on.
- When CDHD2S is disabled, the brake output is off.

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

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

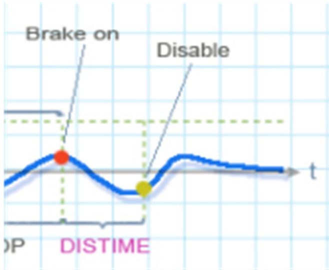


Figure 6-43 Active disable time (DISTIME)

When the "Disable" command is executed, the CDHD2S immediately changes the brake output value and disables the CDHD2S control after waiting for the Active Disable Time (DISTIME) to end.

When a fault such as STO or loss of feedback occurs, the drive immediately switches the brake output value and disables CDHD2S control.

6.16Motor temperature sensor

CDHD2S supports two types of motor temperature sensors: thermostat (on/off) and thermistor (thermistor).

The following parameters are use to define the motor temperature sensor type and the response of the drive to over-temperature condition.

VarCom	Description
THERM	Indicate whether the motor has an over-temperature fault.
THERMODE	Define how the drive responds to motor over-temperature fault. If the motor has no temperature sensor, or if the sensor is not wired, set THERMODE=3, and the drive will ignore the fault.
THERMTYPE	Indicate whether the sensor is PTC (positive temperature coefficient) or NTC (negative temperature coefficient) type sensor. When using a thermostat (on/off motor temperature sensor), set THERMTYPE=0 to define PTC type.
THERMREADOUT	Read the temperature sensor resistance.

THERMTRIPLEVELTHE RMCLEARLEVEL	The detection and removal mechanism of motor over-temperature fault is subject to hysteresis mechanism. When the resistance exceeds a certain value, it will trip and the fault can only be cleared when the resistance drops below a different value. ● For PTC thermistors, when the resistance is equal to or greater than THERMTRIPLEVEL, the motor over-temperature fault will lead to tripping. When the resistance is equal to or less than THERMTRIPLEVEL, the fault can be cleared. ● For NTC thermistors, when the resistance is equal to or less than THERMTRIPLEVEL, the motor over-temperature fault will lead to tripping. When the resistance is equal to or greater than THERMTRIPLEVEL, the fault can be cleared. ● If the motor temperature sensor is a thermostat, the resistance is zero in normal state and infinite in fault state.

When the drive detects a motor over-temperature condition, it will block the motor over-temperature fault and the digital display will display **H|FH.**

6.17Error Correction

6.17.1 Overview of error correction

The CDHD2S drive has an error correction function that can cancel repeatable positioning errors.

An error map is generated using an external measurement device such as a laser interferometer. The error map is stored in the non-volatile drive memory. The drive retrieves the correction value in real time based on the actual position and performs dynamic (on-the-fly) correction. After the correction, the error is negligible. Therefore, no additional position feedback device is required.

6.17.2 Error correction table - example

In this example, the load position on the linear axis is measured with a laser interferometer. The axis travel distance is one meter. The drive software commands the motor to rotate every 100mm so that the motor moves through 10 position ranges. As the motor moves the load, the laser system measures the distance traveled by the load, comparing it to the motor encoder position at each point. The difference between the two values is the error correction value.

To ensure smooth movement, the drive performs linear interpolation between the points of the error table. In this example, to move the platform to 275 mm from the origin, the controller selects the two data points closest to the error map (200 and 300 mm) and calculates the correction value for the 275 mm point.

Table 6-23

Motor Encoder position	External measurement position	Corrected value
0	0	0
100	99	1
200	202	-2
300	300	0
400	400	0
500	500	0

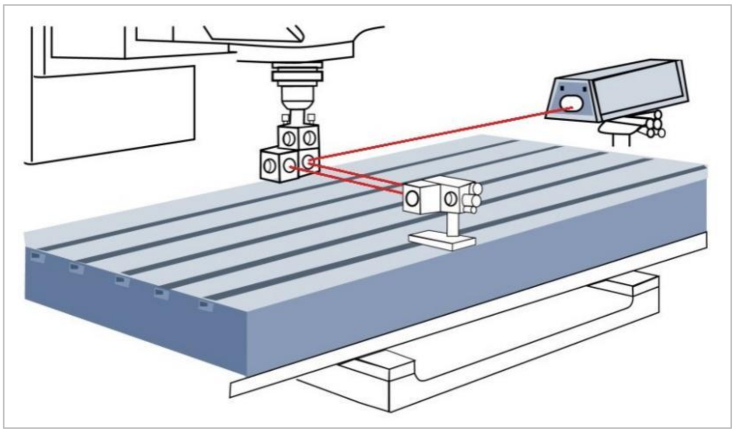


Figure 6-44 Laser interferometer measuring travel distance

6.17.3 Error correction function of CDHD2S

The CDHD2S error correction function can be applied in several motor system types:

- Direct drive linear platform
- Direct drive rotary platform
- Linear platform driven by servo drive (motor rotates and the error is linear)
- Rotary platform driven by servo motor (motor rotates and load rotates)

Error correction is available for all absolute and incremental encoders supported by CDHD2S.

Note:	When using the error correction function in an incremental system, homing is required.
Note:	When the CDHD2S error correction function is used in a dual control loop system, the secondary (load) encoder value is corrected. When the CDHD2S error correction function is used in a single control loop system, the primary (motor) encoder value is corrected.

6.17.4 Error correction parameters and commands

The following parameters are used to configure and execute the error correction function.

Table 6-24

VarCom	Description
ERRCOREN	Define user's request to activate the error correction function.
ERRCORST	Indicate the state of the error correction function after sending the user request (ERRCOREN 1).
ERRCORSTARTPOS	Define the position corresponding to the first valid input of the error correction table.
ERRCORACTIVENUM	Define that effective input times of the error correction table. The error correction table can define (and take effect) up to 1000 inputs.
ERRCORINTERVAL	Define the measurement error and add the distance between the positions where the correction table is located. Defined in unit of (LOAD).
ERRCORUNITS	Define the unit of error position data transmitted through the error correction table.
ERRCORSTARTOFF	Define the offset from the first valid input of the error correction table.
LMUNITSNUM	Denominator of motor feedback and load feedback scaling ratio.
LMUNITSDEN	Numerator of motor feedback and load feedback scaling ratio.
ERRCORRESET	Used to restore all error correction parameters and table inputs to their default values. When ERRCORRESET is set to 1, it will be reset.
ERRCORSETINDEX	Define the correction values specifically entered in the correction table.
ERRCORFAILINDEX	An index indicating that the input of the error correction table failed due to the invalid error size. The error shall not exceed the maximum value of 1 (rotation unit is degree/linear unit is millimeter)
PFBRAW	Position feedback value, excluding error correction and position modulus. Used for troubleshooting debugging.

6.17.5 Error correction feedback unit

Motor load ratio

When using a direct drive linear (DDL) platform or a direct drive rotary (DDR) platform, the motor to load mechanical ratio is 1:1.

$$\frac{\text{LMUNITSNUM}}{\text{LMUNITSDEN}} = \frac{1}{1}$$

- In this example, the motor and load position feedback (PFB) values and units are the same.

When using a linear platform driven by a servo drive (motor rotates and the load is linear), the mechanical ratio is 1 revolution of the motor per n mm of linear motion.

$$\frac{\text{LMUNITSNUM}}{\text{LMUNITSDEN}} = \frac{1}{n}$$

When using a rotary platform driven by a servo motor (motor rotates and the load is linear), the mechanical ratio is 1 revolution of the motor for every n turns of the load.

$$\frac{\text{LMUNITSNUM}}{\text{LMUNITSDEN}} = \frac{1}{n}$$

6.17.6 Error correction settings

The following figure shows the parameters used by the error correction map.

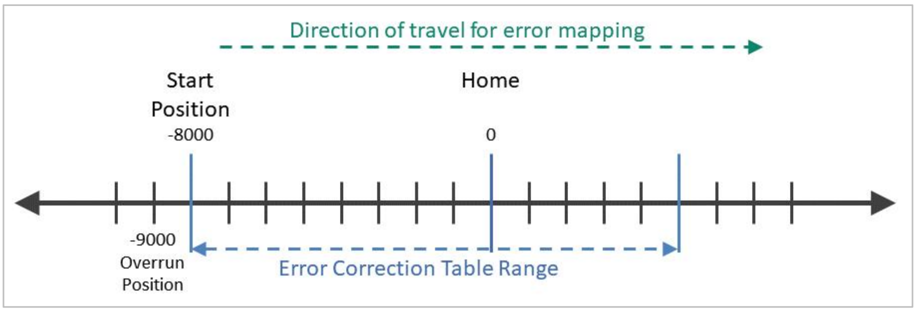


Figure 6-45 Error correction map - example

Procedure: Manual configuration and generation of error correction table

Use ServoStudio2 adn any measuring device

1. In the ServoStudio2 Error Correction screen, enter the position range settings and setting values for error sampling and correction.

- Start position
- Number of sampling points
- Interval (sampling point spacing)
- Calibration unit (if required)
- Load/motor mechanical ratio (if required)

2. Move the motor to a position that is at least a few millimeters away from the start position (start point) of the error correction table.

3. Move the motor to the start position, and then to several positions consistent with the positions and intervals defined by ServoStudio2.

4. Using a measurement device, perform error correction measurements at each designated position and generate a set of error correction values.

5. In the ServoStudio2 correction table, the index and position values will be displayed based on the values entered on the right side of the screen. Manually enter the correction value for each position, calculated as follows:

6.
7.
8.

9. Table 6-25

Encoder value	Measured value	Corrected value
X1	Y1	Y1–X1=ERR1
X2	Y2	Y2–X2=ERR2
X3	Y2	Y3–X3=ERR3

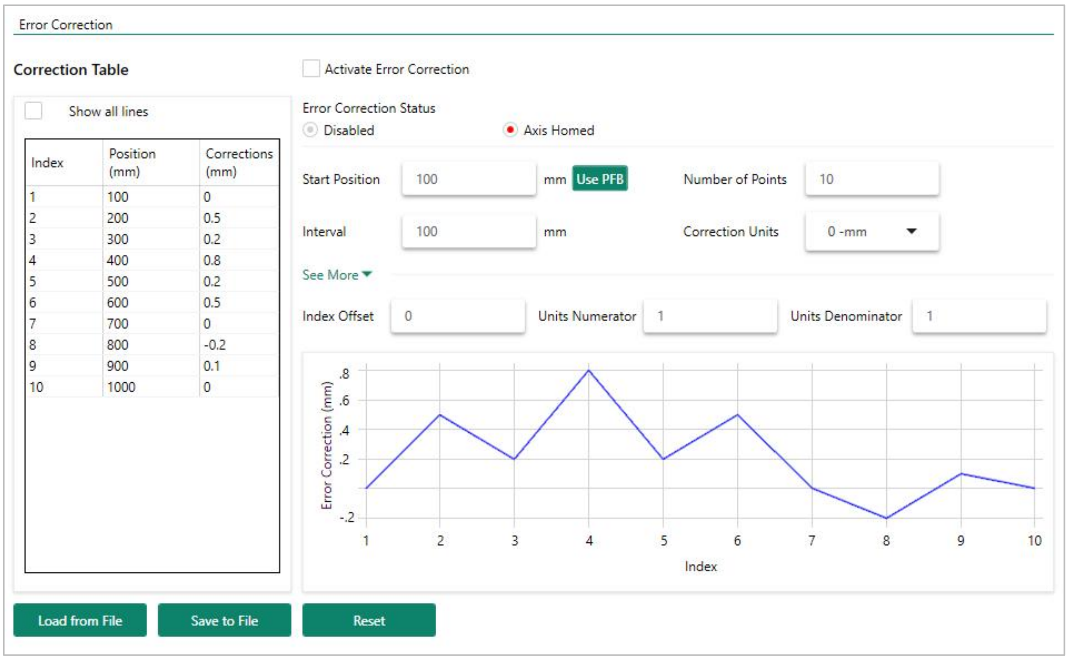


Figure 6-46 Error correction table - example

10. Save to file (SSV format)

The settings and all indexes in the error correction table are saved to an SSV file.

Procedure: Configure an error correction table for use with RenishawRTL files

Using ServoStudio2 and Renishaw laser interferometer

Note: This procedure is based on RenishawXL=80 laser interferometer and exported RTL file. Renishaw is the only third-party system supported by CDHD2S error

correction function at present.

It is assumed that the Renishaw system has been installed in accordance with the manufacturer's instructions and that the user knows how to operate the hardware and software.

CDHD2S|ServoStudio2

1. Make sure CDHD2S is working in serial communication mode (COMMODE0).
2. Configure motor and motor feedback parameters.

3. If using an incremental system, perform homing (HOMECMD).

4. Open the Error Correction screen.

On the right side of the screen, enter the position range settings and setting values for error sampling and correction.

- Start position
- Number of sampling points
- Sampling point interval
- Calibration unit (if required)
- Index offset (if required)
- Load/motor mechanical ratio (if required)

Note The CDHD2S and laser system must have the same physical reference (home) position.

Laser system

5. Use "CARTO Capture - Define Tag" to configure error table.

Select linear definition.

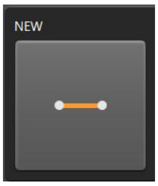


Figure 6-47

6. CARTO Capture - Define Tag > Target menu.

a. Define the following settings. Use the same values from the define configuration in ServoStudio2:

- First target (the first point that will be measured)
- Last target (the last point that will be measured)
- Interval (distance between measurement points)
- Target per round (total number of points that will be measured)

b. Define one-way travel: The bidirectional option must be cleared.

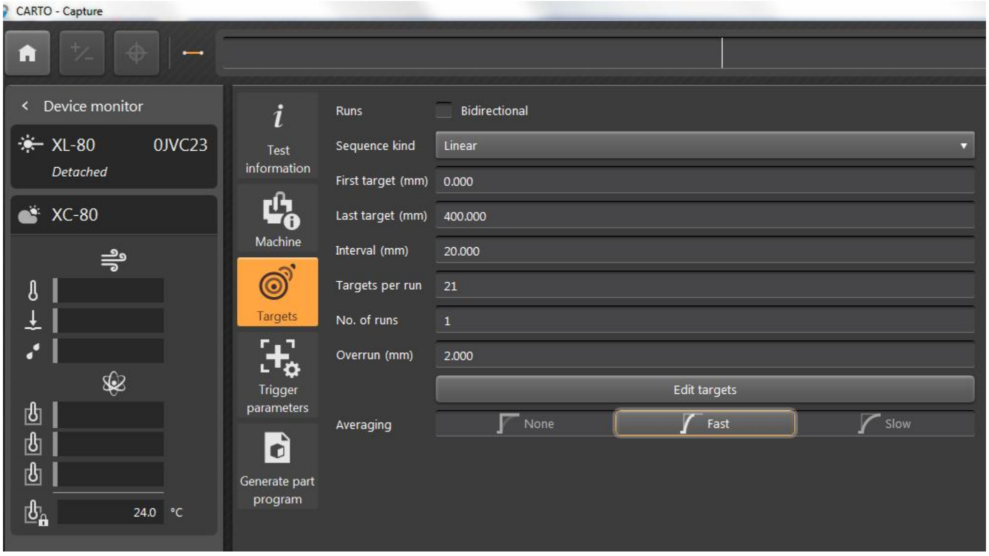


Figure 6-48

7. CARTO Capture - Define Tag > Trigger Parameters menu.

Use position triggering. This mode automatically captures data by comparing laser measurements to target positions and records error measurements when the machine is within specified range of tolerance, stability period and stability range.

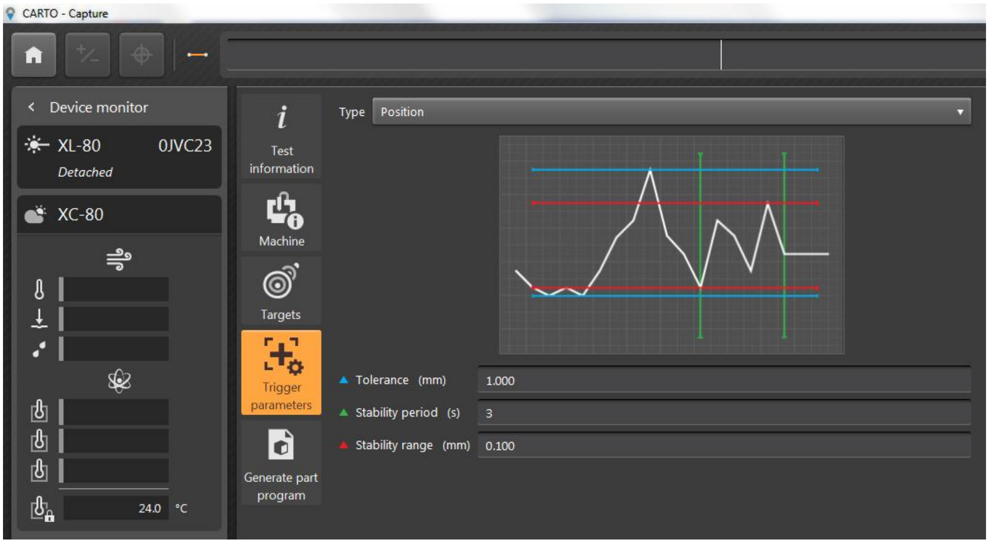


Figure 6-49

8. CARTO Capture - Capture tab is at the bottom of the screen, press Capture.

(When capture is activated, the laser is reset to 0; if not reset, use the DATUM function.)

The laser system will now perform measurement sampling.

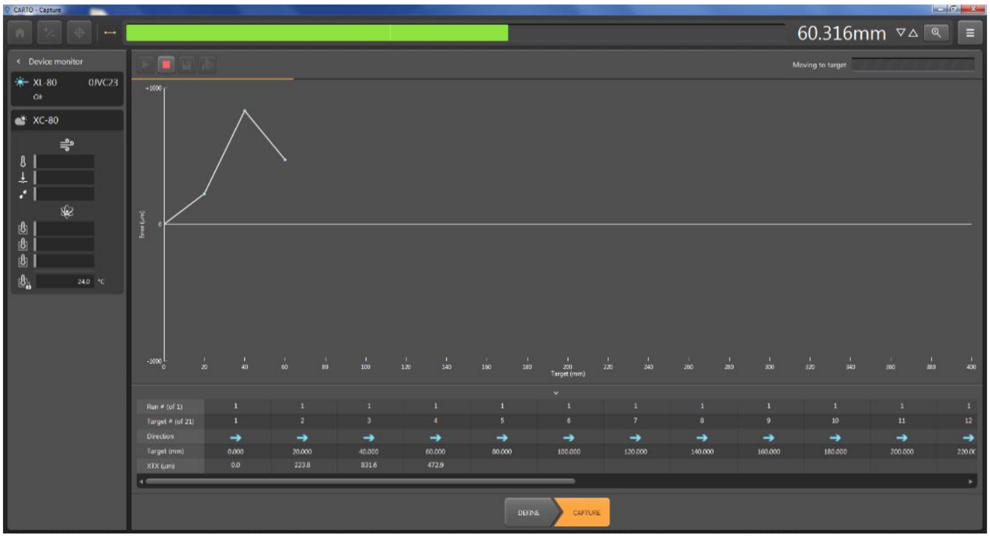


Figure 6-50

CDHD2S|ServoStudio2

9. Issue a command to move the axis to an out-of-range position.

The out-of-range position should be at least a few millimeters from the start capture position. The out-of-range position must be defined as an axis movement from the out-of-range position to the sampling range in the defined direction of laser movement.

10. Issue a command to move the axis from the out-of-range position to the first sampling position.

11. Issue a command to move the axis to the same position where the laser system is set up to perform the measurement. Scripts can be used. Please refer to the example below.

The procedure must include a delay (DELAY) command for each measurement point, with a duration slightly longer than the laser trigger definition time. The recommended value is 5 seconds.

```
#ClearOutput

#Var$start_position=-10

#Var$stop_position=401

#Var$interval=20

#Var$cmd=0

#Var$Vel=80

#Var$index=1

#Var$Corr

en
```

```
#Delay5000
moveabs-1060
#Delay5000
moveabs$start_position$vel
#delay5000
#while$cmd<$stop_position
moveabs$cmd$Vel
#Delay5000
#printpfbpfbraw
#Round$index0
$corr=errcorsetindex$index
#print$corr
$index=$index+1
$cmd=$cmd+$interval
#End_While
k
```

Laser system

12. CARTO capture.

After all sampling is completed, press the Save button to save the error correction data.

13.CARTO exploration. Select Open File.

Figure 6-51

14. From the list, select the data that will be used for error correction and press Export Test (first button) at the bottom of the screen.

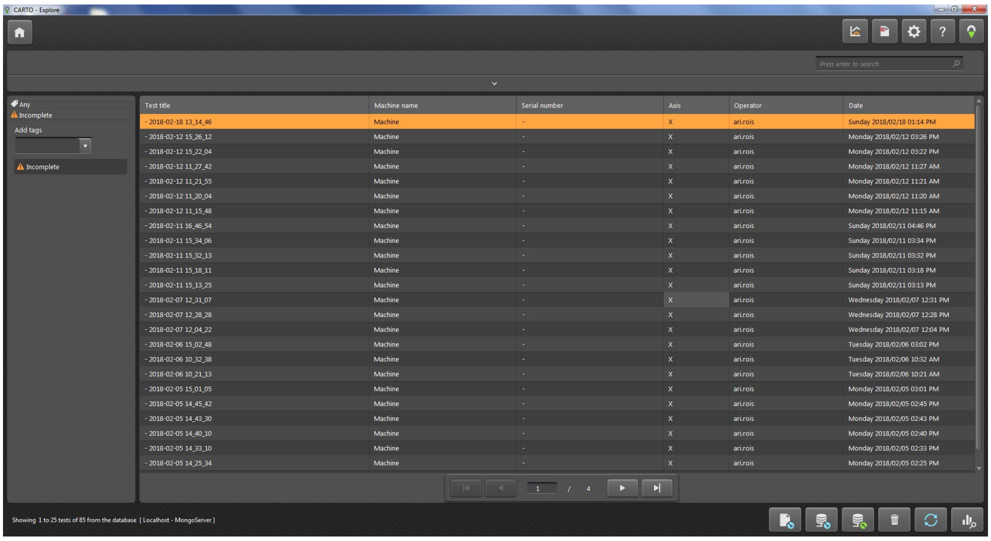


Figure 6-52

CDHD2S|ServoStudio2

15. In the error correction screen, press Load from File to load the data file saved in CARTO.(*.RTL).

16. The data will now be loaded from the file and the error correction table will be imported and displayed.

17. Enable option: Activate error correction.

18. The yellow line indicates the position that the error correction value is applied.

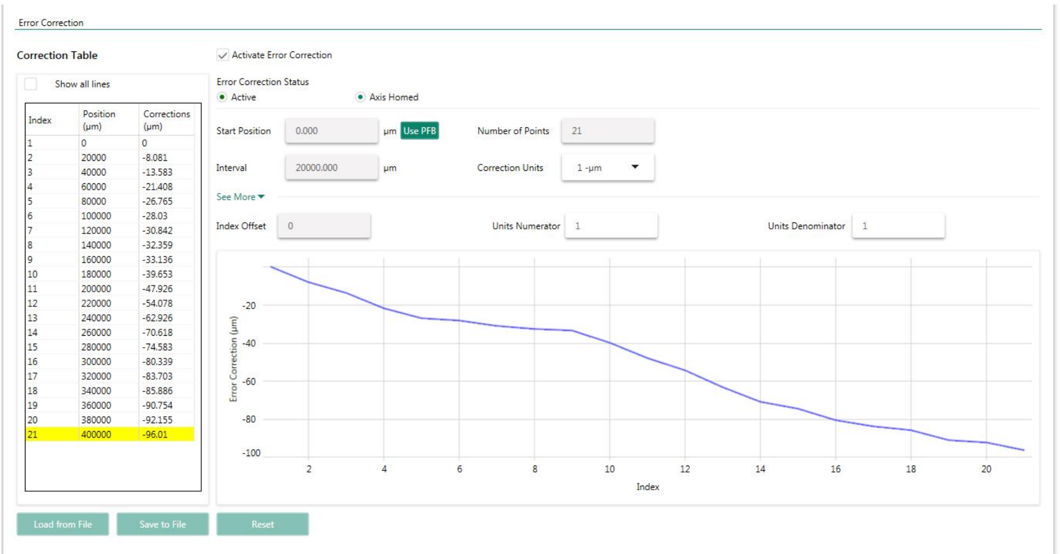


Figure 6-53

19. Use the SAVE command (Save button in the menu bar) to save the error correction table to the non-volatile drive memory.

20. It is recommended that you repeat the measurement process using a laser system and confirm that the error has been reduced.

6.18Gantry System

6.18.1 Gantry system overview

The gantry system use two parallel axes (Y1 and Y2) to control a single linear axis that is orthogonal (right angle) to the X-axis.

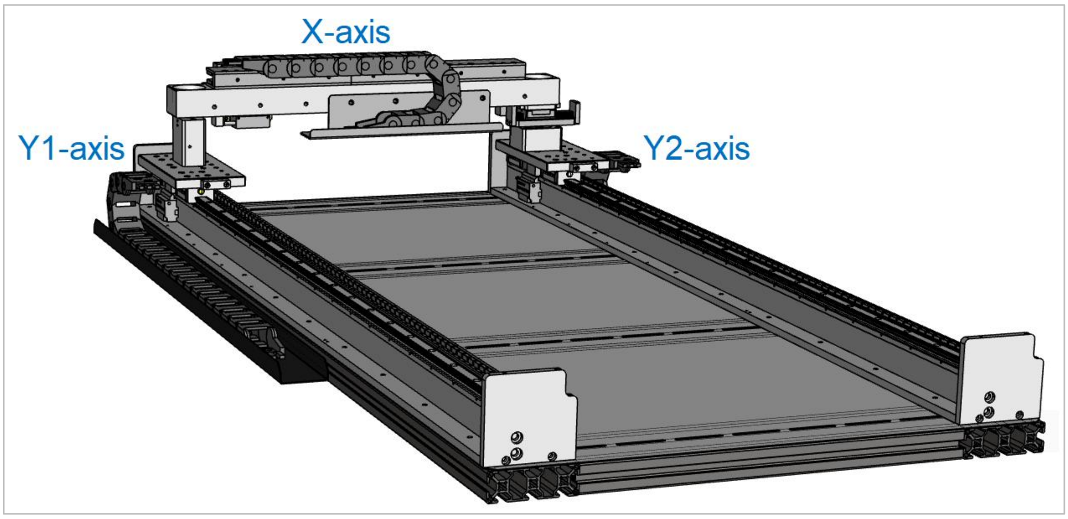


Figure 6-54 Gantry axis

In many gantry systems, the two parallel linear axes (Y1 and Y2) are controlled separately and may interfere with each other, manifesting as vibration, high current consumption, slow acceleration and velocity, and reduced accuracy.

The CDHD2S gantry system synchronizes the two Y-axes through two CDHD2S drives that work together and use high-speed communications to generate and control motion along the Y-axis.

Each Y-axis can be driven by a linear or rotary motor.

Both Y-axes must use the same feedback device type with the same resolution.

6.18.2 Gantry type

The CDHD2S gantry system provides two gantry structure types: rigid and flexible. They are different in the orthogonality of gantry axes and the coupling elasticity of axes.

Gantry type parameters (GANTRYTYPE) must be defined to ensure correct zeroing and appropriate offset compensation.

Rigid gantry system

In a rigid gantry structure, the Y and X axes are strictly orthogonal (at right angles to each other), and the mechanical coupling between them is inelastic. When one Y-axis moves, the other Y-axis moves accordingly without causing any axis offset.

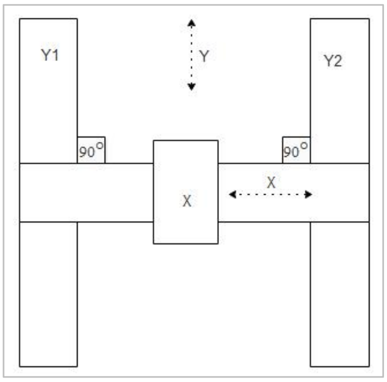


Figure 6-55 Rigid gantry structure

Flexible gantry system

In a flexible gantry structure, the mechanical coupling between one or two Y-axes and the X-axis is elastic.

The differential motion of the two Y-axes causes a certain amount of rotational motion around the center of the gantry. This rotational motion (yaw) is considered a differential axis by the CDHD2S system.

Therefore, the flexible gantry system needs to control the difference between the Y1 and Y2 axis positions.

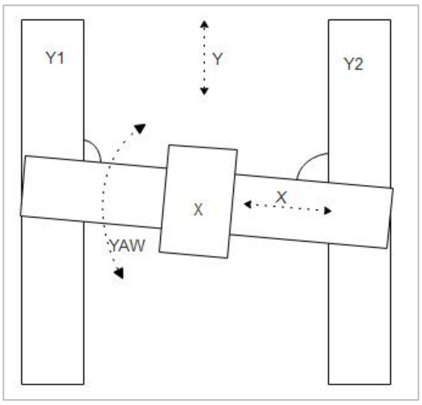


Figure 6-56 Flexible gantry structure

Flexible gantry yaw alignment

In a rigid gantry system, the yaw value is 0 and the X and Y axes are orthogonally aligned. Therefore, no yaw alignment is required. But in a flexible gantry system, offset may occur. Use parameter GANTRYOFFSET to align yaw.

