LDHD2

LDHD2 Servo Drive User Manual

Revision 1.1

SERVOTRONIX
always in motion™

Revision History

Doc. Rev.	Date	Remarks
1.0	Mar. 2020	LDHD2 – Preliminary release
1.1	April. 2026	LDHD2-HV added

Copyright Notice

Trademarks

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EtherCAT is a registered trademark of Beckhoff Automation GmbH
Windows is a registered trademark of Microsoft Corporation

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Disclaimer

This product documentation was accurate and reliable at the time of its release. Servotronix Motion Control Ltd. reserves the right to change the specifications of the product described in this manual without notice at any time.

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 a LDHD2 drive only.Upon receipt, open the package and remove all packing materials.Check to ensure there is no visible damage to the product. If damage is detected, notify the carrier immediately.

Contents

1. Introduction

1.1 LDHD2 Product Overview

The LDHD2 is a high-performance servo drive optimized to control direct drive linear motor and direct drive rotary motor. It is the second generation of the servo drive series.

The LDHD2 servo drive is intended for applications using EtherCAT fieldbus, controlled by the Servotronix softMC multi-axis controller, or any third-party EtherCAT controller.

LDHD2 also accepts pulse and direction command inputs, and can be used with third-party controllers that do not support EtherCAT.

USB communication enables plug and play commissioning by means of ServoStudio 2 software. Wizards for motor setup, application configuration and automatic tuning streamline the commissioning process. The software also allows users to program and monitor the servo system.

Refer to the*Ordering Information*for the various options for the LDHD2 drive.

1.2 Ordering Information

The following diagram shows the ordering options that comprise the various model numbers of the drive and motor product lines. To enquire about product availability, contact Servotronix.

1.3 LDHD2 Ordering Information

table1-1 LDHD2 Ordering Options

		LDHD2		–	6		2A		EC	–	0
LDHD2 Servo Drive – HD Series											
Rating											
	120/240VAC										
	Cont.	Peak.									
	[A rms]	[A rms]									
3	3	9									
6	6	18									
	380/440VAC										
12	12	36									
18	18	54									
24	24	72									
Input Power Supply											
2A	·Single Phase 120 L-N VAC +10% -15% 50/60 Hz										
	·Single Phase 240 L-N VAC +10% -15% 50/60 Hz										
4D	·Three Phase 380 L-L VAC +10% -15% 50/60 Hz										
	·Three Phase 440 L-L VAC +10% -15% 50/60 Hz										
Communication Interfaces											
EC	EtherCAT, Pulse Train, USB										
Special Options											
[*blank*]	Standard										

1.4 LDHD2 Product Label

Different product models appear identical. Model numbers and specifications appear on the product label on the drive's back panel.

table1-2 LDHD2 Product Label Codes

Item	Description
Model	Catalog number (ordering info)
S/N	Product serial number. Digit 1 = manufacturer code Digits 2, 3 = year code Digit 4 = month code Last 7 digits = serial code
Ref	Manufacturer's part number
Rev	Part number revision. 2 digits.

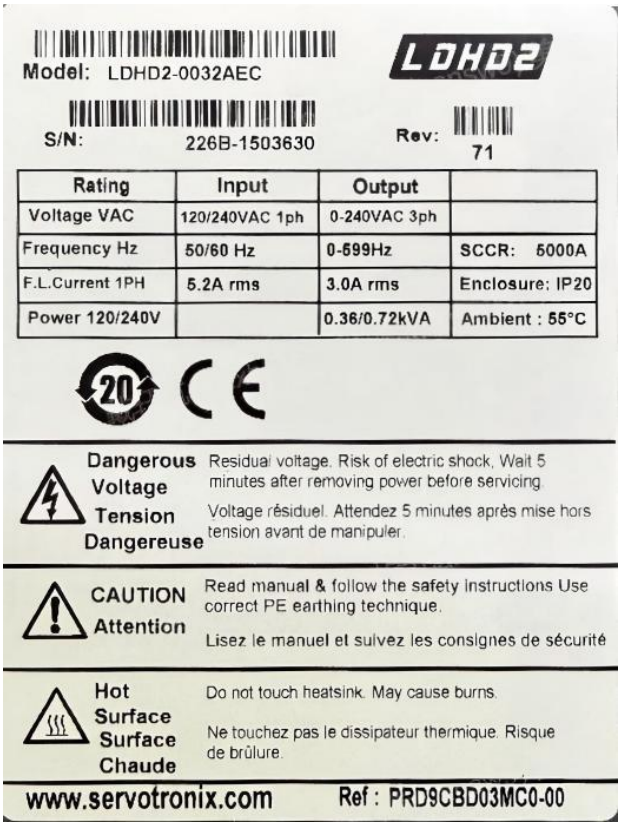


figure1-1 LDHD2 Product Label – Example

1.5 Documentation Set for LDHD2

The documentation set for the LDHD2 servo drive consists of the manuals listed below.

- **LDHD2 User Manual**. Hardware setup, operation and tuning.
  Intended for persons who are qualified to transport, assemble, commission, and maintain the drive.
- **ServoStudio 2 Reference Manual**. Graphical user interface (GUI) provided with the LDHD2 for configuring, operating and tuning the drive.
- **VarCom Reference Manual**. Parameters and commands for configuring, operating and tuning the drive.
- **EtherCAT Reference Manual**. Implementation of CAN over Ethernet (CoE) protocol in the drive.

Note Documentation is also available in the online Help package that is bundled with ServoStudio 2 software.

2. Safety and Standards

2.1 Safety Symbols

Safety symbols indicate a potential for personal injury or equipment damage if the prescribed precautions and safe operating practices are not followed.

The following safety-alert symbols are used on the drive and in the documentation.

table2-1 Safety-Alert Symbols

Symbol	Meaning	Description	ISO 7000/ IEC 60417
	Caution	Indicates caution is necessary when operating the device. Also indicates the current situation needs operator awareness or operator action to avoid undesirable consequences.	0434
	Dangerous voltage	Indicates hazards arising from dangerous voltages.	5036
	Protective earth; protective ground	Identifies any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth (ground) electrode.	5019
	Caution, hot surface	Indicates the marked item can be hot and should not be touched without taking care.	5041

2.2 Safety Guidelines

The LDHD2 is intended for use as a component within a machine system.

The machine builder and integrator must ensure the protection of both personnel and the complete machine system.

The machine builder and/or integrator must perform a risk assessment in view of using the LDHD2 in the intended application. Based on the results, the appropriate safety measures must be implemented.

The LDHD2 must be used in compliance with all applicable safety regulations and directives, and all technical specifications and requirements.

The LDHD2 utilizes hazardous voltages. It must be properly grounded.

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

The machine owner and the machine operator are responsible for ensuring personnel cannot enter the hazard zone while the machine is energized unless adequate functional safety mechanisms are in place.

Only qualified personnel may perform installation, operation, service and maintenance procedures. These persons must have sufficient technical training and knowledge to foresee and recognize potential hazards that may occur when using the product, modifying settings, and operating the mechanical, electrical and electronic components of the entire machine system.

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

2.2.1 Installation Safety

Note Incorrect handling of the LDHD2 may cause personal injury and/or damage to equipment.

When connecting the LDHD2 to other control equipment, be sure to follow two basic guidelines to prevent damage to the drive:

- The LDHD2 must be grounded via the earth ground of the main AC voltage supply.
- Any motion controller, PLC or PC that is connected to the LDHD2 must be grounded to the same earth ground as the LDHD2.

- Before installing or commissioning the LDHD2, review all relevant product documentation.
- Perform the installation in strict compliance with product specifications and installation instructions.
- All system components must be connected to ground. Electrical safety is provided through a low-resistance earth ground connection. (Protective Class 1 according standard EN/IEC 61800-5-1.) The motor should be connected to protective earth by an independent earthing conductor rated not less than the motor wire.
- As part of the machine design, the machine builder must generate a hazard analysis for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause personal injury and/or damage to equipment.
- The drive meets IP20 (per IEC 60529); therefore, the machine builder must select a suitable enclosure. The enclosure must meet at least IP54 (per IEC 60529), and be composed of metal or a material with rating flammability of 5 VA, and not have any openings in the bottom.
- The leakage current to protective earth is greater than 3.5 mA; therefore, compliance with IEC61800-5-1 requires either doubling of the PE connection (by one grounding connection through the mains power cable earthing wire, and another connection through the heat sink connection to the grounded machine base), or the use of a copper connecting cable with a cross-section greater than 10 mm^2. Use the drive mount screws and the PE connection screws to meet this requirement.
- Wiring of a yellow color with or without one or more green stripes must not be used, except for protective bonding.
- Power cables should be rated at least 600V, 75°C.

2.2.2 Operational Safety

Note Machine builder are responsible for machine safety implementation, testing and certification. The machine manual must define operational and maintenance conditions and safety precautions.

- Perform all machine operations in strict compliance with product specifications and installation instructions.
- The machine builder must provide a power mains disconnect device in accordance with local regulations.
- During operation, keep all covers and cabinet doors shut.
- During operation the machine has electrically charged components and hot surfaces. The LDHD2 heat sink can reach temperatures of 90°C. Control and power cables can carry a high voltage, even when the motor is not rotating.
- Machine axes with a suspended load or unbalanced load must have an additional mechanical safety block (such as a motor-holding brake) to prevent the load from falling out of control. Serious injury may result if the load is not properly safeguarded.
- After powering down the drive and before handling the drive, wait at least 5 minutes for bus capacitors to be fully discharged.

2.2.3 Maintenance Safety

Note Incorrect handling of the LDHD2 may cause personal injury and/or damage to equipment.

- Before performing maintenance on the LDHD2 (or the machine it drives), review all relevant product documentation.
- Perform maintenance procedures in strict compliance with the product maintenance requirements and instructions.
- To prevent electric arcing and hazards to personnel and electric contacts, never disconnect or connect the product while the power source is energized.
- After disconnecting the power source from the machine, wait at least 5 minutes before touching or disconnecting parts of the machine that normally carry electrical charges (such as capacitors, contacts, screwed connections).
- Before touching the machine, measure the electrical contact points with a meter. Be certain voltage is below 30 VDC before handling components.

2.3 Material Safety Data

The LDHD2 is marked is in accordance with SJ/T 11364, which applies to electronic and electrical products sold in the People's Republic of China.

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

LDHD2 contains certain hazardous substances, and can be used safely for 20 years, after which it should enter the recycling system.

table2-2 Hazardous Substances

Part Name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr (VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
Metal parts	X	O	O	O	O	O
Plastic parts	O	O	O	O	O	O
Electronic	X	O	O	O	O	O
Contacts	O	O	O	O	O	O
Cables and cabling accessories	O	O	O	O	O	O

O: Indicates that the concentration of hazardous substance contained in all of the homogeneous materials for this product is below the limit stipulated in GB/T 26572.

X: Indicates that the concentration of hazardous substance contained in at least one of the homogeneous materials used for this product is above the limit stipulated in GB/T 26572.

2.4 Standards Compliance

The LDHD2 will be tested and certified according to the following standards.

table2-3 Standards Compliance

Standard	Directive/Description	Certif. Mark
IEC 61800-5-1	**Low Voltage Directive 2014/35/EU** Adjustable speed electrical power drive systems.	CE
IEC 61800-3	Electromagnetic Compatibility (EMC) Directive 2004/108/E Adjustable speed electrical power drive systems.	CE
IEC 61800-3	**Electromagnetic Compatibility (EMC) Directive 2014/30/EU** Adjustable speed electrical power drive systems. Intended for use in second environment.	CE
EN 50581	**European Regulations 2011/65/EU RoHS (Restriction of Hazardous Substances)** Technical documentation required for declaring compliance with the applicable substance restrictions.	CE
SJ/T 11364	**Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products (China RoHS 2.0)** Hazardous substances in electronic and electrical products; environmental protection use period and recyclability.	20

Standard	Directive/Description	Certif. Mark
EU REACH	**Regulation (EC) 1907/2006 Concerning the Registration, Evaluation, Authorization and Restriction of Chemicals.** The production and use of chemical substances, and their potential impacts on both human health and the environment.	

IEC International Electrotechnical Commission
EN European Standard (Euro Norm)
CSA Canadian Standards Association
EU European Parliament and Council of the European Union

3. LDHD2 Drive Specifications

3.1 Dimensions

The various models of LDHD2 drives all have the same exterior dimensions, as shown in the following figure.

Note LDHD2-003 do not have a fan.

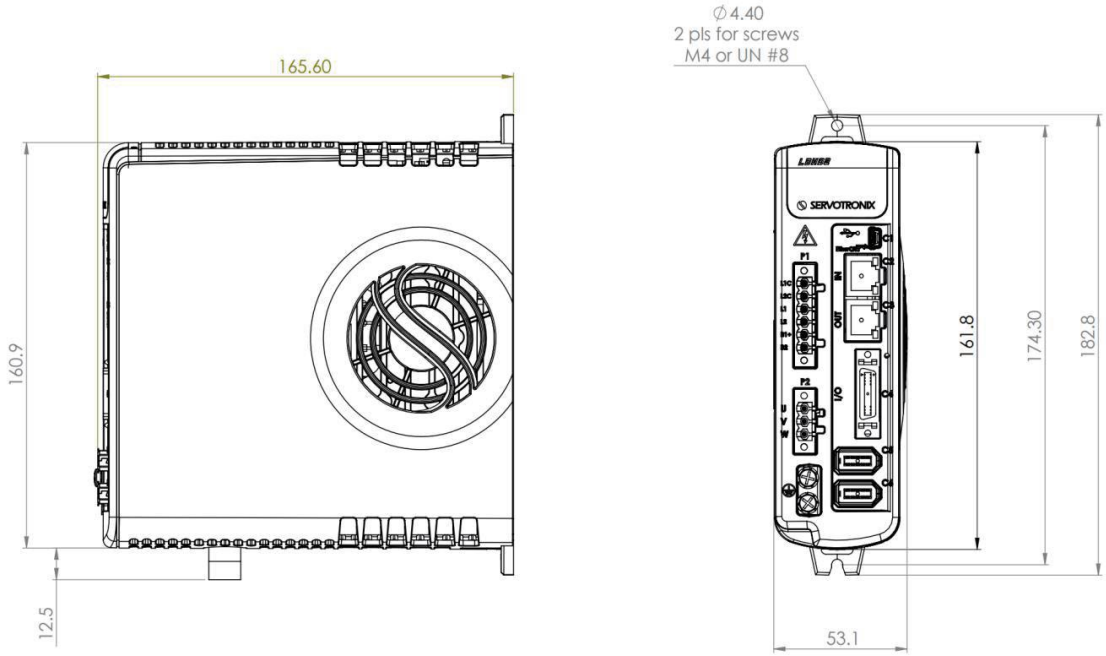


figure3-1 LDHD2-003/006 Dimensions (mm)

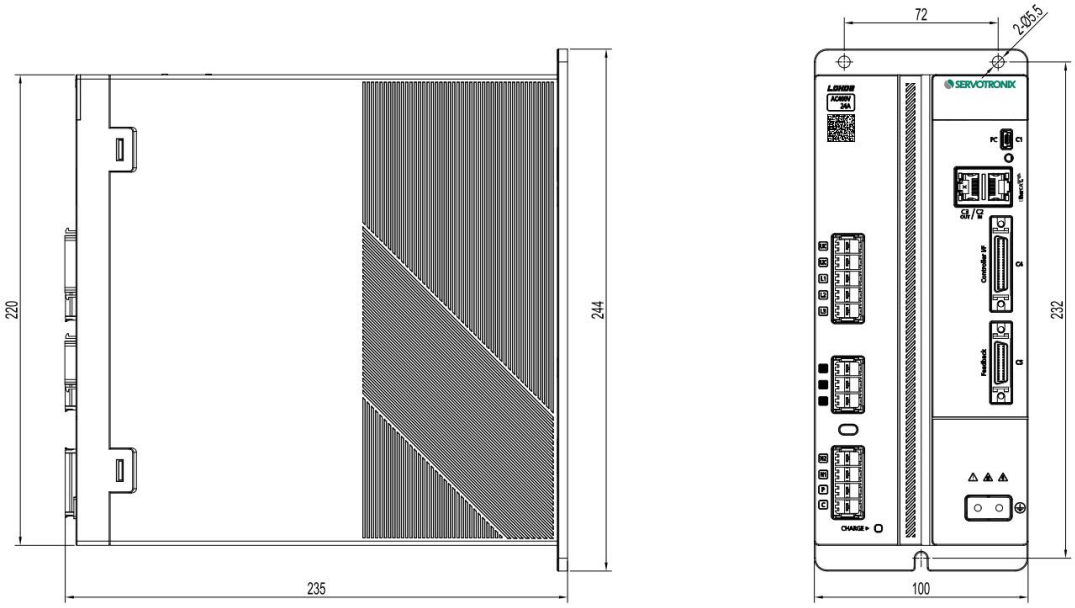


figure3-2 LDHD2-012/018/024 Dimensions (mm)

3.2 Mechanical and Electrical Specifications

table3-1 Mechanical and Electrical Specifications-LDHD2-003/006(120/240 VAC)

Item		LDHD2-003	LDHD2-006
Ratings			
Input Power Circuit: L1, L2	Voltage(VAC Line-Neutral) Nominal ±10%	120/240	120/240
	Line Frequency (Hz)	50/60	50/60
	120/240 VAC	1 Phase	1 Phase
	Continuous Current (Single Phase A rms)	5.2	9
	Line Fuses (FRN-R, LPN, or equivalent) (A)	6	10
	Withstand Voltage (Primary to Earth)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)
Control Circuit Input Power (L1C,L2C)	120 ±10 or 240 ±10 VAC	1 Phase	1 Phase
Logic Input Fuse (Time Delay)	120 or 240 VAC (A)	0.5	0.5
Drive Output	Continuous Output Current (A rms)	3	6
	Continuous Output Current (A peak)	4.24	8.48
	Peak Output Current (A rms) for 2 seconds	9	18
	Peak Output Current (A peak) for 2 seconds	12.72	25.45
	kVA at 120 VAC	0.36	0.72
	kVA at 240 VAC	0.72	1.44
	PWM Frequency (kHz)	16	16
Soft Start	Max. Surge Soft Start Current (A)	7	7
	Max. Charge Time (ms)	350	350
Control Circuit Loss	W	5	5
Hardware			
Unit Weight	kg	0.75	0.97
Connection Hardware	PE Ground Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm
Wire Size	Control Circuit (AWG) up to 3 meters	24–28	24–28
	Main Circuit Motor Lines (AWG)	18	16
	Main Circuit AC Inputs (AWG)	18	16
	PE Ground Screw	M4	M4
Mounting	Book mounting		
Clearance Distance (must be free of intrusions, including cables, which could reduce cooling efficiency)	Side-to-Side (mm)	10	10
	Top/Bottom (mm)	50	50

Voltage Trip			
	Under-Voltage Trip (Nominal) (VDC)	User-defined	User-defined
	Over-Voltage Trip (VDC)	420	420
Power Temperature			
Fan	Normally operates at quarter power; when temperature exceeds high-speed fan trigger temperature, operates at full power	Not applicable	Yes
	Trigger Temperature for High Speed Fan (°C)	Not applicable	45
Power Module	Power Module Over- Temperature Fault Regulated (°C)	80 ±5%	80 ±5%
	Power Module Over- Temperature Fault Non-regulated (°C)	100 ±5%	100 ±5%
External Regenerative Resistor (B1+, B2)			
External regenerative resistor requirement (regen resistor not supplied with drive)	Peak Current (A)	12.7	25.5
	Minimum Resistance (Ω)	31.5	16
	Power Rating (W)	System related	System related
Application Information	Internal Bus Capacitance (μF)	660	1120
	VLOW (Regen Circuit Turn Off) (VDC)	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400

table3-2 Mechanical and Electrical Specifications-LDHD2-012/018/024 (120/240 VAC)

Three phase AC 380/440V	**Specification**	**High-voltage LDHD2-012**	**High-voltage LDHD2-018**	**High-voltage LDHD2-024**
Rating				
Input power circuit: L1,L2,L3	Rated voltage(VAC Line-Line)±10%	380/440	380/440	380/440
	Line frequency(Hz)	50/60	50/60	50/60
	380/440VAC	3 phase	3 phase	3 phase
	Continuous current (3 phase Arms)	9	13	17
	Line fuse(FWP,or equivalent)	25	35	50
	Voltage-	1500VAC	1500VAC	1500VAC

		(2121VDC)	(2121VDC)	(2121VDC)
Control circuit input power(P2)	380/440VAC	Single phase	Single phase	Single phase
STO Fuse(Time Delay)	380/440VAC	0.5	0.5	0.5
STO(safety torque off)	STO power supply(DC voltage)	24±10%	24±10%	24±10%
	24VDC±10%(Arms)	0.1	0.1	0.1
STO quantity	STO	2	2	2
Drive output	Continuous output current[Arms]	12	18	24
	Continuous output current(Apeak)	16.97	25.45	33.94
	Peak output current(Arms)2s	36	54	72
	Peak output current(Apeak)2s	50.9	76.36	101.8
	kVA,380V AC voltage	5.8	7.2	9.8
	kVA,480V AC voltage	8	8	8
Soft start	Maximum soft-start surge current(A)	9	10	12
	Maximum charging time(ms)	1200	1200	1500
Power circuit loss	W			
Logic circuit loss	W	25	25	25
Total-power loss	W			
Hardware				
Unit weight	kg	3.9	4.2	4.3
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)	12-14	12	10-14
	Main circuit AC input(AWG)	12-14	12	10-14
	PE grounding screw	M4	M4	M4
Installations	Installation of Book			
Net distance	Left and right(mm)	10	10	10
	Top/bottom(mm)	50	50	50
Voltage trip				
	Low voltage trip(nominal)(DC voltage)	350	350	350
	Overvoltage trip(DC voltage)	820	820	820

Power supply temperature				
Fan	Usually does not run; 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)	55	55	55
Power module	Overheating fault regulation(°C)power module	75±5%	80±5%	95±5%
	Overheating fault unregulation(°C)power module	115±5%	115±5%	115±5%
External regenerative resistor(B1+,B2)				
Internal regenerative resistor(B1+,B2)	Peak current(A)	22	22	22
	Resistance(Ω)	35	35	35
	Power	100	200	200
External regenerative resistor requirements(regenerative resistor is not provided with the drive)	Peak current(A)	30	45	55
	Minimum resistance(Ω)	25	17	14
	Power rating(W)	System related	System related	System related
Application information	Internal bus capacitance(μF)	910	1200	1500
Application information	VLOW(regenerative circuit off)(DC voltage)	750	750	750
	VMAX(regenerative circuit on)(DC voltage)	770	770	770

3.3 Control Specifications

table3-3 Control Specifications

Item		Specification
Motors	Types	Direct drive linear motor, Direct drive rotary motor
	Automatic Motor Phasing	Automatic configuration of motor phasing, encoder direction, Hall sensor sequence
Operation Modes	Selectable Control Modes	Current (Torque) control, Velocity control, Position control, HD control
Current (Torque) Control	Performance	Update rate 16khz, Output waveform sinusoidal
	Step Response Time	Actual current reaches command in two cycles, 62.5 µs
	Control Loop	DQ, PI, Feedforward
	Reference Command	USB, EtherCAT
	Autotuning	Automatic setting of current control loop parameters
Velocity Control	Performance	Update rate 125 µs (8 kHz)
	Selectable Velocity Control Loops	PI, PDFF, Standard pole placement, Advance pole placement, Standard pole placement high frequency, Pole placement with active dumping
	Filters	First order low pass filter, Double first order low pass filter, Notch, High pass filter, Band pass filter, User defined polynomial filter
	Reference Command	USB, EtherCAT
Position Control	Performance	Update rate 125 µs (8 kHz)
	Control Loop	PID and feedforward
	Reference Command	Pulse and direction with electronic gearing, USB, EtherCAT
HD Control	Performance	Update rate 125 µs (8 kHz)
	Control Loop	Nonlinear control algorithm provides very low tracking error, zero or minimum settling time and smooth movement; includes an adaptive feedforward feature that is applied at end of movement to achieve zero or minimum settling time.
	Filters	One second order low pass, two notch filters, and other filters to handle flexible and resonant systems
	Reference Command	Velocity: USB, EtherCAT Position: Pulse Train, USB, EtherCAT
	Autotuning	Automatic inertia load measurement, automatic setting and optimization of HD control loop parameters.
Brake	Method	Controlled stop, Dynamic braking, Motor electromechanical braking.

Item		Specification
Display	User Interface	1 digit 7-segment LED display
GUI	User Interface	ServoStudio 2 Windows-based application
	Function	Setting connection, Drive information, Power information, Motor, Feedback, I/O selection/configuration, Motion setting/tuning, Fault history/display, Setup wizard, Expert view
Electronic Gearing	Method	User defined input signal ratio
Rotary Units	Position	Revolutions, counts, degrees
	Velocity	rps, rpm, deg/s
	Acceleration/ Deceleration	rps/s, rpm/s, deg/s2
Linear Units	Position	Counts, pitch, mm, µm
	Velocity	mm/s, µm/s
	Acceleration/ Deceleration	mm/s2, µm2/s

3.4 Protective Functions and Environmental Specifications

table3-4 Protective Functions and Environmental Specifications – All LDHD2 Models

Item	Specification
Protective Functions	Including, but not restricted to: Under- and over-voltage, Over-current, Drive and motor over-temperature, Motor foldback, Drive foldback, Feedback loss, Not configured, Circuit failure.
Compliance *PENDING*	IEC 61800-5-1: Low Voltage Directive 2006/95/EC. Adjustable speed electrical power drive systems.
	IEC 61800-3: EMC Directive 2004/108/E. Adjustable speed electrical power drive systems.
	EN 50581: Support Essential Requirements of EU RoHS Directive 2011/65/EU. Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
	REACH: EC Regulation 1907/2006. Regulation on chemicals and their safe use.
Environment	Ambient temperature: Operation 0–55°C, Storage 0–70°C 0°C ≤ Ta ≤ 45°C corresponds to 100% load, while 45°C <Ta ≤ 55°C corresponds to 70% load (load derating>45°C: 3%/K).
	Humidity: 10–90%
	Altitude: If in accordance with specified clearances, per IEC 61800-5-1, the LDHD2 is rated for use at altitudes up to 2000m
	Vibration: 1.0g
Operating Conditions	Protection class: IP20, pollution degree: 2 as per IEC 60664-1 Do not use in the following locations: corrosive or flammable gasses, water oil or chemical, dust including iron dust and salts

3.5 Communication Specifications

table3-5 Communication Specifications

Item	Specification
EtherCAT	CiA 301 application layer and CiA 402 device profile for drives and motion control
	Communication cycle time: 0.125ms to 16ms (For values exceeding 16ms, please contact the manufacturer for parameter customization)
USB	ASCII-based, ServoStudio 2, HyperTerminal
	Baud rate: 115200 bit/s
	Maximum cable length: 3 m

3.6 I/O Specifications

table3-6 I/O Specifications

Item		Specification
Digital Inputs (x 4)	Signal	Configurable. Opto-isolated. Sinking or sourcing supply.
	Voltage	24V (IEC 61131)
	EMI Protection	yes
	Max. Input Current	6 mA
	Propagation Delay Time	1 ms
	Frequency	1 kHz
Fast Digital Inputs (x 2)	Signal	Configurable. Opto-isolated. Sinking or sourcing supply.
	Voltage	24V (IEC 61131)
	EMI Protection	yes
	Max. Input Current	12.5 mA
	Propagation Delay Time	1 μs
	Frequency	1 MHz
Digital Outputs (x 4)	Signal	Configurable. Opto-isolated. Open collector. Sinking or sourcing supply.
	Voltage	24V (IEC 61131)
	EMI Protection	yes
	Max. Output Current	100 mA
	Over-Current Protection	yes
	Propagation Delay Time	1 ms
Fast Digital Outputs (x 1)(Only high-voltage models)	Signal	Configurable. Opto-isolated.Open collector.Sinking or sourcing supply.
	Voltage	24V (IEC 61131)
	Max. Output Current	100 mA
	Propagation Delay Time	1 ms

Pulse Train	Signal	RS422 line receiver
	Max. Input Frequency	5 MHz
Equivalent Encoder Output	Signal	AB quadrature and index differential, RS422 line transmitter
	Max. Output Frequency	5 MHz

3.7 Motor Feedback Specifications

table3-7 Motor Feedback Specifications

Item		Specification
Power Supply	Supply Voltage from Drive	5 VDC
	Max. Supply Current from Drive to Primary Encoder	320 mA @5V
Cable	Max. Length	Per device specifications
Incremental Encoder	Differential RS422 or RS485	AB quadrature, with or without index
	AB Quad Max. Input Frequency	4 MHz (before quadrature)
	Min. Index Pulse Width	1 µs
Hall Sensor	Signal	Open collector single-ended
Serial Synchronous (SSI) Encoder	Signal	Differential data and clock for synchronous encoders Data only for asynchronous encoders
	Protocols	Endat 2.2, BISS-C
Tamagawa Encode	Signal	RS485

3.8 STO/Functional Safety Specification(high-voltage model)

table3-8 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	16-28AWG
Current loss	24VDC±10%	DC voltage: 15-30V, current loss: 10-20mA

4. Drive Setup

4.1 System Wiring Overview

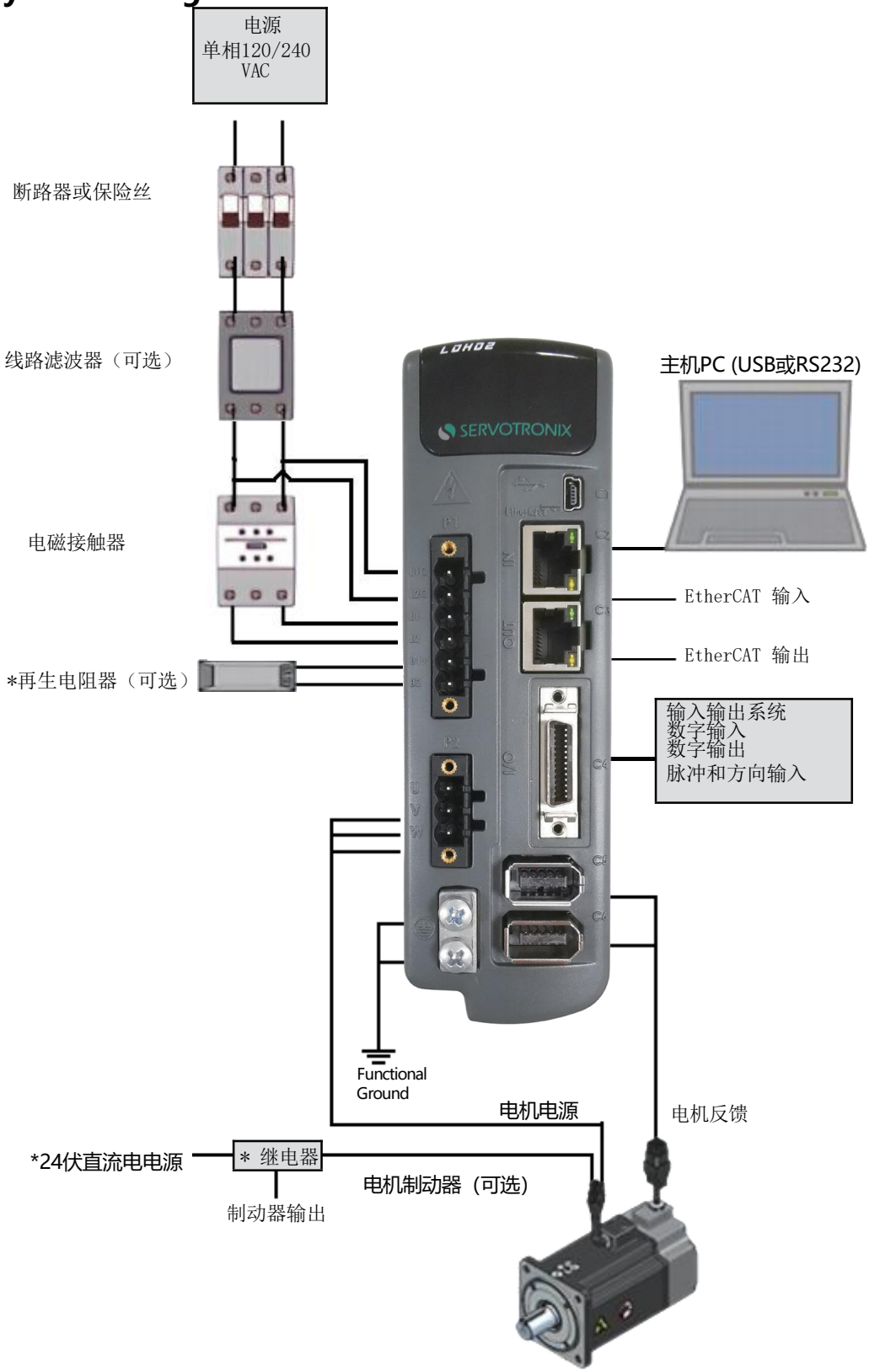


figure4-1 LDHD2-003/006 120-240VAC (medium-voltage) EC model system wiring

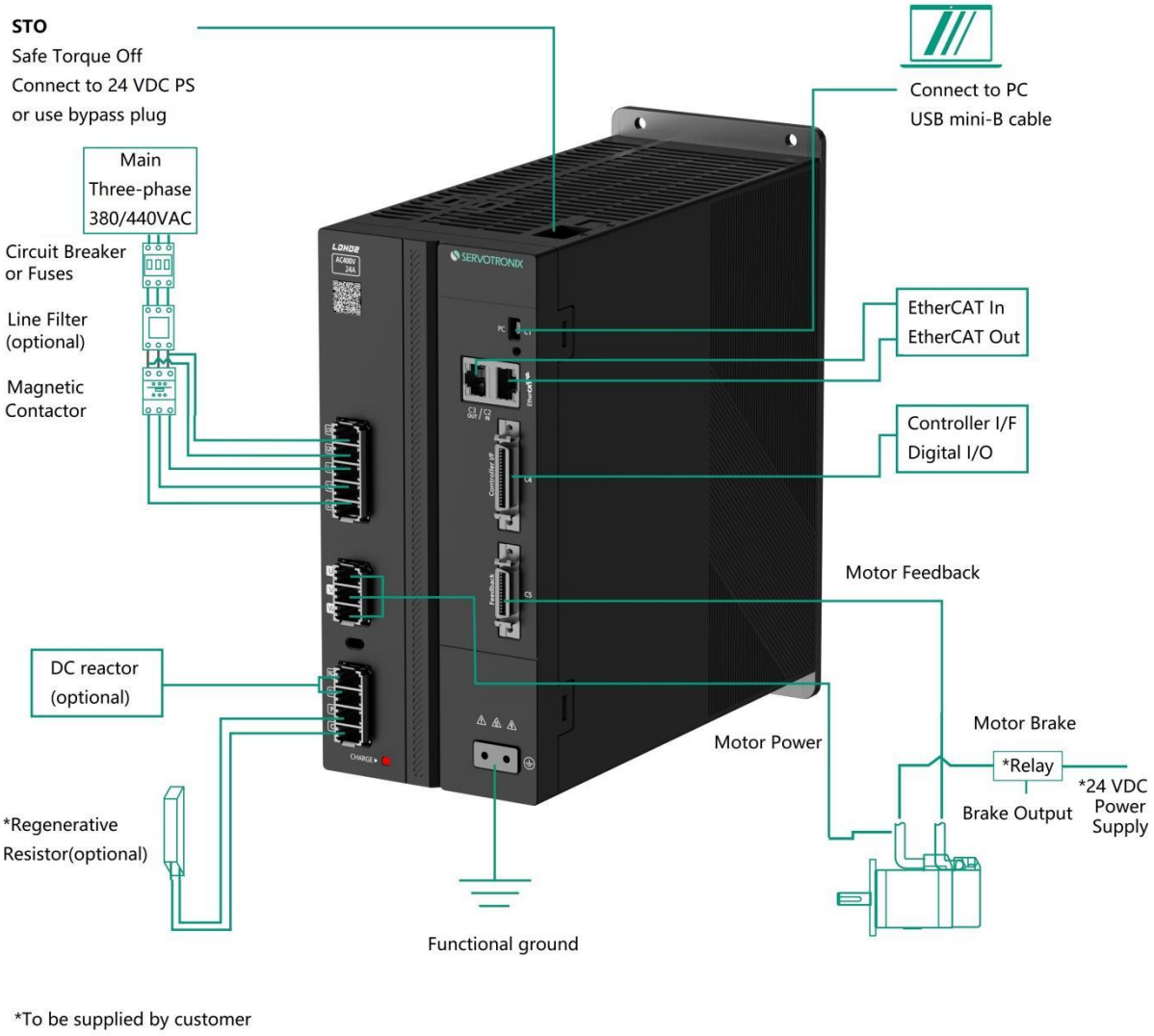


figure4-2 LDHD2-012/018/024 380-440VAC (high-voltage) EC model system wiring

4.2 Setup Procedure Overview

Perform the following steps to install and setup a LDHD2 system.

1. Mount the LDHD2.
2. Make all wiring and cable connections, as required by your application:
   - Grounding
   - Fieldbus devices
   - I/Os
   - Motor feedback
   - Motor
   - Regeneration resistor, if required
   - Motor brake, if required
   - AC input voltage
3. Connect the drive to the host computer.
4. Power up the drive and the host computer. Refer to*Power Up*.
5. Install ServoStudio 2 software. Refer to the ServoStudio 2 Reference Manual.

4.3 Power Up

After completing all hardware connections, you can turn on power to the drive.

Note If logic and bus AC supplies are separate, it is recommended that logic AC be turned on before bus AC.

Look at the digital display on the LDHD2 front panel.

Upon initial power up, the digital display indicates a Parameter Memory Checksum Failure (flashing **e**). This fault will be cleared once the drive is configured and the parameters are saved in the drive's non-volatile memory.

4.4 Drive Addressing

Within an EtherCAT network, a physical node address (identification number) does not have to be specifically allocated to a device; the EtherCAT controller will assign the address.

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

4.5 Connectors and Cables

4.5.1 Connector and cable wire diameter for LDHD2-003/006(medium-voltage)

table4-1 Connector for LDHD2 (medium-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
P1	AC power input	RoHS 2EDGKCMD-6P6-BKSn-5.08	11201707000875
P2	Motor phase line interface	RoHS 2EDGKCMD-3P3-BKSn-5.08	11201707000876

table4-2 Wire diameter of LDHD2(medium-voltage)

Interface	LDHD2-003 Wire diameter	LDHD2-006 Wire diameter
P1	Logic power cable 24-28 AWG Bus power cable 18 AWG	Logic power cable 24-28AWG Bus power cable 16AWG
P2	Motor cable 18AWG	Motor cable 16AWG

4.5.2 Connector and cable wire diameter for LDHD2-012/018/024(high-voltage)

table4-3 Connector for LDHD2 (high-voltage)

Interface	Function	Manufacturer part number	Servotronix part number
STO	STO	15EDGKNHGB-8P8-BKSn-3.5	STO kit 12115000001401 Connector 11201707001695
P1	Power input interface	5EDGKDGB-5P5-BKSnBD-7.62	11201707002695
P2	Motor input interface	5EDGKDGB-3P3-BKSnBD-7.62	11201707002715
P3	Reactor and Regenerative Resistance	5EDGKDGB-4P4-BKSnBD-7.62	11201707002696

table4-4 Wire diameter of LDHD2(high-voltage)

Interface	LDHD2-012 Wire diameter	LDHD2-018 Wire diameter	LDHD2-24 Wire diameter
STO	16-28AWG	16-28AWG	16-28AWG
P1	Logic power cable 24-28 AWG Bus power cable 12-14 AWG	Logic power cable 24-28 AWG Bus power cable 12AWG	Logic power cable 24-28 AWG Bus power cable 10-14 AWG
P2	12-14AWG	12AWG	10-14AWG
P3	12-14AWG	12AWG	10-14AWG

4.6 Host Computer System

The following computer system and software are required:

- 2 GHz CPU
- 1 GB RAM
- 1000 MB available on hard drive (after .net 4 is installed)
- USB interface for communication with the drive
- Operating system: Windows 7, Windows 8, Windows 10. 32-bit or 64-bit.
- For ServoStudio 2, the recommended screen resolution is 1280x800; minimal resolution is 1024x800.
  It is recommended that Windows display settings be set to **Smaller – 100% (Default)**.
- .Net4 (for details, refer to.NET Framework System Requirements). If .NET 4 is not installed on the computer, ServoStudio 2 will guide you through the installation, but will not install it automatically.
- ServoStudio 2, the graphical software interface for configuring and testing the drive.
  Download from the Servotronix website or contact Technical Support.
  Refer to *Software Installation* in the ServoStudio 2 Reference Manual.

Note ServoStudio 2, provides compatibility with LDHD2 firmware version 2.0 and later.

Installing ServoStudio 2

1. Download ServoStudio 2 software installation file from the Servotronix website or contact Technical Support.
2. Install ServoStudio 2 software on the host computer.
3. When installation is complete, start ServoStudio 2 from the Windows Start menu or the shortcut on your desktop.

Note

If the error message "**the system cannot find the file specified**" is displayed when installing the software, do the following:

- Copy the installation file to the computer hard drive.
- Right-click the installation file, and select Run as Administrator.

Installing USB Device Drivers for LDHD2

The ServoStudio 2 installation attempts to install the USB drivers for LDHD2 automatically, using the driver files in C:\Program Files (x86)\ Servotronix\ServoStudio 2\Drivers\.
Alternately, if the PC is connected to the Internet, and the PC and the LDHD2 are connected by USB cable, Windows will attempt to automatically download and install the USB drivers if does not detect them on the PC.

If neither automatic installation succeeds, install the drivers from the Windows Device Manger, according to the following steps.

1. Open the Windows Device Manager.
2. Under **Ports** or **Universal Serial Bus controllers**, find the device/icon marked as **Unknown**.
3. Right-click on the unknown device and select **Update Driver**.

4. Select **Browse my computer**, and browse to the location:
   C:\Program Files (x86)\ Servotronix\ServoStudio 2\Drivers\
5. Make sure the option **Include subfolders** is selected, and press **Next**.
6. When prompted by Windows, press **Install**.
7. Repeat steps 3 to 6.

Notes

The USB drivers have two layers; therefore it is recommended to repeat the **Update Driver** procedure twice.

LDHD2 USB drivers are digitally signed.

LDHD2 USB drivers are supported in Windows 7 and 10, 32-bit and 64-bit.

4.7 File for Fieldbus Devices

The XML EtherCAT device description file for the LDHD2 must be installed on the host computer or PLC controller. Download the file from the Servotronix website or contact Technical Support.

4.8 EMI Suppression

4.8.1 CE Filtering Techniques

The LDHD2 drive complies with the CE standards specified in

Standards Compliance. Proper bonding, grounding and filtering techniques must be applied in order to meet this standard.

Noise currents often occur in two types. The first is conducted emissions that are passed through ground loops. The quality of the system grounding scheme inversely determines the noise amplitudes in the lines. These conducted emissions are of a common-mode nature from line to neutral (or ground). The second is radiated high-frequency emissions usually capacitively coupled from line-to-line and are differential in nature.

To properly mount the EMI filters, the enclosure should have an unpainted metallic surface. This allows for more surface area to be in contact with the filter housing and provides a lower impedance path between this housing and the back plane. The back panel, in turn, has a high frequency ground strap connection to the enclosure frame or earth ground.

4.8.2 Grounding

When connecting the LDHD2 to other control equipment, be sure to follow two basic guidelines to prevent damage to the drive:

- The LDHD2 must be grounded via the earth ground of the main AC voltage supply.
- Any motion controller, PLC or PC that is connected to the LDHD2 must be grounded to the same earth ground as the LDHD2.