The GANTRYOFFSET value is the difference (distance) between the Y1 and Y2 reference points. Typically, the reference point is the motor index or home switch.

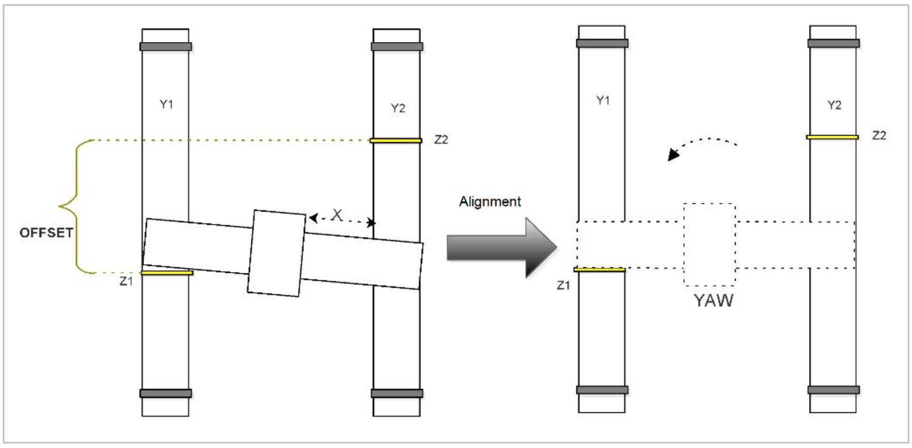


Figure 6-57 Gantry yaw alignment

If the motor manufacturer's specifications provide the motor index positions of Y1 and Y2, the GANTRYOFFSET value can be simply calculated as the difference between the Y1 index position and the Y2 index position.

If the value of GANTRYOFFSET is unknown, use one of the following methods to determine its value:

- Use an offset measuring device (such as a laser interferometer) to measure manually. This method is regarded as the most accurate and recommended.
- Automatic measurement using parameter GANTRYOFFSET. You can use the command GANTRYFINDOFFST to monitor the measurement status. When the measurement is completed, the GANTRYFINDOFFST value becomes 1. The parameter GANTRYOFFSET represents the measured value. Perform this measurement procedure multiple times to ensure measurement accuracy. To apply and maintain the GANTRYOFFSET value, set GANTRYOFFSETST=1.

Once completed, save the results to drive memory.

System GANTRYOFFSET only needs to be defined once. Subsequent homing commands will use the correct GANTRYOFFSET value. In addition, the flexible gantry system will be aligned according to the GANTRYOFFSET value every time it is powered on or switched from the disabled state to the enabled state.

6.18.3 Gantry control mode

The CDHD2S gantry system is controlled via a pair of two drives mated via communication cables. These two drives are called "paired" drives.

The drive of Y1 axis is the main drive. The gantry main drive receives position commands from the motion controller and executes a position loop on the virtual Y axis (calculated as the average value of Y1 and Y2).

The drive of Y2 axis is a differential drive. The gantry differential drive handles the error between the two axes (Y1 and Y2). In a rigid gantry system, its role is to keep the error between Y1 and Y2 as close to 0 as possible.

Note: While the error can be set to a non-zero value (as defined by the controller), the goal for gantry is usually 0 error between the Y1 and Y2 axes.

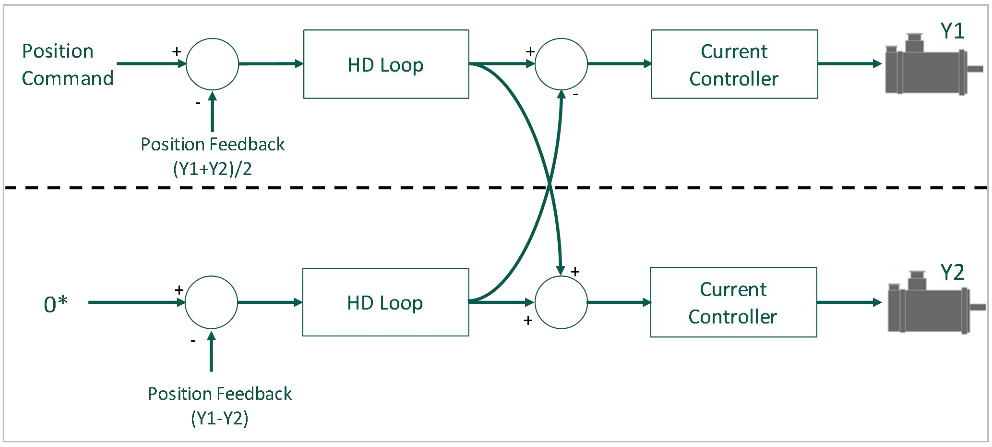


Figure 6-58 Gantry control module

Note: Main and differential controllers are available for both rigid and flexible gantry types. However, for rigid gantry, it is not recommended to use a differential controller, and the gain parameter of the differential controller should be set to 0.

In a flexible gantry system using fieldbus, the motion controller can send non-zero reference commands to the gantry differential axis.

The parameter GANTRYCMDTYPE defines whether to accept or ignore (fixed at 0) differential commands.

6.18.4 Gantry operation mode

The CDHD2S gantry drive is only valid in position operation mode.

When COMMODE=0 (serial communication; without fieldbus), the operation mode can be gearing mode (OPMODE4) or serial positioning mode (OPMODE8).

When COMMODE=1 (EtherCAT/CANopen communication; with fieldbus), the operation mode can be profile position (opmode1), periodic cycle position (opmode8), and homing (opmode6).

Reference commands can be generated by EtherCAT/CANopen, pulse train or serial communication devices.

6.18.5 Gantry parameters and commands

The following parameters are used to configure and monitor gantry applications.

Some parameters apply to both main and differential axes, while others apply only to one gantry axis. Please refer to the VarCom documentation for details.

Table 6-26

VarCom	Description
GANTRYMODE	Define whether the position loop is applied to the mean or the difference between the positions of two gantry motors.
GANTRYCMDTYPE	Define how the gantry drive responds to reference commands. Defines the position feedback value that the drive will report through EtherCAT/CANopen object and encoder simulation.
GANTRYALIGNMODE	Define the alignment method of flexible gantry system.
GANTRYTYPE	Define the gantry structure as rigid or flexible.
GANTRYCOMMSTATE	Indicate whether the gantry drive is communicating.
GANTRYINTERFACE	Define the controller interface used to connect the communication cables between gantry drives.
GANTRYMSTRPFB	Gantry main position feedback value=(Y1+Y2)/2 (read-only).
GANTRYDIFFPFB	Gantry differential position feedback value=(Y1-Y2) (read-only).
GANTRYMSTRVFB	Gantry main position feedback value=(V1+V2)/2 (read-only).
GANTRYDIFFVFB	Gantry differential position feedback value=(V1-V2) (read-only).
GANTRYMSTRICMD	Current command generated by gantry master controller (read-only).
GANTRYDIFFICMD	Current command generated by gantry differential controller (read only).
GANTRYALIGN	Start the gantry Y-axis alignment program.
GANTRYALIGNED	Indicate whether the Y-axis of the gantry is aligned (read-only).
GANTRYFINDOFF	Indicate the program for finding the difference (distance) between reference points Y1 and Y2.
GANTRYFINDOFFST	Indicate the status of gantry offset finding program.
GANTRYOFFSET	Distance difference between reference points Y1 and Y2 Required value of flexible gantry system.
GANTRYOFFSETST	Indicate whether the stored GANTRYOFFSET value is valid and can be used for alignment program.
GANTRYPRTNRMFB	Second (pairing) gantry motor position (read-only).
GANTRYPRTNRICMD	Second (pairing) gantry axis current command (read-only).

GANTRYPRTNRVFB	Second (pairing) gantry motor velocity (read only).

6.18.6 Gantry setup

When setting up a CDHD2S gantry system, perform the following steps:

1. If the gantry system includes limit switches, ensure they are installed as follows:
   - The positive limit switches on Y1 and Y2 must be parallel, and the alignment deviation must not be greater than 5mm.
   - The negative limit switches on Y1 and Y2 must be parallel, and the alignment deviation must not be greater than 5mm.

2. Connect the motor of the first gantry axis to the first drive, and connect the second motor to the second gantry drive. Make sure each pair of power and feedback cables is connected to the right drive.

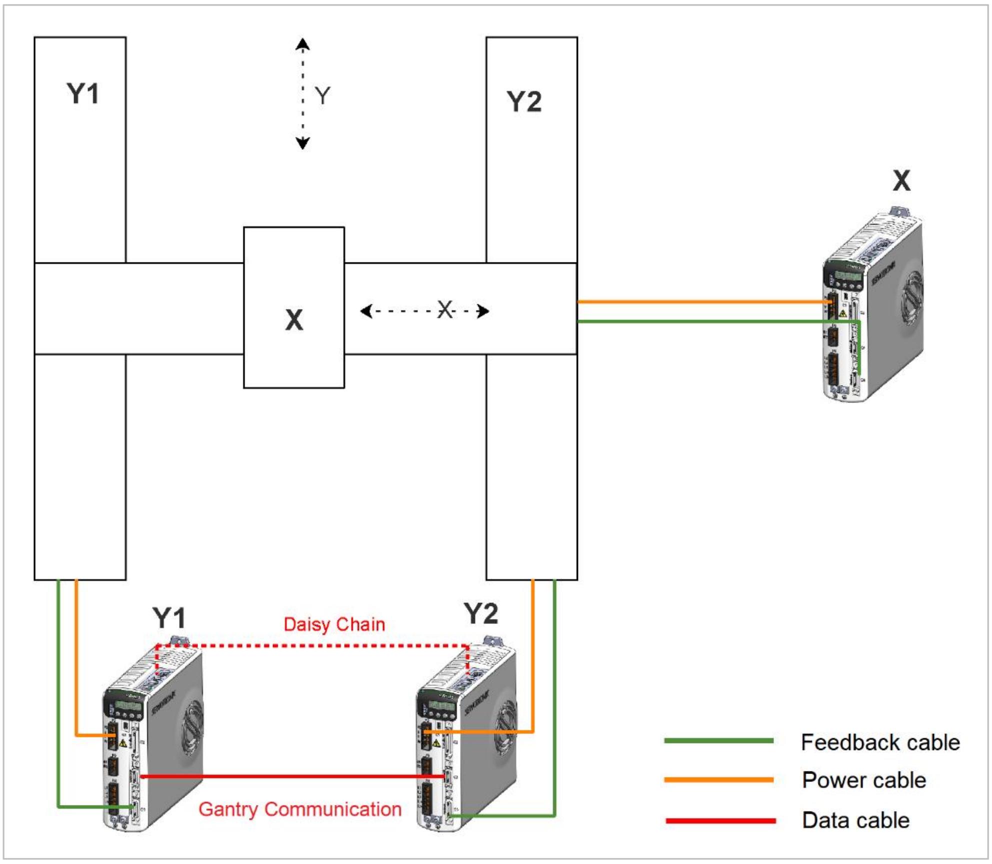


Figure 6-59 Gantry wiring and communication

3. Gantry drives are connected to each other through two interfaces, C3 and C8. Fast communication between axis drives requires C3 connectors.

Parameter configuration and tuning require C8 daisy chain wiring.

4. Define addresses for each drive. Use HMI panel (medium-voltage models) or rotary switch (low-voltage models). Please refer to the

Drive Addressing section. Restart the drive after setting the address.

Set up and test each axis individually:

Note: For the two gantry Y-axes, the motor cannot be configured with the ServoStudio2 motor setup wizard.

5. The first gantry axis:

a. Configure motor and feedback device parameters according to manufacturer specifications. Use the ServoStudio2 "Motor" screen.

b. Check the current control loop of the first axis.

Open the ServoStudio2 "Motor" screen. Select serial current operation mode. Select parameters IQ (current Q axis) and ICMD (current command) for recording. Enter the Current Command value. Start recording.

If the motor parameters ML (motor induction) and MR (motor impedance) are set correctly, the test results should be good.

If noise occurs, increase the KCD value (minimum level of dead time compensation) from 1 to 10 to improve performance.

c. Test motor movement.

Make sure the second gantry motor drive is disabled.

Open ServoStudio2 operation mode. Select serial current operation mode.

Enter a "Current Command" value less than 10% of MICONT (motor continuous current).

When the motor moves, observe the value change in the status bar of ServoStudio2. Ensure that positive values generate positive velocity. If this is not the case, set MFBDIR to reverse the motor feedback direction, and use the ZERO command to adjust MPHASE.

6. The second gantry axis: Repeat step 5.

7. Two gantry axes are tested together.

a. Open the ServoStudio2 gantry screen.

b. In the Configuration tab: Set the ID of main axis and differential axis drives.

c. When both drives are disabled, manually move the gantry platform and observe the position and velocity values of the main axis and differential axis in ServoStudio2.

Make sure that the position values of the two axes increase in the same direction.

Make sure that the velocity values of the two axes also reflect the same direction.

If the directions do not match, modify the DIR of one of the axes.

d. In the Configuration tab: Define the gantry type as Rigid or Flexible.

8. Execute gantry system homing. Please refer to the *Gantry System Homing* section. If using a flexible system, you must set the GANTRYOFFSET value.

9. Perform gantry main controller and differential controller tuning. Please refer to the *Gantry Tuning* section.

6.19Homing

CDHD2S provides several methods for homing the motor.

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

Homing types 1-14, 17-30 and 33-35 are standard homing methods and are defined in CiA402.

Define additional homing types according to customer requirements.

Use the ServoStudio2 "Homing" screen to define and execute the homing procedure.

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

Table 6-27

VarCom	Description
AUTOHOME	Define whether to perform automatic homing when powered on.
HOMEACC	Acceleration and deceleration values in the homing process.
HOMECMD	Start the homing process.
HOMECMD0	Stop the homing process.
HOMEOFFSET	Set the “zero” position offset (count).
HOMESPEED1	Search the initial velocity used by the homing process in the process of limit switch, zero switch and hard stop.
HOMESPEED2	Search the velocity used by the homing process in the process of homing triggers (which may be index pulses, limit switch transitions, zero switch transitions or other sources (defined by HOMETYPE)).
HOMESTATE	Display the current status of the system homing process.
HOMETYPE	Define the type of homing process that will be executed.

6.19.1 Index homing and motor resolver

Index pulse homing can be used with resolver motor feedback.

Homing methods: HOMETYPE1–14, 33, 34, -8, -12, -33, -34, -40, -44, -65, -66, -97, -98. The resolver index pulse position refers to the point where the motor mechanical angle (MECHANGLE) is zero.

In order to achieve better accuracy in the homing procedure (i.e. minimum position feedback (PFB) count starting from MECHANGLE0), reduce the value of HOMESPEED2.

6.19.2 Index homing and single/multi-turn encoder

The index pulse homing can also be used with absolute multi-turn and absolute single-turn feedback devices. The index pulse position used for homing is the zero position of the single-turn data.

Homing methods: HOMETYPE1 - 14, 33, 34, -9, -10, -13, -14, -34, -65, -66, -97, -98. In these methods, HOMESPEED1 is used before a limit switch, zero switch, or hard stop is detected.

Once an appropriate sequence time occurs (for example, the direction of the limit switch is reversed), the axis detects the index pulse (or the equivalent signal on the absolute encoder) in HOMESPEED2 motion.

6.19.3 Switch positive edge homing

Homing methods: HOMETYPE24, 28

In some cases, reaching the positive edge with HOMESPEED1 may be too fast, resulting in inaccurate homing position.

In order to improve the homing accuracy of methods 24 and 28, it is recommended to use homing methods -24 and -28. Both methods involve reversing the motion with HOMESPEED2 until the required event occurs.

6.19.4 Gantry system homing

The homing command (HOMECMD) must be sent to the CDHD2S gantry main drive to start and control the two gantry motors to home

In an EtherCAT/CANopen system, each drive must be set to the "homing" operation mode (OPMODE6) and then wait to receive a homing command from the motion controller. The homing will be performed first by the gantry main drive, and then the gantry differential drive will be started to home.

Please refer to the *Gantry Setup and Gantry Tuning* section.

Rigid gantry system homing

In a rigid CDHD2S gantry system, the homing requirements and methods are as follows:

- Any standard homing method (HOMETYPE) can be used.
- The HOMETYPE definition is for the Y1 (main) motor and is used on the entire gantry system. The HOMETYPE of Y2 (differential) must be set to HOMETYPE=35 (has no effect on the axis).
- Only the homing reference (index pulse, zero switch, limit switch) is considered for the Y1 motor; the homing reference of the Y2 motor is ignored.
- If the homing type relies on the limit switch to reverse direction during the home search process, the first limit switch detected on Y1 or Y2 will cause a change in direction.
- If the homing type relies on the hard stop to change direction during the home search process, the first hard stop on either Y1 or Y2 will cause a change in direction.

Flexible gantry system homing

In a flexible CDHD2S gantry system, the homing requirements and methods are as follows:

- Each of the two gantry motors must have an index switch or zero switch.
- Apply the same homing type to both Y-axes, and can be any of the following types:
  - HOMETYPE1, 2 (limit switch and index pulse homing)
  - HOMETYPE23, 24, 25, 26, 27, 28, 29 or 30 (limit switch and zero switch homing)
  - HOMETYPE-33, -34 (index pulse homing after hard stop)
  - HOMETYPE-56, -60 (zero switch homing after hard stop)

When the homing command is issued to the gantry host, the following situations will occur:

1. The preliminary rough alignment is performed on both axes. The two are closely aligned with each other but not perfectly aligned.
2. Both axes start moving simultaneously toward the limit switch or hard stop.
3. Both axes move in reverse direction at the same time and search for the Y1 axis homing reference. The axis moves until it reaches the limit switch/hard stop in the opposite direction (on the Y1 or Y2 axis).
4. The axes move in reverse direction at the same time, and search for the Y2 axis homing reference.
5. Finally, to align the two axes orthogonally, the homing process moves the differential axis based on the GANTRYOFFSET value. The gantry system returns to home.

7.Operations

7.1Power on the drive

Warning! Enabling the drive may cause the motor to move.

Three conditions are required to enable the CDHD2S drive:

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

Use the ServoStudio2 Enable and Fault screen to view and set the conditions required to enable the drive.

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

- The Enabled|Disabled buttons in the ServoStudio2 toolbar indicate drive state.

Figure 7-1

If it lights up, the drive is enabled (activated). The motor is being energized.

If the light is off, the drive is disabled.

- The decimal point 1 on the digital display of the drive indicates the enabled/disabled state of the drive.

If it lights up when the operation mode is displayed, the drive is enabled, as shown in the example here.

If not, the drive is disabled.

7.2Drive Operation Mode

The CDHD2S can run in multiple operation modes. Each operation mode has a main control loop (current/torque, velocity or position) and a specific type of command input.

When using the VarCom instruction, the operation mode is set via the OPMODE value:

0=Velocity control, using serial commands

1=Velocity control, using analog inputs

2=Current control, using serial commands

3=Current control, using analog inputs

4=Position control, using pulse/gearing inputs

8=Position control, using serial commands

When using CANopen or CANopenoverEtherCAT (CoE) communication, the operation mode can be set via object 6060h and reported via object 6061h.

1=Profile position

3=Profile velocity

4=Profile torque

6=Homing

7=Interpolation position

8=Periodic synchronization position

9=Periodic synchronization velocity

10=Periodic synchronization torque

For details, please refer to the CDHD2SEtherCAT and CANopen manuals.

7.3Current Operation

7.3.1 Serial current operation

In serial current mode (OPMODE2), only the current loop is active and the drive responds to commands received via the USB or RS232 port.

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

In the ServoStudio2 "Movement" screen, select "Operation Mode" - Serial Current, which is used to modify and test parameters.

7.3.2 Analog current operation

When operating in the analog current mode (OPMODE3), only the current loop is active and the drive responds to analog commands from the main analog input (connected at controller I/F (C2) pins 8 and 26).

In the ServoStudio2 "Movement" screen, select "Operation Mode" - Analog Current, which is used to modify and test parameters.

7.3.3 Current control

Note: It is not necessary to change the values in the Current Loop screen unless requested by technical support.

Current control loop tuning is derived from motor properties and bus voltage. In the ServoStudio2 "Motor Setup" wizard, the current control loop is tuned.

7.4Velocity Operation

7.4.1 Serial velocity operation

In serial velocity mode (OPMODE0), the drive current and speed loops are active and the drive responds to commands received via the USB or RS232 port. The command specifies that the velocity is subject to acceleration and deceleration limits.

In the ServoStudio2 "Movement" screen, select "Operation Mode" - Serial Velocity, which is used to modify and test parameters.

7.4.2 Analog velocity operation

When operating in "Analog Velocity " mode (OPMODE1), the drive current and velocity loops are active and the drive responds to analog commands from the main analog input (connected at controller interface (C2) pins 8 and 26).

The command specifies that the velocity is subject to the acceleration limit defined by the variable ACC.

7.4.3 Velocity control

Please refer to VarComVELCONTROLMODE.

- PI controller (using KVP and KVI)
- PDFF controller (using KVP, KVI, KVFR)
- Standard pole placement controller (using MJ, MKT, BW, LMJR, TF)
- HD velocity loop (with integrating circuit) (using KNLD, KNLP)

HD velocity control (with integrating loop) (recommended)

Please refer to VarComVELCONTROLMODE7.

Before using the HD velocity controller, first execute the ServoStudio2 "Autotuning" wizard, then adjust the tuning manually (if necessary).

You can then continue using the HD velocity controller.

VELCONTROLMODE7 has the velocity control advantage of HD nonlinear controller.

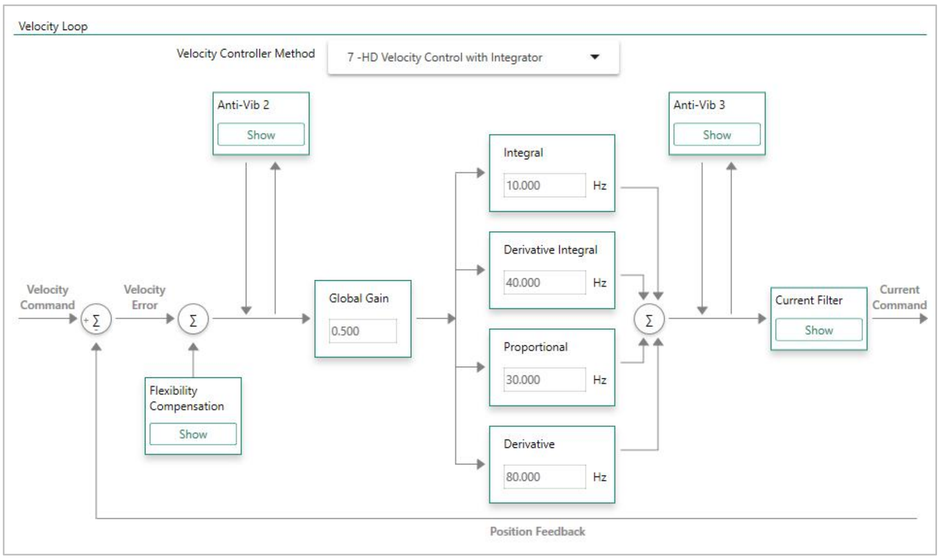


Figure 7-2 Velocity control loop - HD velocity control (with integrating circuit)

proportional-integral (PI) controller

Please refer to VarComVELCONTROLMODE0.

The figure below shows the PI controller.

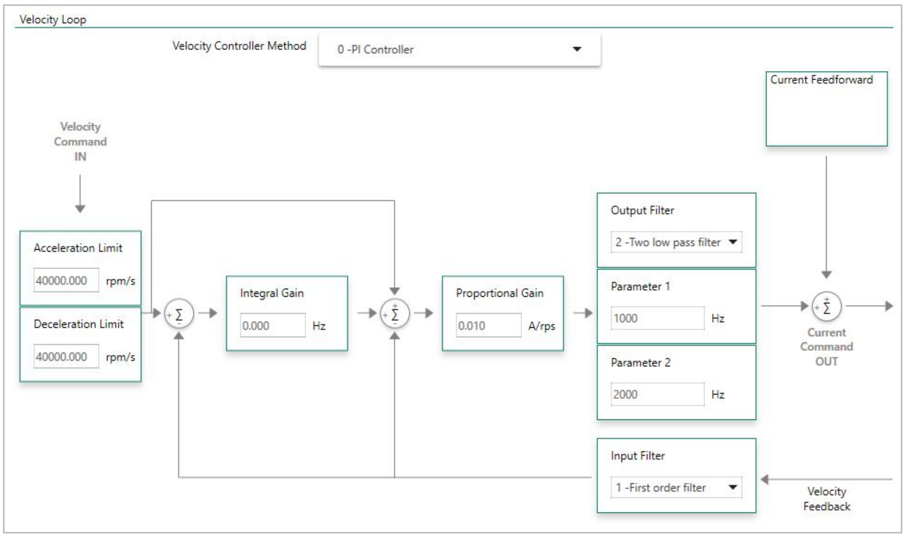


Figure 7-3 Velocity control loop - PI controller

The PI controller is a unit feedback system without prefilter. The proportional gain (KVP) stabilizes the system and The integral gain (KVI) compensates the steady-state error.

The controller parameters KVP and KVI as well as KVFR are tuned through trial and error.

Pseudo-differential feedforward feedback (PDFF) controller

Please refer to VarComVELCONTROLMODE1.

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

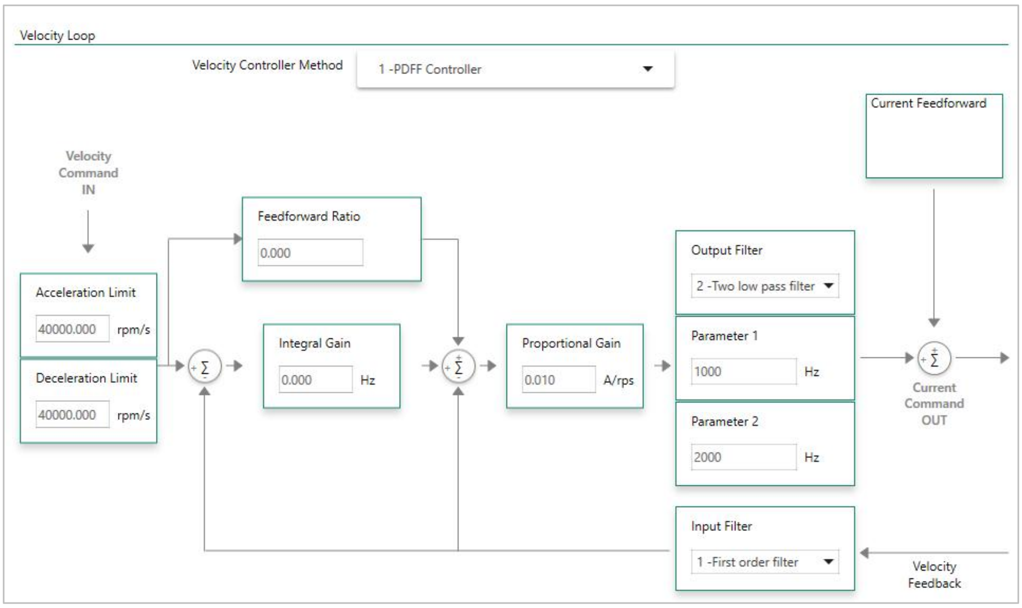


Figure 7-4 Velocity control loop PDFF controller

When the application requires maximum responsiveness, less integral gain is required and KVFR can be set to a high value. When the application requires maximum low-frequency stiffness, KVFR is set to a low value, allowing high integral gain without causing overshoot. This will also cause the system to respond to commands slowly. Moderate KVFR values are generally suitable for motion control applications.

PDFF is a generalized controller. The control parameters KVP, KVI and KVFR are tuned through trial and error.

Standard pole placement (PP) controller

Please refer to VarComVELCONTROLMODE2.

For pole placement (PP) controller tuning, only two parameters are required: load inertia ratio (LMJR) and closed loop system bandwidth (BW).

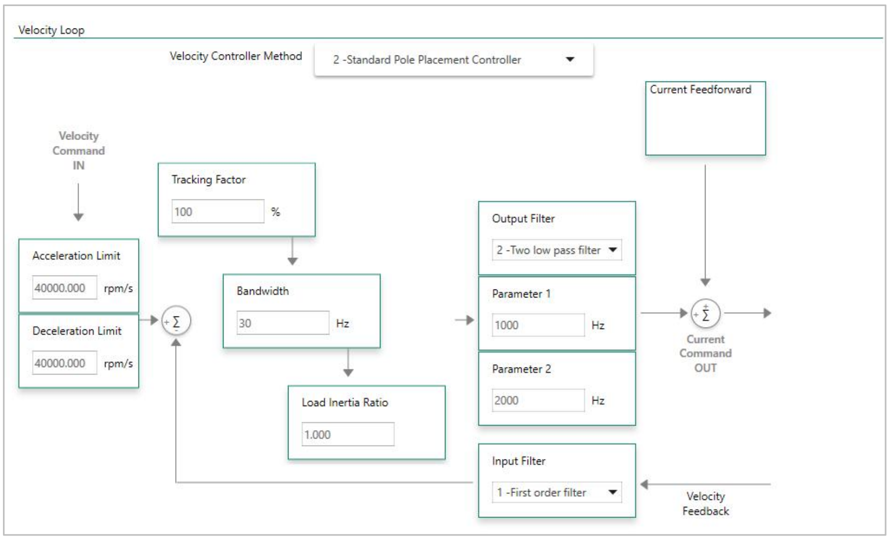


Figure 7-5 Velocity control loop - standard pole placement (PP) controller

For controller design, it is not necessary to know the load inertia. Parameter tuning is simple, as described in the following procedure. Use the following procedure to manually tune a pole placement (PP) velocity controller.