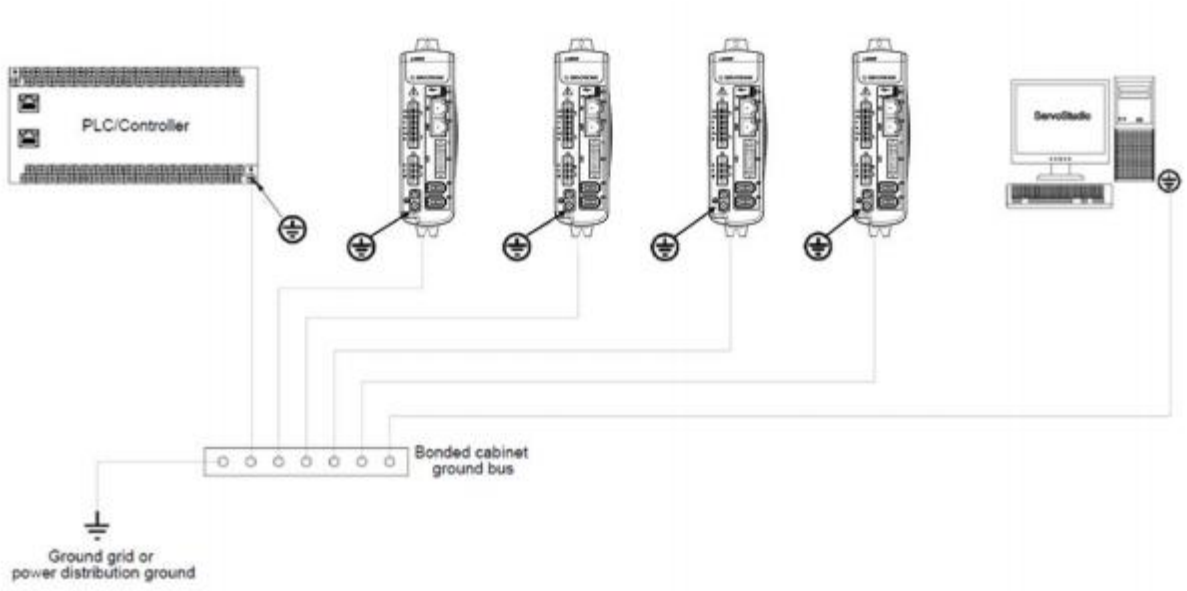


figure4-3 LDHD2 System Grounding

System grounding is essential for proper performance of the drive system.

The AC input voltage ground wire must be connected to the PE terminal, located on the LDHD2 front panel. This is necessary for both safety and EMI reduction.

Use a single point ground for the system (start wiring) to avoid ground loops.

It is strongly recommended that the LDHD2 be mounted to a metallic back panel, and that a high frequency ground be provided to connect the back panel to earth ground. Provide an electrical connection across the entire back surface of the drive panel. Electrically-conductive panels such as aluminum or galvanized steel are recommended. For painted and other coated metal panels, remove all coating behind the drive. The objective is to provide an extremely low impedance path between the filters, drives, power supplies, and earth ground for high-frequency signals that might cause EMI. Use a flat braid or copper busbar to achieve high-frequency grounding. Use the shortest braid possible when connecting high frequency grounds.

Ensure good connections between the cabinet components. Connect the back panel and cabinet door to the cabinet body using several conductive braids. Never rely on hinges or mounting bolts for ground connections. Ensure good ground connection from cabinet to proper earth ground. Ground leads should be the same gauge as the leads to main power or one gauge smaller.

The host computer must also be properly grounded.

4.8.3 Shielding and Bonding

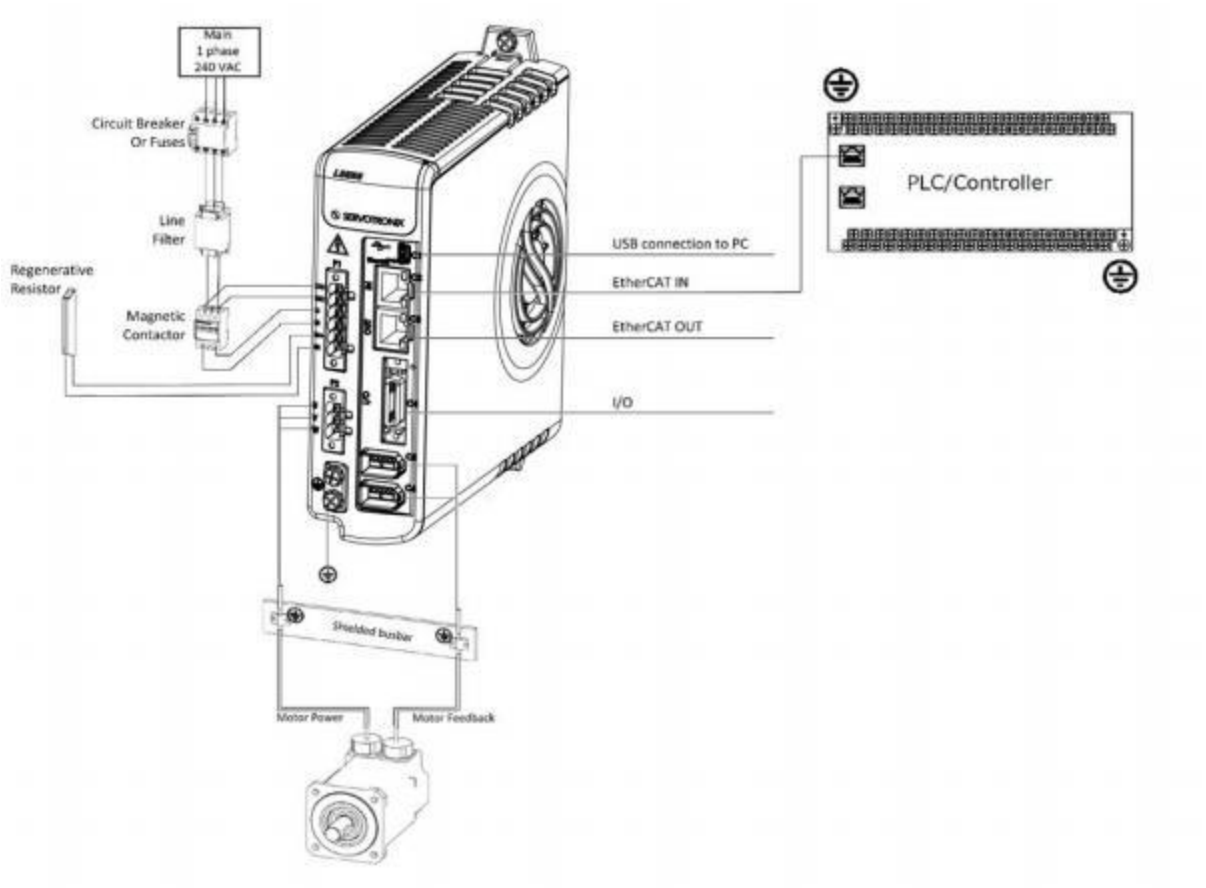


figure4-4 LDHD2 Shielding and Bonding

To minimize noise emissions and maximize the immunity levels of the drive system, motor and feedback cables must be shielded and properly bonded to a grounded surface.

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

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

The motor and feedback shielded cables should be exposed as close as possible to the drive. This exposed cable shield is bonded to the back panel using either non-insulated metallic cable clamps or cable bonding clamps.

It is recommended to use a star point shield connection with a shielding busbar.

4.8.4 Input Power Filtering

The LDHD2 electronic system components require EMI AC line filtering in the input power leads to meet the CE requirements for the industrial environment.

Care must be taken to adequately size the system. The type of filter is determined according to the voltage and current rating of the system and whether the incoming line is single phase or three phase. One input line filter can be used for multi-axis control applications.

For manufacturer names and part numbers of line filters recommended for the LDHD2, refer to*Line Filters*.

Implementation of the input power filter must adhere to the following guidelines:

- Maintain separation of leads entering and exiting the mains filter.
- Filter must be mounted on the same panel as the drive.
- Filter must be mounted as close as possible to the drive, to prevent noise from being capacitively coupled into other signal leads and cables.
- When mounting the filter to the panel, remove any paint or material covering. Use an unpainted metallic back panel, if possible.
- Filters are provided with a ground terminal, which must be connected to ground.
- Filters can produce high leakage currents. Filters must be grounded before connecting the supply.
- Filters should not be touched for 10 seconds after removing the supply.

4.8.5 Additional EMI Suppression Recommendations

Power and control cables should be routed separately. A distance of at least 200 mm is recommended, and improves the interference immunity.

If input power and motor leads need to cross, make sure they cross at a 90°angle.

Feedback lines may not be extended, since this would cause the shielding to be interrupted, and possibly disturb the signal processing.

Splice cables properly. If you need to divide cables, use connectors with metal backshells.

Make sure that both shells connect along the circumference of the shields. No portion of the cabling should be unshielded. Never divide a cable across a terminal strip.

4.9 Electrical System Considerations

4.9.1 Fuses

Circuit protection must be in compliance with the National Electrical Code and/or the regulations defined by national, state, provincial and/or local authorities.

- US fuses: Class RK5 or CC or J or T, 600 VAC 200 kA, time-delay. The fuse must be UL and CSA listed; UR-recognized is not sufficient.
- EU fuses: Types gRL or gL, 400 V/500 V, time-delay.
- Fuse holders: Standard fuse blocks, or finger-safe fuse holders according to IEC 60529. For example:
  - Bussmann: CH Series modular fuse holders, fuse size up to 30A, class J, 3 poles: CH30J3
  - Ferraz: Ultrasafe fuse holders, fuse size up to 30A, class J, 3 poles: US3J3I

4.9.2 Leakage Current Considerations

Leakage current via the PE conductor results from the combination of equipment and cable leakage currents. The leakage current frequency pattern comprises a number of frequencies, whereby the residual-current circuit breakers definitively evaluate the 50 Hz current. For this reason, the leakage current cannot be measured using a conventional multimeter.

As a rule of thumb, the following assumption can be made for leakage current on cables, depending on the PWM frequency of the output stage:

- *Ileak* = *n* x 20 mA + *L* x 1 mA/m at 8 kHz PWM frequency at the output stage
- *Ileak* = *n* x 20 mA + *L* x 2 mA/m at a 16 kHz PWM frequency at the output stage
  (where *Ileak* = leakage current, *n* = number of drives, *L* = length of motor cable)

Since the leakage current to PE is greater than 3.5 mA, compliance with IEC61800-5-1 requires that either the PE connection be doubled or a connecting cable with a cross-section greater than 10 mm^2 be used. Use the PE terminal and the PE connection screws to meet this requirement.

4.10 Mechanical Installation

4.10.1 Mounting the LDHD2

Using the bracket on the back of the LDHD2, mount the LDHD2 on a grounded conductive metal panel. The panel must be sufficiently rigid.

For mounting dimensions, refer to *Dimensions*.

4.10.2 Mounting Multiple Units

When multiple LDHD2 units are mounted side-by-side within a cabinet or enclosure, the recommended minimum spacing between units is 10 mm. The recommended minimum top and bottom clearance is 50 mm for all LDHD2 models.

It is important to maintain an ambient temperature within the enclosure that does not exceed 45°C. If LDHD2 units are mounted on a backplane, also make sure the backplane temperature does not exceed 45°C. It is recommended that a cooling fan be installed at the bottom of the cabinet for best circulation.

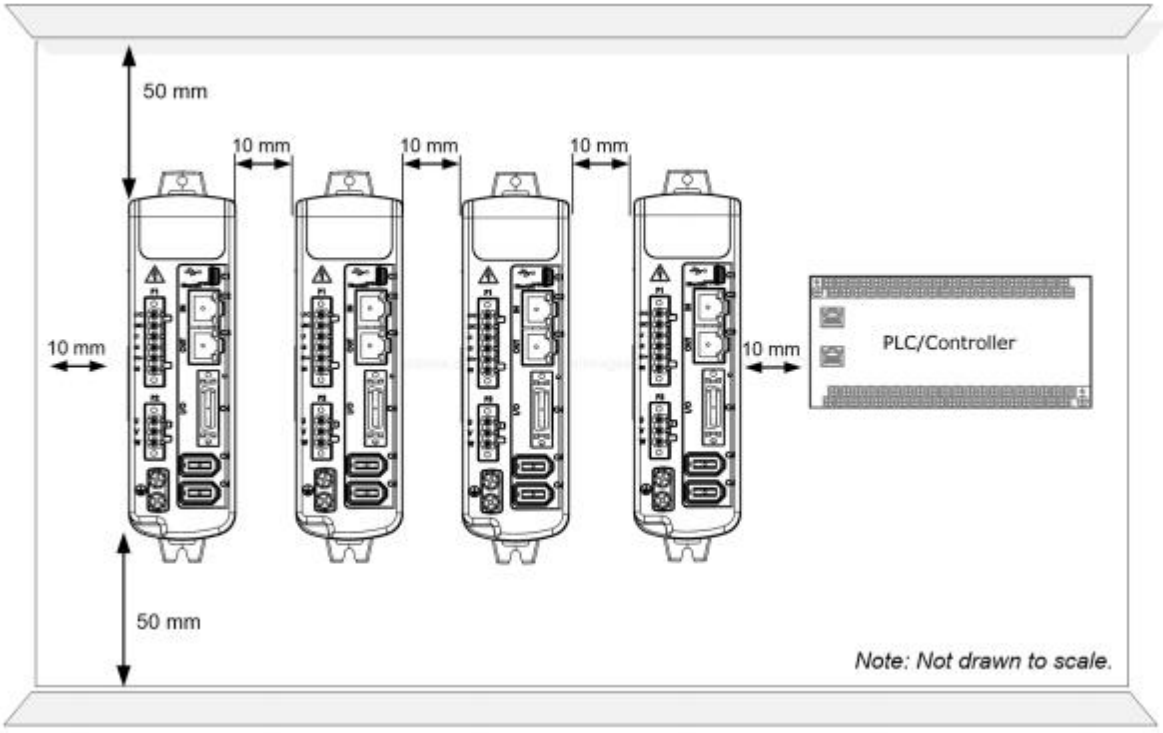


figure4-5 Mounting Multiple LDHD2 Units within Cabinet

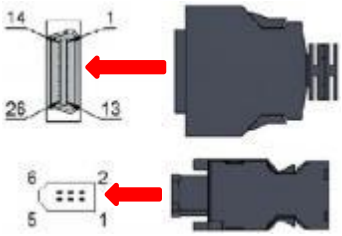
4.11 Control Board Connections

4.11.1 LDHD2-003/006（medium-voltage） Control Board Pin outs

I/F	Mfr	Mating Connector	Manufacturer PN
C2 |C3	Molex	R34S Connector	44915-0011
C4	3M	Solder Plug Connector	10126-3000PE
	3M	Solder Plug Junction Shell	10326-52F0-008
C5 |C6	3M	Solder Plug Connector	36210-0100XX
	3M	Shell kit	36310-3200-008

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

C2:EtherCAT IN C3:EtherCAT OUT RJ45	
1	TX+
2	TX-
3	RX+
4	
5	
6	RX-
7	
8	



C4: IOs 3M Solder Plug			
1	Common Input	14	Digital Input 1
2	Digital Input 2	15	Digital Input 3
3	Digital Input 4	16	
4	Common Output	17	Digital Output 1
5	Digital Output 2	18	Digital Output 3
6	Digital Output 4	19	
7	Equivalent encoder output A+	20	Equivalent encoder output A-
8	Equivalent encoder output B+	21	Equivalent encoder output B-
9	Equivalent encoder output Z+	22	Equivalent encoder output Z-
10	Direction Input +	23	Direction Input -
11	Pulse Input +	24	Pulse Input -
12	Fast digital input 5	25	Fast digital input 6
13		26	

C5:Feedback	
1	Power supply to feedback device
2	Ground
3	Incremental encoder A+ / SSI encoder clock+
4	Incremental encoder A- / SSI encoder clock-
5	Incremental encoder B+ / SSI encoder data +
6	Incremental encoder B- / SSI encoder data -
7	Incremental encoder Z+
8	Incremental encoder Z-
9	
10	

C6:Feedback	
1	Power supply to feedback device
2	Ground
3	Hall U+
4	Hall V+
5	Hall W+
6	
7	
8	
9	
10	

figure4-6 LDHD2-003/006(medium-voltage) Control Board Pin Assignments

4.11.2 LDHD2-012/018/024(high-voltage) Control Board Pin outs

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

C2:EtherCAT IN C3:EtherCAT OUT RJ45	
1	TX+
2	TX-
3	RX+
4	
5	
6	RX-
7	
8	

C5:Feedback			
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	
6		19	
7		20	
8		21	Ground (5V return)
9		22	
10		23	
11	5V supply	24	Ground (5V return)
12	Motor temperature sensor	25	Motor temperature sensor(Ground)
13	5V supply	26	Shield

C4:Controller I/F			
1	Common output	19	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	
8	Digital input 7	26	Digital input 8
9	Direction input+	27	Direction input-
10	Ground	28	Pulse input-
11	Pulse input-	29	Ground
12	Fast digital output 8 (Reserved, not connected)	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 loop
17	Fast digital output 24V	35	Digital output 4
18	Digital output 5	36	Digital output 6

figure4-7 LDHD2-012/018/024(high-voltage) Control Board Pin Assignments

4.11.3 USB Serial Communication – C1

For commissioning, the drive is connected to the host computer through interface C1 (USB port). It is strongly recommended that you use the USB cable supplied by Servotronix, which has been tested and proven for reliability.

Refer to*Host Computer System*.

Note LDHD2 USB drivers are digitally signed

4.11.4 EtherCAT Communication – C2 and C3

Interfaces C2 and C3 are RJ45 ports that serve as transmitter and receiver for drives operating on an EtherCAT network.

The LEDs on interfaces C2 and C3 indicate fieldbus status. Refer to*Fieldbus Status LEDs*.

Refer to the LDHD2 EtherCAT Reference Manual for details on installation, configuration and operation of drives being used on EtherCAT networks.

4.11.5 I/O Interface – C4

Wire the inputs and outputs according to the requirements of your application.

Unused pins must remain unwired.

Common input and common output on the I/O interface (C4) are connected internally.

All digital inputs and digital outputs on all LDHD2 models are opto-isolated.

table4-5 LDHD2-003/006(medium-voltage) I/O Interface

Pin	Function	Description	Pin	Function	Description
1	Common Input	24V~5V or 0V (Depends if sink or source)	14	Digital Input 1	Opto-isolated programmable digital input. Sink/Source.
2	Digital Input 2	Opto-isolated programmable digital input. Sink/Source.	15	Digital Input 3	Opto-isolated programmable digital input. Sink/Source.
3	Digital Input 4	Opto-isolated programmable digital input. Sink/Source.	16		
4	Common Output	24V or 0V (Depends if sink or source)	17	Digital Output 1	Opto-isolated programmable digital output. Sink/Source.
5	Digital Output 2	Opto-isolated programmable digital output. Sink/Source.	18	Digital Output 3	Opto-isolated programmable digital output. Sink/Source.
6	Digital Output 4	Opto-isolated programmable digital output. Sink/Source.	19		
7	Equivalent encoder output A+	High side of the equivalent encoder output signal A (RS422)	20	Equivalent encoder output A-	Low side of the equivalent encoder output signal A (RS422)
8	Equivalent encoder output B+	High side of the equivalent encoder output signal B (RS422)	21	Equivalent encoder output B-	Low side of the equivalent encoder output signal B (RS422)
9	Equivalent encoder output Z+	High side of the equivalent encoder output signal Z (RS422)	22	Equivalent encoder output Z-	Low side of the equivalent encoder output signal Z (RS422)
10	Direction Input +	High side of the direction signal	23	Direction Input -	Low side of the direction signal
11	Pulse Input +	High side of the pulse signal	24	Pulse Input -	Low side of the pulse signal
12	Fast digital input 5	Fast opto-isolated programmable digital input.	25	Fast digital input 6	Fast opto-isolated programmable digital input.
13			26		

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

table4-6 LDHD2-012/018/024(high-voltage) I/O Interface

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		NC	25	Grounded	Digital ground
8	Digital input7	Reserved, NC	26	Digital input8	Reserved, not connected
9	Direction input +	Direction signal high (RS422), or down counting signal high	27	Direction input -	Direction signal low (RS422), or down counting signal low
10	Grounded	Digital ground	28	Pulse input +	Pulse signal high(RS422), or main encoder signal A high, or up counting signal high
11	Pulse input -	Pulse signal low(RS422), or main encoder signal A low, or up counting signal low	29	Grounded	Digital ground
12	Fast digital output 8	Reserved, not connected	30	Fast digital output 7	Optoisolated programmable digital output. Read using OUT7
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	Digital output 4	Optoisolated programmable digital output. Read using OUT4
18	Digital output 5	Reserved, not connected	36	Digital output 6	Reserved, not connected

Digital Inputs and Outputs Wiring – C4

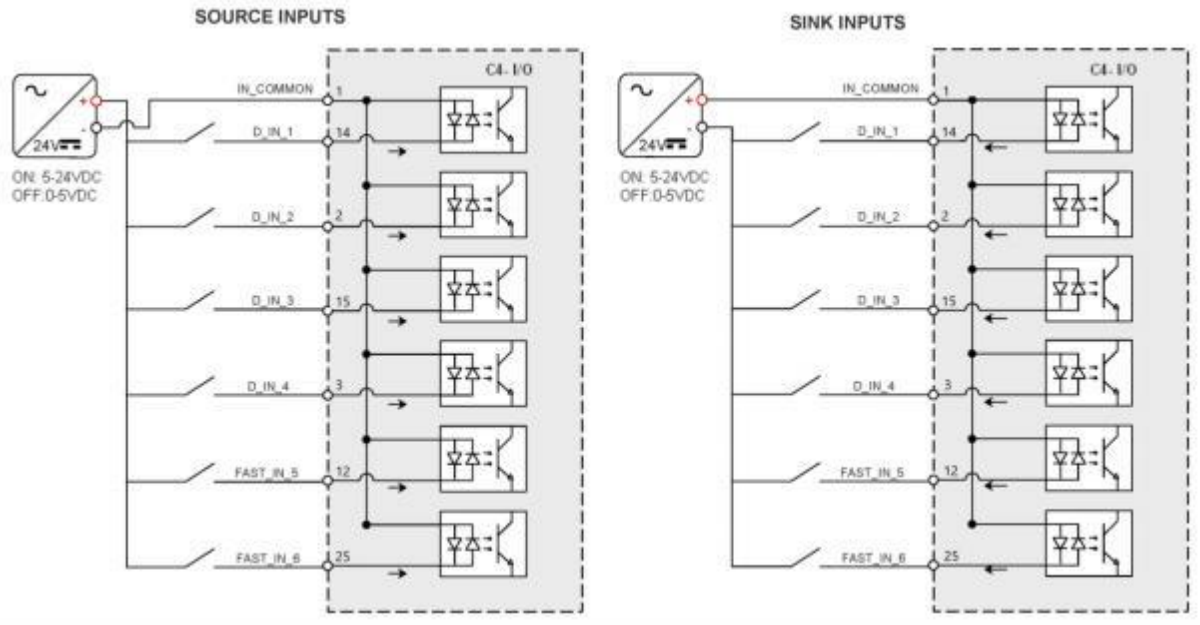


figure4-8 Figure 4-6. Digital Input Wiring – C4

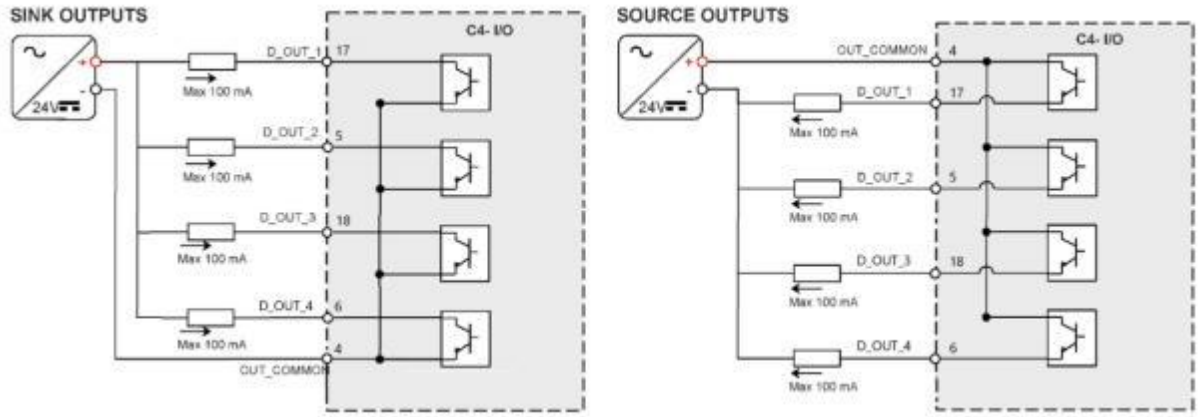


figure4-9 Figure 4-7. Digital Output Wiring – C4

Pulse and Direction Opto-Isolated Wiring – C4

The LDHD2 enables the connection of PLCs with a 24 VDC single-end signal to the drive.