Procedure: Manual tuning of pole placement (PP) velocity controller

Manual tuning consists of an initial step of load inertia estimation, and subsequent steps of designing an optimal controller.

In ServoStudio2, go to the Terminal screen or Terminal tab and perform the steps using the standard ASCII protocol. In addition, it is possible to use the ServoStudio2 Range screen to perform and record movements, and to evaluate and adjust parameters.

1. Set operation mode to serial velocity: OPMODE0.

2. Set the velocity compensator to standard pole placement: VELCONTROMODE2.

3. Enable drive: EN.

4. Set the required bandwidth. It is recommended to start with a low value (10Hz) and increase it gradually.

5. Set the load inertia ratio to zero: load/motor inertia ratio (LMJR)0.

The load/motor inertia ratio (LMJR) is expressed as a percentage of the moment of inertia.

The load/motor inertia ratio (LMJR) range is 0 to 10,000. This range value represents the range of load to inertia ratio (from 0:1 to 100:1). For example, to set the ratio of load inertia to motor inertia to 10:1, use the command load/motor inertia ratio (LMJR) 1000. At this time, the step response should have maximum overshoot, but the control loop should be stable (low gain).

6. Activate the recording mechanism to record velocity command, current command and actual (feedback) velocity: RECORD11024 "VCMDICMDV

7. Jog the motor at constant low velocity: J[value 1]

For example: start with command J150

8. Activate recording trigger: RECTRIGVCMD[value2]201.

Value 2 should be greater than value 1 from the previous step; for example: RECTRIGVCMD200201.

9. Jog the motor at a velocity higher than that specified in the RECRTIG command. This is actually a step command. The higher the step size, the better the results. The step distance should be no less than 300(rpm). For example: J500.

10. Recording takes about half a second. After this, reduce the motor velocity.

11. Check whether the recording process is terminated: REC is completed.

12. Display data recorded by dumping to serial port: GET

13. Analyze the results.

If the current command is saturated during the process (the absolute value of ILIM is obtained), reduce the step size or bandwidth, and then return to step 6.

14. Check the feedback velocity:

- If a negative pulse signal or vibration occurs, reduce the load/motor inertia ratio (LMJR) to the average value of the current load/motor inertia ratio (LMJR) and the last load/motor inertia ratio (LMJR) with an overshoot signal, and then Go back to step 6.
- If an overshoot signal occurs, increase the load/motor inertia ratio (LMJR) by 100, and then return to step 6.
- Repeat the process until tje overshoot is minimized

(Load/motor inertia ratio (LMJR) may ask for estimated load inertia.)

7.5Position Operation

7.5.1 Serial position operation

CDHD2S has a dedicated operation mode (OPMODE8) for simple serial port positioning applications. The host transmits serial commands through the serial port. The command specifies the target position and cruise velocity, and sets additional trajectory information (such as acceleration, deceleration and trajectory type) with explicit variables.

In the ServoStudio2 "Movement" screen, select "Operation Mode" - Serial Position, which is used to modify and test parameters.

Table 7-1

VarCom	Description
ACC	Define the acceleration.
DEC	Define the deceleration.
PE	Position error (also called following error). PE is the calculated absolute difference between PCMD and position feedback (PFB). Read only.
PCMD	Position reference command. Read only.
PFB	Actual position based on motor feedback. Read only.

Incremental (relative) motion

Incremental or relative motion moves the motor relative to its current position. Relative motion is always referenced to the current position of the load (and motor shaft) and can be used in indexing applications such as fixed-length shear feeders and turntables.

Reference point parameter position feedback (PFB) is the actual position obtained based on motor feedback.

The movement can be carried out in any direction, depending on the position value mark. For example, if the target position is one revolution, the motor will make one revolution from the starting point.

Table 7-2

VarCom	Description
MOVEINC	Command to perform incremental position movement according to the effective acceleration setting.

The position feedback (PFB) value can be modified or compensated using parameter PFBOFFSET. This parameter is used for manual homing, or just for testing incremental motion.

Procedure: Set 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 position feedback (PFB).
4. Set PFBOFFSET to a negative position feedback (PFB) value.
5. When using counts as the position unit, PFBOFFSET can only be set to an integer value, even if the actual position feedback (PFB) count of real value display contains fractions (due to internal interpolation of the encoder signal).

Absolute motion

Absolute motion is always relative to an absolute reference point.

Reference point position feedback (PFB)=0 point.

Table 7-3

VarCom	Description
MOVEABS	Command to perform incremental position movement according to the effective acceleration setting.

End of motion

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

Table 7-4

VarCom	Description
PEMAX	Maximum allowable counting position error (no fault).
PEINPOS	Tolerance window that declares “in position” status. When PE (position error) value is less than the PEINPOS (position error tolerance) value, the motor is considered to be in position. When PE (position error) value remains lower than PEINPOSTIME within the time defined by PEINPOS, the motor is considered to be stable.
INPOS	Indicate the “motor in position” state. Read only. When the motor is in position, INPOS=1, regardless of the motion trajectory state. When the motor is not in position, INPOS=0.
STOPPED	Indicate the “motor stable” state. Read only. STOPPED=-1. Motion is interrupted. STOPPED=0. The motion trajectory is in progress. STOPPED=1. The trajectory is completed. STOPPED=2. The trajectory is completed and INPOS=1.

7.5.2 Position control

The CDHD2S has two position control loop options - HD (non-linear) and linear.

HD (non-linear) position controller

HD position control is a proprietary algorithm designed to minimize position errors during movement, and to minimize settling time at the end of movement. We recommend this controller. Please refer to the *Tuning*.

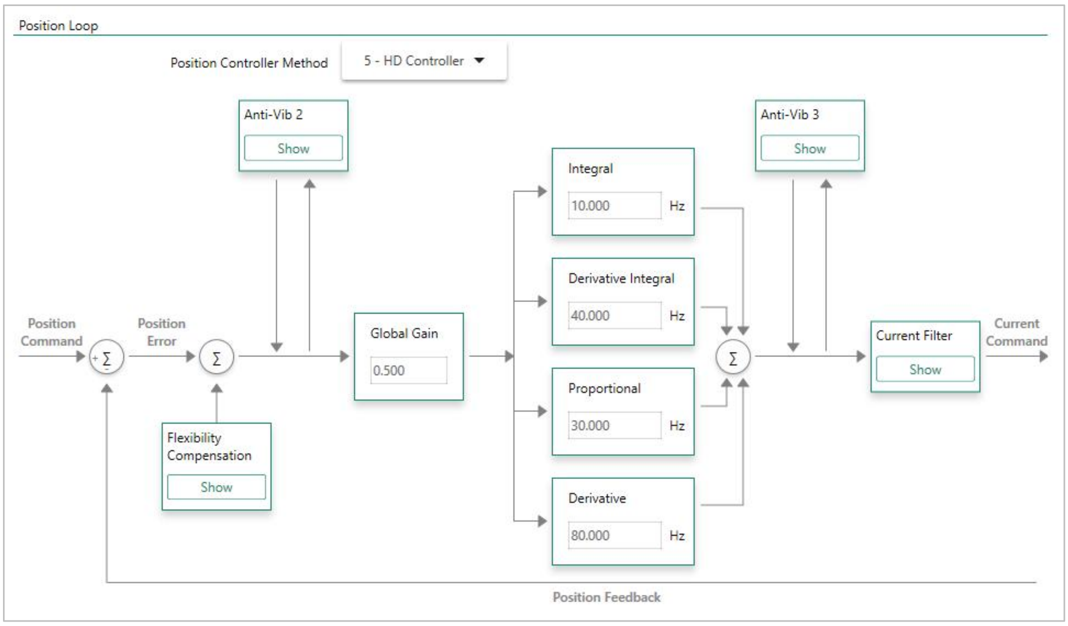


Figure 7-6 Position control loop - HD controller

Linear position controller

Linear position controller is a feedforward PID controller with limited integral saturation (anti-terminal) option.

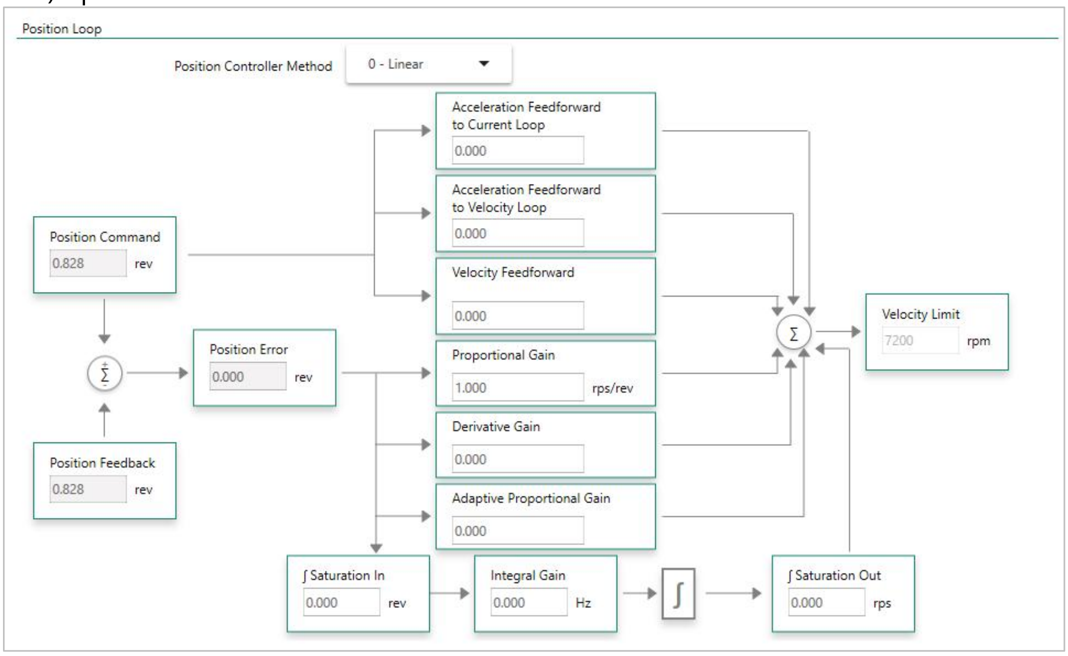


Figure 7-7 Position control loop - linear

7.6Gearing/Pulse Train Operation

In the gearing/pulse train operation mode, the drive current, velocity and position loops are active loops and the drive is synchronized to the main input command signal of the pulse train. The CDHD2S can be configured to read this input signal as an encoder follower, up/down counter, or pulse/direction counter.

In the ServoStudio2 "Movement" screen, select "Operation Mode" - gearing/pulse train to modify and monitor parameters.

Various gearing methods are defined by the parameter GEARMODE.

Table 7-5

VarCom	Description
GEARMODE0	Encoder following; send a signal through the controller interface (C2). Signals are received at pins 28 and 11 (quadrature A) and pins 9 and 27 (quadrature B) through the controller interface.
GEARMODE1	Pulse and direction; send a signal through the controller interface (C2). Signals are received at pins 28 and 11 (pulse) and pins 9 and 27 (direction) through the controller interface.
GEARMODE2	CW/CCW (up/down); send a signal through the controller interface (C2). Signals are received at pins 28 and 11 (CW) and pins 9 and 27 (CCW) through the controller interface.
GEARMODE3	Encoder following (secondary encoder); send a signal through the machine interface (C3). Signals are received at pins 1 and 11 (quadrature A) and pins 2 and 12 (quadrature B) through the machine interface.
GEARMODE4	Pulse and direction (secondary encoder); send a signal through the controller interface (C3). Signals are received at pins 1 and 11 (pulse) and pins 2 and 12 (direction) through the controller interface.

Note:

GEARMODE0:
The controller interface (C2) cannot supply voltage to the handwheel or the main encoder of the machine. This voltage is only available from the machine interface (C3).
GEARMODE0, 1, 2:
If inputs 5 and 6 are set for INMODE17 and 18 respectively, signals are received from fast inputs 5 and 6 at controller interface (C2) pins 32 and 15.

Regardless of whether gearing mode is used, the input signal needs to be geared, allowing you to set the input pulse ratio to the encoder count. Gearing establishes the relationship between the number of input pulses (HWPEXT counts) and the motor shaft position increment. The occurrence rate of motor shaft (motor velocity) position increment is determined by gearing relationship and pulse train line frequency. The gearing relationship is as follows:

$$\frac{GEARIN}{GEAROUT} \times \frac{1}{XENCRES}$$

In addition to tuning the current, velocity, and position loops, the following table shows some of the parameters used to configure and monitor the gearing.

Table 7-6

VarCom	Description
GEAR	Activate the gearing function.
GEARIN	Gearing ratio numerator. GEARIN value symbol determines the direction of rotation.
GEAROUT	Gearing ratio numerator.
XENCRES	Resolution of external pulse source.
HWPEXT	Position measured by the external feedback device.

7.6.1 Pulse and direction

In "pulse and direction" position control, the drive is synchronized to a main input command signal in the form of a pulse train.

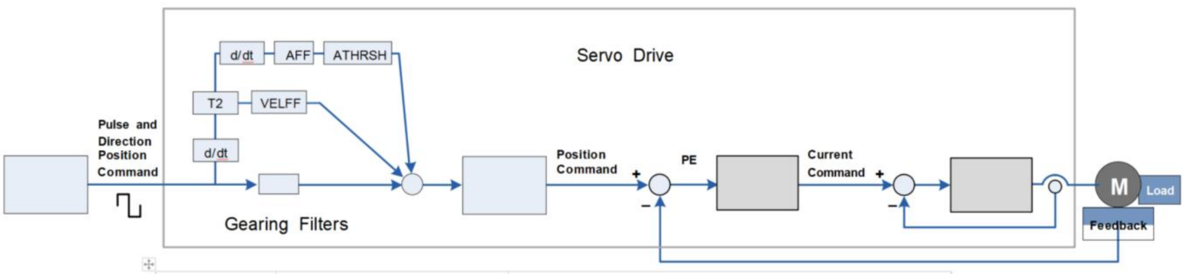


Figure 7-8 Pulse and direction position control

The drive receives each rising edge of the pulse to increase (or decrease, depending on the direction) the external input position counter (HWPEXT) of the drive by one position count. This counter value is transmitted through the gearing module and becomes the motor position command.

Compare the position command and the motor position (PFB) to determine the position error (PE). The drive corrects the position error by incrementing the motor to the commanded position.

In the "pulse and direction" mode, if the absolute value of GEARIN is equal to GEAROUT, and XENCRES is equal to 4×MENCRES (i.e. the resolution of the motor encoder after quadrature), then one input pulse is equivalent to one motor feedback count.

For example, assume that the motor encoder resolution is 2500 lines per revolution. If you set GEARIN=1, GEAROUT=1 and XENCRES=10000, this will cause the motor to rotate once every 10000 pulses (assuming the direction is fixed during this period).

Note: The drive homing function remains active in this configuration.

Pulse and direction operation

For "pulse and direction" operation, the pulse signal must be defined as digital input 5 (INMODE517) and the direction signal must be defined as digital input 6 (INMODE618).

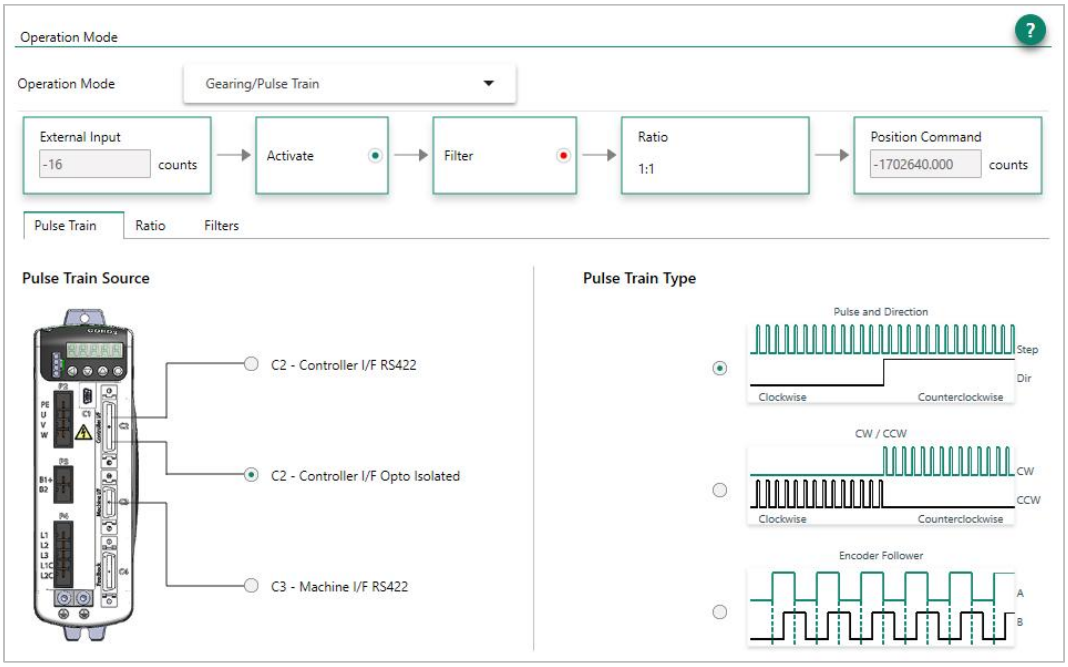


Figure 7-9 Setting pulse and direction commands using optoisolated inputs

Step 1 - Setup and tuning

1. Run the ServoStudio2 "Motor Setup Wizard" to ensure that the motor setup is completed successfully.

2. Run the ServoStudio2 "Autotuning Wizard" to ensure that the autotuning is completed successfully.

Step 2 - Select pulse and direction

1. In ServoStudio2, enter the "Operation Mode" screen and select "Operation Mode - gearing/pulse train" (OPMODE4).

2. In the pulse train tab, select “pulse train source” and “pulse train type”:

- If using "differential":

Select controller I/FRS422 and the pulse and direction (P&D) option.

- If using "optoisolated":

Select controllerI/F optoisolated and pulse and direction (P&D) options. This option will automatically set the definition for digital inputs 5 and 6.

Step 3 - Digital inputs 5 and 6 setup (optoisolated inputs only)

1. Enter the "Drive Configuration > Digital IO" screen.
2. Make sure digital input 5 is set to a 17-pulse signal.
3. Make sure digital input 6 is set to the 18-directional signal.

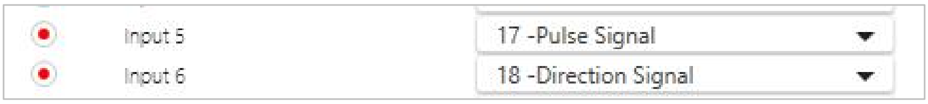


Figure 7-10 Digital input of pulse and direction signals

Step 5 - Set pulse and direction parameters

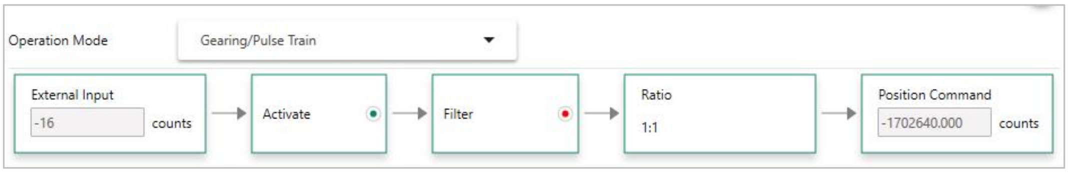


Figure 7-11 Pulse and direction operation parameters

1. Make sure gearing mode is enabled (GEAR=1).
2. In the Ratio tab, set the input resolution and gear ratio.

The relationship between input pulse and motor shaft motion is determined by the external encoder resolution (HWPEXT) and the gear ratio (GEARIN/GEAROUT).

For example: Set the PLC controller to provide 1024 line pulses as a CDHD2S system input command to make the motor rotate two turns. The settings should be as follows:

External encoder resolution=1024

Gear ratio multiplier = 2

Gear ratio divisor=1

3. In the Filter tab, set and adjust the gear filter and command smoothing filter as needed. Command smoothing filter

- Smoothing filter (MOVESMOOTHMODE). Select this option to activate the filter.
- Hard/Soft (MOVESMOOTHAVG). Drag the slider to adjust the value.
- Gear command smoothing filter
- Gear noise filter (GEARFILTMODE). Select this option to activate the filter.
- Hard/Soft(GEARFILTDEPTH). Drag the slider to adjust the value.

7.6.2 CW/CCW (up/down) counting

In a CW/CCW (or up/down) system, a pulse on one signal increases motor position, while a pulse on the other signal decreases motor position. The signal must be connected to the controller interface (C2).

When a pulse signal is applied to the A channel, the external position counter (PEXT) is incremented and the motor is rotated in the positive direction. When a pulse signal is applied to the B channel, the external position counter (PEXT) is decremented and the motor is rotated in the negative direction. Line frequency and gearing relationships determine the velocity and amount of shaft movement.

- Set GEARMODE to 2 and inform the drive to receive signals via the pulse and direction inputs on the control interface (C2).

7.6.3 Encoder follower (master/slave)

In encoder follower mode, the drive follows the quadrature encoder signal generated by the master. The direction of movement is determined by quadrature signals (A is ahead of B, or B is ahead of A).

For example, the master device could be a handwheel, a machine main encoder (connected to the main camshaft), or the equivalent encoder output of another servo drive.

If the master device is a handwheel or a main encoder, after setting XENCRES equal to the encoder resolution (before quadrature) and setting the gear ratio to 1, the motor will rotate once for each input revolution.

For example, assume that the handwheel resolution is 120 lines per revolution (i.e., 480 counts after quadrature). After setting GEARIN=1, GEAROUT=1 and XENCRES=120, the motor will rotate once every turn of the handwheel.

Quadrature signals can be connected to the controller interface (C2) or the machine interface (C3). The GEARMODE parameter informs the drive the interface to which the signal is connected.

- Set GEARMODE to 0 and inform the drive to receive signals via the pulse and direction inputs on the controller interface (C2).

Note that the controller interface (C2) cannot provide voltage to the handwheel or the main encoder of the machine.

- Set GEARMODE to 3 and inform the drive to receive signals through the secondary encoder input on the machine interface (C3).

8.Drive Debugging

8.1CDHD2S HD Controller

The CDHD2S has two user-selectable position control loops - linear and HD (non-linear).

The HD control loop is a proprietary algorithm designed to minimize position errors during movement and settling time at the end of movement.

The HD algorithm uses a parallel configuration where all branches are executed at the same level and within the same sampling period. Introduce variable gain on each branch and automatically optimize for high gain and stability.

The HD controller also includes an adaptive feedforward feature that is applied at the end of the movement to deliver zero or minimal settling time. In addition, the HD controller provides low-pass, notch, and other filters to handle flexible and resonance systems.

The ServoStudio2 Position Control Loop screen provides user-modifiable access to HD control loop parameters.

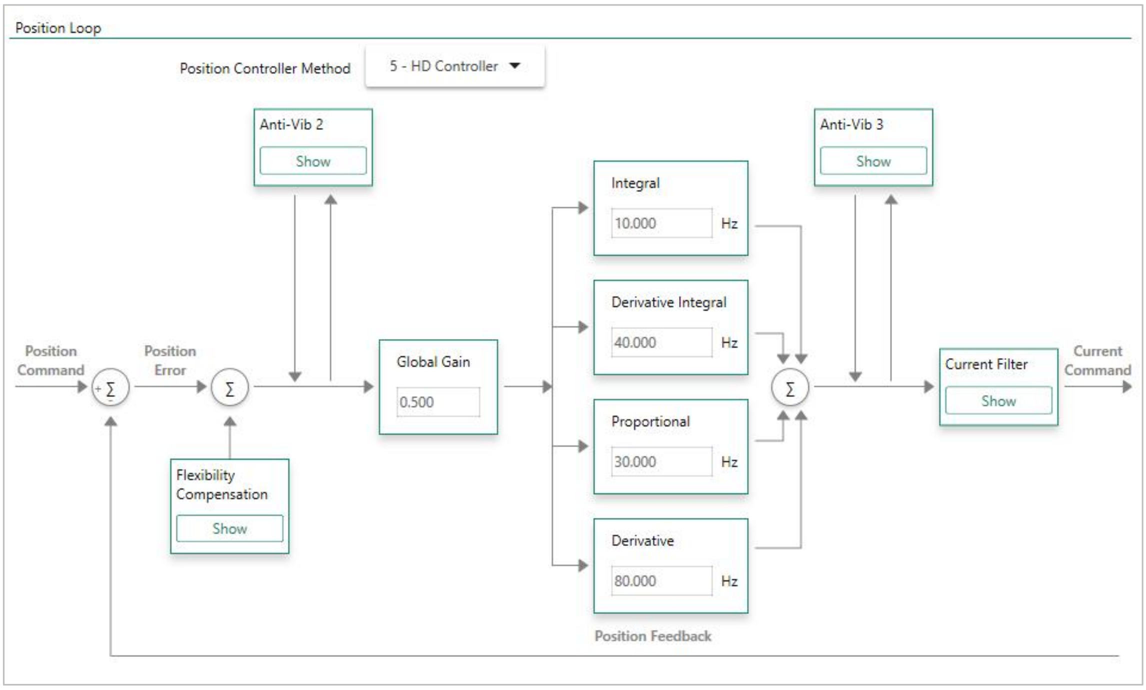


Figure 8-1 CDHD2SHD control loop

8.2CDHD2S HD Controller Autotuning

Warning! Tuning is potentially dangerous. Before starting any tuning procedure, make sure no one is within the motion envelope curve and that the panic button is within reach.

Perform autotuning on the HD control loop of the CDHD2S. There is no autotuning procedure for linear control loop.

Initially use the Autotuning wizard to set the HD control loop parameters. Drive tuning performed by the wizard is usually sufficient. However, you may need to manually tune control parameters to optimize them for your specific application. Parameters can be viewed and modified in the ServoStudio2 Position Loop - HD Controller screen.

Automatic and manual tuning use similar methods. During the autotuning, the movement quality is measured and evaluated by the drive or software. During manual tuning, the quality of movement is evaluated by the user. In both cases, modify the servo control parameters step by step and select the values that deliver the best performance.

The Autotuning wizard can also be used to optimize drive parameters to produce the most efficient transmission for a specific task or application. Setting and optimizing parameters via the Autotuning wizard can be drive-based or PC-based:

- If an electronic motor nameplate is detected at power-up (such as PRO2 and PRDH2 motors with sensAR magnetic encoders), or if the software is running offline, ServoStudio2 will activate the drive-based autotuning wizard.
- If no electronic motor nameplate is detected at power-up, ServoStudio2 will activate the PC-based autotuning wizard.

8.3Drive-based autotuning

If an electronic motor nameplate with a servo parameter bundle is detected at power-up (e.g. PRO2 and PRHD2 motors with sensAR magnetic encoder), ServoStudio2 will activate the drive-based autotuning wizard. This wizard is also activated if the software is run offline.

There are four possible common options for drive-based autotuning: Fast/Internal, Fast/External, Advanced/Internal and Advanced/External.

- Fast autotuning requires no user input, just activate each step.
- Advanced autotuning requires user input.
- Internal reference - Drive commands used for tuning are generated by the drive.
- External reference - Drive commands used for tuning are generated by an external controller (e.g. PLC).

8.3.1 Drive-based autotuning - fast

Fast autotuning requires no user input, just activate each step.

Fast autotuning consists of the following steps:

1. Select Fast/Internal or Fast/External.
2. Start autotuning.
3. Test results.
4. Save parameters.

For details on each step, please refer to the *Drive-Based Autotuning - Advanced*.

Table 8-1 Drive-based autotuning process steps

	Fast	Advanced
Model	x	x
Inertia		x
Movement		x
Options		x
Start	x	x
Test	x	x
Save	x	x

8.3.2 Drive-based autotuning - advanced

The advanced autotuning process includes the following steps:

1. Select Advanced/Internal or Advanced/External.

Optional: Manually move the axis to the start position (available when the drive generates gearing). If necessary, use the positive and negative buttons to place the load in a position where the motor can safely rotate three times in each direction.

2. Load/motor inertia ratio estimation.
3. Set the transmission profile.
4. Set parameter optimization options.
5. Run autotuning.
6. Test results.
7. Save parameters.

Click Next to proceed to the next screen during this procedure.

Step - Tuning mode

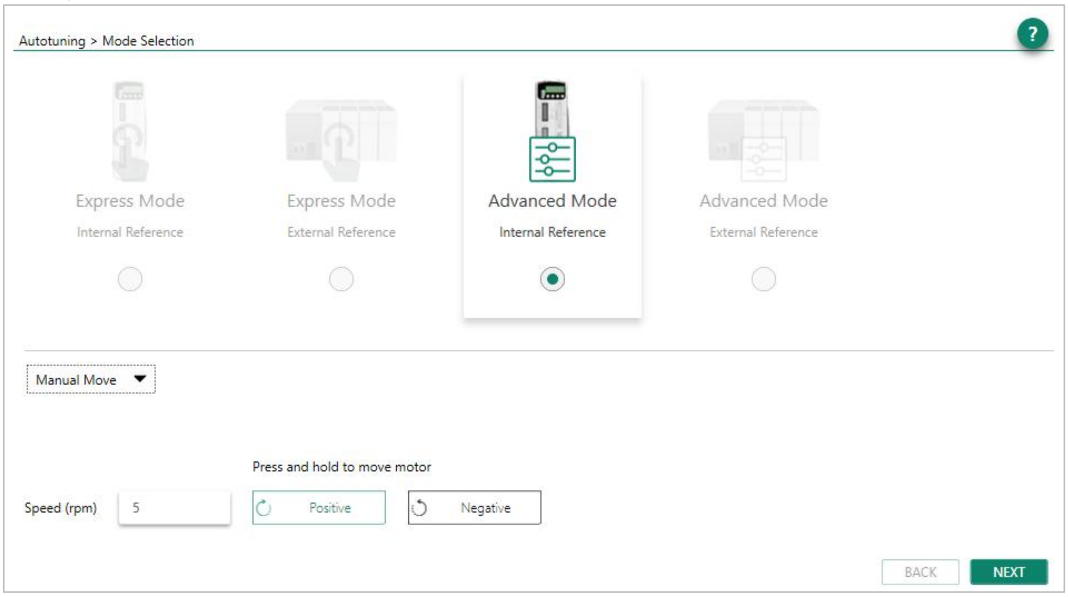


Figure 8-2 Autotuning - tunning mode

1. Select Advanced/External (or Advanced/Internal).

2. Transmission testing usually begins at the midpoint of the motion stroke. If your application requires a different start position, use Manual Move.

Use the negative and positive buttons to place the load in a position where the motor can safely rotate three times in each direction. Press and hold the button for continuous transmission.

3. Click Next to continue.

Step - Load/Motor inertia ratio

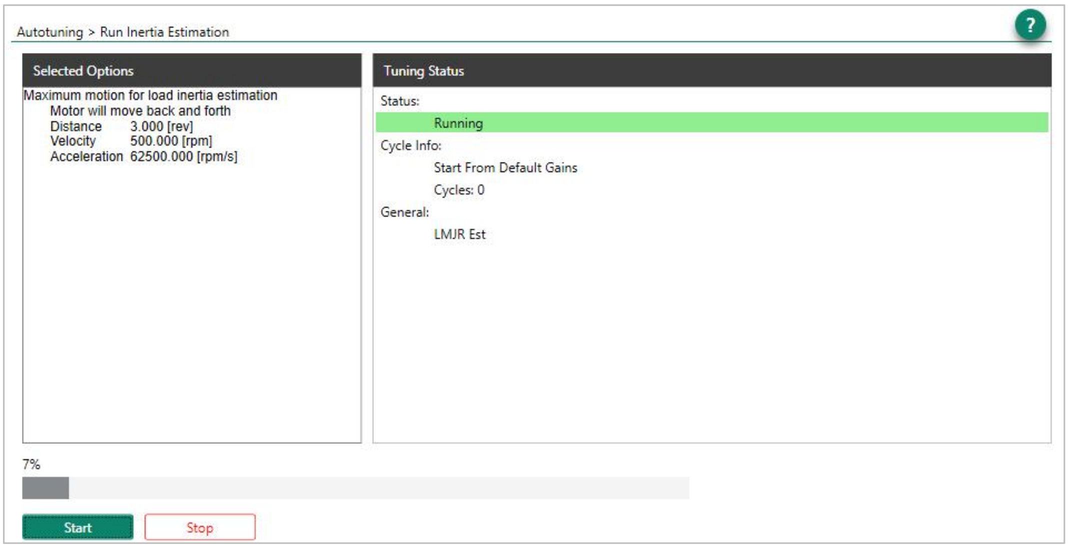


Figure 8-3 Autotuning - inertia ratio estimation

Typically, you should allow the servo drive to estimate the load/motor inertia ratio (LMJR).

You may need to manually set the moment of inertia (step 4 - option: load/motor inertia ratio (LMJR) value) to get better performance, for example:

- If the load/motor ratio is very large.
- If you know the exact value of the load inertia connected to the motor.
- If the load inertia changes.
- If using a multi-axis robot.

Step - movement

Note: movement steps are only available if the drive (internal) is a gear generator.

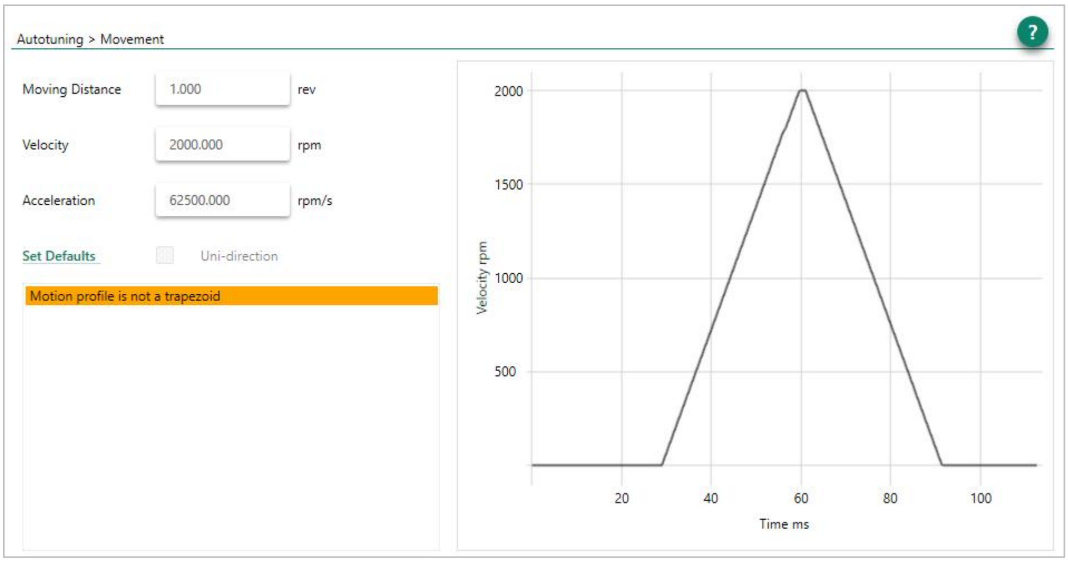


Figure 8-4 Autotuning - transmission profile. Not applicable

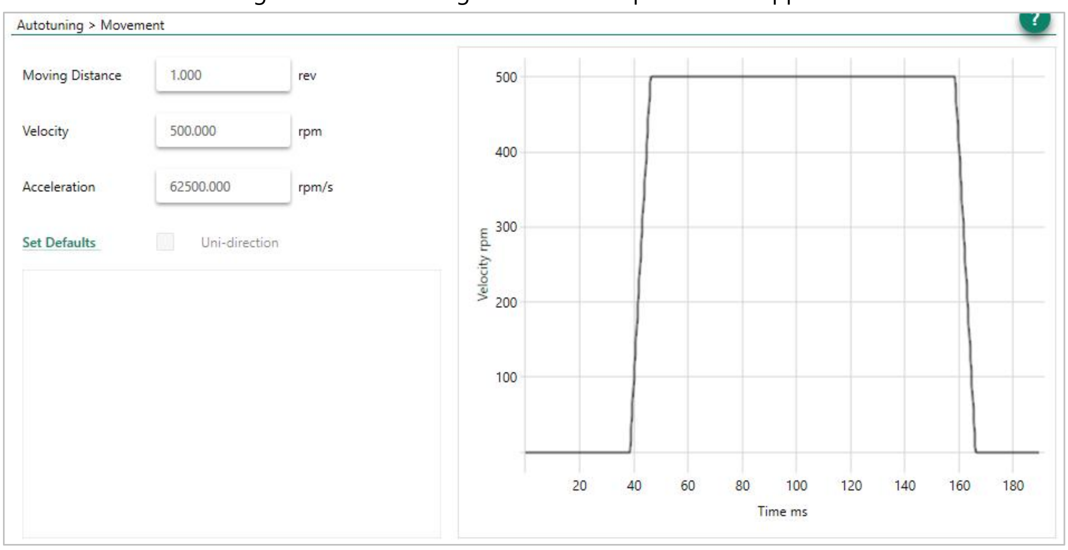


Figure 8-5 Autotuning - transmission profile. Applicable

Autotuning must be performed using transmission profile, replicating the actual mechanical characteristics of the motion performed in the application. Click Set Defaults to set values that produce a good trapezoidal profile on the graph.

The software will indicate whether this profile is suitable for the autotuning procedure.

- Highlight orange: profile available, but not recommended
- Highlight red, profile not available

Step - Autotuning options

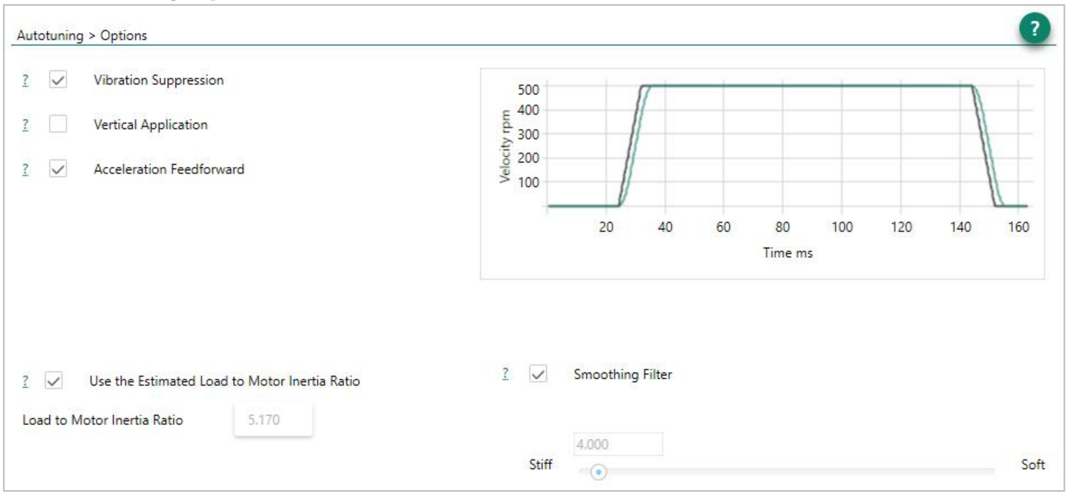


Figure 8-6 Autotuning - options

Option: Vibration suppression

Select Vibration Suppression for the autotuning vibration suppression parameter sets (anti-vibration 2 and anti-vibration 3).

Clear this option if you want to set the vibration reduction parameters manually or apply without vibration reduction.

Increased anti-vibration may lead to the following effects:

- Vibration will be suppressed, thus improving settling time.
- High HD loop gain is allowed.
- Increasing the position error of the motor, but the position error and vibration of the end effector will be decreased.

Option: Vertical application

Select this option for gravity compensation when the axis moves vertically. If checked, autotuning will set the value of parameter IGRAV. Clear this option if the axis moves in two directions in a balanced (non-vertical) way.

Options: Acceleration feedforward

Select this option to reduce tracking errors during exercise. If checked, autotuning will set the value of parameter KNLAFRC. If the overshoot is too large, clear this option.

Options: Smoothing

Select this option to automatically tune the input profile command. If checked, autotuning will adjust the profile smoothing parameters. Clear this option if the application is multi-axis and requires equal smoothing on all axes.

If cleared, MOVESMOOTHAVG is used, and its value is in the range of 1-15 ms.

Option: Load/motor inertia ratio (LMJR) value

Typically, autotuning can use the load/motor inertia ratio (LMJR) value calculated in the autotuning step - inertia ratio estimation.

If you need to change the load/motor inertia ratio (LMJR) value detected by the drive, please use this option. Enter a load/motor inertia ratio value.

Please refer to "Step - Load/Motor Inertia Ratio".

Step - start

Click start to run the autotuning process.

Start repeatedly enabling the drive and running the motor!

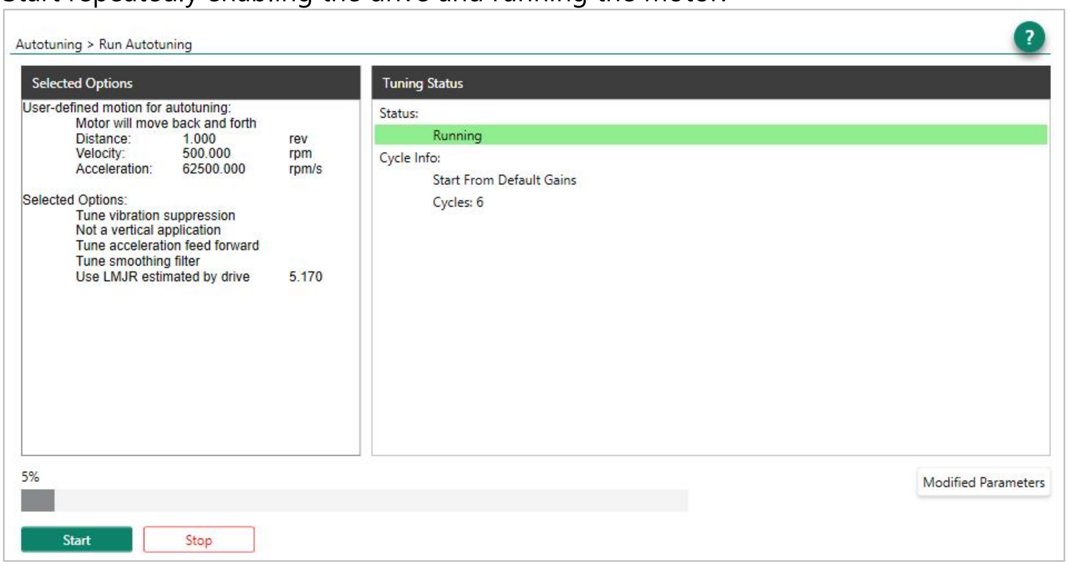
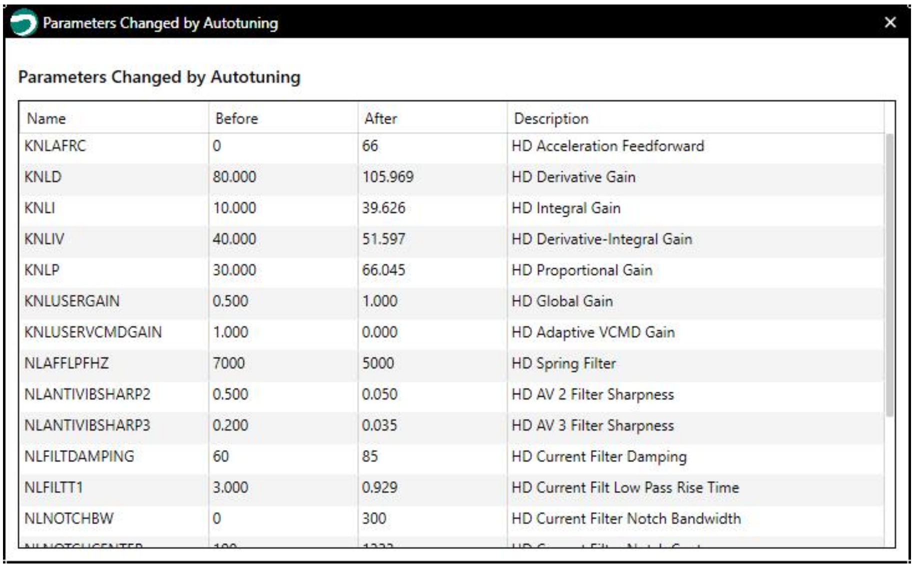


Figure 8-7 Autotuning - start

The motor moves continuously back and forth while testing values at intervals over the entire range of each control loop parameter. After autotuning is completed, click Modify Parameters to view the new settings.



Name	Before	After	Description
KNLAFRC	0	66	HD Acceleration Feedforward
KNLD	80.000	105.969	HD Derivative Gain
KNLI	10.000	39.626	HD Integral Gain
KNLIV	40.000	51.597	HD Derivative-Integral Gain
KNLP	30.000	66.045	HD Proportional Gain
KNLUSERGAIN	0.500	1.000	HD Global Gain
KNLUSERVCMDGAIN	1.000	0.000	HD Adaptive VCMD Gain
NLAFFLPFHZ	7000	5000	HD Spring Filter
NLANTIVIBSHARP2	0.500	0.050	HD AV 2 Filter Sharpness
NLANTIVIBSHARP3	0.200	0.035	HD AV 3 Filter Sharpness
NLFILTDAMPING	60	85	HD Current Filter Damping
NLFILTT1	3.000	0.929	HD Current Filt Low Pass Rise Time
NLNOTCHBW	0	300	HD Current Filter Notch Bandwidth

Figure 8-8 Autotuning - parameters changed by autotuning

Step - Test

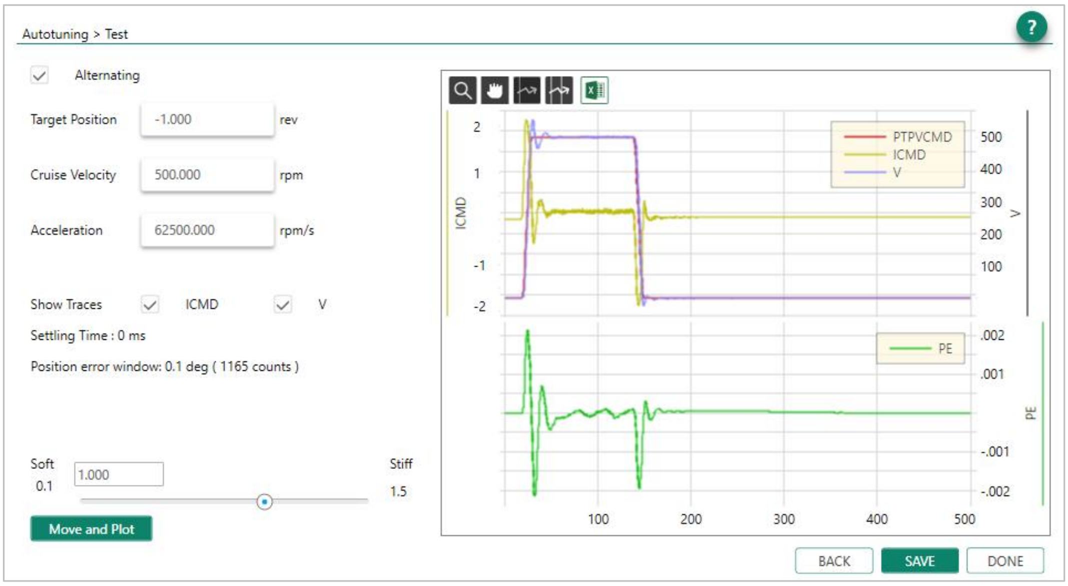


Figure 8-9 Autotuning - test

4. Click Move and Plot to send the current command to the drive and plot the response.

Move and Plot enables the drive and the motor will run!

The resulting graph shows the position command profile in velocity unit (PTPVCMD). Option can also display motor velocity measured by feedback device (V) and current command (ICMD). The second plot shows position error (PE).

The wizard also displays the system-calculated settling time and position error window values.

Toolbar buttons allow you to examine the drawing more carefully and export the results to a spreadsheet. These functions are also found in the ServoStudio2 Range screen.

5. Optional: modify the motion settings and/or gain settings and repeat the test under different conditions:

- Target position
- Cruising velocity
- Acceleration (and deceleration)
- HD Global Gain (KNLUSERGAIN); This is the global gain parameter of the HD control loop. The higher the gain value, the stricter the control, and the lower the value, the looser the control.

6. Click Save to save the parameters of the autotuning settings.

Step - Save

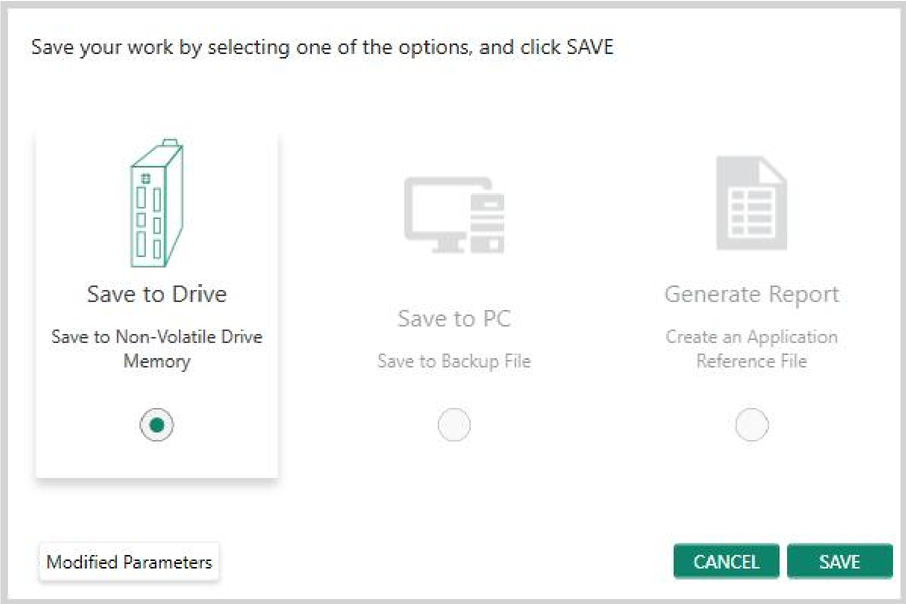


Figure 8-10 Autotuning - save

To complete the autotuning process, do all of the following:

- Click Save to Drive to save the parameters in the drive RAM to its non-volatile drive memory.
- Click Save to PC to save the parameters in the drive RAM to a backup file on your computer. Parameters are saved in text files with TXT or SSV extension. Text files can be edited using Notepad or any other text editor.
- Click Generate Report to create a record of your system settings that can be used for future reference and/or sent to technical support if needed.

It is recommended that you generate a report every time you complete application configuration, even if the system is running normally.

8.4PC-based Autotuning

If no electronic motor nameplate is detected at power-up, ServoStudio2 will activate the PC-based autotuning wizard.

The PC-based Autotuning wizard overrides the user's unit settings and works with the following units:

- Position: count
- Velocity: rpm/s for rotary motors, mm/s for linear motors
- Acceleration/deceleration: rpm/s2 for rotary motors, mm/s2 for linear motors

Step - Load/Motor inertia ratio (LMJR) estimation

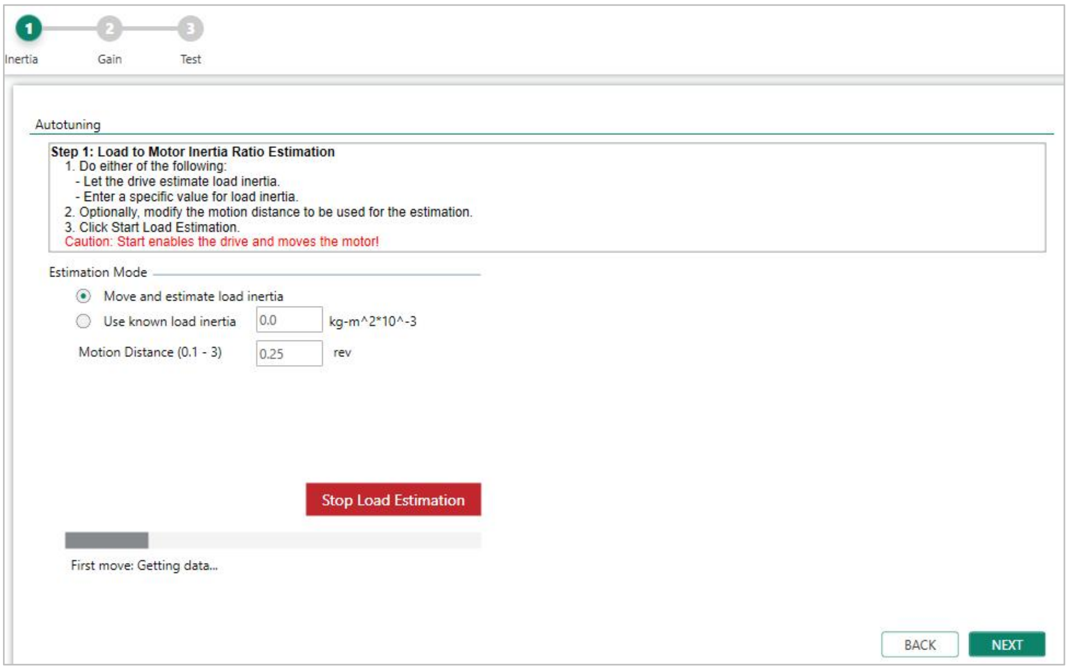


Figure 8-11 PC-based autotuning wizard - load/motor inertia ratio (LMJR) estimation

1. For automatic estimation, select "Move and estimate load inertia". Or

if you know the load inertia connected to the motor, select "Use known load inertia" and enter the value.

2. Modify the number of motor revolutions used as motion distance during load estimation (optional).

3. Click "Start Load Estimation".

Start enabling the drive and running the motor repeatedly!

ServoStudio2 estimates the current load of the motor and displays the results.

4. Click OK to send the calculated parameters to the drive.

5. Click Next to continue.

Step - Gain optimization

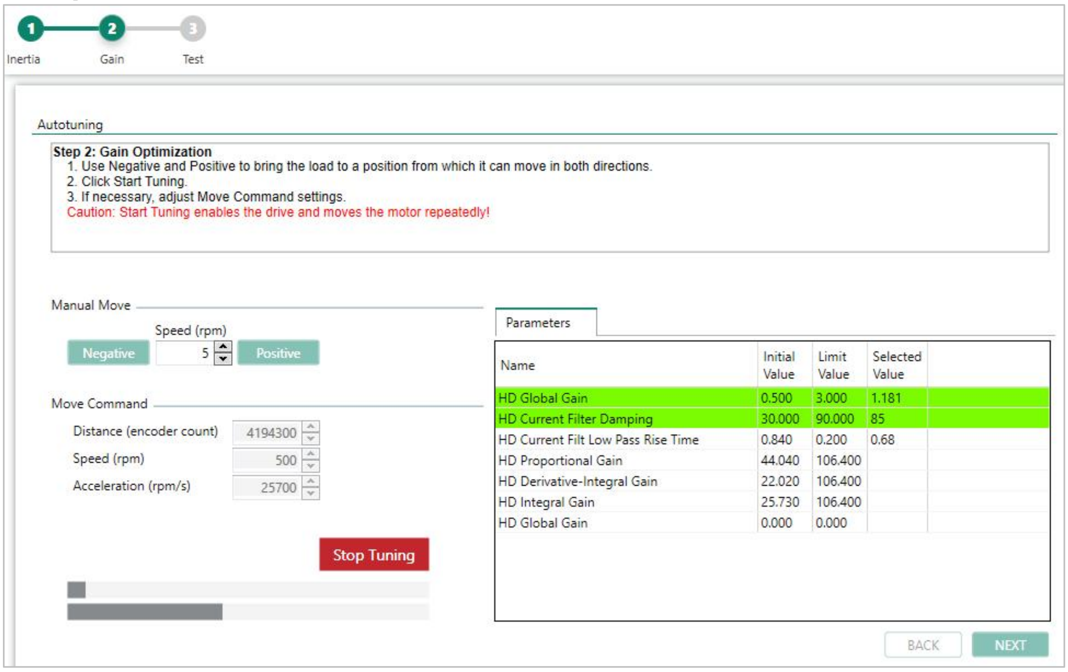


Figure 8-12 PC-based autotuning wizard - gain optimization

1. The Move Command values shown are recommended; based on the motor you defined in the setup. Use the negative and positive buttons to position the load where the motor can safely rotate a full range in each direction.

2. If necessary, adjust the Manual Move speed setting.

3. Click Start.

Start enabling the drive and running the motor repeatedly!

The motor moves continuously back and forth while testing values at intervals over the entire range of each control loop parameter. Once optimal results are achieved, the optimal values are displayed in the parameter table.

The top bar shows the progress of parameters currently being tested.

The bottom bar shows the progress of the entire process.

4. If necessary, adjust the "Move Command" settings, then click "Start" to repeat the test.

Step - Test movement quality

Figure 8-13 PC-based autotuning wizard – test movement quality

1. Click Move and Plot to send the current command to the drive and plot the response.

⚠ **Move and Plot** enables the drive and the motor will run!

2. A graphic will appear. This figure shows the velocity command generated by the point-to-point position profile map (PTPVCMD) along with the position error (PE).

The wizard also displays the system-calculated settling time and position error window values.

Toolbar buttons allow you to examine the drawing more carefully and export the results to a spreadsheet. These functions are also found in the ServoStudio2 Range screen.