This type of signaling requires the use of the fast digital inputs on the LDHD2 I/O interface (C4).

For this configuration, LDHD2 inputs 5 and 6 must be set to INMODE 17 and 18, respectively. (Applicable/recognized in GEARMODE 0, 1, 2).

- The Pulse signal is connected to fast digital input 5 on pin 12.
- The Direction signal is connected to fast digital input 6 on pin 25.
- The cable shield on the PLC side can be connected to any available shield connector.
- The cable shield on the LDHD2 side can be connected to the shell of the 26-pin connector.

Note The 24 VDC power supply must be provided by the user.

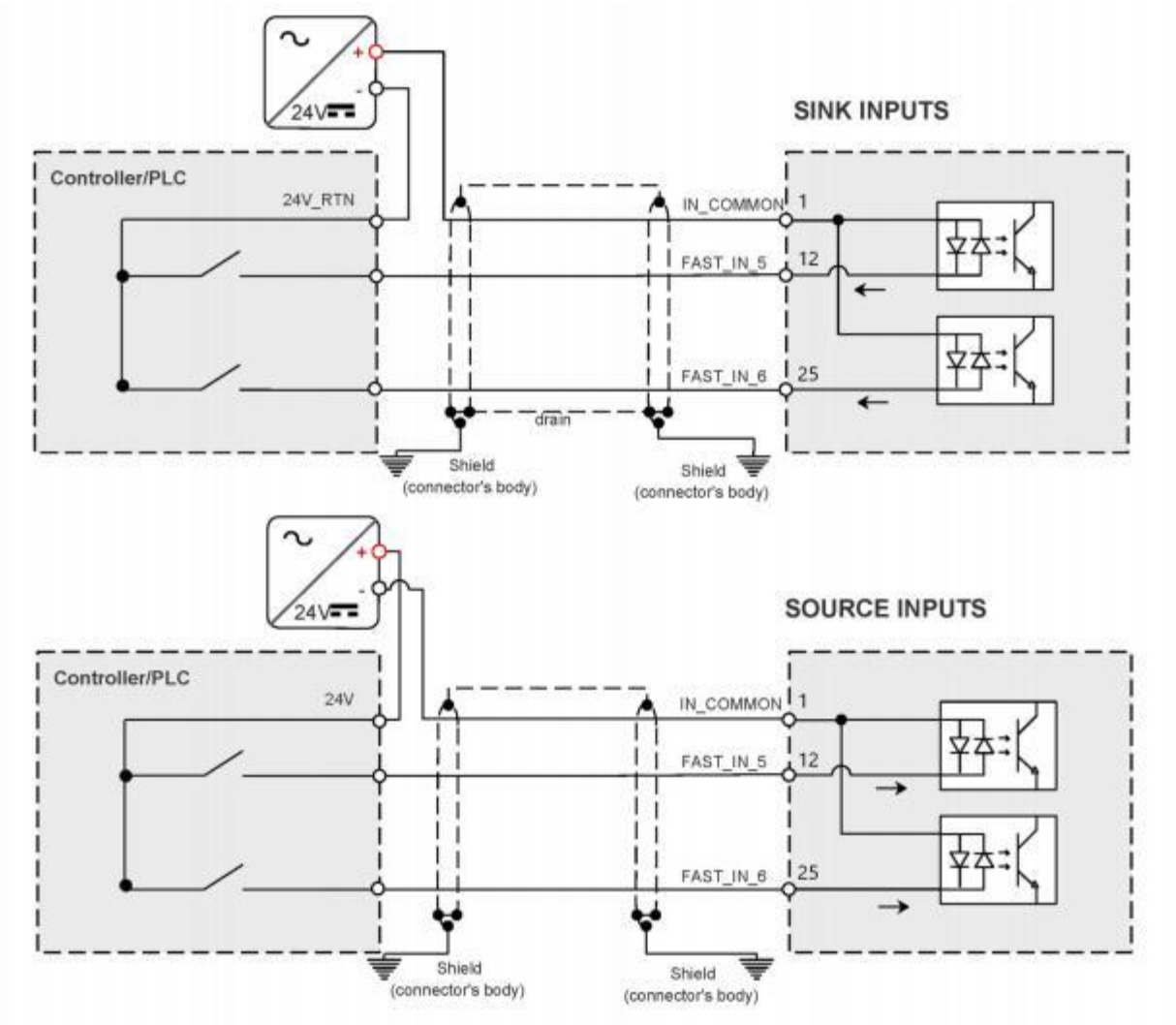


figure4-10 Figure 4-8. Pulse and Direction Opto-Isolated Inputs Wiring – C4

Pulse and Direction Differential Inputs Wiring – C4

- The Pulse signals are received from the controller or PLC on pins 11 and 24.
- The Directions signals are received from the controller or PLC on pins 10 and 23.

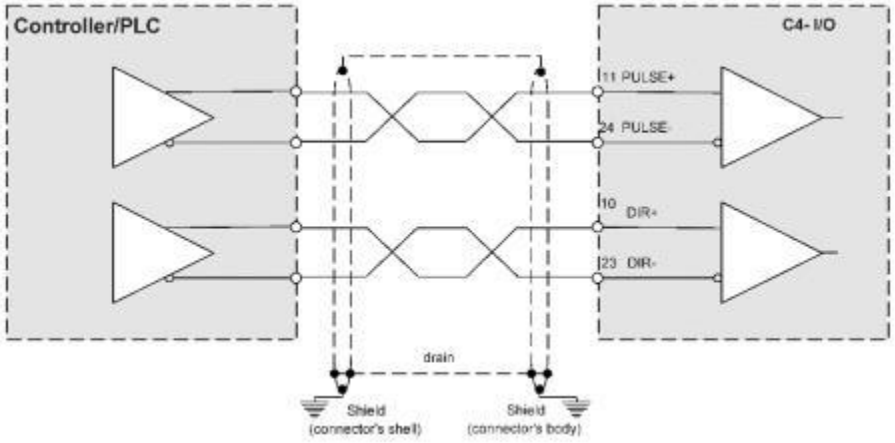


figure4-11 Pulse and Direction Differential Inputs Wiring

Simulated Encoder Equivalent Outputs Wiring – C4

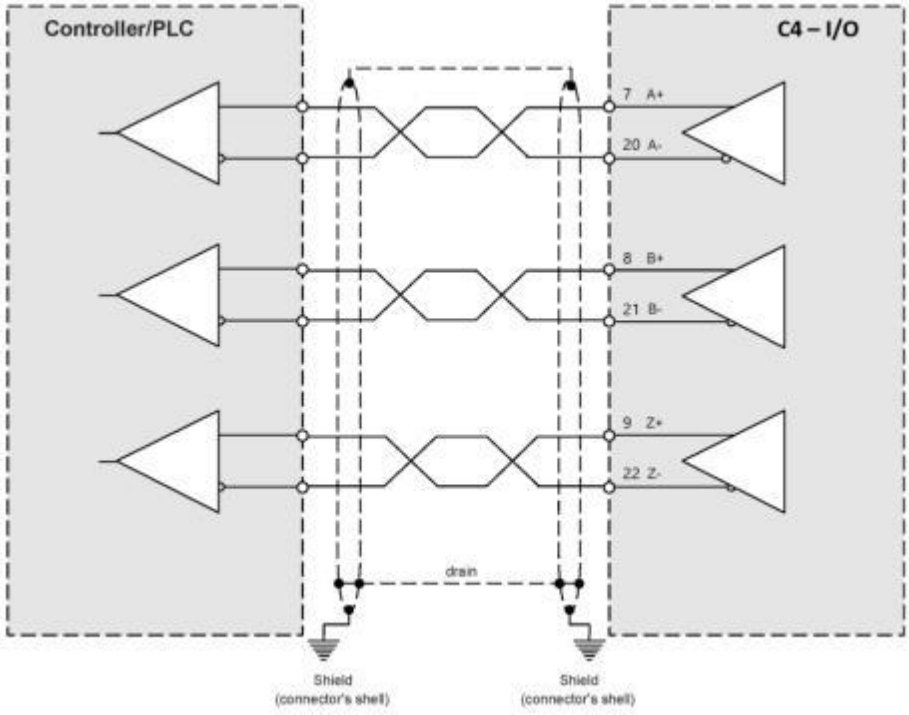


figure4-12 Simulated Encoder Equivalent Outputs Wiring – C4

4.11.6 Motor Brake Wiring

The LDHD2 does not have sufficient amperage to activate a motor brake, but can control a motor brake via an external relay. The selection of power supply, relay and diodes depends on the specification of the actual motor brake used in your application.

You can connect the relay to any digital output on the LDHD2 I/O Connector (C4).

Motor brake wiring requires the following:

- Flyback diodes: D1 and D2 (for example, PN 1N4002)
- Relay: 24 V < 100mA
- Relay coil: > 500 Ω
- External power supply: 24V

Refer also to*Motor Brake Control*.

When using an inductive load, such as motor brake, be sure to install flyback diodes according to wiring diagram.

When using a DC relay to switch inductive loads, such as a relay sequence circuit, a motor brake, or a DC solenoid, it is important to always absorb surges (e.g., with a diode) to protect the contacts; that is, the drive's digital inputs and outputs. Switching these inductive loads on and off can generate a counter-electromotive force (Back-EMF) of several hundred to several thousand volts, which can severely damage contacts and greatly shorten product life.

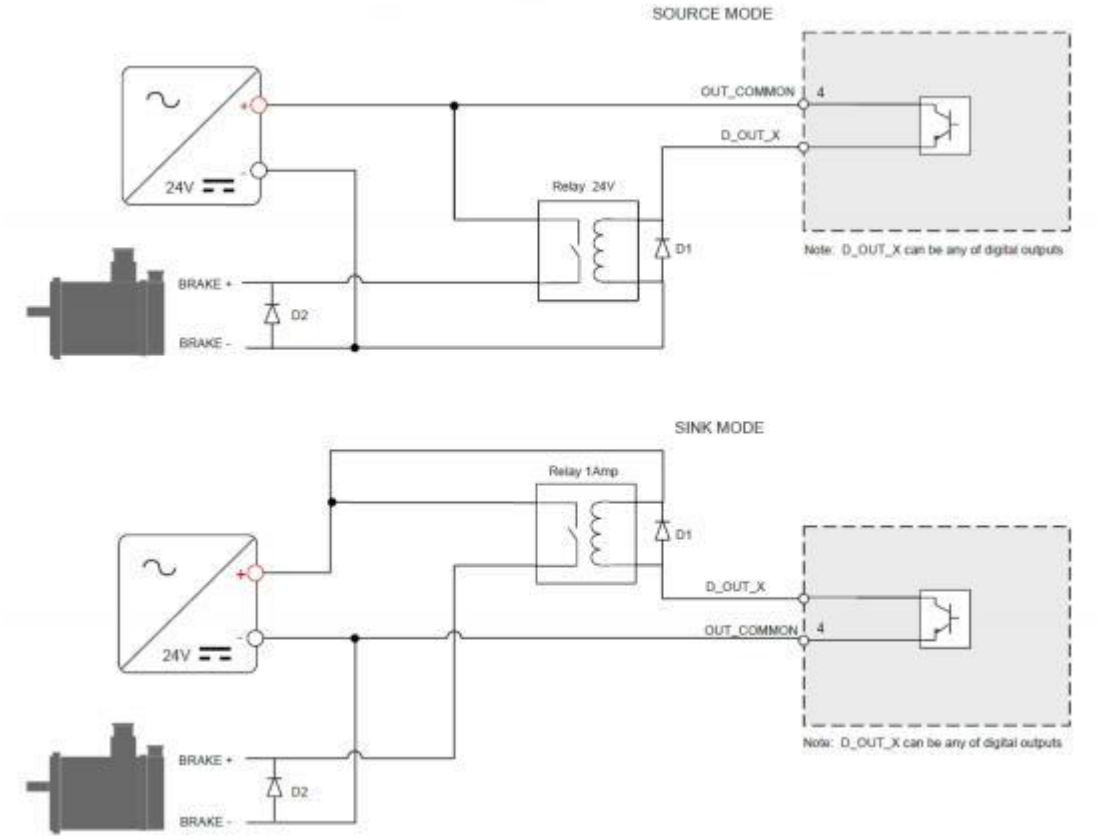


figure4-13 Motor Brake Wiring LDHD2

4.11.7 Motor Feedback Interface – C5 and C6

Wire the motor feedback interface according to the type of feedback device to be used in your application. Refer to the tables in*Motor Feedback Wiring*for common types of feedback wiring.

Unused pins must remain unwired.

Note

Serial communication encoders have the following properties:

- Serial encoder data is bidirectional.
- Serial encoder clock is only output.
- Low-voltage indication comes directly from the encoder; the drive does not have the capability to verify encoder battery voltage.

table4-7 LDHD2-003/006(medium-voltage)Feedback Interface (C5)

Pin	Function
1	Power supply to feedback device
2	Ground
3	Incremental encoder A +
	SSI encoder data +
4	Incremental encoder A -
	SSI encoder data -
5	Incremental encoder B +
	SSI encoder clock +
6	Incremental encoder B -
	SSI encoder clock -
7	Incremental encoder Z +
8	Incremental encoder Z -
9	
10	

table4-8 LDHD2-003/006(medium-voltage)Feedback Interface (C6)

Pin	Function
1	Power supply to feedback device
2	Ground
3	Hall U +
4	Hall V +
5	Hall W +
6	
7	
8	
9	
10	

table4-9 LDHD2-012/018/024(high-voltage) Feedback Interface(C5)

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 V+
5	Hall W+	18	
6		19	
7		20	
8		21	Ground (5V return)
9		22	
10		23	
11	5V supply	24	Ground (5V return)
12	Motor temperature sensor	25	Motor temperature sensor(Ground)
13	5V supply	26	Shield

4.11.8 LDHD2-MV Motor Feedback Wiring

The following tables show the most common feedback variations. If you need additional information, or your motor feedback does not match any one of the following, contact Technical Support.

Use the ServoStudio 2 Motor Setup procedure and the Feedback screens to define motor feedback type, resolution, and other parameters.

Wiring – Incremental Encoder A Quad B, Index Pulse and Halls

table4-10 Feedback Interface (C5)

Pin	Function
1	Power supply to feedback device
2	Ground
3	Incremental encoder A +
4	Incremental encoder A -
5	Incremental encoder B +
6	Incremental encoder B -
7	Incremental encoder Z +
8	Incremental encoder Z -
9	
10	

table4-11 Feedback Interface (C6)

Pin	Function
1	Power supply to feedback device
2	Ground
3	Hall U +
4	Hall V +
5	Hall W +
6	
7	
8	
9	
10	

Wiring – Single-Ended Halls

table4-12 Feedback Interface (C6)

Pin	Function
1	Power supply to feedback device
2	Ground
3	Hall U +
4	Hall V +
5	Hall W +
6	Ground
7	Hall U +
8	
9	
10	

Wiring – BiSS-C Encoder

table4-13 Feedback Interface (C5)

Pin	Function
1	Power supply to feedback device
2	Ground
3	SSI encoder data + (SLO+)
4	SSI encoder data - (SLO-)
5	SSI encoder clock + (MA+)
6	SSI encoder clock - (MA-)
7	
8	
9	
10	

Wiring – HEIDENHAIN (EnDat 2.x Communication Only)

table4-14 Feedback Interface (C5)

Pin	Function
1	Power supply to feedback device
2	Ground
3	SSI encoder data +
4	SSI encoder data -
5	SSI encoder clock +
6	SSI encoder clock -
7	
8	
9	
10	

4.11.9 LDHD2-HV Motor Feedback Wiring

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

Wiring-Incremental encoder AB quadrature, index pulse and Hall

table4-15 Feedback interface(C5)

Pin	Twisted pair cables	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(GND)
11		+5V DC voltage
24		0V DC voltage

Wiring – single-ended Hall

table4-16 Feedback wiring – single-ended Hall(C5)

Pin	Twisted pair cables	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(GND)
26		Shielding

Feedback wiring - BiSS-C encoder

table4-17 Feedback wiring - BiSS-C encoder(C5)

Pin	Twisted pair cables	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 – HEIDENHAIN (EnDat2.x communication only)

table4-18 Feedback wiring - HEIDENHAIN (EnDat2.x communication only)

Pin	Twisted pair cables	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

4.12 LDHD2-003/006(medium-voltage)Power Board Connections

Refer to the Power Board Pin Assignments diagram.

Make sure the main voltage rating matches the drive specification. Applying incorrect voltage may cause drive failure.
Do not apply power until all hardware connections are complete.

Prevent inrush surge:

Bus Power (L1-L2): After switching off bus power, wait 1 minute before switching on again, regardless of time in On state.

Logic Power (L1C-L2C): After switching off logic power, wait 30 seconds before switching on again.

4.12.1 LDHD2-003/006(medium-voltage) Power Board Pinouts

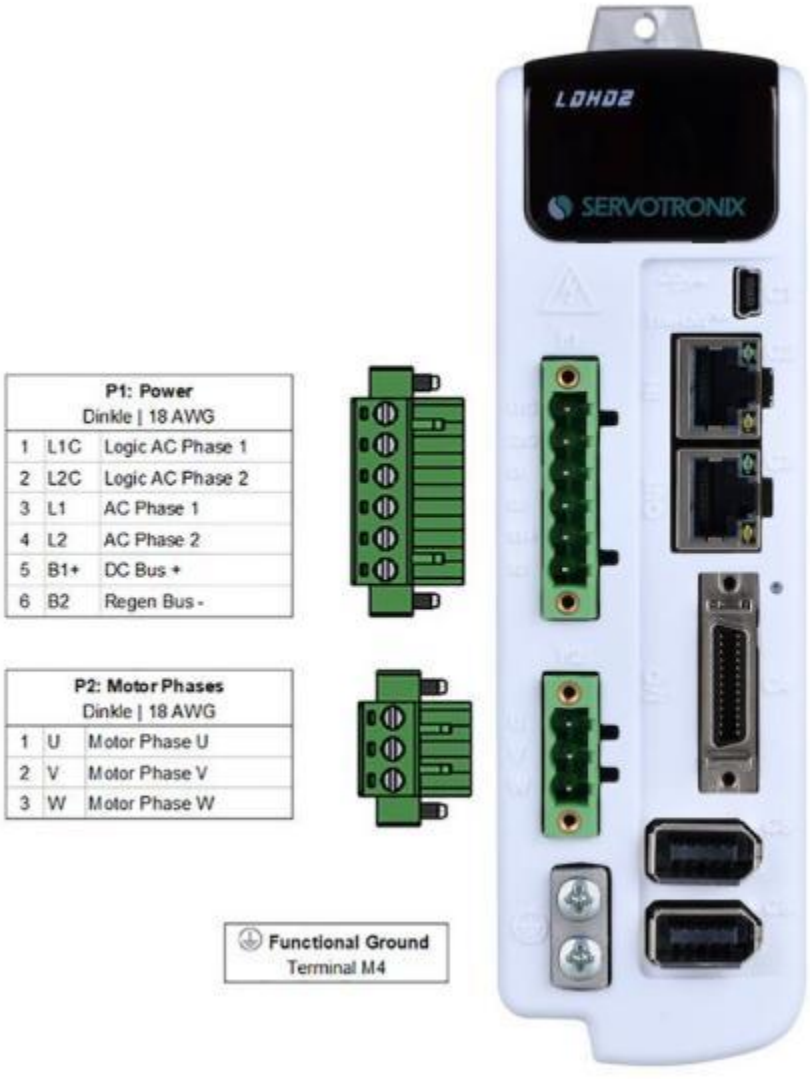


figure4-14 LDHD2-Power Board Pin Assignments

4.12.2 Functional Ground

Connect the AC input voltage ground wire to the Functional Ground terminal, located on the LDHD2 front panel. Use an M4 ring or spade terminal.

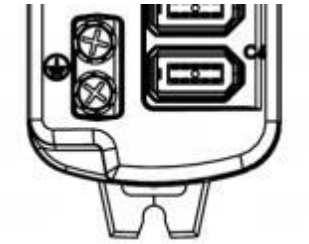


figure4-15 Ground Terminals

4.12.3 Power – P1

Use the mating connector for this interface.

- Connect L1 and L2 (for bus power): connect line and neutral to L1 and L2.
- Connect L1C and L2C (for logic power): connect line and neutral to L1C and L2C.
- If the application requires a regeneration (regen) resistor, connect the regen resistor between terminals B1+ and B2. Refer to*Regeneration*.

4.12.4 Motor Phases– P2

Use the mating connector for this interface.

The LDHD2 must be grounded. Make sure the AC input voltage ground wire is connected to the Functional Ground terminal on the LDHD2 front panel.