3. Modify the motion settings and/or gain settings and repeat the test under different conditions (optional):

- Target position
- Cruising velocity
- Acceleration (and deceleration)
- HD Global Gain (KNLUSERGAIN); This is the global gain parameter of the HD control loop. The higher the gain value, the stricter the control, and the lower the value, the looser the control.

Step - Save

To complete the autotuning process, do all of the following:

- Click Save to Drive to save the parameters in the drive RAM to its non-volatile drive memory.

- Click Save to PC to save the parameters in the drive RAM to a backup file on your computer. Parameters are saved in text files with TXT or SSV extension. Text files can be edited using Notepad or any other text editor.
- Click Generate Report to create a record of your system settings that can be used for future reference and/or sent to technical support if needed.

It is recommended that you generate a report every time you complete application configuration, even if the system is running normally.

8.5Summary of Autotuning Parameters

The following table lists the parameters that can be optimized and set during the autotuning procedure.

Not all parameters are modified during this process. The final value of the parameter is determined by the specific options selected by the user in the Autotuning Wizard.

√ Use autotuning to optimize parameter value

Y/N Set parameters by autotuning, or user can manually set the value

8.6Record and evaluate performance

8.6.1 Diagnosis

After autotuning is completed, the system may show unsatisfactory behavior, such as:

- The servo motor is noisy.
- The servo motor is hot.
- Performance is inconsistent.
- Foldback occurs; i.e. the motor requires a current level that the drive cannot handle continuously.
- System jitter.
- Extreme movement.
- Excessive overshoot leads to reaching the application mechanical limit.

The following figure describes the procedure for diagnosing system behavior and applying filters to improve performance.

CDHD2S recording function is used for performance verification, tuning and debugging. ServoStudio2 provides a full-featured graphical interface for recording, plotting and measuring data. Please refer to the ServoStudio2 Reference Manual for details.

To improve or change the performance of your CDHD2S system, please refer to the performance diagnostic chart and manually modify and evaluate parameters.

Procedure: Modify and test parameters

After each modification of parameters, please perform the following operations:

1. Make sure the operation mode is set to serial position.

2. Perform forward and backward movements, and record PE, ICMD and PTPVCMD.

3. Use the ServoStudio2 "Range" screen to plot and evaluate the recorded values.

4. Check the PE settling time.

8.6.2 Recording data in ServoStudio2

Procedure: Recording data in ServoStudio2 - example

1. In the ServoStudio2 Range screen, select the Run tab.

- Set the target position value to 3 turns.
- Set the values of the motion parameters to produce a motion at 50% of the motor's maximum velocity, and 75% of the maximum acceleration required by the application. In this example:
  - Maximum velocity (cruise velocity) is set to 1000
  - Acceleration (and deceleration) is set to 50000
- If forward and backward movements are required, select the "Alternate" option.

The aim is to obtain motion profiles with a large duration of acceleration, smooth and deceleration stages.

2. In the Logger Setup panel, select the following record variables:

- PTPVCMD (position command velocity)
- ICMD (current command)
- PE (position error)

3. In the "Logger Setup" panel, enter the sample value and trigger variable:

- Sample: 1000
- Interval: 16
- Trigger: IMM

4. Make sure the drive is enabled and click the Run Record and Plot button in the Range toolbar.

Figure 8-14

Note that the trajectory scale factor of the "Position Error" variable shown here is 50.

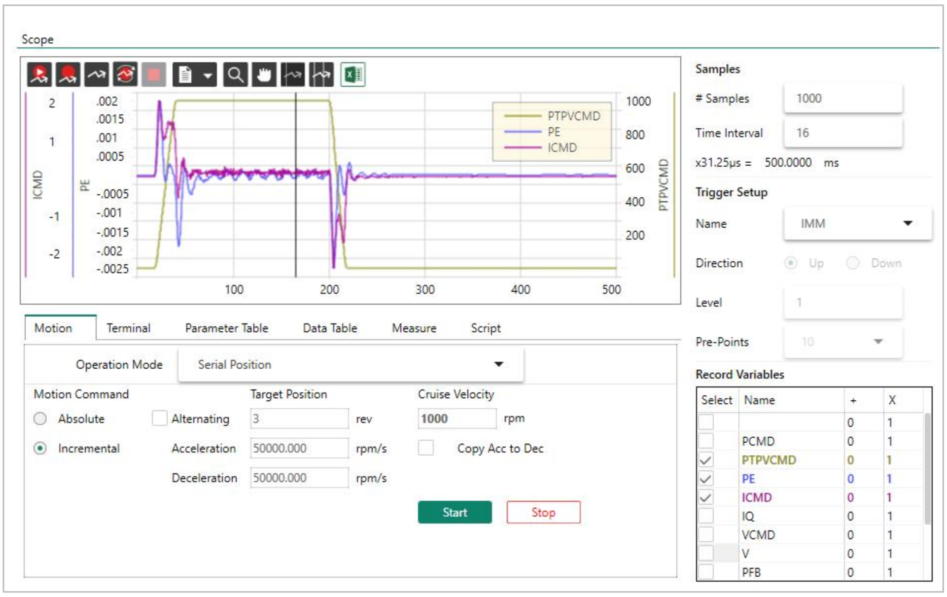


Figure 8-15 Motion obtained using default parameter values

5. Select the "Parameter Table" tab.

Motion | Terminal | Parameter Table | Data Table | Measure | Script

Parameter	Value	Unit
HD Global Gain	1.000	
HD Derivative Gain	139.691	Hz
HD Proportional Gain	88.593	Hz
HD Derivative-Integral Gain	69.213	Hz
HD Integral Gain	35.436	Hz
HD Flexibility Compensation	5000.000	Hz
HD Spring Filter	5000	Hz
HD Maximum Adaptive Gain	1.600	
HD Current Filter Damping	85	%
HD Current Filt Low Pass Rise Time	0.547	ms
HD Current Filter Notch Center	1333	Hz

Figure 8-16 Parameter - example

The parameter KNLUSERGAIN (HD global gain) is set to 1.000 during autotuning. For other manual tuning, you can start with this setting. If the gain is too high - as evidenced by vibration and noise - lowering the value of KNLUSERGAIN can deliver a smooth motion.

6. Check the position error and settling time
Right-click in the graph pane and select Show Settling Time.

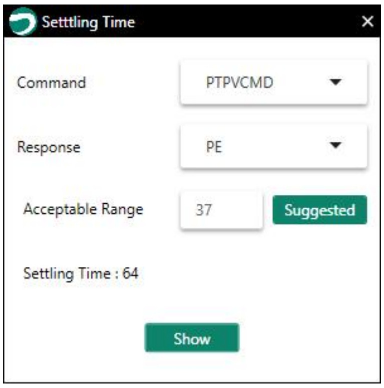


Figure 8-17 Position error (count) and settling time (ms)

The acceptable range of response (position error) is the motion at the end point (in count).

Acceptable range:

Example:

Mechanical dimensions (connector length) = 0.5 meters

Motor resolution: 1 revolution = 17 bits = 131072 counts

Gear ratio=1:100

Acceptable range:

If the motor rotates 100 times, the end point motion is 0.2x10-6 meters. Acceptable range: 50-100.

8.6.3 Recording data in the terminal

Procedure: Record data (terminal)

1. Use the command RECORD to define the variables to be recorded, the recording interval and the number of points to be recorded. The syntax for recording command is:
RECORD{sampling time}{number of points}{variable 1}[variable 2][variable 3]
For example: RECORD32100"VCMD"V"ICMD
Record 100 points of VCMD, V and ICMD every 1 ms
Note that there must be a quotation mark (") before the variable.
2. Use the command RECTRIG to define the variables and conditions that trigger recording. The syntax for recording trigger command is:
RECTRIG{variable}[level][pretrigger][up|down]

Note: If the specified number of pre-trigger points is greater than the number of points actually recorded before triggering, the recorded pre-trigger segment will include the variable value before the motion started.

For example, when the acceleration is 10000rps/s, record a jog (J) from zero to 1000rpm; specify the recording level as 1rpm, the direction upward, 128 pre-trigger points and the time interval as 1. Since there will be no movement of 128 pre-trigger points, the recorded data will be filled with zeros (zero velocity command before movement).

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

4. Set the variable GETMODE to 0. Then use the command GET to retrieve data recorded in comma-separated variable (CSV)ASCII format.

Table 8-2

Function	VarCom	Description
Recording activation command	RECORD	Define the variables to be recorded, as well as the recorded time span and sampling time.
	RECTRIG	Define the trigger conditions for starting recording and the pre-trigger duration.
	RECOFF	Turn off the active record.
Record utility information	RECLIST	List all variables that can be recorded by the recording function.
	RECTRIGLIST	List all options that trigger recording.
Status flag	RECRDY	Indicate that the record is ready.
	RECING	Indicate that a trigger condition has occurred and the record is active.
	REC COMPLETE	Indicate that the recording has been completed.
Data retrieval	GETMODE	Define the format of recorded data (binary /ASCII).
	GET	Retrieve the recorded data.

8.6.4 Evaluate PTPVCMD

Note: ServoStudio2 has not been fully updated.

The parameter PTPVCMD (Position Command Generator velocity) reports the derivative of the position command profile in velocity unit. PTPVCMD can be used to record and view actual velocity and velocity commands, which can only be used as derivatives of the position profile.

PTPVCMD is a trajectory velocity command that applies to all position loops.

VCMD is the output velocity command of the linear controller.

VCMD is not used for HD (non-linear) control.

The following figure shows an example of PTPVCMD recording indicating poor performance.

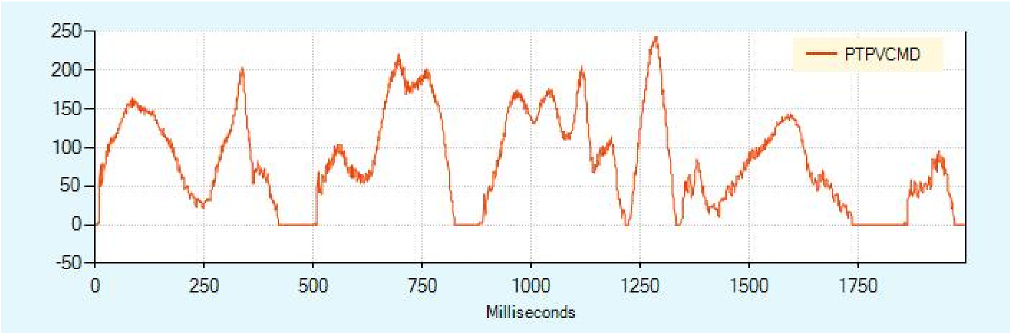


Figure 8-18 Poor performance of PTPVCMD

8.6.5 Evaluation of ICMD and/or PE oscillation

Note: ServoStudio2 has not been fully updated.

The figure below shows an example of ICMD (current command) and PE (position error) oscillations that indicate poor performance.

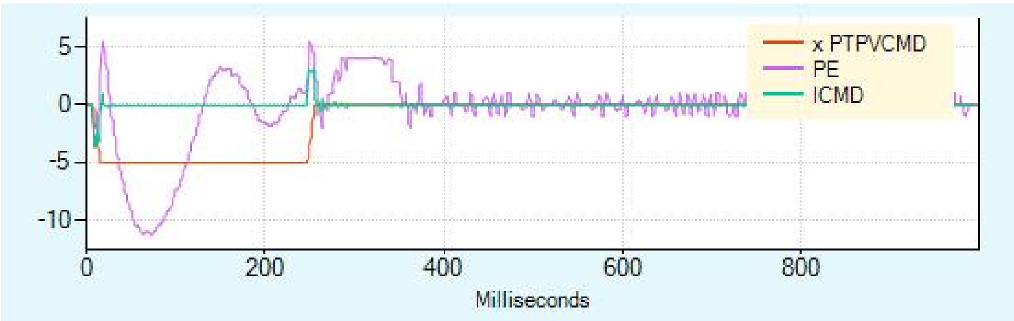


Figure 8-19 Poor performance of ICMD and PE

To determine if the oscillation is greater than 300Hz, use the ServoStudio2FFT function on the PE or ICMD recording:

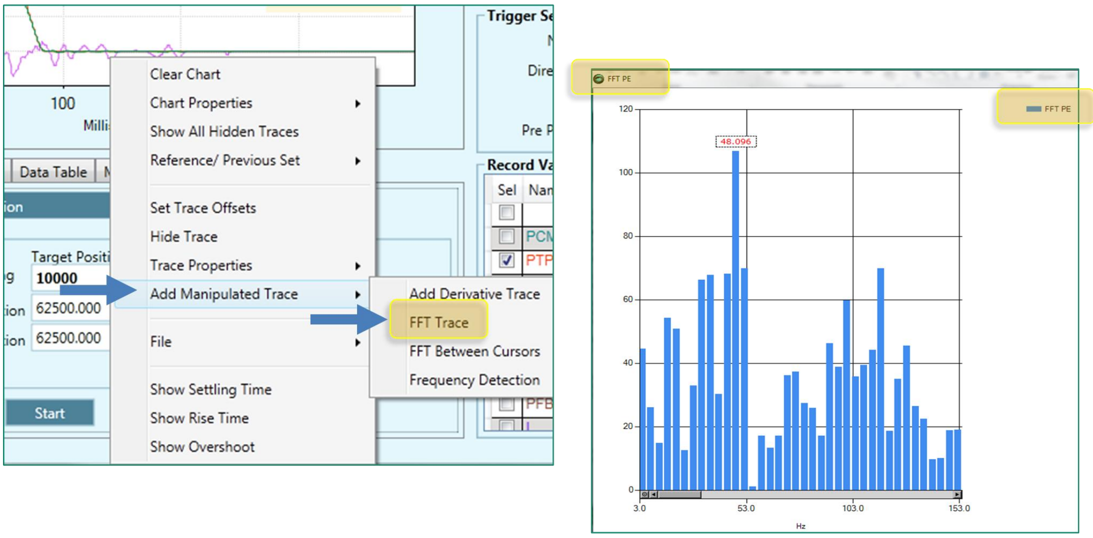


Figure 8-20 FFT tracking evaluation

8.7Current Command Low Pass Filter

Note: ServoStudio2 has not been fully updated.

The HD control loop output is a current command. This current command is low-pass filtered before being transmitted to the current controller. The autotuning procedure sets optimal low-pass filter parameter values during the load estimation process.

- NLFILTDAMPING (HD current filter damping), expressed as a percentage, maintains the filter bandwidth at the cutoff frequency.
- NLFILTT1 (HD current filter low-pass rise time), in milliseconds, defines the reciprocal of the cutoff frequency.

If noise occurs, it may be necessary to fine-tune the low-pass filter.

Increase NLFILTT1 in 10% increments until the noise reaches an acceptable level.

If the system becomes unstable, the global gain (KNLUSERGAIN) may need to be reduced.

After tuning KNLD, NLFILTDAMPING and/or NLFILTT1 can be further tuned. Please refer to the *KNLD - Differential Gain*.

To achieve the fastest response time of the HD control loop, the low-pass filter can be manually adjusted. The goal is to use the maximum value of NLFILTDAMPING and the minimum value of NLFILTT1.

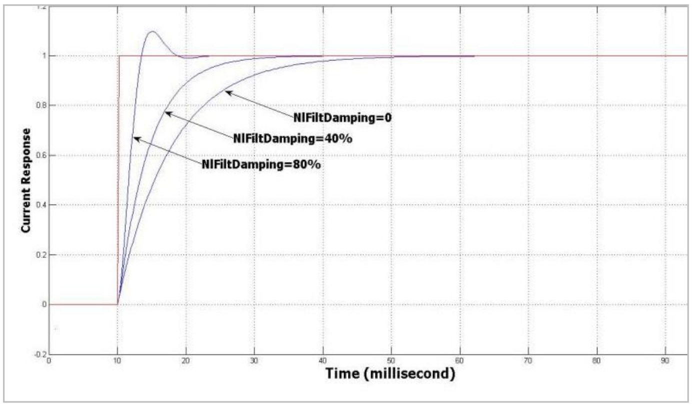
1. Increase NLFILTDAMPING until ICMD noise and/or oscillations are observed, then decrease by 10%.

2. Decrease NLFILTT1 until ICMD noise and/or oscillations are observed, then increase by 20% and at least 0.05ms.

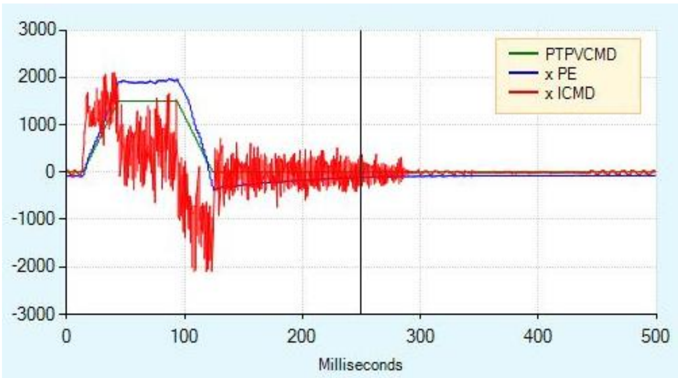
If the equipment to be controlled has resonance at a high frequency, NLFITT 1 can be used for current output. NLFILTT1 can effectively reduce the noise, but it will also reduce the control bandwidth and the potential stiffness of the system.

NLFILTDAMPING can minimize low-pass negative effects. NLFILTDAMPING can be set independently of NLFILTT1 to provide overshoot response. Combined with the low-pass characteristics of mechanical system, it is helpful to deliver a high bandwidth control.

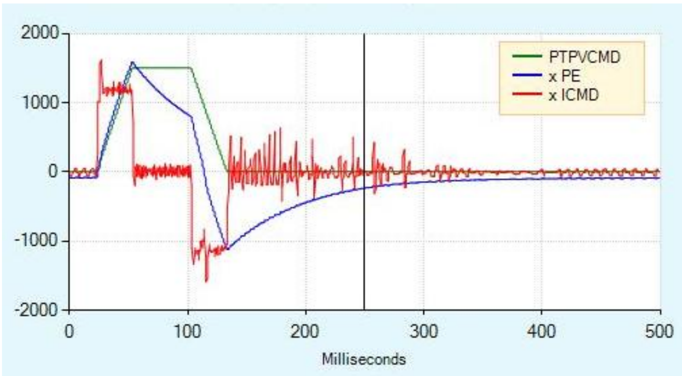
NLFILTDAMPING0%40%80%



NLFITT1
value too low



NLFITT1
value too low



NLFITT1
selected value

Figure 8-21 Low-pass filter

8.8Gear filter

Note ServoStudio2 has not been fully updated.

The gear filter can be used if the system exhibits the following characteristics:

- The resolution of pulse and direction commands is low.
- The coupling between the motor and the load is not strong.
- The movement stroke is short.
- The motor makes noise after tuning.
- The current fluctuates greatly during the settling process.
- The motor temperature is abnormally high.

Before applying the gear filter, make sure GEARINMODE=1

When a system has multiple axes, the gear filter value must be the same for all axes.

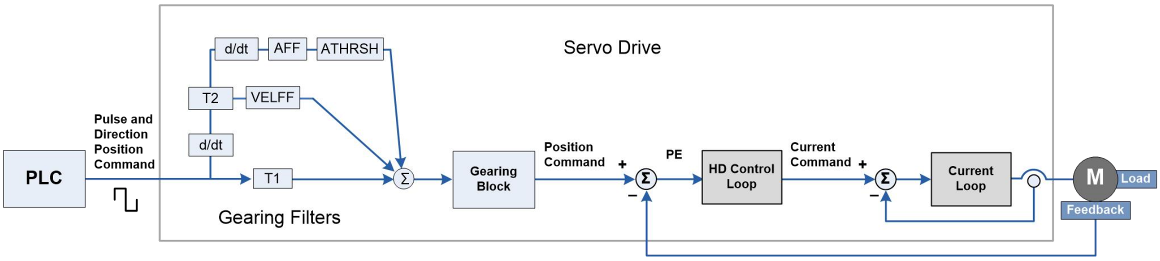
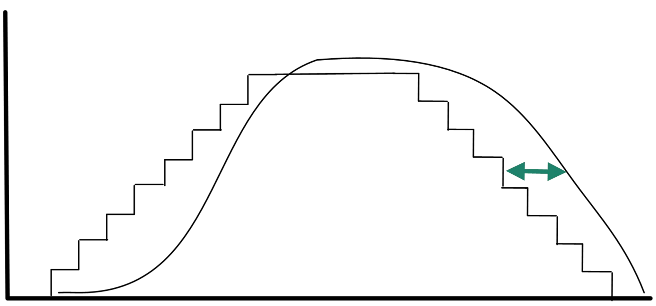


Figure 8-22

Table 8-21

T1	GEARFILTT1	Gear filter depth
T2	GEARFILTT2	Gear filter velocity and acceleration depth
ATHRSH	GEARACCTHRESH*	Gear acceleration threshold
VELFF	GEARFILTVELFF*	Gear filter velocity feedforward
AFF	GEARFILTAFF*	Gear filter acceleration feedforward
	*Use default value. If necessary, please contact technical support	



Gear filter - example 1
Increasing GEARFILTT1 will smooth the input command PTPVCMD,
but it will increase the delay.
Suggested value:
GEARFILTT1=~2 input step width
GEARFILTT2=2GEARFILTT1

Figure 8-23 Gear filter

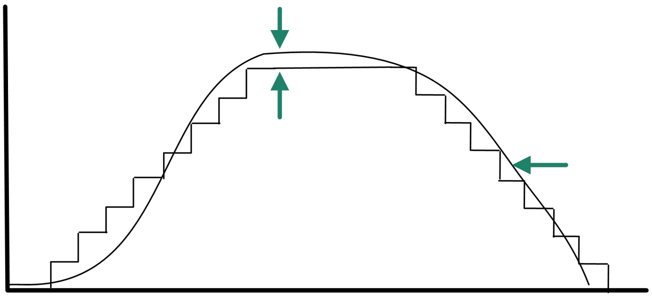


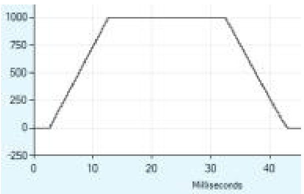
Figure 8-24 Tuning gear filter

Gear filter – example 2
Increasing GEARFILTT2 and VELFF can compensate for the delay, but it will increase the overshoot. IfGEARFILTVELFF=GEARFILTT2, no delay.

8.9Moving Smoothing Filter

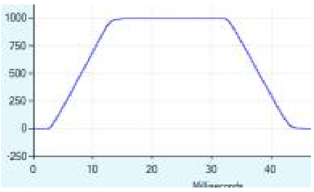
Note ServoStudio2 has not been fully updated.

The HD control provides three options for smooth position command, defined by the parameter MOVESMOOTHMODE.



MOVESMOOTH0:

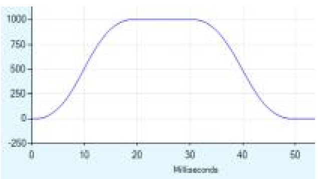
Profile smoothing without position command.



MOVESMOOTH1:

MOVESMOOTHLPFHZ-based profile low-pass smoothing (in Hz).

The lower the value, the greater the smoothness.



MOVESMOOTH2:

Average (in ms) S-curve based on MOVESMOOTHAVG.

Time expands the average.

Binary values (2, 4, 8, 32, 64, 128, 256)

Figure 8-25 Smoothing filter

To apply a smoothing filter to external reference commands, such as pulse train or EtherCAT/CANopen, specific bits in MOVESMOOTHSRC must first be set.

8.10Notch filter

Note ServoStudio2 has not been fully updated.

The notch filter can be used to eliminate high-frequency oscillations that can occur in systems with flexible connections between motor and load, such as:

- Ball screw linear slide with coupling
- Belt drive
- Harmonic drive

Oscillation usually occurs during the first step of tuning (feedback gain). Tuning is done by checking the oscillation frequency and setting the notch accordingly. Once the notch parameters are set, the tuning process can continue.

The HD control notch filter can be used at any time during tuning to suppress oscillations at fixed frequencies greater than 300Hz:

- NLNOTCHCENTER (HD current filter - notch filter center)
- NLNOTCHBW (HD current filter – notch filter bandwidth)

The second set of HD control notch filters (NOTCH2CENTER and NLNOTCH2BW) are available through the terminal but do not appear in the ServoStudio2 control loop screen.

8.11Anti-vibration Filter

Note: ServoStudio2 has not been fully updated.

Anti-vibration overview

The anti-vibration function of the HD controller is based on a proprietary control algorithm and is used to suppress vibration at a constant frequency.

The vibration suppression function operates in a closed loop, detecting oscillations when they occur and suppressing them immediately. Active damping load oscillation significantly reduces the time required for heavy load or end effector to stabilize at the target position. Although the position error at the encoder level may be high, the overall performance of the system evaluated at the load position is improved.

A typical example is that a load is fixed to a servo control motor by means of a shaft with certain flexibility. If the motor's servo control is set to a position error close to zero during motion, the load will oscillate strongly. Every change in acceleration (jerk) creates a disturbance, causing load oscillation. Although a stiff HD control loop will overcome these oscillations at the motor position level, the load will still oscillate strongly.

The anti-vibration feature can handle systems with oscillation frequencies up to 100Hz.

The figure below shows the four stages of the vibration suppression process.

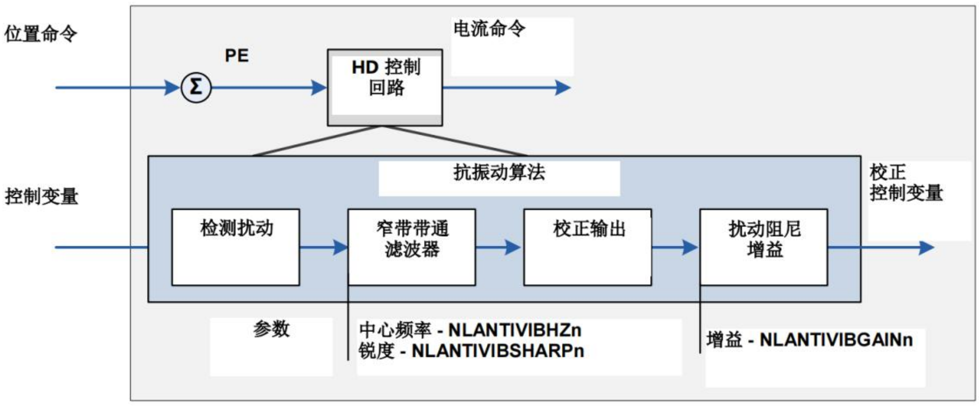


Figure 8-26 Anti-vibration filter

Stage 1: Detect disturbances sensed by the system using various control variables as inputs, such as position error and current. The disturbed values are calculated for the next stage.

Stage 2: The disturbed values are passed through a narrowband bandpass filter, selecting disturbances caused by system oscillations. The center frequency and width of the bandpass filter are set by the parameters NLANTIVIBHZn and NLANTIVIBSHARPn respectively.

Stage 3: Calculate the correction output to be added to the control variable.

Stage 4: Add the correction output to the control variable using the damping gain (parameter NLANTIVIBGAINn).

Anti-vibration tuning procedure

After autotuning, more anti-vibration tuning may be required.

If additional vibration frequencies need to be suppressed, the tuning process can be repeated with a second set of anti-vibration filters. The following table shows the parameter values modified by the tuning procedure.

Table 8-3

HD anti-vibration filter	Parameters	Default	Range
Center frequency 2	NLANTIVIBHZ2	100	5 to 800 [Hz]
Center frequency 3	NLANTIVIBHZ3	400	5 to 800 [Hz]
Sharpness 2	NLANTIVIBSHARP2	0.5	0.01 to 10
Sharpness 3	NLANTIVIBSHARP3	0.2	0.01 to 10
Suppression gain 2	NLANTIVIBGAIN2	0	0 to 99
Suppression gain 3	NLANTIVIBGAIN3	0	0 to 6

Note: Although parameters NLANTIVBHZ, NLANTIVIBSHARP and NLANTIVIBGAIN are still available, they are not recommended.

1. Set the narrowband center frequency.

- Perform an action and measure the resonance (oscillation frequency) of the current command (ICMD):
  - In the Range screen, right-click the ICMD plot.
  - Select FFT and Differentiation.
  - Select FFT tracking.

The FFT tracking will look like this, for example:

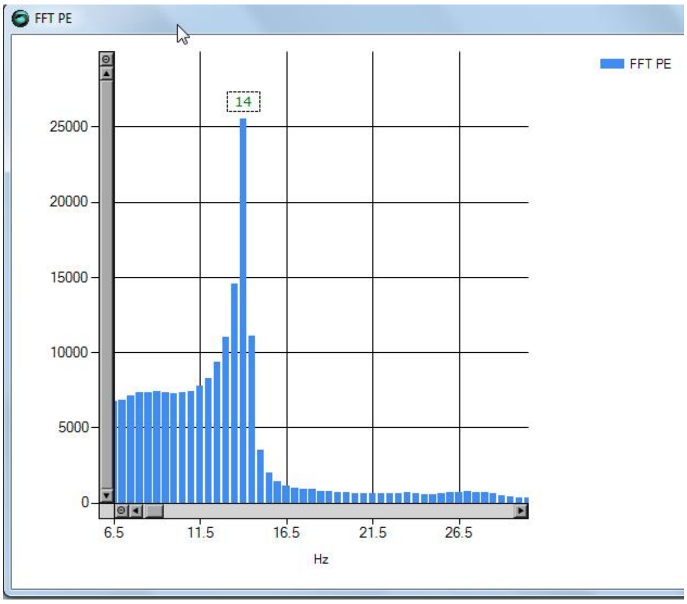


Figure 8-27 FFT tracking

- Set the value of parameter NLANTIVIBHZn to the peak or dominant resonance (in Hertz). In the example shown here, the value is 14Hz.

2. Set the narrowband center sharpness (width).

- Set the value of parameter NLANTIVIBSHARPn according to the resonance sharpness (width) of the narrowband filter.

Estimate the width by comparing the plot in the FF Traking dialog box to the plot below, which shows the NBF frequency response as a function of the NLANTIVIBSHARPn value. Typical setting range is 0.1 to 1.0.

The figure below shows the narrowband filter frequency response.

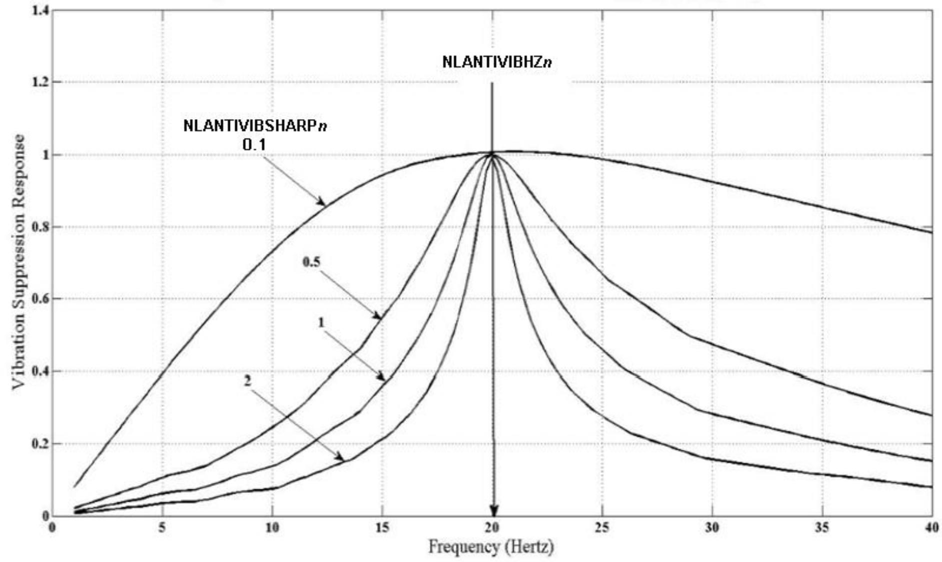


Figure 8-28 Frequency response varying with NLANTIVIBSHARPn

Suitable for 20Hz center frequency

Step 2 – Tune damping gain

Increase the value of parameter NLANTIVIBGAINn until optimal damping is reached.

- At each increment, the current command (ICMD) is recorded and the oscillation damping is checked. Obtain optimal system damping for better damping current oscillations.

Note: If high-frequency vibration occurs while increasing this parameter, please slightly reduce the adaptive global gain (KNLUSERGAIN).

Anti-vibration tuning – example

Note: Some variable plots are scaled (indicated by "x").

When tuning without vibration suppression, position errors, current oscillations and settling time are very long.

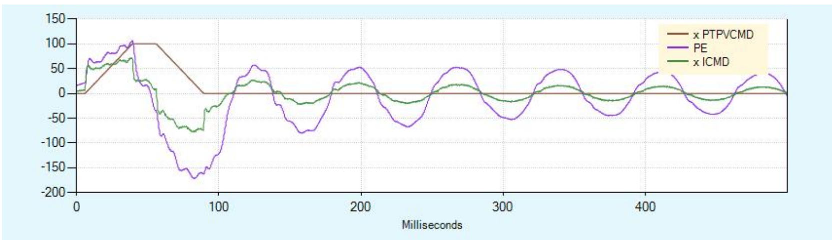


Figure 8-29 Position error and current oscillation without vibration suppression

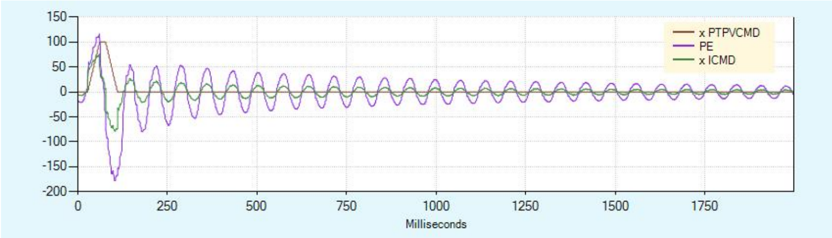


Figure 8-30 No vibration suppression, long settling time

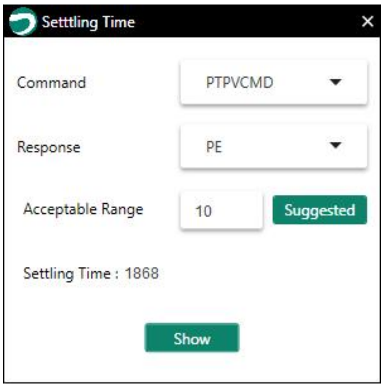


Figure 8-31 Settling time - without anti-vibration tuning

In order to suppress oscillations and shorten settling time, the following parameters need to be set:

- NLANTIVIBHZ2=14Hz, measure the resonance frequency.
- NLANTIVIBSHARP2=0.5, estimate the width based on the sharpness shown in the FFT tracking.
- NLANTIVIBGAIN2=8, determined by manually increasing the value from 0 until the optimal settling time is reached.

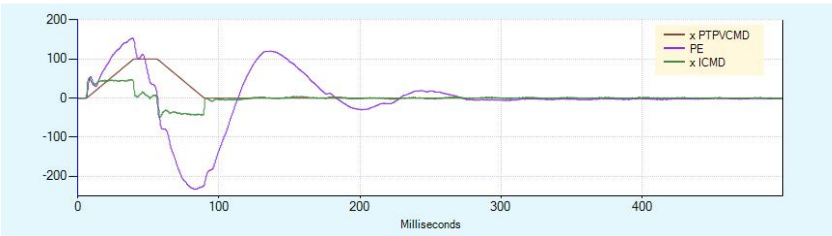


Figure 8-32 Using vibration suppression tuning - position error and current oscillation are reduced

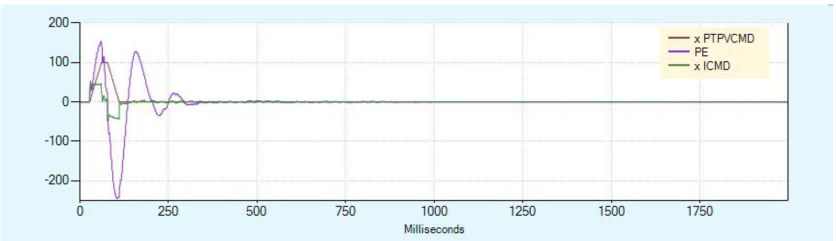


Figure 8-33 Using vibration suppression tuning - settling time is short

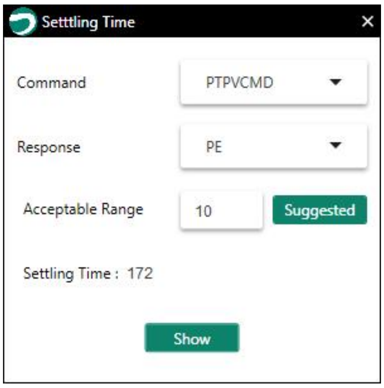


Figure 8-34 Settling time - with anti-vibration tuning

8.12Gain - Manual Tuning

Note: ServoStudio2 has not been fully updated.

KNLD - differential gain

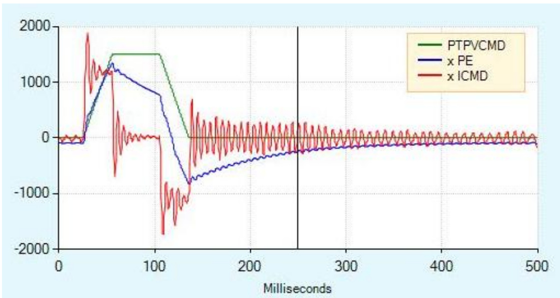
1. Set KNLP to half of the default settings.

2. Set KNLI and KNLIV to zero.

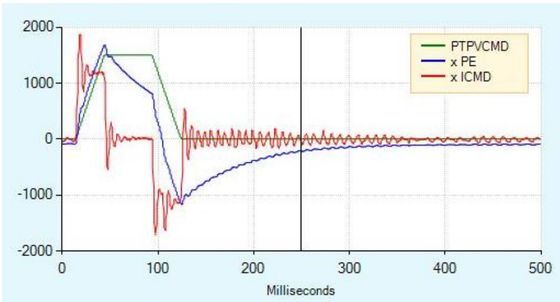
3. Increase the KNLD value until oscillations of ICMD are observed.

The acceptable level of ICMD ripple depends on the system, mainly the load. It can usually be determined by acoustic noise. Light load (load/motor inertia ratio (LMJR) <2): 5% of rated current may be normal.

High load (load/motor inertia ratio (LMJR) > 2): 10% of rated current may produce acceptable ripple.



KNLD value is too high



KNLD selected value

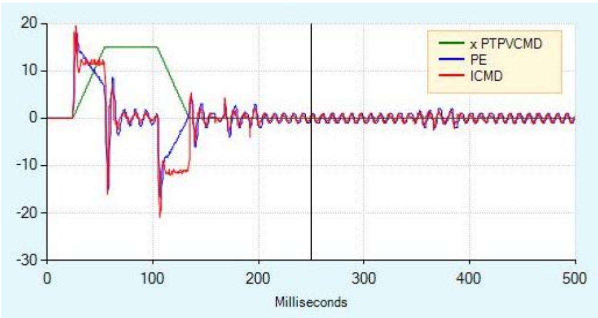
Figure 8-35 Differential gain tuning

Increase the KNLIV value until the position error (PE) starts to oscillate.

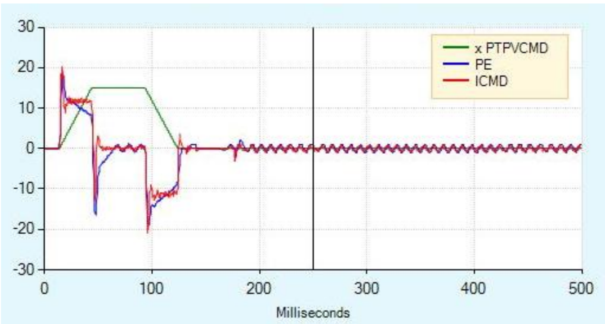
Increasing the KNLIV value can reduce the position error, reduce the sensitivity to external disturbance, and reduce the steady-state position error (if any) when stopping.

Optimal tuning: Position error decreases as quickly as possible after each motion phase change (jerk), no oscillations during phase transitions; no position error overshoot; oscillation at stop is acceptable (±1 encoder count).

Optimal settling time: If possible, increase the KNLIV value until the position error returns to 0 before the end of the deceleration stage.



KNLIV value is too high;
The oscillation at stop is too strong;
Position error overshoot



KNLIV selected value;
Good settling time

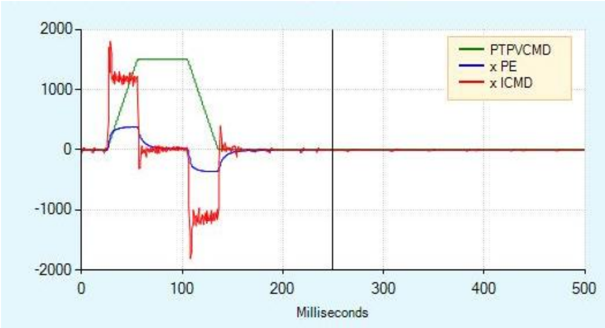
Figure 8-36 Differential - integral gain tuning

Increase the KNLP value until the position error (PE) starts to oscillate.

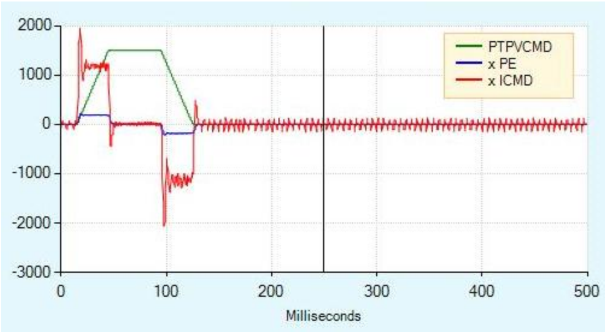
With the increase of KNLP value, the shape of position error becomes square, which reflects the constant during acceleration and deceleration.

As the KNLP proportional gain becomes high, the position error reaches a stable value at each stage of motion (acceleration, smooth, deceleration).

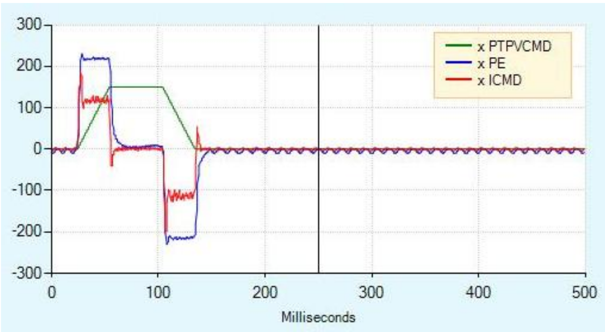
Optimal tuning: The shape is as square as possible, indicating that the position error is constant at each stage of motion and that there are no oscillations during the transitions between stages (acceleration to smooth, smooth to deceleration, deceleration to stop).



PE becomes flat during acceleration and deceleration



KNLP value too high; oscillation at stop



KNLP selected

Figure 8-37 Proportional gain tuning

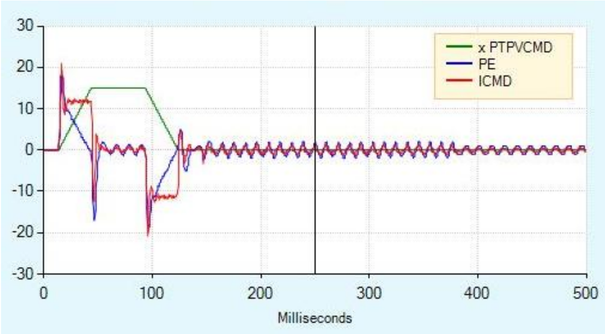
KNLI - integral gain

KNLI is used to reduce position errors during movement and stop.

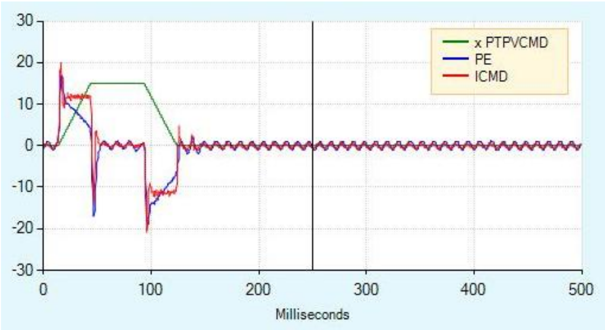
Optimal adjustment: the maximum value that does not produce overshoot or oscillation.

Optimal settling time: If possible, increase the KNLIV value until the position error returns to 0 before the end of the deceleration stage.

Result: The position error is slightly reduced; the oscillation at stop is acceptable (±1 encoder count); there is no position error overshoot at the end of the deceleration stage (stop point).



KNLI value is too high; position error oscillation at stop Position error overshoot



KNLI selected value

Figure 8-38 KNLI tuning

8.13Flexible compensation tuning

Note ServoStudio2 has not been fully updated.

The flexible compensation parameter reduces the vibration caused by the load and the tracking error through the sudden change of acceleration (jerk). They also minimize overshoot and settling time.

- Set NLPEAFF (HD flexible compensation) according to the stiffness of the system (in Hertz). Stiff systems require high values. Systems with high load inertia and flexible couplings require lower values; the normal range is 400 to 30 Hz. If not used, set to 5000Hz.
- NLAFFLPFHZ (HD spring filter), in Hertz, applies a low-pass filter to the command position acceleration used to perform compensation. The acceleration is calculated based on the input command position, and may be noisy if the input command position has a low resolution (such as a pulse train input). The application of the low-pass filter NLAFFLPFHZ smoothes the calculated command position acceleration, and when applying the parameter NLPEAFF, it should be used when noisy operation is observed.

Optimal tuning: Typically, the maximum frequency is 400Hz. Therefore, for heavy load and flexible systems, the typical range of NLPEAFF is 400 to 30Hz.

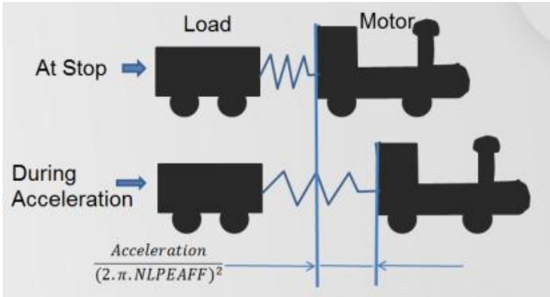


Figure 8-39 Equipment flexibility

Procedure: Flexible compensation tuning

1.Set NLAFFLPFHZ=3×KNLD

2. Start with the highest value of NLPEAFF and decrease until you reach the best result for your application. The criterion can be settling time or position error.

8.14Dual feedback position control loop debugging

Note ServoStudio2 has not been fully updated.

The variable position feedback (PFB) represents the feedback used to control positioning when secondary feedback is enabled and used in the control loop (SFBMODE1).

The position controller in the dual feedback control system is a dedicated P-gain controller with velocity feedforward and acceleration feedforward. The velocity loop can be PI or PDFF and uses motor feedback to control the motor. Current loops also use motor feedback to control the motor.

The dual feedback position controller includes three gain parameters:

- KNLDUALLOOPKP: Position loop proportional gain.
- KNLDUALLOOPVFF: Position loop velocity feedforward.
- KNLDUALLOOPAFF: Position loop acceleration feedforward.

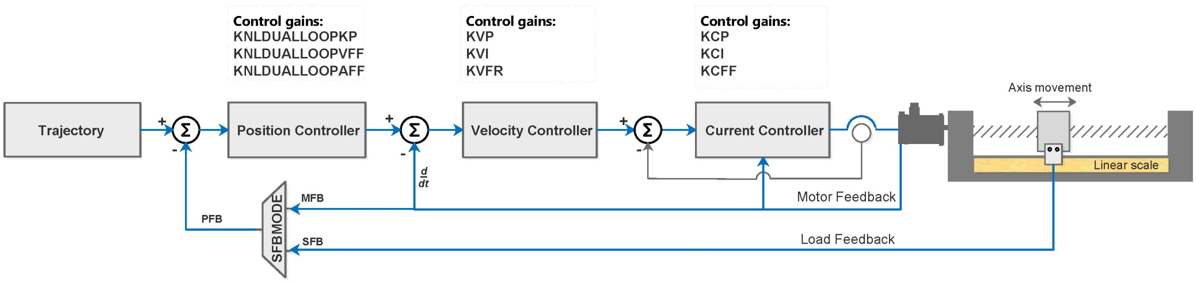


Figure 8-4 Dual feedback position control loop

Procedure: Tune a dual feedback position control loop

1. Make sure the drive is running in serial communication mode (COMMODE0).

2. Configure the motor and motor feedback parameters.

3. Set the motor to the load to inertia ratio (LMJR) value.

If unknown, use ServoStudio2 autotuning estimated value.

4. Configure secondary feedback device parameters. Please refer to the *Secondary Feedback*.

5. Make sure the motor feedback and secondary feedback are in the same direction. If not, use SFBDIR to inverse the direction.

6. Enable secondary feedbainvert ck and activate dual loop mode (SFBMODE1).

7. Tune velocity controller:

a. Switch to serial velocity operation mode (OPMODE0).

b. Define PDFF velocity controller (VELCONTROLMODE1).

c. Select the variables to be recorded: VCMD, MVEL, ICMD

d. Use these variables to tune the motor's velocity loop:

•Adjust velocity proportional gain (KVP).

•Adjust velocity integral gain (KVI).

•Adjust velocity feedforward (KVFR).

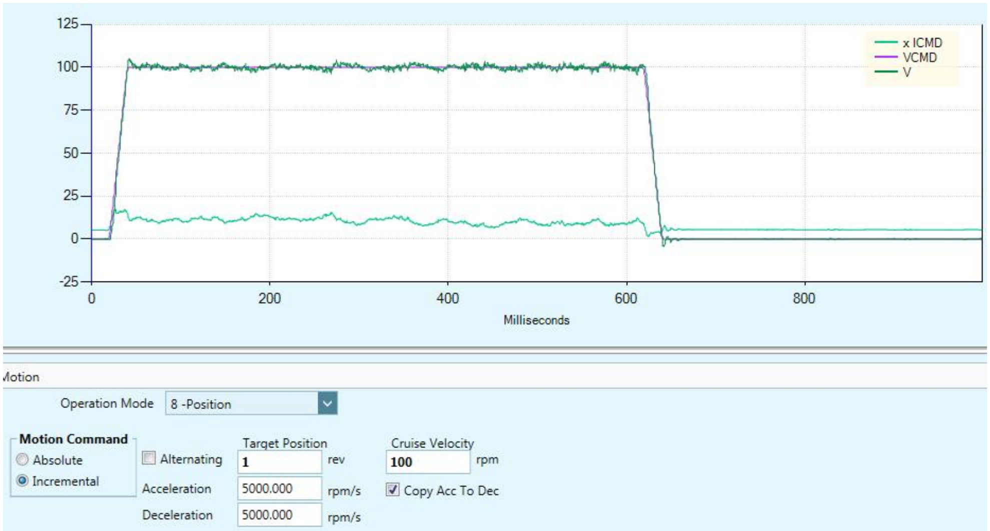


Figure 8-41 Dual feedback - tune velocity controller—example

8.Adjust the dual feedback position controller:
a. Switch to serial position operation mode (OPMODE8).

b. Select the variables to be recorded: PTPVCMD, V, PE, ICMD.

c. Use these variables to tune the dual feedback position loop:

- Tune proportional gain (KNLDUALLOOPKP)
- Tune velocity feed forward (KNLDUALLOOPVFF)

Best adjustment: Gradually increase the KNLDUALLOOPKP value until ICMD oscillates, or noise is heard. Then reduce the KNLDUALLOOPKP value by 10%.

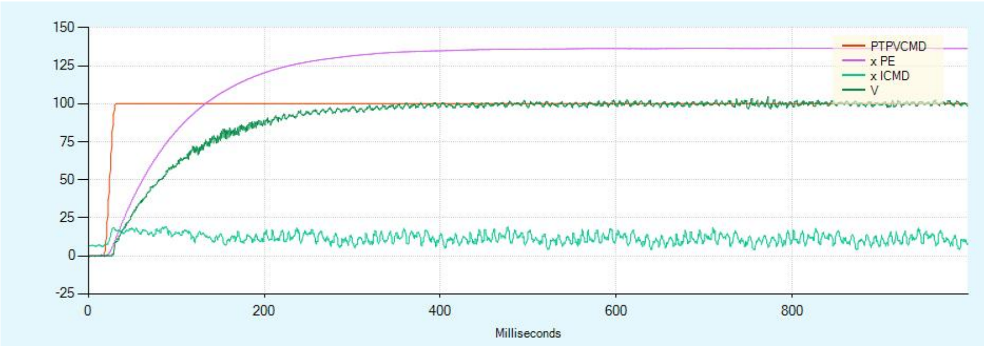


Figure 8-42 Dual feedback - tune position controller (KNLDUALLOOPKP) - example

d. Set the velocity feedforward to 100% (KNLDUALLOOPVFF):

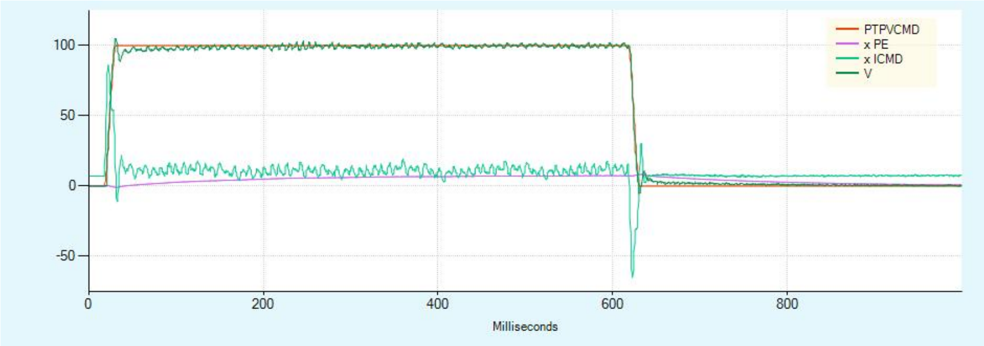


Figure 8-43 Dual feedback - tune position controller (KNLDUALLOOPVFF) - example

8.15Gantry Tuning

Note: The tuning process (movement/recording) of the gantry system is performed by the gantry main drive.

All motion commands of the gantry system must be issued by the gantry main drive.

The gantry differential drive will reject the motion command.

Procedure: Tune the gantry system

1. Make sure you have completed the gantry system setup described in the *Gantry Setup* section.

2. Open ServoStudio2 operation mode screen.

Select serial position (OPMODE8, COMMODE0) operation mode for each drive.

3. Open ServoStudio2 Control>Position Loop screen.

Select position controller method 5 - HD Controller for each drive.

(POSCONTROLMODE5)

4. Open ServoStudio2 Control > Range screen. Make sure the selected drive is the gantry host.

- Define the parameters to be recorded.

PTPVCMD

PE

V

ICMD

- Define a serial position motion command, execute and record. View the result chart.

Note: ServoStudio2 will record the PE and ICMD of both drives.

5. Gradually increase KNLD (HD differential gain) until the system produces audible noise. The goal is to maintain the highest KNLD with the least amount of filtering.

While continuously testing the system, adjust the gain of the gantry main drive, as described in the following steps.