4.13 LDHD2-012/018/024(high-voltage)Power Board Connections

4.13.1 LDHD2-012/018/024(high-voltage) Power Board Pinouts

STO			
GND	24V - (provided by driver)	+24V	24V + (provided by driver)
COM	STO1-	STO1	STO1+
COM	STO2-	STO2	STO2+
NC	Not Connected	NC	Not Connected

P1:AC Input		
1	L1C	Logic Power Supply 380VAC Phase 1
2	L2C	Logic Power Supply 380VAC Phase 2
3	L1	Bus Power Supply 380VAC Phase 1
4	L2	Bus Power Supply 380VAC Phase 2
5	L3	Bus Power Supply 380VAC Phase 3

P2:Motor		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W

P3:DC Reactor and Regeneration		
1	N2	DC Reactor(optional)
2	N1	DC Reactor(optional)
3	P	DC Bus+/Regen Bus+
4	C	Regen Bus-

figure4-16 LDHD2-012/018/024(high-voltage) Power Board Pinouts

4.13.1 STO

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

STO Dinkle | 16-28AWG			
GND	24V - (provided by driver)	+24V	24V + (provided by driver)
COM	STO1-	STO1	STO1+
COM	STO2-	STO2	STO2+
NC	Not Connected	NC	Not Connected

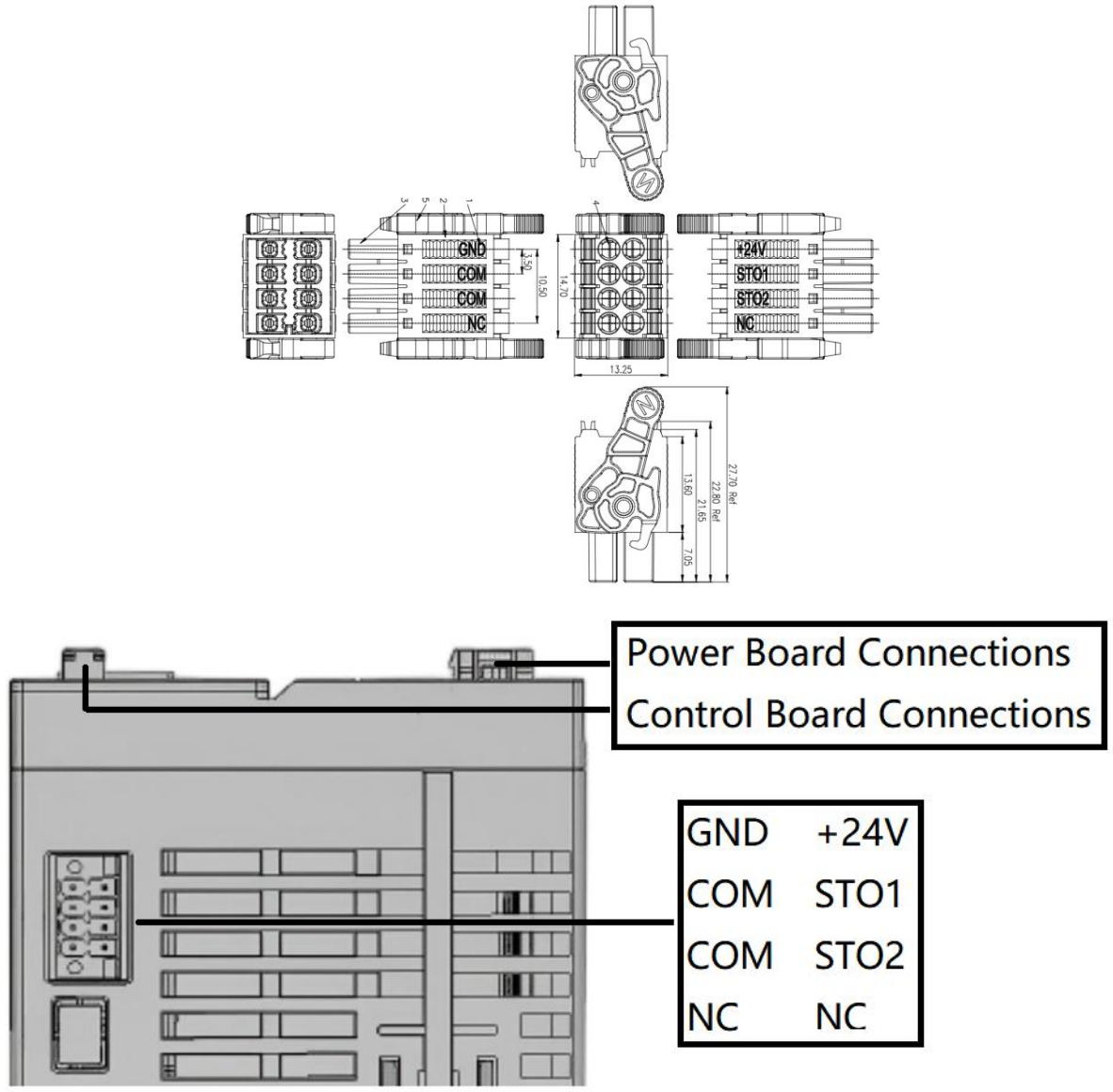


figure4-17 LDHD2-012/018/024(high-voltage) STO bypass plug

4.14 Regeneration

4.14.2 Regenerative Energy Overview

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

Regenerative energy that is not dissipated is added to the electrical energy already stored in the capacitors of the bus module. If the capacitors are capable of storing the energy, the system does not require a regeneration resistor.

In some cases, often due to a high inertial mismatch between the load and motor, excessive energy is added to the capacitors, causing the voltage on the capacitors to reach the over-voltage threshold, which then disables the drive. To prevent over-voltage, and potential damage to the system, the excessive regenerative energy must be dissipated by a regeneration resistor.

To determine whether a system requires a regeneration resistor, and if so, the level of capacity, refer to Regeneration Resistance Calculations to calculate system properties.

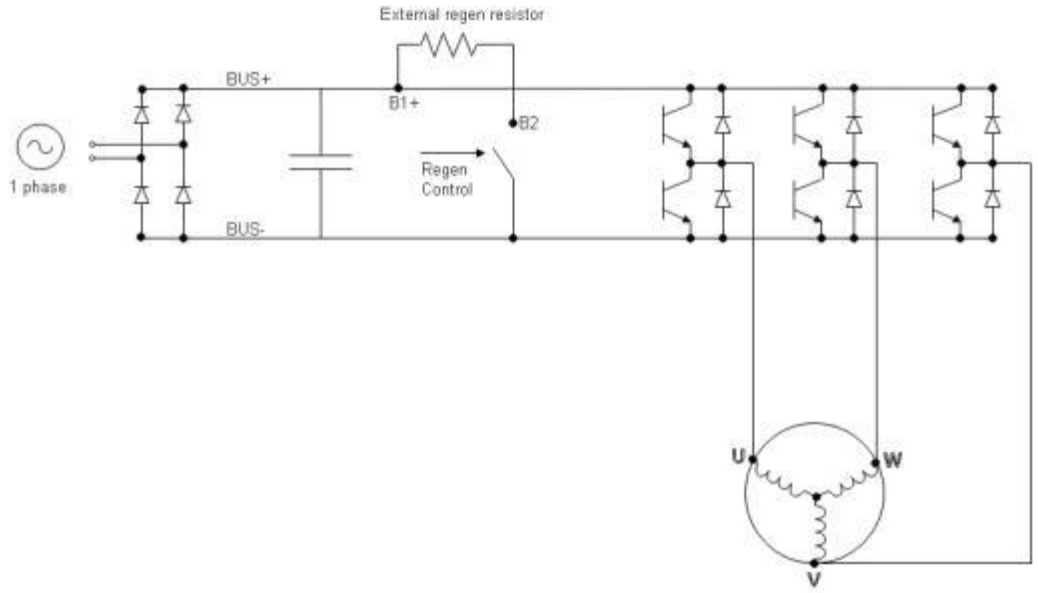


figure4-18 Regeneration Resistor Circuit

4.14.3 Regeneration Resistance – LDHD2 Bus Specifications

table4-19 Bus Specifications - Single Phase 120/240 L-L VAC

Drive Model	Capacitance (µF)	VNOM (VDC)	VLow (VDC)	VHigh (VDC)	VMAX (VDC)
LDHD2-003	660	170/340	380	400	420
LDHD2-006	1120	170/340	380	400	420

4.14.4 Regeneration Resistor Overload Protection

Motor energy regeneration is always active in the LDHD2.

There are two modes for the motor energy regeneration function:

- Regeneration **with** resistor overload protection.

  The regeneration resistor circuitry itself requires overload protection to ensure the resistor functions reliably. In this mode, use the configurable LDHD2 regeneration resistor parameters to apply this protection.

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

  In bang-bang mode, when bus voltage exceeds the upper threshold level (400V), the regeneration resister will be activated by the drive; when bus voltage is reduced to the lower threshold level (380V), the regeneration resister will be deactivated.

Use the regeneration resistor protection with caution.

If the motor increases bus voltage, resulting in activation of the protection mechanism, an over-voltage condition may result.

4.14.5 Regeneration Resistor Parameters

The regeneration resistor capacity is defined by several parameters.

To activate the regeneration resistor protection function in the LDHD2, parameter REGENRES and/or parameter REGENPOW must be set to a value other than -1, which is the default value.

VarCom	Description
REGENRES	Resistance of the regeneration resistor, in ohms.
REGENPOW	Power of the regeneration resistor, in watts.
REGENMAXONTIME	The maximum time for which the regeneration resistor may be continually activated (on), in milliseconds.
REGENMAXPOW	The maximum calculated power of the regeneration resistor, in watts.

Note

If the system does not have a regeneration resistor, set REGENRES = -1 and REGENPOW = -1

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

4.15 Firmware Update

4.15.1 Firmware Update Preparation

Important: Before updating the firmware, be sure to do the following:

- Refer to the Release Notes and any other documentation supplied with the new firmware.
- Since parameter settings may be lost during the update, backup drive parameters from each drive in the system, and keep these files secure. After the update is completed, the parameters can be reloaded/restored.

  To backup parameters, go the ServoStudio 2 Backup & Restore screen, and press the **Save to Backup** button.

4.15.2 Firmware Update Options

The Download Firmware button in the ServoStudio 2 **Drive Information** screen opens the Firmware Download dialog box

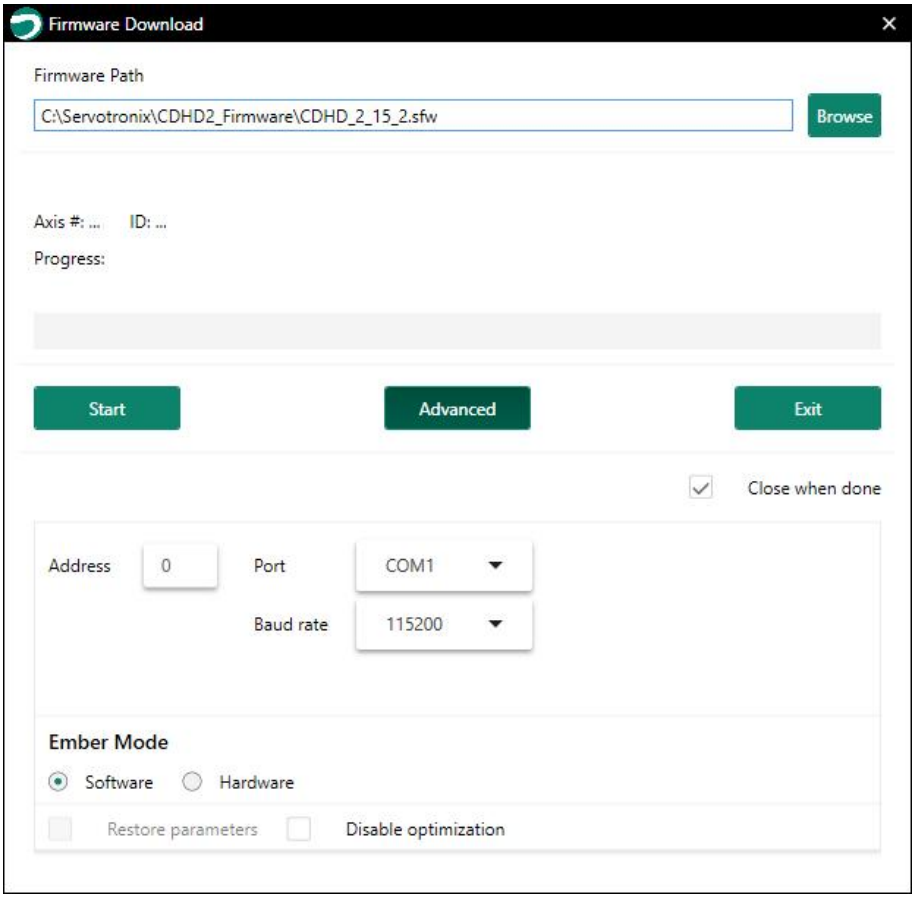


figure4-19 Firmware Download

Firmware Path	The path and name of the file containing the firmware update. The file name indicates the firmware version; for example: 2_00_0*.sfw represents firmware version 2.0.x. The default path is \My Documents\ServoStudio 2. Press **Browse** to select another path.
Start	Activates the firmware update.
Advanced	Expands the dialog to show additional options
Close When Done	When selected, the Firmware Download dialog box closes automatically once the procedure is completed.
Address	• When only one drive is connected to the host computer, a drive address is not needed. The software attempts to communicate with the drive that was communicating with the host before the Firmware Download process was activated. Thus, if the drive responds to serial communication, the firmware download process will proceed. • When multiple drives are connected to the host in a daisy-chain, a drive address must be specified. When a drive address is specified, the software starts by sending the command \\ which stops all drives connected to the selected serial port from responding to serial communication. It then issues the command \nn which instructs only the drive with address nn to respond. Then it begins the firmware download.
Port	The COM port of the host computer to which the drive is connected. Make sure this COM port is not being used by any other application.
Baud Rate	The rate must be set to 115200.
Ember Mode	Ember is the process used for burning new firmware on the drive's flash memory. • **Software**: Normally use the default Software option. • **Hardware**: If the firmware loading process has been interrupted and you are unable to establish communication with the drive, use this option.
Disable Optimization	The firmware update procedure uses an optimization method to improve performance. In rare instances this optimization may cause the procedure to fail. In such an instance, disable the optimization and restart the firmware update.
Restore Parameters	When selected, the firmware update procedure stores all user parameters to memory before downloading the firmware and restores the parameters after the update. This option can be disabled. This option is not available if host and drive are not communicating. **Note**: Regardless of this option setting, it is strongly recommended that you use the **Save to Backup** option in the Backup & Restore screen to preserve the existing drive parameters before updating the firmware.

4.15.3 Firmware Update over Serial Connection

Procedure: Updating Drive Firmware over Serial Connection

1. Download the drive's firmware file (*.sfw) from the product web page to a host computer.
2. From the ServoStudio 2 Drive Info screen, press **Download Firmware**.

   The Firmware Download dialog box opens, and allows you to send the firmware file to the drive over a serial communication link.
3. Browse to and select the firmware file.
4. Press **Start** to download the firmware file to the drive.
5. During the firmware update process, the digital display shows a steadily lit **E** .

   The process takes several minutes. When the process is complete, the new firmware starts running.
6. Download the drive parameter file to the drive.
7. Execute SAVE to save the parameters in the drive's non-volatile memory.
8. Cycle power, and run the machine.
   If machine behavior has changed, contactTechnical Support.
9. Retrieve the parameter file from the drive, and save the file for future reference and backup.
10. Repeat the firmware update procedure for each drive in the machine.

4.15.4 Firmware Update over EtherCAT

Firmware updates can be performed using File over EtherCAT (FoE) download protocol. The LDHD2 runs in a bootloader state to allow firmware download to the host controller via the EtherCAT network. Standardized firmware download to devices is therefore possible, even without the support of TCP/IP.

Note Drive Resident (Bootloader) must be version 1.3.1 or higher.
The version can be checked in the ServoStudio 2 Terminal screen, by means of the command VER. If the system has a regeneration resistor, a value of -1 for either REGENRES or REGENPOW deactivates the regeneration resistor overload protection algorithm.

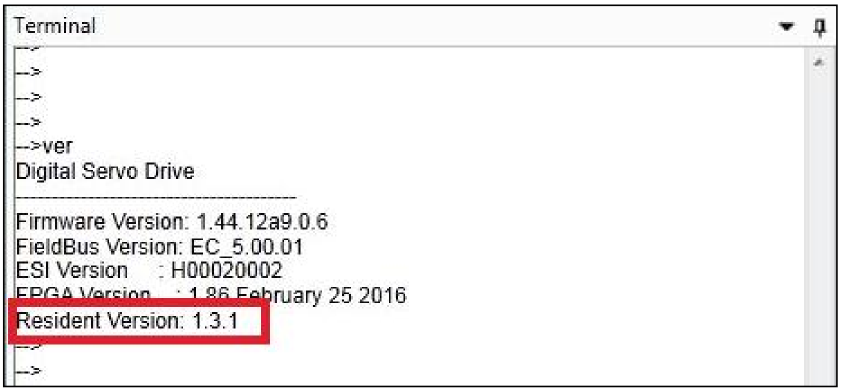


figure4-20

Procedure: Updating Drive Firmware over EtherCAT

1. Install TwinCAT 3.0 on the host PC.

Follow the instructions provided by Beckhoff.

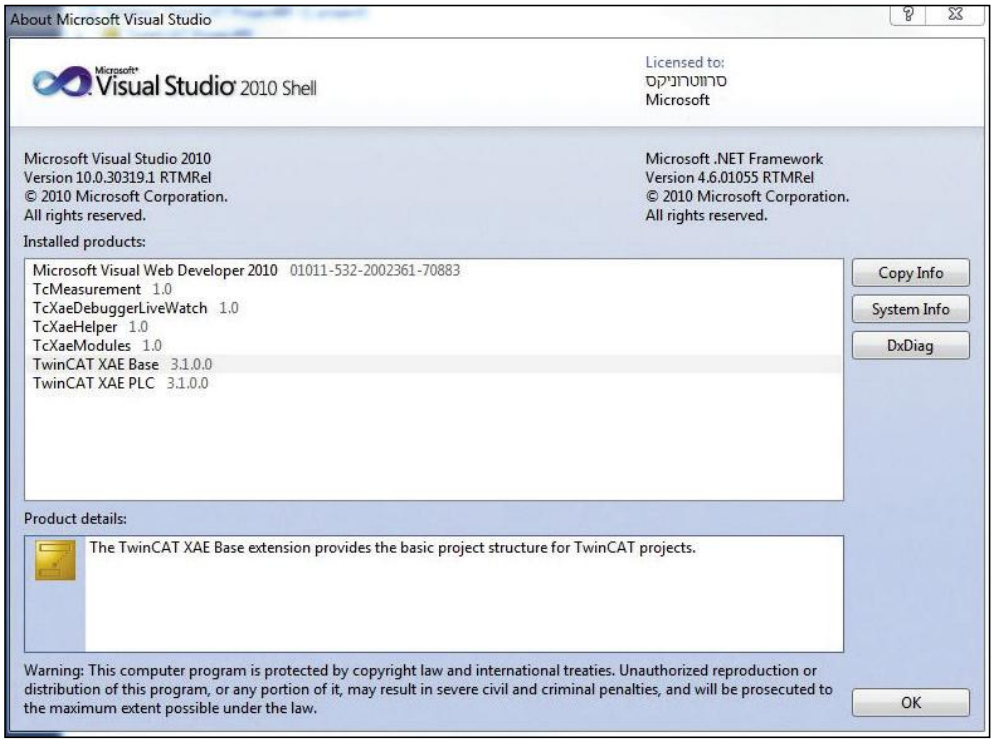


figure4-21

2. In TwinCAT connect to the LDHD2 drive.

3. In the TwinCAT navigation menu, select I/O > Devices … LDHD2 drive.

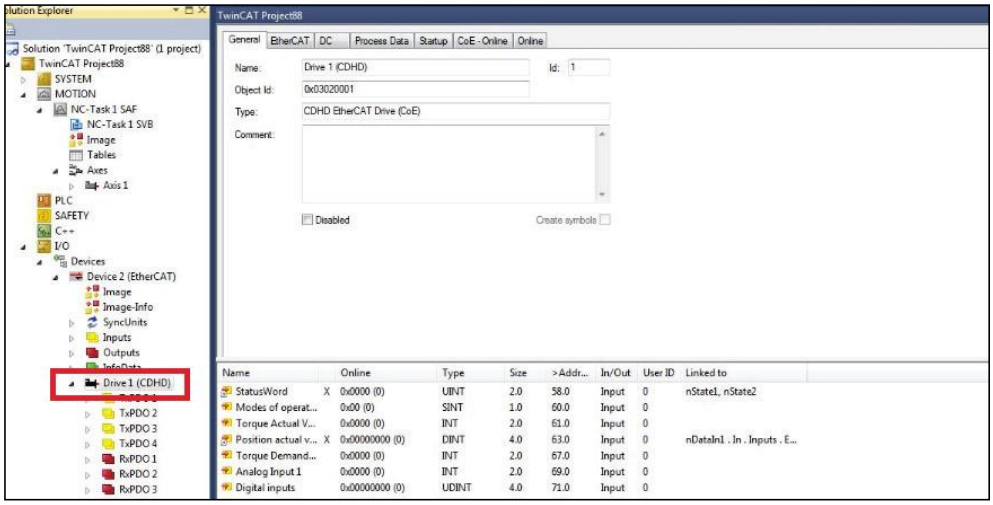


figure4-22

4. Go to the Online tab.

Press Bootstrap.

Wait until Current States becomes BOOT.