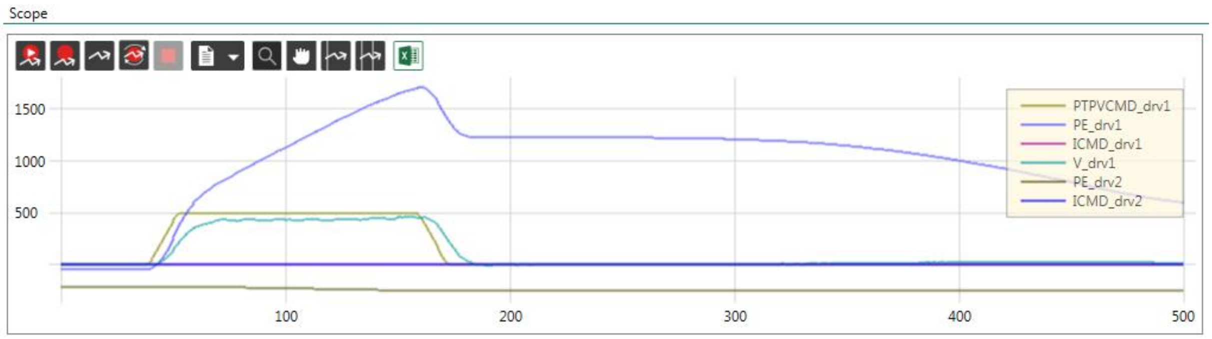


Figure 8-44 KNLD=1

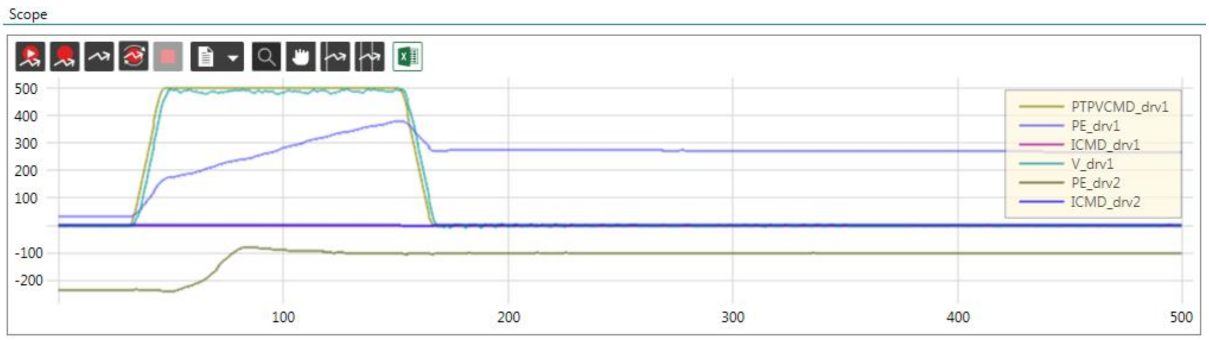


Figure 8-45 KNLD=20

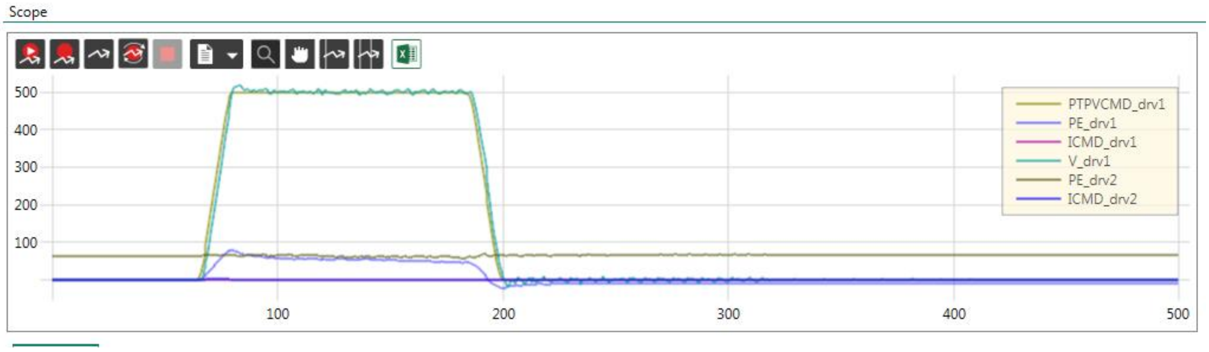


Figure 8-46 KNLD=50

6. Gradually increase the KNLP (HD proportional gain) value until the position error decreases.

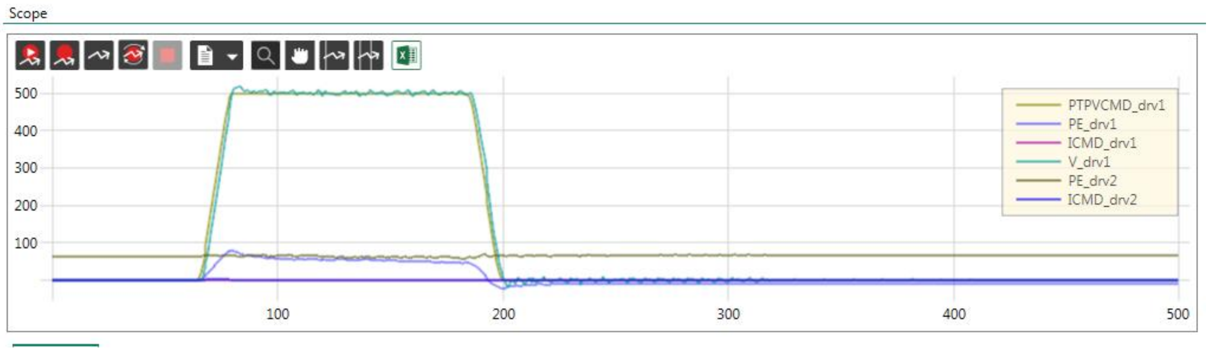


Figure 8-47 KNLD=20

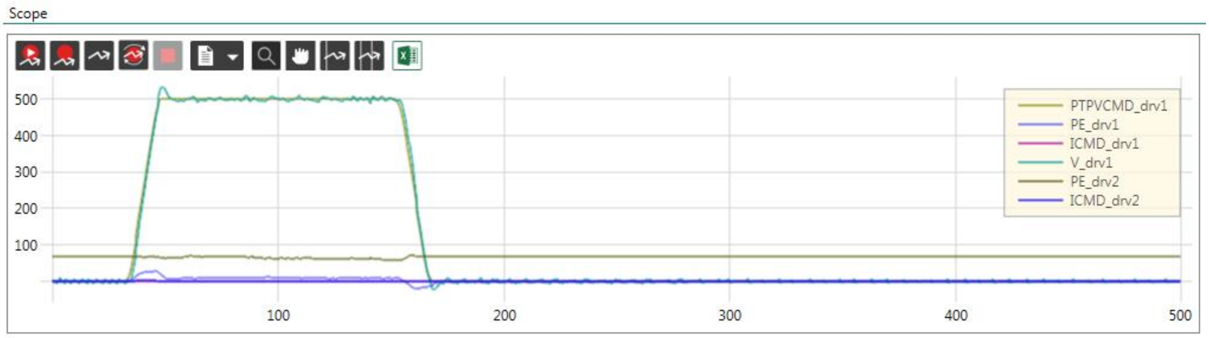


Figure 8-48 KNLD=50

7. Increase the KNLI (HD integral gain) value to reduce the static error.

The maximum value of KNLI should be less than $\frac{KNLP}{2}$.

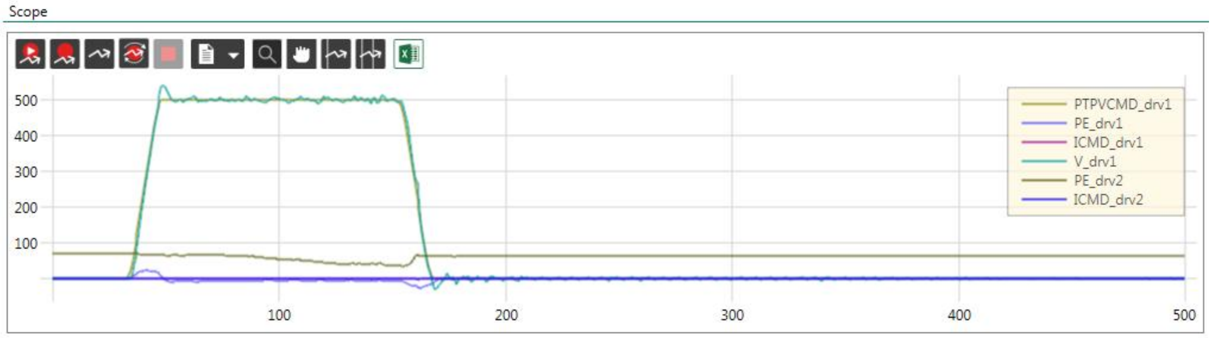


Figure 8-49 KNLD=20

8. If necessary, reduce the setup time by increasing the KNLIV (HD differential-integral gain) value. If there is oscillation at the end of the movement, decrease KNLIV.

9. Switch the drive axis to the gantry differential drive.

10. For a rigid gantry system, set the gain parameter of differential drive HD control loop to 0.

For a flexible gantry system, adjust the differential drive gain parameter as described in the previous steps. It is likely that KNLI and KNIV will need to be set to 0 to prevent the current from rising during quiescence.

To test performance, switch the drive axis to the gantry main drive and perform a move/record.

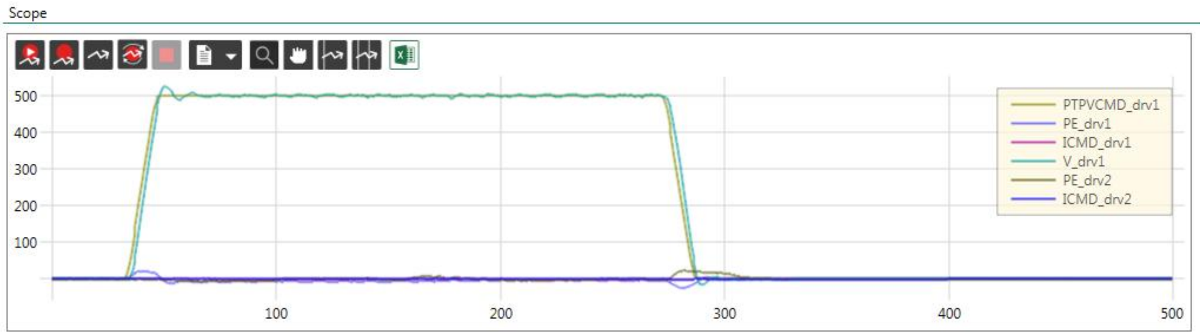


Figure 8-50 Tuning both axes

Tuning using the Terminal - example

\1

K

#Delay100

CLEARFAULTS

KNLUSERGAIN1

NLTFDESIGNMODE1

NLTFBW400

KNLD32

KNLP16

KNLI0

KNLIV0

KNLVFF1

\2

KNLUSERGAIN1

NLTFDESIGNMODE1

NLTFBW400

KNLD32

KNLP8

KNLI0

KNLIV0

KNLVFF1

\1

RECOFF

RECORD322000“PTPVCMD“PE“GANTRYMSTRVFB“ICMD

RECTRIG“PTPVCMD101001

ACC100

DEC100

MOVEABS1400000500

#PLOT

#Delay4000

MOVEABS0250

8.16Tuning Questions - Q&A

When should I use a notch filter?

When your equipment has high-frequency vibration and produces sharp sound or horn sound when you increase the gain. Although the system has good performance, it will produce a lot of acoustic noise at low speed. What should I do?

Tune the system at high speed, reduce the global gain KNLUSERGAIN value, increase the rise time of low-pass filter NLFILTT1, and then increase NLMAXGAIN.

The system is flexible and overshoots at the end of the movement. How to eliminate overshoot?

Use a low-value acceleration filter NLAFFLPFHZ and reduce NLPEAFF. This will create an overshoot and eliminate it before stopping.

9.Functional Safety

9.1Safety Torque Shutdown (STO) Overview

Functional safety in CDHD2S servo drives is implemented through the Safe Torque Off (STO) function. Activating the Safe Torque Off (STO) function will cause the drive to stop supplying power to control motor movement. STO ensures that the energy generated by no torque can continue to act on the motor, and prevents the drive from accidentally starting or the motor from rotating when it remains connected to the power supply.

The advantage of STO integration using standard safety technology (using electromechanical switchgear) is that it eliminates separate components and does not require associated wiring and servicing.

In addition, the switching time of this function is shorter than the switching time of electromechanical components in traditional safety concepts.

Note: When the STO function is in effect, the STO circuit power is removed and the motor power is disabled.

The STO function is defined in the standard EN/IEC61800-5-2 and is related to uncontrolled stop that complies with the IEC60204-1 standard Category 0 Stop.

Standard EN/IEC61800-5-2 specifies functional safety requirements for adjustable velocity electric drive systems. According to the requirements of this standard, when the STO function is in effect, no power is applied to the motor to make it move.

The STO function can be used when power needs to be removed to prevent accidental start-up.

Warning: Drives with suspended loads must be equipped with an additional mechanical safety block (e.g. motor brake) because the drive cannot control the load when STO is active. If the load is not properly protected, it may cause serious personal injury.

The STO function in CDHD2S removes the power provided by the power module gate drive, suppressing the PWM pulses generated by driving IGBT, as shown in the figure below.

9.2STO Module in Servo Drive

At present, there are many types of STO modules used in different CDHD2S servo drives:

- STO_A3, STO_A4 and STO_A5 only generate the positive power supply voltage for the gate drive.
- STO_B generates both positive and negative supply voltages for the gate drive.

Table 9-1

Product series	Dimensions	Input voltage	Nominal output current	STO circuit	STO compliance

CDHD2S	2A	AC 120/240V	1.5A, 3A	STO_A3	Yes*
CDHD2S	2B	AC 120/240V	4.5A, 6A	STO_A3	Yes*

9.3STO Functional Safety Specification

Note: At present, the STO function of all CDHD2S models are waiting for certification.

Table 9-2

Features	**Specification**					
Performance level	Meeting 4PLe category (ISO13849-1)					
Safety integrity level	Meeting SIL3 (IEC61508/IEC62061/61800-5-2)					
Reliability data	SFF	MTTFd	PFH*	PFDAVG**	PL	Cat.
	98.9%	66757.5	1.71E-9	1.5E-4	e	4
	*Failure probability per hour **On-demand failure probability, calculated based on annual demand.					

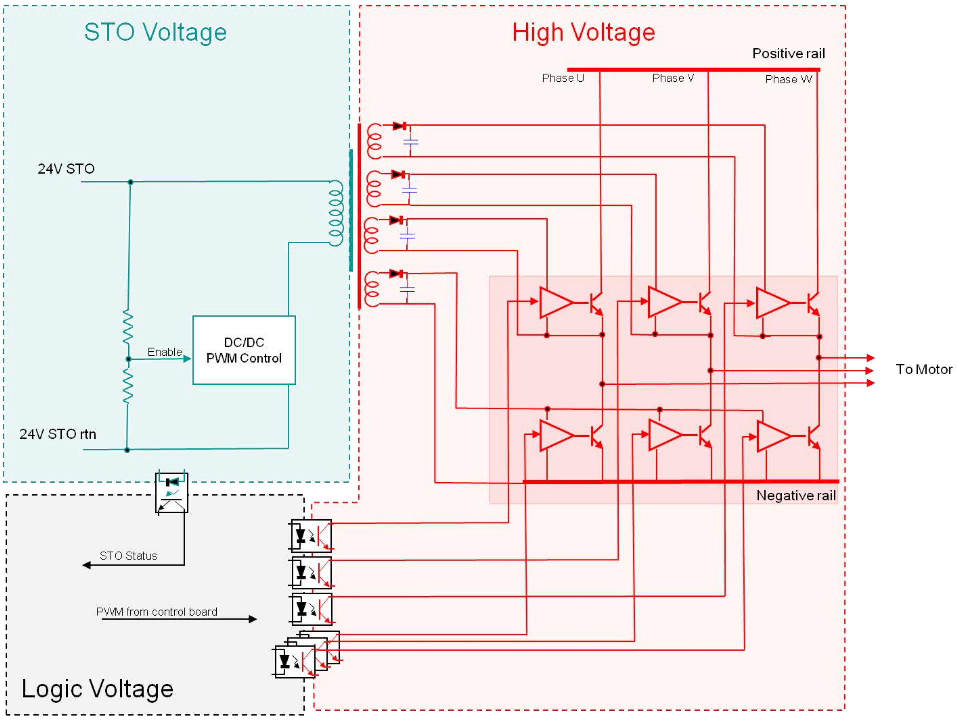


Figure 9-1 STO circuit wiring

9.4STO system requirements

STO power supply

To avoid excessive voltage levels at the STO input, safety-related parts must use low voltage.

A 24V power supply must be used. The power supply device must comply with the PELV/SELV requirements stipulated in the EN60204-1 standard *Safety of machinery — Electrical equipment of machines Part 1: General requirements*.

Note: The built-in 24V DC power supply of the CDHD2S is not approved for safety applications and is therefore prohibited from being used as an STO power supply.

STO cable

According to the EN61326-3-1 standard, the STO cable length must be less than 30 meters.

Shielded and double insulated cable must be used. Double insulation refers to the need for cable sleeves on supply wires. Cable sheathing must be connected to the power ground.

The optimal size of cable is 22AWG (0.34mm2). Since the current consumption of the STO circuit is less than 0.25A, 24AWG (0.25mm2) is also suitable.

STO cable must be spatially isolated from any source of environmental stress, whether mechanical, electrical, thermal or chemical.

9.5Use STO

STO behavior

In accordance with the STO specifications specified in the IEC61800-5-2 standard, the STO function is specially used to provide safe stop of motion system. Triggering STO function causes the power supply of the motor control circuit to be removed, thus making the motor out of control. When STO is triggered during the motor movement, the motor shaft and its connected mechanical components slide until it stops moving by its own friction.

The immediate effect of STO is that the drive cannot provide any energy generated by torque. STO can be used in the case that the motor is planned to come to a standstill in a sufficiently short time based on load and friction, and in the application where the motor coasting and deceleration will not have any impact on safety.

The figure below shows what will happen to the motor when the STO function is active. The figure depicts that the motor is driven in constant speed mode, and when the power supply of STO circuit is removed, the motor coasting stops.

The figure shows the motor velocity according to time. The behavior of the motor when it is controlled to stop (STO function is not effective - VCMD and V trace) and coasting to stop (STO function is effective - reference trace) is compared.

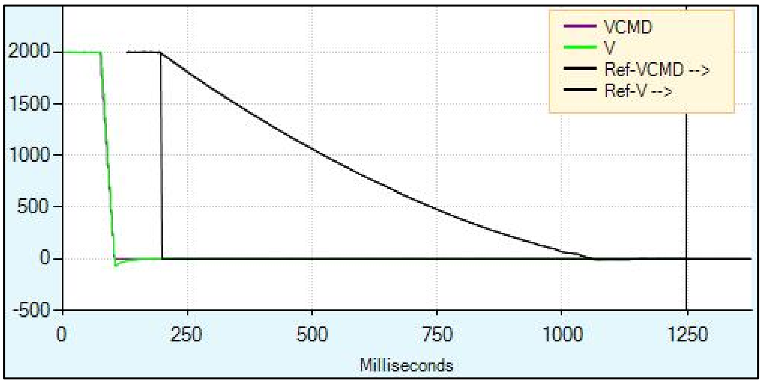


Figure 9-2 Motor coasts to a stop when STO takes effect

STO indicator

STO status and diagnostic information is provided in the following ways.

Digital display

If the drive is disabled and STO is in effect (STO power is removed), a warning condition will occur and n will be normally on when the panel is in status mode (08 indicates the operation mode in this example). If the drive is enabled and STO is active (STO power is removed), a fault condition will occur and the digital display will automatically switch to fault mode.

If panel mode switches back to status mode while a fault condition still exists, the display will show Sn with n flashing (according to panel mode behavior).

Serial communication

When using serial communication (terminal), ST query returns the status report list. The state is slightly different when STO takes effect (STO power supply is removed), depending on whether the drive is enabled or disabled when STO power supply is removed.

If the drive is disabled and STO is in effect (STO power is removed), a warning condition will occur and the status report will display the warning:

Drive is not active

Drive is not ready:

No SW enabled

Warning exists:

WRN1STO signal not connected

If the drive is enabled and STO power is removed, this is a fault condition and the status report will indicate the fault.

Drive is not active

Drive is not ready:

No SW enabled

Fault exists

FLT4STO fault

Since the drive is enabled and fails, the failure recovery procedure must be performed.

CANopen and EtherCAT

If the drive is enabled and STO power is removed, a fault condition will occur.

Object 603Fh subindex 0 provides the current error error code.

The STO fault code is 12673 (decimal).

STO event recovery

If the drive is disabled while the STO function is in effect, no recovery procedure is required. Once power is restored to STO, the drive will operate normally.

If the drive is enabled while the STO function is active, the drive will enter a fault state. Since the drive fault status is blocked, the drive cannot be enabled until the fault status is clearly cleared, so a fault recovery procedure is required.

After STO power is restored, the fault clearing command must be executed. After successful fault clearing, the drive works again. Fault clearing can be performed in any of the following ways:

- Switching drive enable: This can be done by executing the drive disable (K) command followed by the enable (EN) command, or by switching the remote enable line (REMOTE).
- In some systems, specific drive inputs are defined as alarm clearing. In such systems, the fault is cleared by switching the input.
- Execute the clear fault command (CLEARFAULTS).

If the STO fault condition no longer exists, the drive will be re-enabled.

STO is forbidden to use

When the STO function is in effect, the STO function shall not be used under the condition that external influence will cause danger (such as hanging load falling).

The STO function is explicitly prohibited in elevator applications. In these cases, additional measures (e.g. mechanical braking) are required to prevent any danger.

STO special circumstances

A short circuit between two non-adjacent IGBTs in a short period of time can cause the movement to reach 120 electrical degrees, even if STO function takes effect. The probability of such an event is extremely low, but it could still happen. However, the probability of such fult is considered negligible.

9.6STO Maintenance

Users must perform manual testing of STO functionality at least once every three months.

The diagnostic test needs to remove the STO power supply voltage and verify that the drive is really in the STO fault state and that the movement is prohibited.

Maintenance procedures are performed as follows:

The system is set up to provide nominal STO voltage to the drive and the drive is enabled.

- The drive is in a fault state and displays an STO fault.
- The drive cannot be enabled.

2. Restore STO voltage and clear the fault. Verify that the drive is enabled.

10.Troubleshooting

10.1Report Generator

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

In general, it is highly recommended that you generate a report every time you complete application configuration, even when the system is functioning normally.

Report generator options can be accessed in two places in ServoStudio2:

- Autotuning Wizard (last step)
- Backup and restore screen

10.2Faults and Warnings

If the CDHD2S is connected to the host through the serial interface, the fault code is transmitted to the host through a text message. This message is saved in the fault history log (FLTHIST) in the non-volatile drive memory, so the fault history will not be lost when the power supply of the drive is restored.

- Warnings are not considered faults and do not disable operation. The system automatically clears the warning status when the conditions that generated the warning no longer exist.
- Faults will occur when settings or conditions may cause improper drive/motor operation and/or damage to the equipment. A fault will automatically disable the drive and display the fault status on the drive display as well as in the software interface.

The fault state of the drive is usually blocked, and the drive will not be enabled until the fault state is clearly cleared. The fault state can only be cleared when the fault condition no longer exists. This can be done in any of the following ways:

- Switch a drive for enabling. This can be accomplished by executing the drive disable command (K) and then executing the enable (EN) command or by switching the remote enable line (REMOTE).
- In some systems, specific drive inputs are defined as alarm clearing. In such systems, the fault will be cleared by switching the input.

The drive will be re-enabled when the fault condition no longer exists.

- Fatal faults. Some faults are called fatal faults because they disable nearly all drive functionality (including communications), preventing the drive from enabling. This condition is typical of internal failure faults, such as watchdog events or internal power failure. Fatal faults require technical support intervention.

Table10-1

VarCom	Description
CLEARFAULTS	Clear all blocking faults.
FLT	Return to the list of faults blocked by the drive.
FLTHIST	Return to the content of the fault buffer.
K|EN	Disable drive|Enable drive
READY	Indicate whether the drive is ready to be enabled.
REMOTE	Indicate the external hardware enabling input status.
ST	Return to the detailed status message of the drive.

10.3Warning, error and fault messages

The following table shows the faults, warnings and error codes that may be displayed when operating in terminal mode.

All faults as well as many warnings are also displayed via the drive digital display. Certain conditions generate only on-screen warning messages.

10.3.1 Warning messages

CDHD2S drive warnings are reported in object 2011h.

Table 10-2 Warning codes and messages

Warning# Number	Warning message (click description for more information)
WRN1	STO
WRN2	Drive foldback warning
WRN3	Motor foldback warning Error!Referencesourcenotfound.
WRN4	Undervoltage
WRN5	Power stage over-temperature
WRN6	Motor over-temperature
WRN9	Control board over-temperature
WRN10	Require phase find The phase difference is required to initialize the commutation angle.
WRN11	PLL not synchronized The phase locked loop (PPL) is not yet synchronized (SYNCSOURCE>0).
WRN15	Hardware positive limit switch open circuit
WRN16	Hardware negative limit switch open circuit
WRN17	Hardware positive and negative limit switches open circuit
WRN18	Software forward limit switch trip
WRN19	Software negative limit switch trip

Warning# Number	Warning message (click description for more information)
WRN20	Software limit switch trip
WRN21	HIPERFACE encoder resolution mismatch The encoder resolution determined by the detected HIPERFACE device differs from the MENCRES setting currently in effect.
WRN22	Multi-turn encoder battery low voltage
WRN24	EnDat encoder resolution mismatch MENCRES does not match the encoder resolution read during initialization.
WRN25	Position feedback (PFB) backup not read PFBBACKUP data has not been received.
WRN27	Detected offset and/or gain adjustment value after SININIT
WRN32	Bus AC power cord disconnected
WRN34	Regenerative resistor overload
WRN35	SensAR: Encoder warning The drive detected a warning on SensAR.
WRN36	Real-time overload warning
WRN37	SFBTYPE1 cannot be used to simulate OPMODE
WRN38	Integrated power module over-temperature
WRN40	Online load/motor inertia ratio (LMJR) estimation active Online load/motor inertia ratio (LMJR) estimation is active.
WRN41	PDO packet does not meet expected length (too long) The PDO packet does not meet the expected length based on the PDO drawing. The packet is too long.
WRN42	RPDO data out of range RPDO data is out of range or beyond min/max limits.
WRN43	Unable to write data while drive is enabled RPDO data cannot be written while the drive is enabled.
WRN44	The command is close to the forward software limit The command is close to the negative software limit.
WRN45	The command is close to the negative software limit The command is close to the forward software limit.
WRN47	CAN communication input passive state CAN bus communication error
WRN48	Default drive configuration Drive configured to default factory settings
WRN49	Fieldbus target command lost The fieldbus controller has not sent the target command 3 times in a row.
WRN50	I2C fails to read the temperature sensor.
WRN51	BiSS-C encoder indicates internal warning

Warning# Number	Warning message (click description for more information)
WRN52	Motor compatibility warning
WRN53	Conflicting digital inputs are turned on
WRN54	Fan circuit warning Blower circuit overloaded or disconnected
WRN55	Excessive electrical noise warning System produces excessive electrical noise
WRN56	Feedback type mismatch The configured feedback type and the connected encoder do not match
WRN57	sensAR encoder over-temperature warning sensAR encoder over-temperature warning
WRN58	sensAR encoder built-in flash memory failure sensAR built-in flash memory failure
WRN59	An excessively high axis shift is detected. The device has detected abnormally high axis shift
WRN60	Gantry paired axis positive limit switch The second gantry axis has reached the forward hardware or software limit switch
WRN61	Gantry paired axis negative limit switch The second gantry axis has reached the negative hardware or software limit switch
WRN62	Internal axis synchronization lost (without HMI) Internal FPGA communication synchronization problem
WRN63	Motor foldback disabled
WRN64	A connection between the controller and the drive is removed Reconnect the controller and drive
WRN65	LOAD failure parameter set to default value LOAD failure parameter set to default value
WRN66	Inter-drive communication warning There is a synchronization loss or timeout error at the inter-drive communication layer
WRN67	Too many communication errors Too many consecutive errors, check errors , or timeout errors
WRN68	Gantry does not receive PFB reply from partner axis The axis sends position feedback data to the partner axis, but the partner axis does not acknowledge receipt.
WRN69	Multi-turn encoder battery voltage low During the secondary feedback, the battery voltage is close to the fault level. Replace the battery as soon as possible.
WRN70	Knlusergain switch threshold configured incorrectly Knlusergain switch threshold configured incorrectly

Warning# Number	Warning message (click description for more information)
WRN71	Scroll display EnDat encoder flipped
WRN72	Invalid VBUSREADOUT In CDHD2-LV, VBUSREADOUT will be equal to VBUS when customerid =
WRN73	Homing is not completed, PEINPOS is too low When homing in gantry mode, the drive waits to settle to zero. When the unit is a degree or lower resolution, corresponding configuration must be performed.
WRN74	Automatic activation of fault triggering function error after power-on Automatic activation of fault triggering function error after power-on
WRN75	PROFINET master requests drive flashing PROFINET master requests drive flashing
WRN76	Self-test failed Self-test failed

10.3.2 Error messages - manufacturers only

Table 10-3 Error codes and messages - manufacturers only

Warning# Number	Error message	Digital display	Error code
ERR20	Unknown command	E0020	08000000h
ERR21	Unknown variable	E0021	08000000h
ERR22	Checksum error	E0022	08000000h
ERR23	Drive activated	E0023	08000000h
ERR24	Drive deactivated	E0024	08000000h
ERR25	Value out of range	E0025	06090030h
ERR26	Value too low	E0026	06090032h
ERR27	Invalid OPMODE	E0027	08000000h
ERR28	Syntax error	E0028	08000000h
ERR29	Value is too high	E0029	06090031h
ERR36	Not programmable	E0036	06010002h
ERR37	Not configured	E0037	08000000h
ERR38	Not applicable	E0038	08000000h
ERR42	Invalid flash memory	E0042	06060000h
ERR43	Record active	E0043	08000000h
ERR44	Recording data is not available	E0044	08000000h
ERR45	NVRAM clear	E0045	08000000h
ERR46	Value must be even	E0046	08000000h

Warning# Number	Error message	Digital display	Error code
ERR49	Value must be a multiple of 0.25	E0049	08000000h
ERR50	Save to flash memory failed	E0050	08000000h
ERR51	Not applicable	E0051	06060000h
ERR54	Direction limit switch command	E0054	08000000h
ERR55	Homing mode active	300SS	08000000h
ERR60	Motor is running	30090	08000000h
ERR62	Communication error	3009Z	08000000h
ERR63	EnDat is not ready	3009c	08000000h
ERR64	EnDatCRC error	3009v	08000000h
ERR65	EnDat busy	3009S	08000000h
ERR66	Password protection	30099	08000000h
ERR67	TM failed to write to EEPROM	3009L	06060000h
ERR68	TM communication CRC failed	30098	05040004h
ERR71	Homing type is not used	300LL	08000000h
ERR72	Invalid homing type	300LZ	08000000h
ERR73	Homing trigger input source is not set	300Lc	08000000h
ERR74	Homing in progress	300Lv	08000000h
ERR75	Homing direction - inverse input is not set. Please refer to CiA402.	300LS	08000000h
ERR82	Function is defined	3008Z	08000000h
ERR94	Command exceeds software limit	3006v	08000000h
ERR95	Invalid feedback	3006S	08000000h
ERR96	Variable is not recordable.	30069	08000000h
ERR97	Value must be an integer	3006L	08000000h
ERR98	Input/output is not supported.	30068	08000000h
ERR99	Active disable in progress	30066	08000000h
ERR100	I2C bus busy	30L00	08000000h
ERR102	Other programs are running	30L0Z	08000000h
ERR103	Clear faults before executing the program	30L0c	08000000h
ERR104	Movement pending	30L0v	08000000h
ERR105	Invalid PTP mode	30L0S	08000000h
ERR106	Invalid checksum	30L09	08000000h
ERR107	Invalid analog output mode	30L0L	08000000h
ERR108	Keep mode active	30L08	08000000h
ERR109	Invalid motor commutation type	30L06	08000000h
ERR113	HC actual velocity out of range	30LLc	08000000h
ERR114	This hardware does not support	30LLv	08000000h