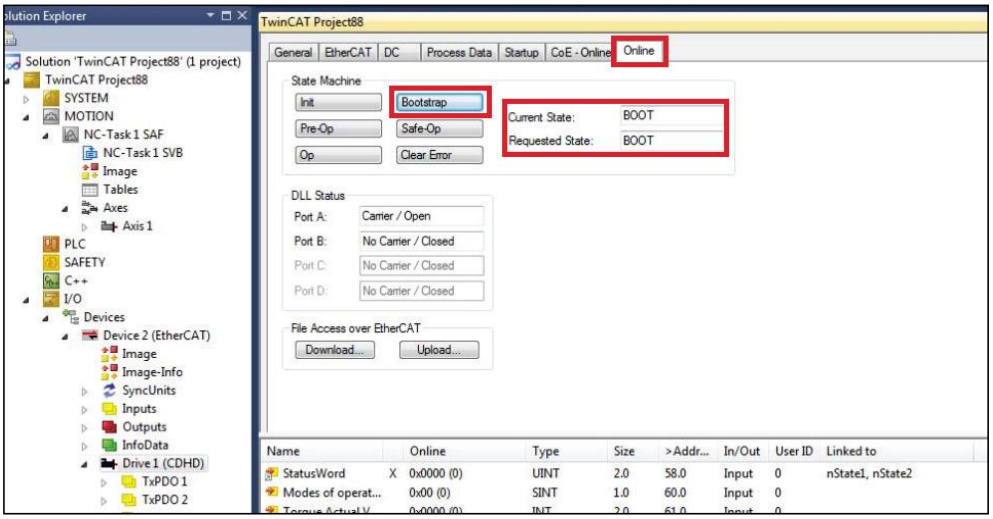


figure4-23

5. Press Download.

6. The File Manager dialog box opens.

Browse to and select the LDHD2 firmware file (with *.i00 extension).

Press Open.

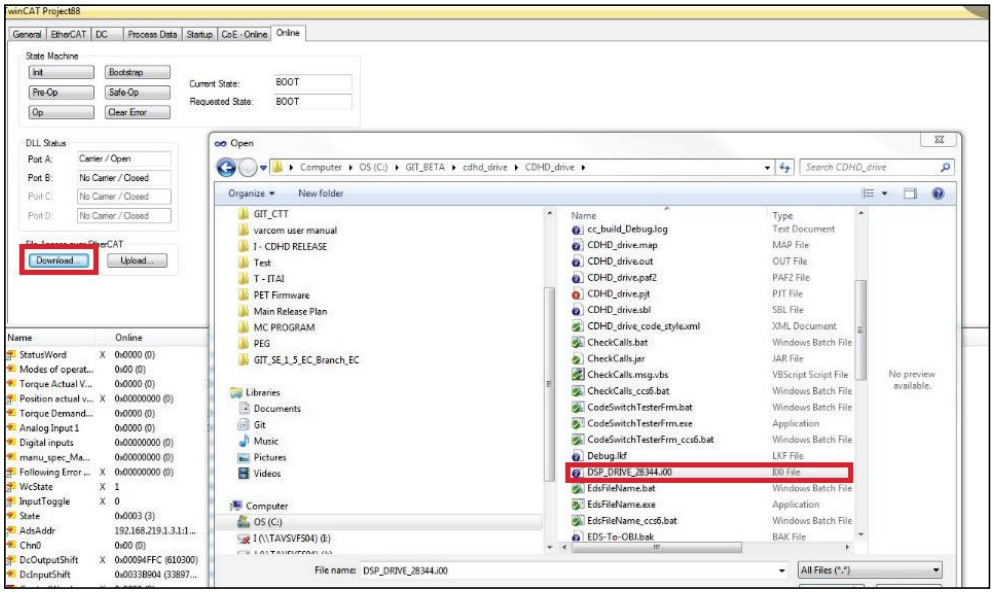


figure4-24

7. The Edit FoE Name dialog box opens.

Do not change anything in this dialog box. Simply press OK.

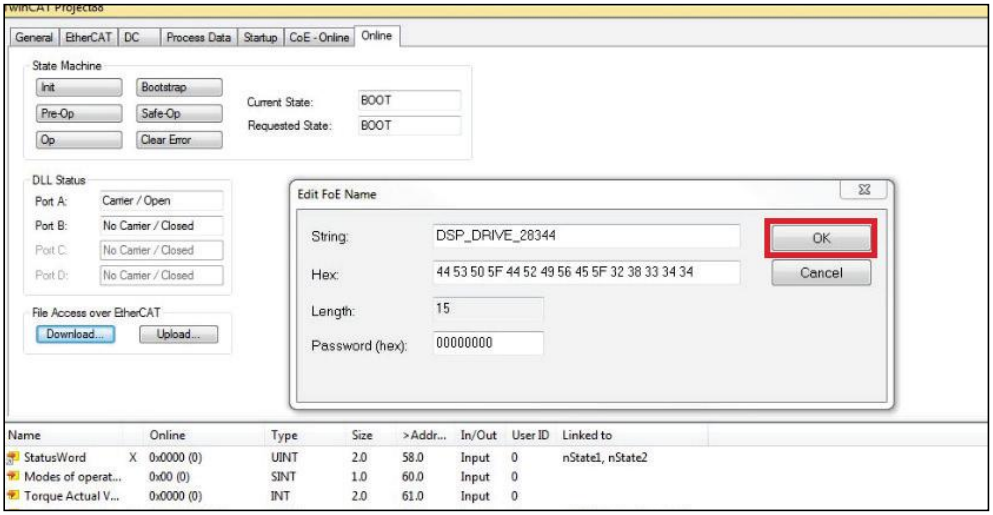


figure4-25

8. The firmware update process begins.

E is displayed on the LDHD2 panel.

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

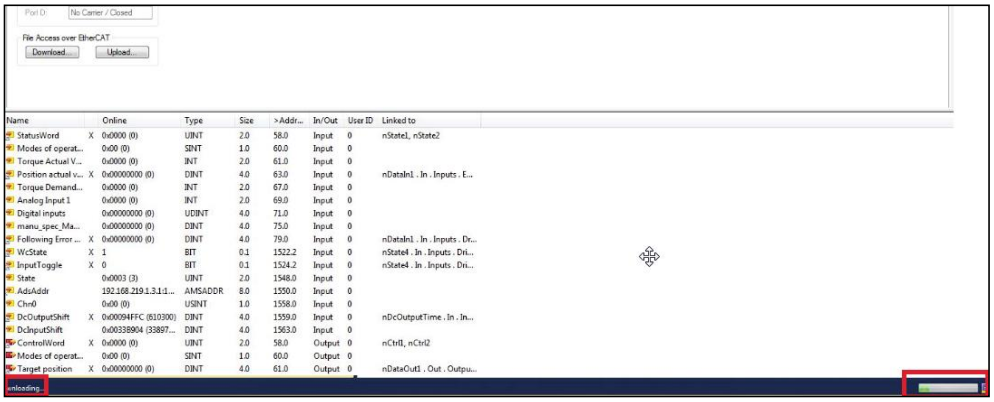


figure4-26

9. When the firmware updated is completed, Current State switches from BOOT to PREOP.

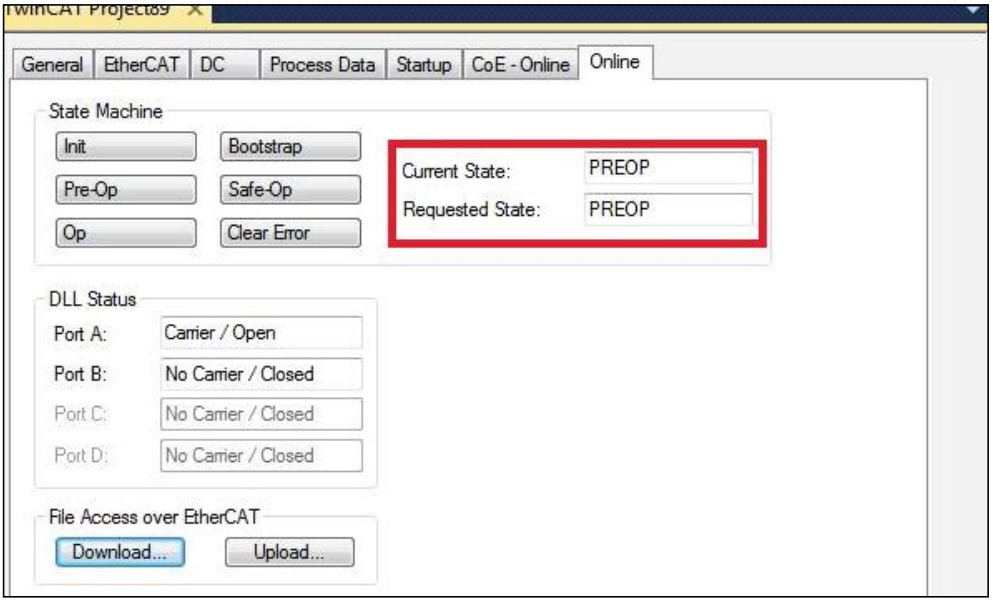


figure4-27

4.15.5 Resuming Operation After Firmware Update

Procedure: Resuming Operation After Firmware Update

1. Go to the ServoStudio 2 **Drive Info** screen in ServoStudio 2, and check the drive firmware version to verify that the new firmware has been loaded.
2. Open the **Backup & Restore** screen, and press the Restore button to reload the previously backed up parameters the drive
3. Check the version release note, and set any parameters that may have been added to the new version.
4. Save the parameters to the non-volatile parameter memory: either execute the serial command SAVE command, or press the Save button on the ServoStudio 2 toolbar.
5. Cycle power, and run the machine. If machine behavior has changed, contact Technical Support.

4.15.6 Ember Mode

Ember is the process used for burning new firmware on the drive's flash memory. The drive must be in the Ember mode for the firmware to be loaded. The drive has two Ember modes, Software and Hardware.

Normally, you can and should communicate with the drive through a master for loading new firmware.

However, if the firmware loading process has been interrupted and you are unable to establish communication with the drive, you need to use the Ember Hardware mode.

To activate the Hardware Ember mode, use a small screwdriver or similar tool to gently press the Hardware Ember switch. This switch is located on the top of the drive.

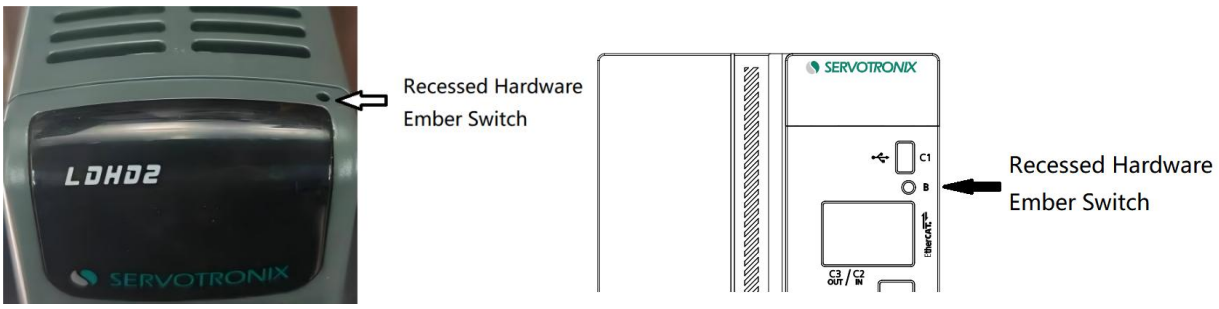


figure4-28 Recessed Hardware Ember Switch

Pressing the switch sets the drive to serial communication Boot-Up mode.

If the drive has a fan, the fan rotates at maximum speed. The fan speed will revert to normal after the firmware has been downloaded successfully and the drive has restarted.

While in Boot-Up mode, all segments of the digital display are lit [**8.**].

4.15.7 Parameter Download over EtherCAT

To automate and simplify the process of downloading parameters to multiple drives, parameters can be downloaded using File over EtherCAT (FoE) download protocol.

Procedure: Downloading Parameters over EtherCAT

1. Use ServoStudio 2, backup the parameters in the drive to an SSV file.
For example, save to a file called LDHD2_parameters.SSV.

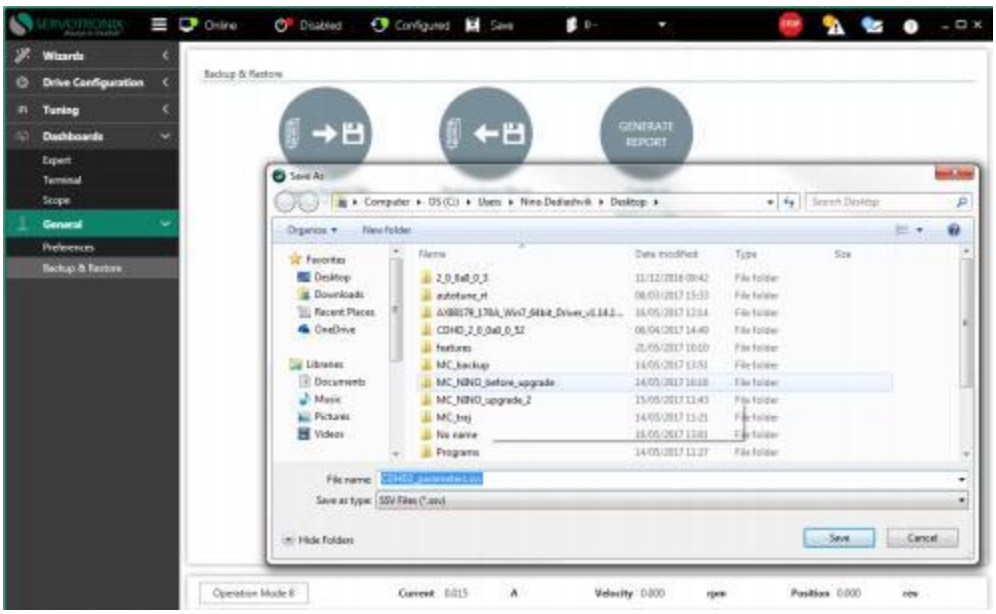


figure4-29

2. Using TwinCAT, connect to LDHD2 drive.
Be sure the drive is in Init or Pre-Op state.

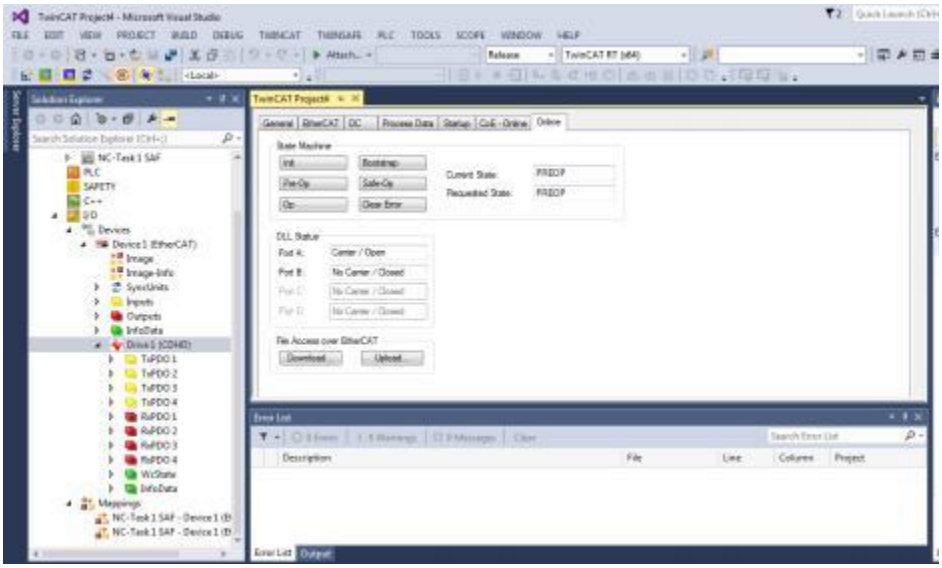


figure4-30

3. Press the Download button, and select the SSV parameter file that you saved in Step 1.

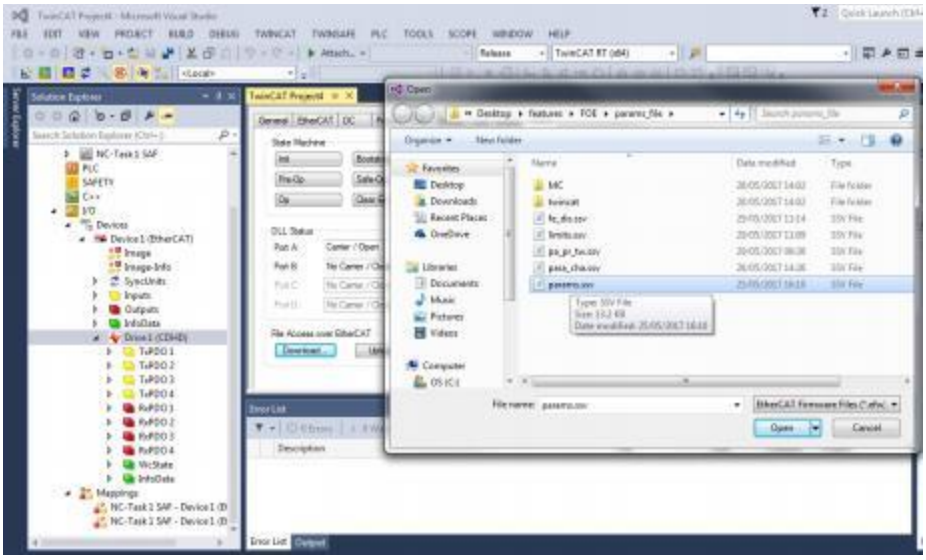


figure4-31

4. Be sure the file name includes the extension .SSV (By default, TwinCAT does not add the extension.)

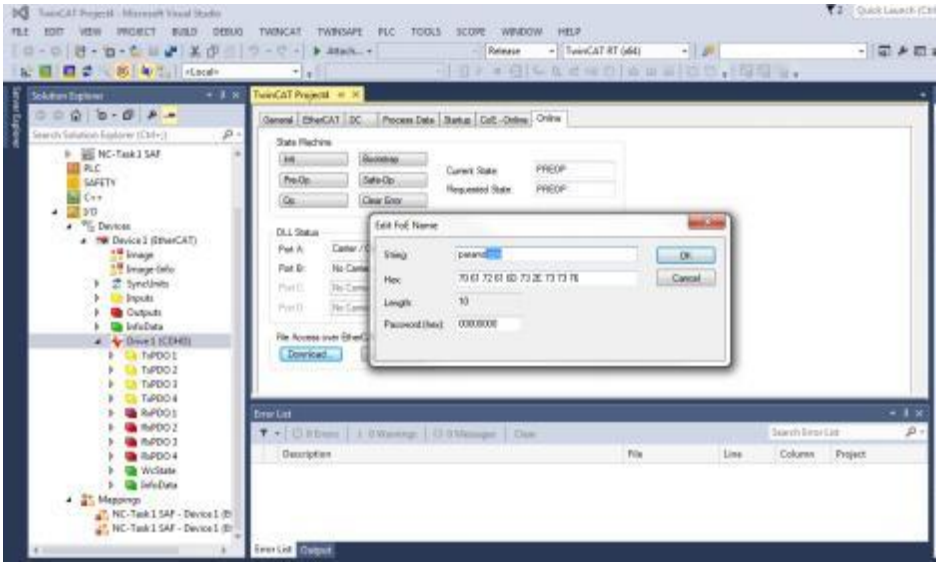


figure4-32

5. Press OK.

Look at the drive. The digital display shows **F o E** (characters displayed in succession) while the parameters are downloading.

6. Wait about 10 seconds. When the download is complete, the digital display returns to its previous setting.

5. Motor Setup

Disable the drive before manipulating motor and feedback parameters.

Many parameters can be modified while the drive is enabled.
Exercise caution, however, as motor behavior will change.

If a parameter cannot be modified while the drive is enabled, ServoStudio 2 will prompt you to disable the drive.

5.1 Motor Setup Wizard

The ServoStudio 2 Motor Setup wizard provides the quickest and easiest method for getting the drive and motor up and running. It configures the essential parameters and the current control loop for a motor without a load.

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

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

Motor Setup – Connection

Typically, the wizard begins with a step to establish communication between the drive and the ServoStudio 2 software.

If ServoStudio 2 is already communicating with the drive, the wizard will skip this step.

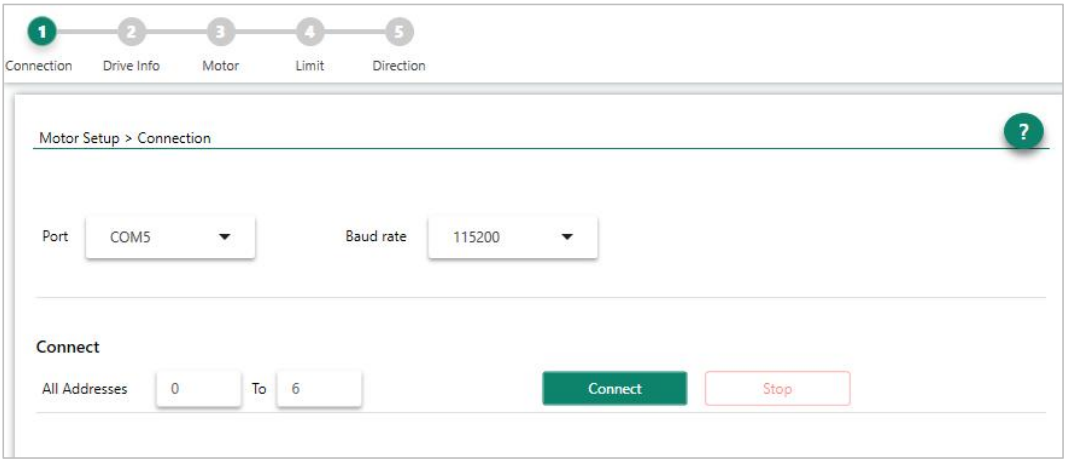


figure5-1 Motor Setup Wizard – Connection

1. Select either a specific COM port or Search All.
2. Press Connect.

Refer to*Communication*.

Motor Setup – Drive Information

If ServoStudio 2 is already communicating with the drive, the wizard will begin at **Drive Information**.

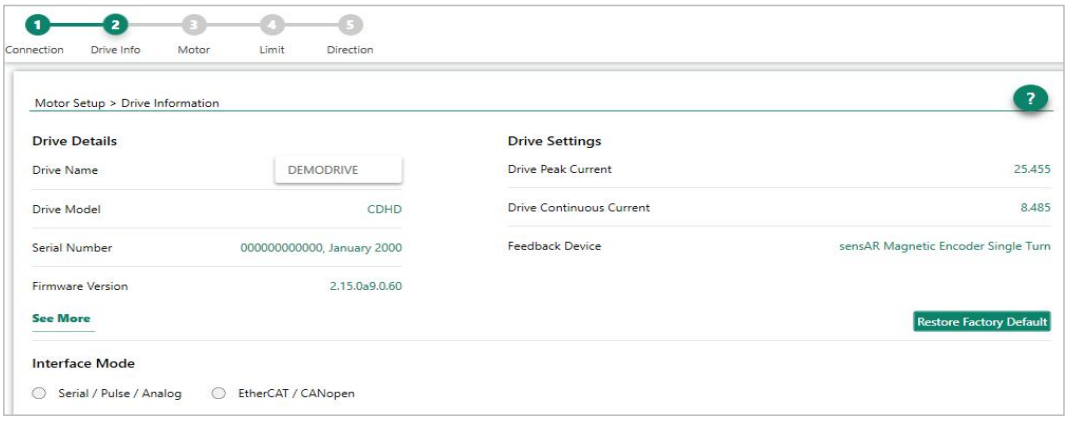


figure5-2 Motor Setup Wizard – Drive Information

1. Review the drive information.
2. Enter a name for the drive, and press Enter after typing the name.

   The name field will change from blue to white, indicating the name has been sent to the drive.

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

This step also shows and allows setting the Command Interface Mode:

- **Serial/Pulse/Analog** indicates drive is active (Servo On) and motion commands are transmitted via a serial, pulse or analog interface. COMMODE 0.
- **EtherCAT/CANopen** indicates drive is active (Servo On) and motion commands are transmitted via an EtherCAT interface. COMMODE 1.

The ServoStudio 2 **Drive Information** screen allows you to view drive properties and define the drive name.

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

VarCom	Description
INFO	Hardware-defined. Returns the drive model and serial number, and version numbers of firmware, control board, power board and FPGA.
DRIVENAME	Optional, user-defined parameter. It is useful when an application has more than one drive. It is recommended that you provide a name for the drive that reflects the function it performs, such as Axis-1.

Motor Setup – Motor Identification and Initialization

You can select a motor from the ServoStudio 2 motor libraries.

If your motor is not listed in the default set of motor libraries, press **Define New Motor**, and use the***New Motor Wizard***

to enter the parameters for your particular motor.

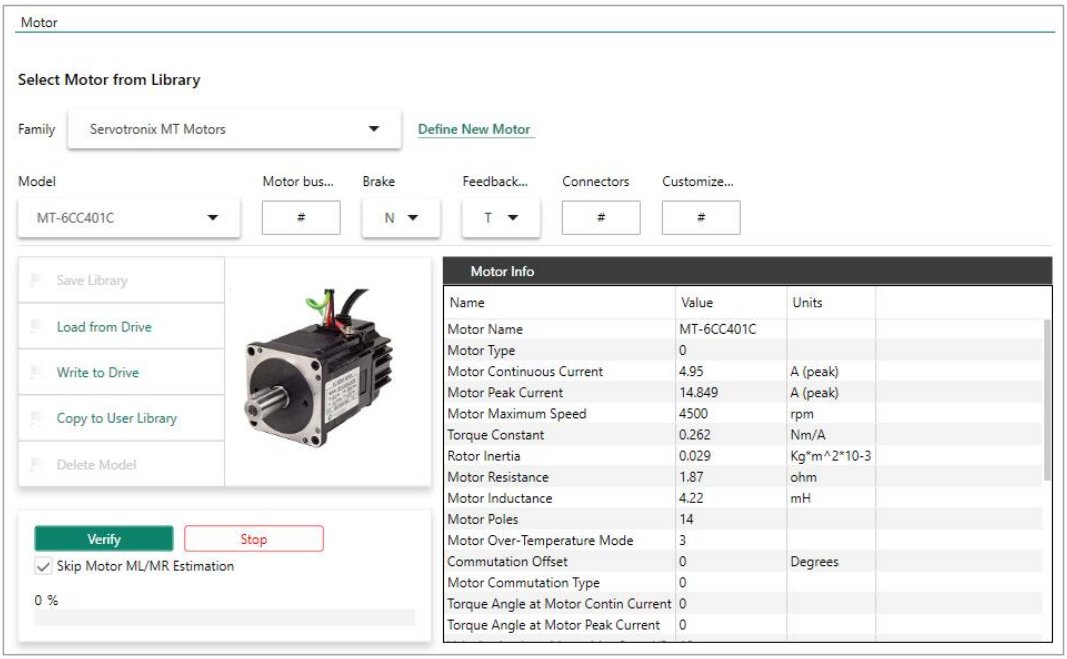


figure5-3 Motor Setup Wizard – Motor Selection

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

Verify enables the drive and moves the motor!

Motor Setup – Current, Velocity and Position Limits

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

The wizard suggests Low, Medium or High limit values for current and velocity. The values are equivalent to 25%, 50% and 100%, respectively, of the maximum range.

Refer to*Current Limits*and*Velocity Limits*.

The wizard also allows you to set the position error threshold level, that is, the maximum value that will not produce a fault.

Refer to VarComPEMAX.

Note If the limits are set too low, the Autotuning wizard might not produce the optimal result.

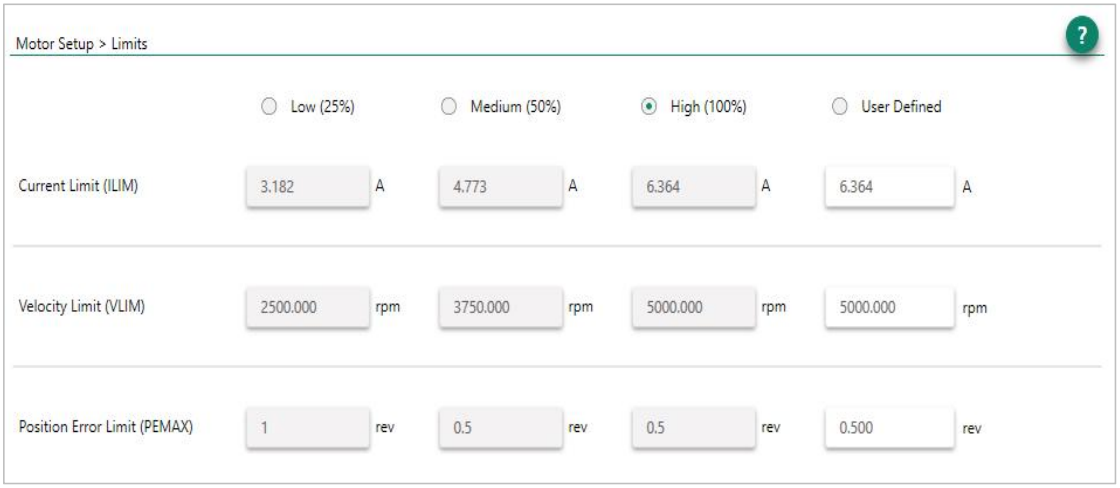


figure5-4 Motor Setup Wizard – Limits

1. Do either of the following to set velocity and current limits, and the position error limit:
   - Select the suggested Low, Medium or High values.
   - Select User Defined, and enter your preferred values.
2. Press Approve to send the values to the drive.

If Current Limit or Velocity Limit is set to a user-defined value of 0, it will prevent motion from occurring.

If Position Error Limit is set to a user-defined value of 0, no position error limit is set, and no faults will be produced.

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

VarCom	Description
DIPEAK	The rated peak current of the drive. Hardware defined. **Read only.**
MIPEAK	The rated peak current of the motor. The value can be manipulated.
IMAX	This value is the maximum current for a drive and motor combination, as calculated by the software. **Read only.**
ILIM	The current limit for the application. This parameter lets you limit the drive's peak current to a value lower than DIPEAK.
ILIMACT	The actual drive current limit. **Read only.**

Motor Setup – Motor Direction

The wizard simplifies the process of defining the rotation direction for a movement command. Otherwise, VarCom instructions are required.

Refer to VarComMPHASEandDIR.

To visually test the direction of motion, press and hold the directional buttons. The test speed is defined as a percentage of Motor Continuous Current. Use a low value so that the direction of motor movement can be easily viewed. By default it is set to 5.

The Motor Setup wizard simplifies the process of defining the rotation direction for a positive command. Otherwise, VarCom instructions are required.

figure5-5 Motor Setup Wizard – Motor Direction

1. To verify motor motion direction, press Negative or Positive.

⚠ Negative and Positive enable the drive and move the motor!

2. To reverse the direction to match your system, press **Inverse Direction**. Refer to VarComMPHASEandDIR.

3. To complete the procedure, press SAVE or DONE.

Motor Setup – Save

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

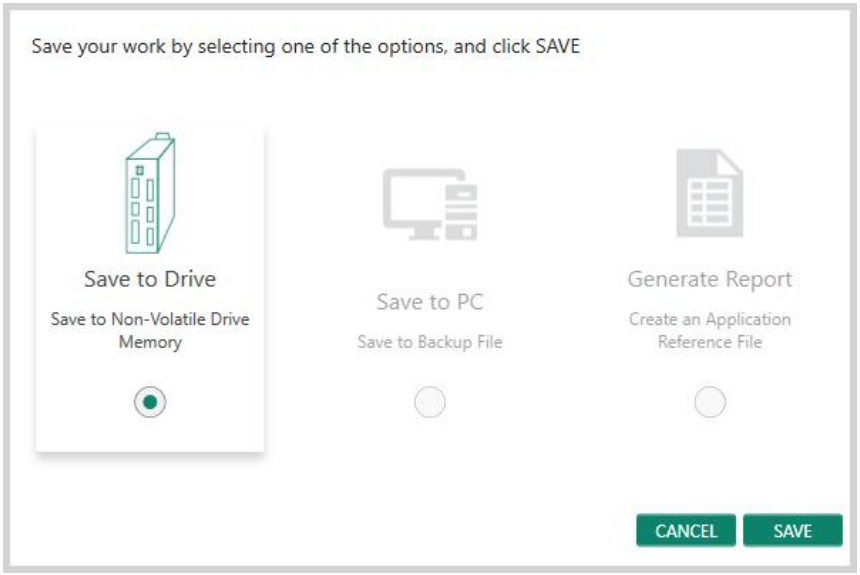


figure5-6 Motor Setup Wizard –Save

Do both of the following:

- Press **Save to Drive** to save the parameters from the drive's RAM to the drive's permanent memory.
- Press **Save to PC** to save the parameters in drive RAM to a backup file on the computer. The parameters are saved in a text file with either TXT or SSV extension. The text file can be edited using Notepad or any other text editor.

It is also recommended that you create an application report:

- Press **Generate Report**.

  When activated, the Report Generator opens a dialog box that allows you to enter application and user information. It then generates a set of CSV and TXT files within a

zip file. The file can be attached to an email that is automatically addressed to Technical Support. You can change the address and send to a different recipient.

Refer to *Report Generator* in the ServoStudio 2 Reference Manual.

5.2 Drive Identification

Drive information is presented and confirmed in the Motor Setup wizard.

The ServoStudio 2 Drive Info screen allows you to view drive properties and define the drive name.

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

VarCom	Description
INFO	Hardware-defined. Returns the drive model and serial number, and version numbers of firmware, control board, power board and FPGA.
DRIVENAME	Optional, user-defined parameter. It is useful when an application has more than one drive. It is recommended that you provide a name for the drive that reflects the function it performs, such as Axis-1.

5.3 Motor Identification

Use the **New Motor wizard** to define a new motor.

The following parameter is used to view and configure motor identity:

VarCom	Description
MOTORNAME	Motor names can also be assigned and modified by users. The motor name always begins with a quotation mark (“). For example: "MT-6CC401C

5.4 Motor Initialization

Motor commutation is performed in the Motor Setup wizard.

The command MOTORSETUP initiates a quick commissioning procedure for setting the parameters that define motor commutation.

During the initialization process, the rotary motor moves forward/backward about two mechanical revolutions in forced commutation, which does not require feedback. MOTORSETUP detects the state of Hall switches, index position and polarity, the order of the electrical phases, the direction of motor movement, and the feedback resolution per electrical revolution.

Based on the data collected, the drive updates the parameters MFBDIR, MPHASE, MPOLES, MENCRES and MENCZPOS, making it possible to begin working with the motor and wiring that are connected to the drive.

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

Notes	Not all parameters are updated by the procedure. It depends which parameters are in use, as determined by MENCTYPE. The value of MICONT is very important, since this value sets the limit for the current used during the procedure.

Procedure: MOTORSETUP

To execute the Motor Initialization procedure, do the following:

1. Disable the drive.
2. Clear any faults in the drive.
3. Enter the command MOTORSETUP.
4. Enable the drive (otherwise the process will hang at Stage 5/51).

The procedure will execute a series of steps.

Once the Motor Initialization procedure is started (even when the drive is disabled) the 7-segment display shows **At1** .
When the setup finishes successfully, the display returns to its normal state; if the setup fails, the display shows **- 5** .

To cancel the motor setup procedure, enter the command MOTORSETUP 0

Any parameters that were modified by the MOTORSETUP procedure will be restored to their previous values.

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

5.5 Current Limits

Current limits are modified and/or confirmed in the Motor Setup wizard.

The **Current Limits** tab in the ServoStudio 2 **Limits** screen allows you to define position limits.

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

VarCom	Description
DIPEAK	The rated peak current of the drive. Hardware defined. Read only.
MIPEAK	The rated peak current of the motor. The value can be manipulated.
IMAX	This value is the maximum current for a drive and motor combination, as calculated by the software. Read only.
ILIM	The current limit for the application. This parameter lets you limit the drive's peak current to a value lower than DIPEAK.
ILIMACT	The actual drive current limit. Read only.

5.6 Velocity Limits

Velocity limits are modified and/or confirmed in the Motor Setup wizard.

The **Velocity Limits** tab in the ServoStudio 2 **Limits** screen allows you to define position limits.

The maximum speed that the drive can compute is hardware defined.

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

VarCom	Description
MSPEED	The maximum motor speed, as defined in the motor datasheet.
VMAX	This value is the maximum velocity for a drive and motor combination. VMAX is based on maximum motor speed. Read only.
VLIM	The maximum application velocity. This parameter lets you limit the motor's maximum velocity to a value lower than VMAX.

5.7 5Position Limits

Position limits are modified and/or confirmed in the Motor Setup wizard.

The **Position Limits** tab in the ServoStudio 2 **Limits** screen allows you to define position limits.

The following parameters are used to define positioning limit mechanisms and error tolerances.

VarCom	Description
PEMAX	The maximum position error allowed without producing a fault, in counts.
PEINPOS	The window of tolerance for declaring an "in position" state.
INMODE# 5	Defines digital input # as the signal that indicates whether the position limit has been reached in the positive direction.
INMODE# 6	Defines digital input # as the signal that indicates whether the position limit has been reached in the negative direction.
LIMSWITCHPOS LIMSWITCHNEG	Indicate the status of all positive and negative limit events. Read only.
POSLIMMODE	Enables and disables the use of software position limits and/or transient position limits and/or homing limits.
POSLIMPOS POSLIMNEG	The maximum and minimum values, in counts, for the software position limits.

5.8 Motor Direction

When the motion command is positive, the direction of motion can be explicitly reversed. The positive direction for a rotary motor, for example, can be either clockwise or counterclockwise, depending on the application requirements.

Motion direction is tested and/or reversed and/or confirmed in the Motor Setup wizard.

The following parameters are used to define motor direction:

VarCom	Description
DIR	Motor direction. DIR can be used to invert the values of position feedback (PFB), velocity (V) and current (ICMD), thereby inverting the direction of motor movement.
MPHASE	The encoder phase relative to the standard commutation table. To reverse the direction of rotation, 180 degrees is added to the value of MPHASE.
MFBDIR	Defines several direction and polarity settings. MFBDIR values are set by the MOTORSETUP procedure.

Caution!

The values of DIR and MPHASE must be changed at the same time, before the drive is enabled, otherwise a commutation fault (motor runaway) may occur.

5.9 New Motor Wizard

If you are using a motor whose parameters are not available in the default sets of motor libraries in ServoStudio 2, you can use the New Motor wizard to define your motor. Once defined, the new motor is added to the set of User Motors in the motor library.

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

Press **Define New Motor** to activate the wizard.

Note

It is recommended that you activate the New Motor wizard from the Motor screen, because parameters cannot be saved to the User Motor library when the wizard is activated from Motor Setup.

A series of dialog boxes prompts you to provide motor parameters, which you should be able to extract from the motor datasheet.

The New Motor wizard allows you to select units and enter values according to the information in your motor's datasheet. In addition, the wizard includes a unit conversion function. Once you have entered all data in the wizard, ServoStudio 2 converts the units into the equivalent values used by the drive. These converted values are maintained in the motor library and in the drive.

New Motor – Motor Specification

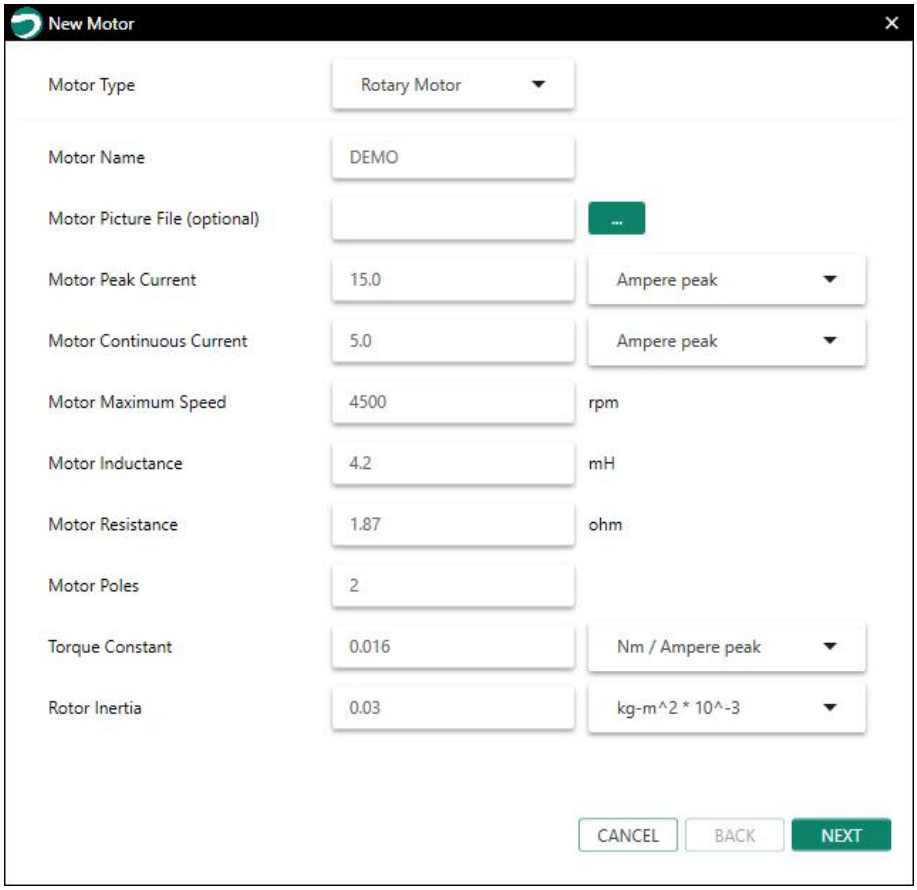


figure5-7 New Motor Definition

VarCom	Description
MOTORTYPE	Rotary Motor / Linear Motor
MIPEAK	Motor Peak Current
MICONT	Motor Continuous Current
MSPEED	Motor Maximum Speed
ML	Motor Inductance
MR	Motor Resistance
MPOLES	Motor Poles
MKT	Torque Constant (Rotary Motor)
MJ	Rotor Inertia (Rotary Motor)
MKF	Torque Constant (Linear Motor)
MMASS	Mass of Motor Without Load (Linear Motor)
MPITCH	Motor Pitch (Linear Motor)

New Motor – Motor Feedback Selection

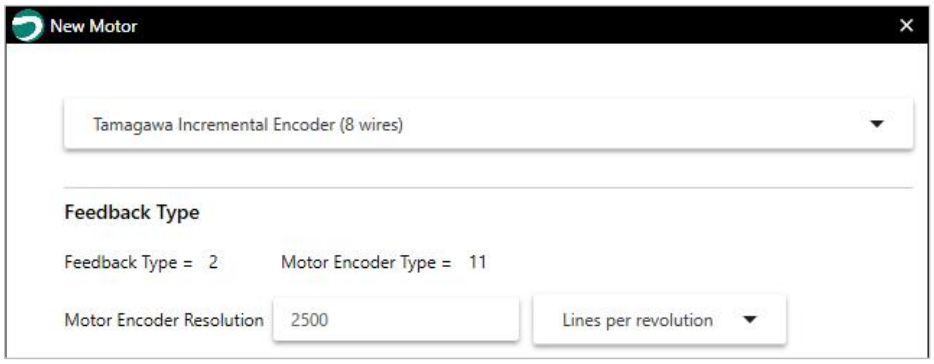


figure5-8 New Motor - Feedback

VarCom	Description
FEEDBACKTYPE	Feedback Type
MENCTYPE	Motor Encoder Type
MENCRES	Motor Encoder Resolution

New Motor – Thermal Protection Definition

figure5-9 New Motor – Thermal Protection

VarCom	Description
THERMODE	Motor Over-Temperature Mode

New Motor – Verify

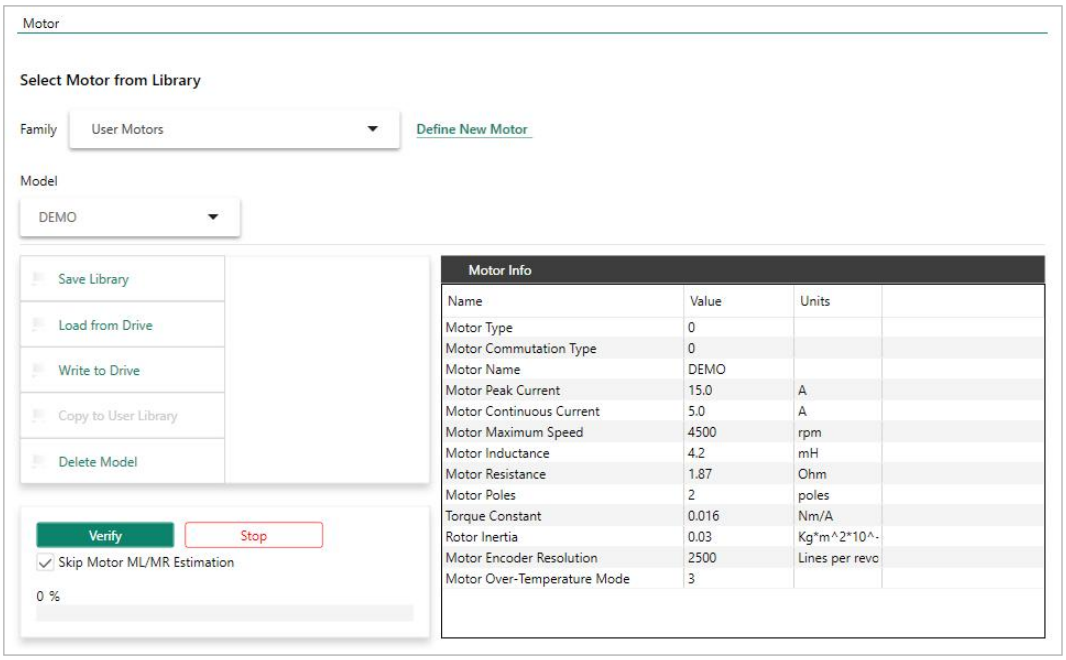


figure5-10 New Motor – Verify

Verify enables the drive and moves the motor!