Warning# Number	Error message	Digital display	Error code
ERR115	Value must be a multiple of 0.125	30LLS	08000000h
ERR116	Fieldbus mode (COMMODE=1) active	30LL9	08000000h
ERR201	Current loop design failed	30Z0L	08000000h
ERR202	MENCRES out of range	30Z0Z	08000000h
ERR204	MSPEED out of range	30Z0v	08000000h
ERR206	MVANGLF out of range	30Z09	08000000h
ERR210	VLIM out of range	30ZL0	08000000h
ERR212	MVANGLH out of range	30ZLZ	08000000h
ERR213	DICONT is greater than DIPEAK	30ZLc	08000000h
ERR214	MENCTYPE does not match	30ZLv	08000000h
ERR215	DIPEAK out of range	30ZLS	08000000h
ERR216	MIPEAK out of range	30ZL9	08000000h
ERR217	MICONT is greater than MIPEAK	30ZLL	08000000h
ERR218	VBUS out of range	30ZL8	08000000h
ERR219	ML out of scope	30ZL6	08000000h
ERR220	MPOLES out of range	30ZZ0	08000000h
ERR221	Velocity loop design failed	30ZZL	08000000h
ERR222	Built-in dual gain exists	30ZZZ	08000000h
ERR223	Require PHASEFIND	30ZZc	08000000h
ERR224	The value is not allowed	30ZZv	06090030h
ERR225	Built-in dual gain does not exist	30ZZS	08000000h
ERR226	MENCTYPE is not valid for linear motors	30ZZ9	08000000h
ERR227	ENCOUTRES*VLIM too high	30ZZL	08000000h
ERR228	Function is not valid for this input	30ZZ8	08000000h
ERR229	MJ out of range	30ZZ6	08000000h
ERR230	MMASS out of range	30Zc0	08000000h
ERR232	Autotuning active	30ZcZ	08000000h
ERR233	Internal configuration failed	30Zcc	08000000h
ERR234	Feedback type mismatch	30Zcv	08000000h
ERR250	Velocity configuration failed	30ZS0	08000000h
ERR254	Cycle recognition active	30ZSv	08000000h
ERR255	Phase find mode is invalid	30ZSS	08000000h
ERR256	Feedback device disconnected	30ZS9	08000000h
ERR257	Feedback device initialization	30ZSL	08000000h
ERR260	No input assigned to touch probe	30Z90	08000000h
ERR261	COMMERRVTHRESH exceeds VLIM	30Z9L	08000000h
ERR263	SensAR: Device is busy	30Z9c	08000000h

Warning# Number	Error message	Digital display	Error code
ERR264	SensAR: Request time out	30Z9v	08000000h
ERR265	SensAR: Flash save failed	30Z9S	08000000h
ERR266	SensAR: protocol error	30Z99	08000000h
ERR267	SensAR: Illegal request	30Z9L	08000000h
ERR268	SensAR: inconsistent addresses	30Z98	08000000h
ERR269	Unable to read motor nameplate data	30Z96	08000000h
ERR270	Unable to set when MTPMODE>0	30ZL0	08000000h
ERR271	Unable to set when COMMODE>0	30ZLL	08000000h
ERR272	POSCONTROLMODE is not supported	30ZLZ	08000000h
ERR274	Unable to publish when SFBMODE>0	30ZLv	08000000h
ERR275	HDTUNE profile is not trapezoidal	30ZLS	08000000h
ERR276	This feedback is not supported	30ZL9	08000000h
ERR277	Feedback returns too much data	30ZLL	08000000h
ERR278	Invalid HDTUNEAVMODE	30ZL8	08000000h
ERR279	SensAR: internal requirement error	30ZL6	08000000h
ERR280	SensAR drive occupied	30Z80	08000000h
ERR281	SensAR drive fault	30Z8L	08000000h
ERR282	SensAR drive acquisition timeout	30Z8Z	08000000h
ERR283	The drive does not home	30Z8c	08000000h
ERR284	SensAR address out of range	30Z8v	08000000h
ERR285	SensARCRC error occurs	30Z8S	08000000h
ERR286	Autotuning activation failed	30Z89	08000000h
ERR287	Homing failed. If ILIM=0, it cannot be homed.	30Z8L	08000000h
ERR288	Communication feedback default value not defined	30Z88	08000000h
ERR289	Feedback memory is not partitioned	30Z86	08000000h
ERR290	Cannot be changed in modulo mode	30Z60	08000000h
ERR291	EnDat stamp value does not match	30Z6L	08000000h
ERR292	EnDat2.X is not supported	30Z6Z	08000000h
ERR293	MENCRES of this drive is too high	30Z6c	08000000h
ERR294	HDTUNEVcruise too low	30Z6v	08000000h
ERR295	HDTUNE distance is not equal	30Z6S	08000000h
ERR296	Flash memory failed to store data	30Z69	08000000h
ERR297	Flash memory failed to read data.	30Z6L	08000000h
ERR298	CANopen internal error	30Z68	08000000h
ERR299	CANopen: object index not found	30Z66	06020000h
ERR300	CANopen: object subindex not found	30c00	06090011h
ERR301	CANopen: wrong object size	30c0L	06070010h

Warning# Number	Error message	Digital display	Error code
ERR302	CANopen: drive NMT status error	30c0Z	08000000h
ERR303	SFBMODE nonlinearity is not supported	30c0c	08000000h
ERR304	Use different signs for positive and negative directions	30c0v	08000000h
ERR305	Use the same sign for positive and negative directions	30c0S	08000000h
ERR306	PHASEFINDMODE=4 (old KCMODE)	30c09	08000000h
ERR307	CANopen: unable to transmit data	30c0L	08000020h
ERR308	Positive limit switch active	30c08	08000000h
ERR309	Negative limit switch active	30c06	08000000h
ERR310	Homing switch is in the reverse state	30cL0	08000000h
ERR311	Movement suddenly stops	30cLL	08000000h
ERR312	BiSS-C: address out of range	30cLZ	08000000h
ERR313	BiSS-C: device busy	30cLc	08000000h
ERR314	BiSS-C: illegal request	30cLv	08000000h
ERR315	BiSS-C: EEPROM save failed	30cLS	08000000h
ERR316	BiSS-C: busy timeout	30cL9	08000000h
ERR317	BiSS-C: internal error	30cLL	08000000h
ERR318	BiSS-C: protocol error	30cL8	08000000h
ERR319	BiSS-C: drive error	30cL6	08000000h
ERR320	BiSS-C: drive acquisition timeout	30cZ0	08000000h
ERR321	BiSS-C: drive occupied	30cZL	08000000h
ERR322	BiSS-C: error in requesting CRC	30cZZ	08000001h
ERR324	HIPERFACE data error. Use HSAVE1.	30cZv	08000000h
ERR325	Predefined and automatic settings	30cZS	08000000h
ERR326	DDHD not allowed	30cZ9	08000000h
ERR328	COMMODE=1 no serial enabled	30cZ8	08000050h
ERR329	Specific user ID command	30cZ6	08000050h
ERR330	VLIM is smaller than VCRUISE	30cc0	0x08000000
ERR331	Total cycle time is greater than 1 second	30ccL	0x08000000
ERR332	Motor parameter estimation active	30ccZ	0x08000000
ERR333	Pulse and direction modes do not allow unidirectional	30ccc	0x08000000
ERR334	DECSTOP is less than autotuning acceleration	30ccv	0x08000000
ERR335	Cannot be changed when PCOM is enabled	30ccS	0x08000000
ERR336	PCOM output not configured	30cc9	0x08000000
ERR337	PCOM cycle data error	30ccL	0x08000000
ERR338	Exceeding PCOM output frequency	30cc8	0x08000000
ERR339	PCOM motor runs during initialization	30cc6	0x08000000
ERR340	PCOM table order wrong	30cv0	0x08000000

Warning# Number	Error message	Digital display	Error code
ERR341	PCOM feedback is invalid	30cvL	0x08000000
ERR342	PCOM drive does not home	30cvZ	0x08000000
ERR343	PCOM type does not exist	30cvc	0x08000000
ERR344	PCOM output mode is undefined	30cvv	0x08000000
ERR345	Dual loop invalid VELCONTROLMODE	30cvS	0x08000000
ERR346	Dual loop invalid ENCOUTMODE	30cv9	0x08000000
ERR347	Dual loop invalid GEARMODE	30cvL	0x08000000
ERR348	Dual loop invalid POSCONTROLMODE	30cv8	0x08000000
ERR349	Invalid SFBTYPE-SFBMODE combination	30cv6	0x08000000
ERR350	MOVESMOOTHAVG128 maximum	30cS0	0x08000000
ERR351	FOE is in progress. Value not allowed.	30cSL	0x08000000
ERR352	Drive not set to correct gantry mode	30cSZ	08000000h
ERR353	Gantry system misaligned	30cSc	08000000h
ERR354	The requested operation mode is not available in gantry mode	30cSv	08000000h
ERR355	Gantry clear fault program active	30cSS	08000000h
ERR356	Gantry system is not ready for activation	30cS9	08000000h
ERR357	Gantry alignment program active	30cSL	08000000h
ERR358	Operation is not allowed when gantry differential controller PEMAX=0	30cS8	08000000h
ERR359	Reject location command based on GANTRYCMDTYPE	30cS6	08000000h
ERR360	Rigid gantry differential controller must use HOMETYPE35	30c90	08000000h
ERR361	Gantry paired axis trips the limit switch	30c9L	08000000h
ERR362	PCOM error from last cycle	30c9Z	08000000h
ERR363	PCOM counter is reset	30c9c	08000000h
ERR364	PCOM types cannot be allocated as PDO	30c9v	08000000h
ERR365	The PCOM time base is not available when the position base is active	30c9S	08000000h
ERR366	The PCOM position base is unavailable when the time base is active	30c99	08000000h
ERR367	Linear control is not supported	30c9L	08000000h
ERR368	Not available in DDHD2CAN when gantry mode is active	30c98	08000000h
ERR369	GANTRYMODE and SFBMODE cannot be configured at the same time	30c96	08000000h
ERR370	PCOMTM value exceeds limit	30cL0	08000000h
ERR371	Recognition process active	30cLL	08000000h
ERR372	Function is not valid for this output	30cLZ	08000000h
ERR373	Gantry system does not home	30cLc	08000000h
ERR374	Error correction enabling requirements are not allowed to	30cLv	08000000h

Warning# Number	Error message	Digital display	Error code
	be modified.		

10.3.3 Fault messages

Table 10-4 Fault codes and messages

Fault# Number	Fault message (Click the description for more information)	Emergency (fault) Error code
FLT1	Drive locking	8180h
FLT2	Parameter memory checksum failed	5585h
FLT3	Overcurrent	2214h
FLT4	STO fault	3181h
FLT5	FPGA configuration failed	6581h
FLT6	Control EEPROM fault	5581h
FLT7	Power supply EEPROM fault	5530h
FLT8	Vbus measurement circuit failed	3182h
FLT9	Overvoltage	3110h
FLT10	Power stage over-temperature	4310h
FLT11	Undervoltage	3120h
FLT12	Not configured	6381h
FLT13	Writing to flash memory failed	5586h
FLT14	Exceeding the velocity limit	8481h
FLT15	Encoder simulation frequency is too high	7387h
FLT16	Drive foldback	2311h
FLT17	Motor foldback	2310h
FLT18	A/B disconnection	7383h
FLT19	Invalid Hall	7384h
FLT20	Index disconnected	7111h
FLT21	Sine feedback communication failed	738Eh
FLT22	A/B out of range	738Fh
FLT23	Motor over-temperature	4410h
FLT24	Sine encoder quadrature fault	7391h
FLT25	Sine/cosine calibration is invalid	7392h
FLT26	Feedback 5V overcurrent	7393h
FLT27	Secondary feedback index disconnected	7180h
FLT28	Secondary feedback A/B line disconnected	7181h
FLT29	Regenerative overcurrent	3180h

Fault# Number	Fault message (Click the description for more information)	Emergency (fault) Error code
FLT30	Field bus velocity overrun	6380h
FLT31	Secondary encoder 5V overcurrent	2189h
FLT32	CAN power supply fault	5582h
FLT33	Self-test failed	5583h
FLT34	Feedback communication error	7380h
FLT35	Nikon encoder operation fault	7381h
FLT36	+15V out of range	5111h
FLT37	-15V out of range	5111h
FLT38	Watchdog fault	—
FLT39	Integrated power module over-temperature	4080h
FLT40	Control board over-temperature	4081h
FLT41	Phase find failed	7082h
FLT42	Tamagawa initialization failed	7382h
FLT43	Current sensor offset is invalid	2380h
FLT44	Motor setup failed	7081h
FLT45	Exceeding the maximum position error	8611h
FLT46	Pulse and direction input lines disconnected	7182h
FLT47	FPGA version mismatch	7090h
FLT48	PLL (Phase Locked Loop) synchronization failed	7386h
FLT49	Tamagawa Abs operation fault	7388h
FLT50	CAN heartbeat lost	8130h
FLT51	Motor phase disconnection	2381h
FLT52	5V out of range	5180h
FLT55	Resolver initialization failed	7394h
FLT56	Absolute multi-turn encoder battery low voltage fault	7385h
FLT57	Issuing an emergency stop	7091h
FLT58	Endat2X feedback fault	7395h
FLT59	Stall fault	7121h
FLT60	Position feedback (PFB) off checksum Invalid	FF8Dh
FLT61	Position feedback (PFB) off data mismatch	FF8Eh
FLT62	No position feedback (PFB) off data	FF8Fh
FLT63	Dynamic brake open circuit load	7112h
FLT64	Power brake short circuit	7113h
FLT65	Fieldbus cable disconnected	7580h
FLT66	Command exceeds acceleration/deceleration limit	7581h
FLT67	Exceeding the maximum position error	8482h

Fault# Number	Fault message (Click the description for more information)	Emergency (fault) Error code
FLT68	Encoder phase error	738Bh
FLT69	Fieldbus target command lost	7582h
FLT70	Internal error	FF01h
FLT71	Differential Hall line disconnected	738Ah
FLT72	Logical AC power fault	—
FLT73	Temperature sensor fault	4096h
FLT76	Pulse train frequency too high	FF97h
FLT77	Communication error (motor out of control) condition detected	7198h
FLT78	Bus AC power cord disconnected	3183h
FLT80	AB positive switching direction fault	738Ch
FLT82	sensAR encoder fault	738Dh
FLT83	Regenerative resistor overload	3199h
FLT85	Motor board read failed	FF02h
FLT86	Need to save and restart	FF03h
FLT87	High PE value	8689h
FLT88	CAN is in bus off state	—
FLT89	Real-time overload fault	FF04h
FLT90	Secondary feedback position mismatch	8688h
FLT91	EtherCAT packet loss	818Dh
FLT92	CAN/EtherCAT status not working	F080h
FLT93	Fieldbus version mismatch	7093h
FLT94	ESI version mismatch	7094h
FLT95	Internal fault of self-defined absolute encoder	7389h
FLT96	Digital output overcurrent detected	2382h
FLT98	Power brake fault	718Fh
FLT99	Sankyo absolute encoder fault	7390h
FLT100	Unstable current loop	8380h
FLT102	BiSS-C encoder indicates internal fault	7097h
FLT103	HIPERFACE encoder data error	7098h
FLT104	High IQ current detected	8381h
FLT105	Digital output overcurrent fault	2382h
FLT106	Feedback type automatic detection failed	7396h
FLT107	EnDat high resolution fault	7397h
FLT108	MOTORNAME/Electronic Motor Nameplate (MTP) data mismatch	FF14h
FLT109	This drive model does not support drive firmware.	FF16h

Fault# Number	Fault message (Click the description for more information)	Emergency (fault) Error code
FLT110	ESI supplier mismatch	7099h
FLT111	MENCZPOS does not match Hall	70A0h
FLT112	sensAR encoder position fault	7398h
FLT113	sensAR over-temperature fault	4380h
FLT114	sensAR working power supply is insufficient	3184h
FLT115	sensAR battery voltage is below threshold	3185h
FLT116	sensAR requires a configuration command.	7399h
FLT117	Internal position synchronization failed.	3186h
FLT118	General fault of multi-turn encoder	3187h
FLT119	sensAR firmware does not match sensAR hardware	FF15h
FLT120	Fieldbus interpolation cycle exceeds synchronization time	7583h
FLT121	Secondary feedback communication error	7380h
FLT122	Received object index exceeds object array size	—
FLT129	Gantry differential axis fault (active disabled)	FF98h
FLT130	Gantry differential axis fault (inactive disabled)	FF99h
FLT131	Drive internal communication fault	FF9Ah
FLT132	Gantry alignment process failed	FF9Bh
FLT133	Gantry differential controller saturation	FF9Ch
FLT134	The gantry cannot receive position feedback confirmation from the paired axis	FF9Dh
FLT135	Gantry FIFO buffer higher than expected	FF9Eh
FLT136	Too many communication errors	FF9Fh
FLT137	Gantry high communication error rate	FFA0h
FLT138	The gantry cannot receive the zero offset confirmation of the paired axis.	FFA1h
FLT139	Gantry paired axis is not enabled	FFA2h
FLT140	Gantry paired axis reports fault	FFA3h
FLT141	Gantry homing failed	FFA4h
FLT143	Drive parameters set to default values	—
FLT144	Gantry enable failed	FFA6h
FLT145	Maximum position error exceeding motor load	8612h
FLT146	Positive limit switch is activated	FF10h
FLT147	Negative limit switch is activated	FF11h
FLT148	Current exceeds trigger limit	709Ah
FLT149	Turn off the drive and change the motor phase	7083h

Fault# Number	Fault message (Click the description for more information)	Emergency (fault) Error code
FLT150	u16_VbusMeasureFilter exceeds 5	—
FLT151	Temp_Sensor_Failure_Qualifier exceeds 250	—
FLT152	Axis_To_Axis_Timeout_Max exceeds 1000	—
FLT153	FPGA_BG_Buffer_Consec exceeds 1000	—
FLT154	Gantry fieldbus disable failed	FFA7h
FLT155	Multi-turn secondary encoder battery voltage is low	739Ah
FLT156	Tamagawa second feedback Abs operation fault	7388h
FLT157	Serial communication timeout	—
FLT158	PLC has stopped or disconnected	1C34h
FLT159	Synchronous communication signal timeout	1C35h
FLT160	Fieldbus slave chip timeout	1C36h

10.4Fieldbus status-LED

10.4.1 Status LED-CANopen

Interfaces C5 and C6 (AF models) share a LED light that indicates fieldbus status when communicating on the CANopen network.

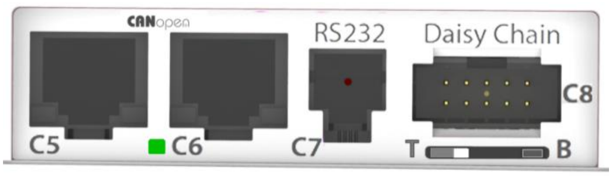


Figure 10-1 Top panel interface and LEDs on the model

Table 10-5

Green light	Normally on - working (OP) status
	Fast flash - preparation (PREOP) status
	Slow flash - stop status
Red light	Flashing - error
Off	The drive is not set to EtherCAT/CANopen command interface mode. Please refer to VarComCOMMODE

10.4.2 Status LED - EtherCAT

Interfaces C5 and C6 (EB and EC models) each have two LED lights that indicate the status of the fieldbus when communicating on the EtherCAT network.

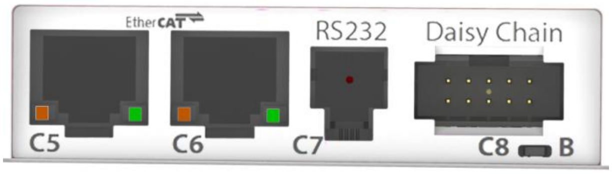


Figure 10-2 Top panel interfaces and LEDs on the EtherCAT model

Table 10-6

Green light	Flashing - communication activity
	Off - no communication activity
Orange light	Normally on - working (OP) status
	Slow flash - SAFEOP status
	Fast flash - preparation (PREOP) status
	Super fast flash - boot program (BOOT) status
	Off - initial (INIT) state

10.4. Status LED - PROFINET

Interfaces C5 and C6 (EB and EC models) each have two LED lights that indicate the status of the fieldbus when communicating on the PROFINET network.

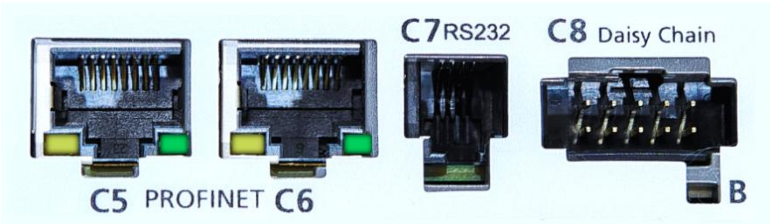


Figure 10-2 Top panel interfaces and LEDs on the PROFINET model

Table 10-7

Green light	Normally on - communication activity
	Off - no communication activity
Yellow light	Normally on - port is connected
	Off - no connection to the port

11.CDHD2S Accessories

11.1Mating Connector Kit

Table 11-1

Description	Servotronix part number
CDHD2S (medium-voltage) power supply mating 1.5A, 3A, AC voltage 120/240V, spring	KIT-2A-PWSPR-00
CDHD2S (medium-voltage) power supply mating 4.5A, 6A, AC voltage 120/240V, spring	KIT-2B-PWSPR-00
CDHD2S (medium-voltage) power supply mating 8A, 10A, 13A, AC voltage 120/240V, crimped	KIT-2C-POWER-00
CDHD2S (medium-voltage) power supply mating 20A, 24A, AC voltage 120/240V, spring	KIT-2D-PWSPR-00
CDHD2S (low-voltage) power supply mating 3A, 6A, 12A, 15A, AC voltage 20/90V	KIT-1D-POWER-00
CDHD2SC2 - controller interface MDR36 pin	KIT-C2MDR36000
CDHD2SC3 – machine interface MDR20 pin	KIT-C3MDR20000
CDHD2SC4 – feedback MDR26 pin	KIT-C4MDR26000
CDHD2SSTO connector	KIT-00P1000-00

11.2Cable

Table 11-2 C1 - USB2.0A to Mini-B cable

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

Item	Specification	Servotronix part number
USB2.0A to Mini-B cable		CBLr0000USBA-00
Shielding	85% copper braided wire shield coverage	
Twisted pair cables	Required	
Maximum length	3m	
Wire gauge	20–28AWG	
EMI filtering	2 ferrite cores, located near each connector	

Table 11-3 C2 - controller interface cable

Item	Specification	Servotronix part number
USB2.0A to Mini-B cable		CBLr0000USBA-00
Shielding	85% copper braided wire shield coverage	
Twisted pair cables	Required	
Maximum length	3m	

Wire gauge	20–28AWG	
EMI filtering	2 ferrite cores, located near each connector	

Table 11-4 C3 - machine interface cable

Item	Specification	Servotronix part number
C2 fly wire	1 meter fly wire 2 meter fly wire 3 meter fly wire 5 meter fly wire 10 meter fly wire	CBL-MDR2-20-01 CBL-MDR2-20-02 CBL-MDR2-20-03 CBL-MDR2-20-05 CBL-MDR2-20-10

Table 11-5 C4 - feedback cable

Item	Specification	Servotronix part number
C2 fly wire	1 meter fly wire 2 meter fly wire 3 meter fly wire 5 meter fly wire 10 meter fly wire	CBL-MDR2-26-01 CBL-MDR2-26-02 CBL-MDR2-26-03 CBL-MDR2-26-05 CBL-MDR2-26-10

Table 11-6 C5|C6——RJ45 industrial Ethernet/EtherCATCat5e cable

Item	Specification	Servotronix part number
RJ45CAT5E cable	Length: 0.5 meters Length: 1 meters Length: 2 meters Length: 10 meters	CBLr00400100-00 CBLr00400180-00 CBLr00400110-00 CBLr00400140-00
Shielding	85% copper braided wire shield coverage	
Twisted pair cables	Required	
Maximum length	10m	
Wire gauge	26-27AWG	

Table 11-7 C7 - RS232 cable

Item	Specification	Servotronix part number
RS232 cable		CBLrRS232AS0-01
Shielding	85% copper braided wire shield coverage	
Maximum length	10m	
Wire gauge	24–28AWG	

Table 11-8 USB to RS232 adapter cable

Item	Specification	Servotronix part number
USB to RS232 cable		CBLr000UT880-00
Shielding	85% copper braided wire shield coverage	
Maximum length	1.5m	

Table 11-9 C8 - daisy chain loop

Item	Specification	Servotronix part number
Cable		--
Shielding	85% copper braided wire shield coverage	
Twisted pair cables	Required	
Maximum length	0.5m	
Wire gauge	24–28AWG	

Table 11-10 C3<>C3 - gantry cable

Item	Specification	Servotronix part number
Gantry cable	0.5 meter cable 1 meter cable 2 meter cable	CBL-00C3GAN-005 CBL-00C3GAN-010 CBL-00C3GAN-020
Twisted pair cables	Required	
Wire gauge	24–28AWG	

11.3D9-RJ45 adapter

Many PLC devices use a D9 type interface for CAN connections.

To connect the CDHD2SRJ45 port to the D9 interface, Servotronix provides an adapter, as shown in the figure below.

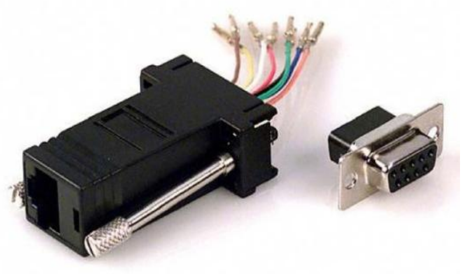


Figure 11-1 D9-RJ45 adapter

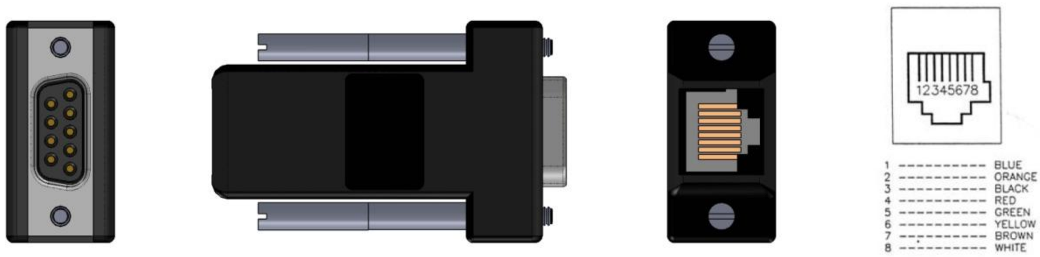


Figure 11-2D9-RJ45 adapter interface

Table 11-11 D9-RJ45 adapter wiring

Function	CDHD2SRJ45 pin	D9 connector pinout
CAN high	1	7
CAN low	2	2
Functional ground	3	3
CAN shield	6	5
Functional ground	7	6

Table 11-12 D9-RJ45 adapter

Description	Servotronix part number
CDHD2S adapter CAN, D9 to RJ45	ADPrCAN_D9|RJ45
CDHD2S adapter DB95, RJ45/jack 8 contacts	ADPr0AMK0001-00

11.4Line filter

The recommended line filter manufacturers and part numbers of CDHD2S are listed in the following table.

Table 11-13 Recommended line filters

High-voltage model	CDHD2S-012	CDHD2S-024	CDHD2S-030
Main line	**Three phase**	**Three phase**	**Three phase**
Manufacturer part number	LCR 096B.02001.00	LCR 096.03501.00	LCR 096.03501.00
Manufacturer part number	CORCOM 25FCD10	LCR 096B.03001.00	LCR 096B.03001.00

11.5Regenerative resistor

The resistance value (ohms, W) is defined by the CDHD2S servo drive. The required power is defined by the application. Therefore, each drive has multiple regenerative resistor options.

The manufacturer and part number of regenerative resistor recommended by CDHD2S are listed in the following table.

Please refer to the *Regeneration*.

Table 11-13 Recommended regenerative resistors for CDHD2S medium-voltage models

	CDHD2S-012	**CDHD2S-024**	**CDHD2S-030**
Power(W)	**Minimum resistance 22Ω**	**Minimum resistance 12Ω**	**Minimum resistance 12Ω**
300	CDHD2S built-in regenerative resistor (P3)	CDHD2S built-in regenerative resistor (P3)	CDHD2S built-in regenerative resistor (P3)
600	ISOTEKULV600N33KFL500	Tobedefined.	Tobedefined.
1000	ISOTEKULV1000N33KFL500	Tobedefined.	Tobedefined.
2000	ISOTEKULM2000N33K	Tobedefined.	Tobedefined.
3000	FRIZLENFGFKU3100602-33	Tobedefined.	Tobedefined.
4000	FRIZLENFGFKU3100802-33	Tobedefined.	Tobedefined.

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