Complete the procedure according to where the New Motor wizard was activated,

- If the New Motor wizard was activated from the Motor screen, press these buttons in the following order:
  - **a.** **Save Library** to save the set of motor parameters to the User Motors library.
  - **b.** **Write to Drive** to send the parameters to the drive.
  - **c.** **Verify** to test the motor configuration.
  - **d.** Wait for the Motor Setup Successful message to appear.
- If the New Motor wizard was activated from the Motor Setup wizard, press **Verify** to send parameters to the drive and test the motor configuration. Wait for the Motor Setup Successful message. (The motor cannot be saved to the User Motors library.)

6. Application Setup

6.1 Parameters

6.1.1 Configuration Parameters

VarCom is a proprietary set of commands and variables, or parameters, used to configure drive functionality when the host and drive are communicating over a serial connection.

VarCom parameters can be accessed and manipulated through ServoStudio 2 software, in either graphical interface screens, or a command-line terminal screen.

While setting parameters, pay close attention to any warning or error messages that appear in ServoStudio 2, and any flashing codes on the drive digital display.

Disable the drive before manipulating motor and feedback parameters.

Many parameters can be modified while the drive is enabled.
Exercise caution, however, as motor behavior may change.

If a parameter cannot be modified while the drive is enabled, a prompt to disable the drive will be displayed.

6.1.2 Managing Parameters - Drive Memory

The LDHD2 drive has two types of memory for storing the drive's parameters:

- **Flash**: Non-volatile memory. It holds the drive's default parameter values (contained within the drive's firmware), as well as the saved set of parameters.
- **RAM**: Volatile memory. The drive's working memory. Parameter values are maintained in RAM while you configure and test the drive and adjust parameters. If power to the drive is disconnected, any unsaved changes in the parameters will be lost.

During power up, the LDHD2 loads parameter values from the non-volatile memory to RAM, and a checksum of these parameter values is calculated. If the checksum is invalid, default parameter values (which are hard-coded in the drive's firmware) are loaded into RAM and a Parameter Memory Checksum Failure fault is set.

The following diagram illustrates the relationships among the different types of memory and commands used for managing the drive parameters.

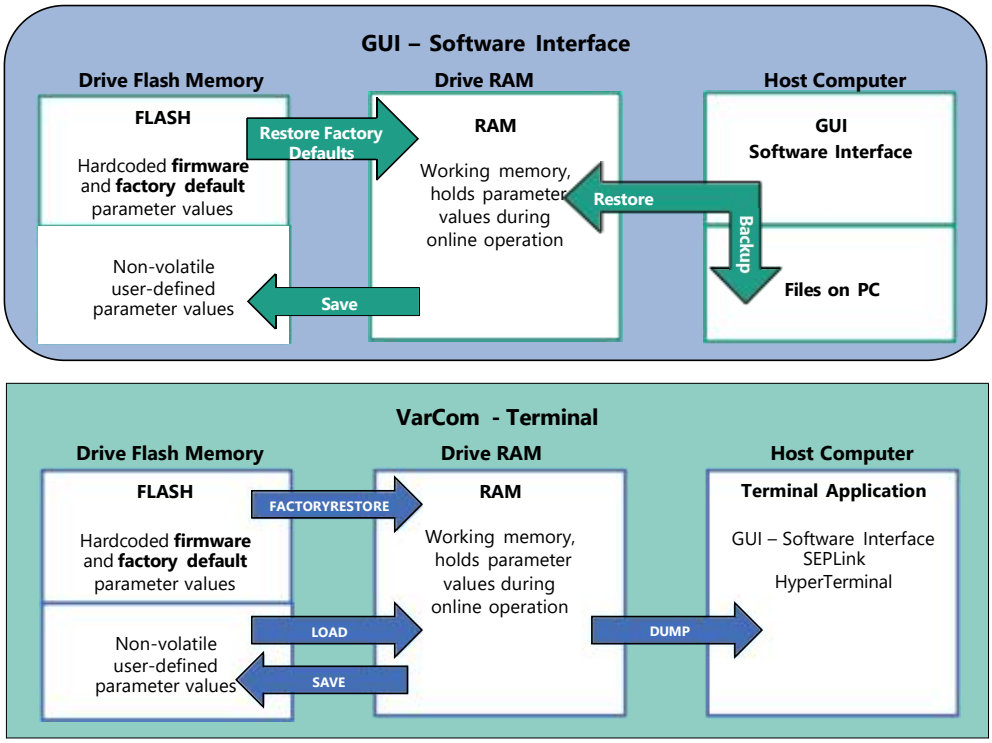


figure6-1 Memory and Commands for Managing Parameters

In ServoStudio 2, drive parameters can be saved to non-volatile memory at any time by pressing the Save button on the toolbar.

6.2 Application Setup Wizard

Application Setup – Interface

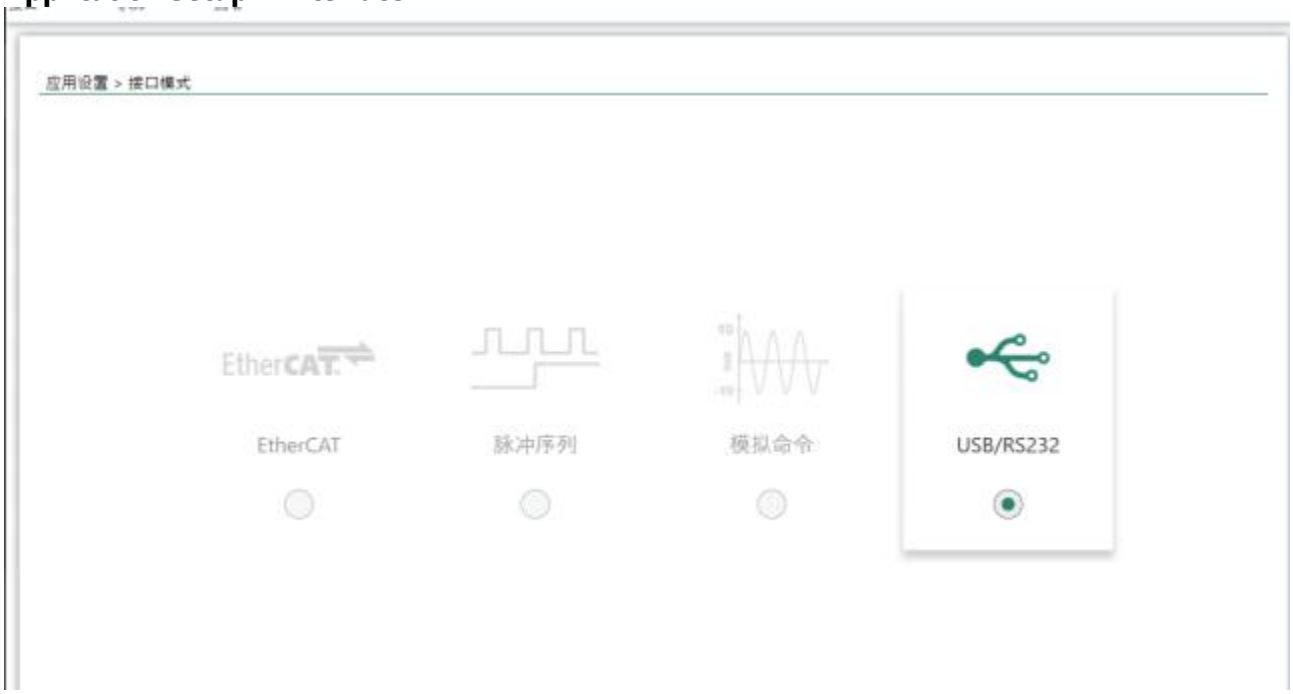


figure6-2 ServoStudio 2 – Application Setup Wizard –Interface Mode

The Application Setup wizard guides you through a procedure that will set drive parameters for your particular application.

The specific Application Setup procedure is determined by the Interface Mode selected in the first step. Subsequent steps may include PDO mapping, definition of position units, gearing ratios, limits, homing, and functionality of inputs and outputs.

Note

When the software is offline, all Interface Modes are displayed.
When the software is communicating with the drive, only the relevant modes are shown.

Application Setup – Operation Mode

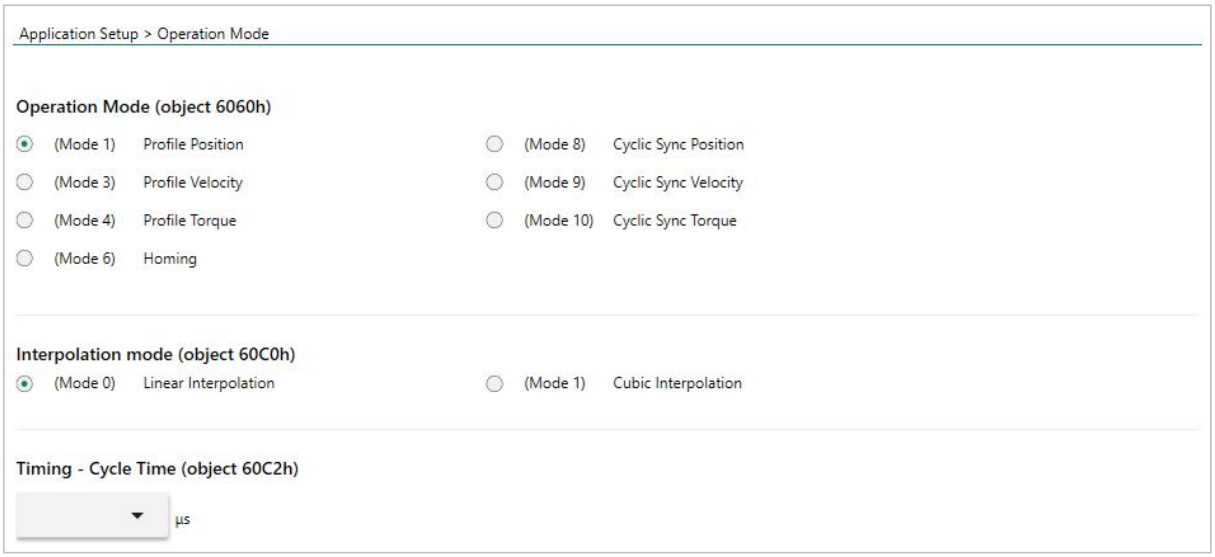


figure6-3 ServoStudio 2 – Application Setup Wizard – Operation Mode (EtherCAT)

Defines the operation mode for a drive system operating in an EtherCAT network.

Refer to the LDHD2 EtherCAT Reference Manual.

Application Setup – Pulse Train

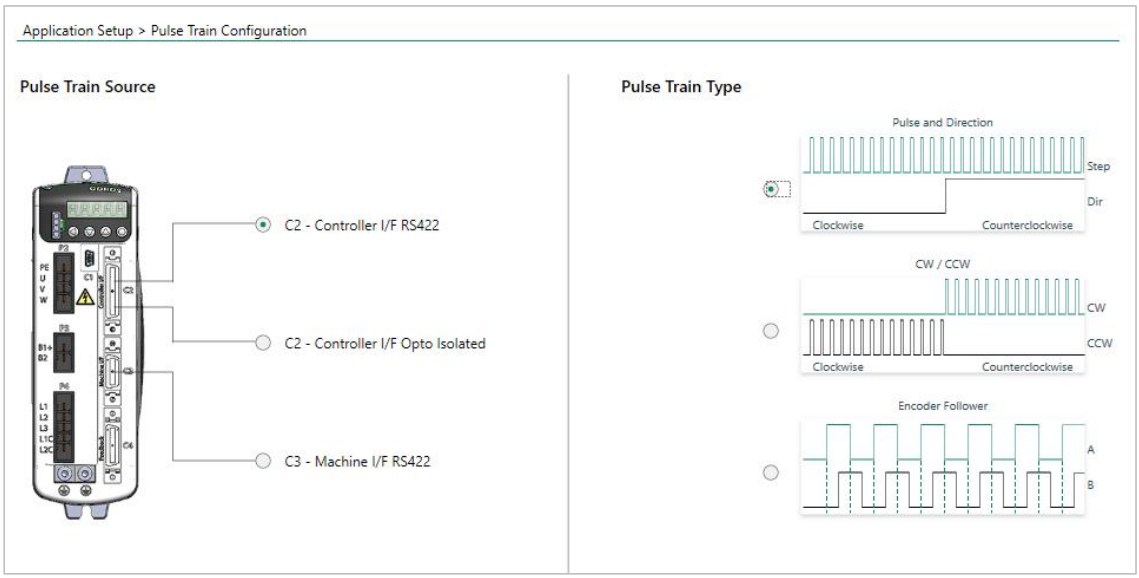


figure6-4 ServoStudio 2 – Application Setup Wizard – Pulse Train

Defines the gearing method for a drive system operating according to gearing (pulse train).

Refer to: *Gearing/Pulse Train Operation*

Application Setup – Resolution

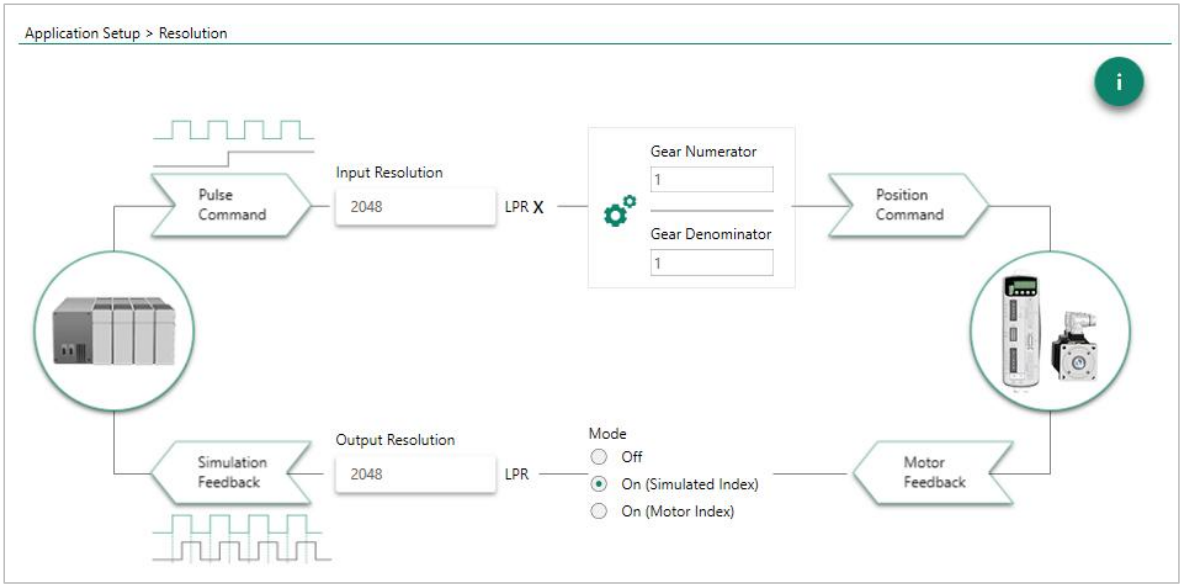


figure6-5 ServoStudio 2 – Application Setup Wizard – Resolution (Pulse Train)

Defines the resolution, gearing ratio, and feedback parameters for a drive system operating according to gearing (pulse train).

Refer to: *Gearing/Pulse Train Operation*

Application Setup – Filters

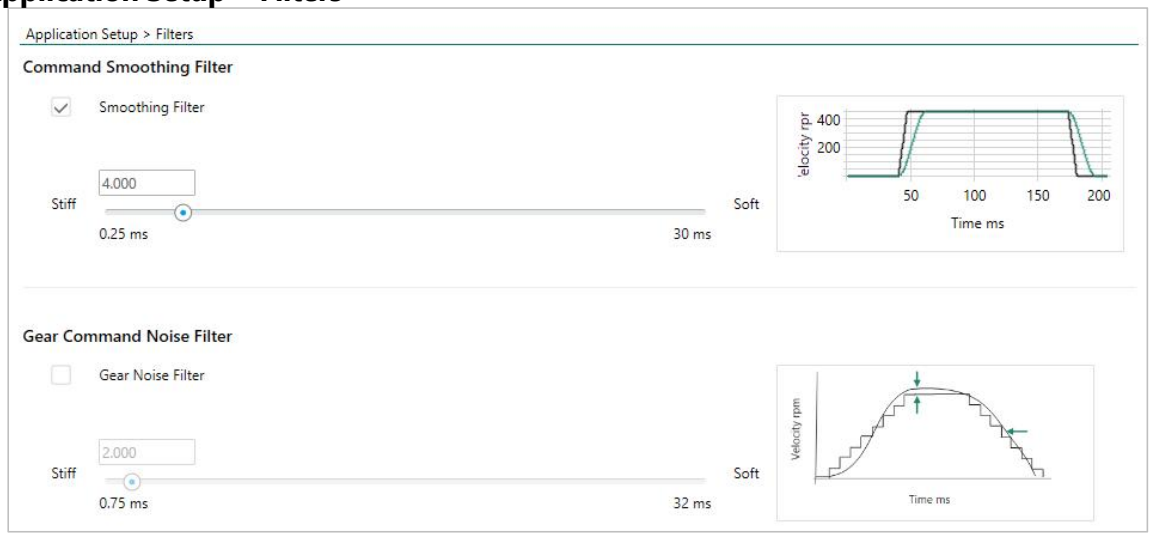


figure6-6 ServoStudio 2 – Application Setup Wizard – Filters (Pulse Train)

Defines the resolution, gearing ratio, and feedback parameters for a drive system operating according to gearing (pulse train).

Application Setup – Limits

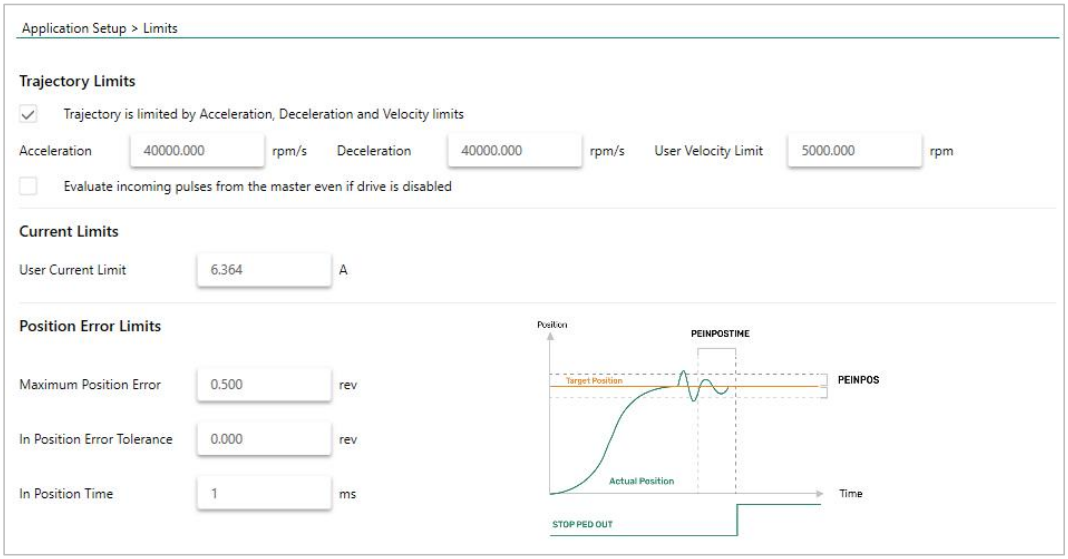


figure6-7 ServoStudio 2 – Application Setup Wizard – Limits (Pulse Train)

Defines the limit parameters for a drive system operating according to gearing (pulse train).

Application Setup – PDO Mapping

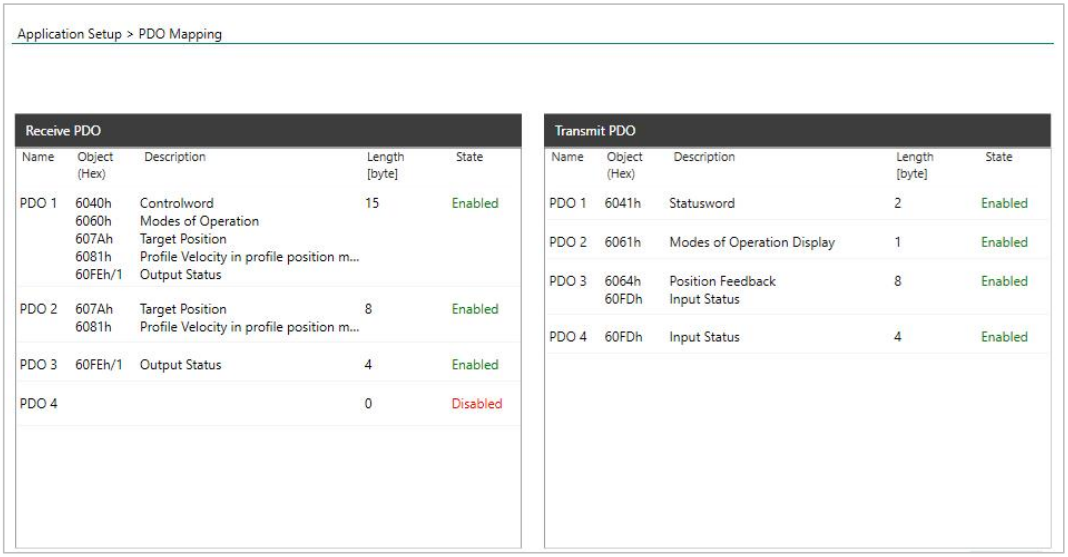


figure6-8 ServoStudio 2 – Application Setup Wizard – PDO Mapping (EtherCAT)

Displayed when Interface Mode is EtherCAT

Application Setup – Position Units

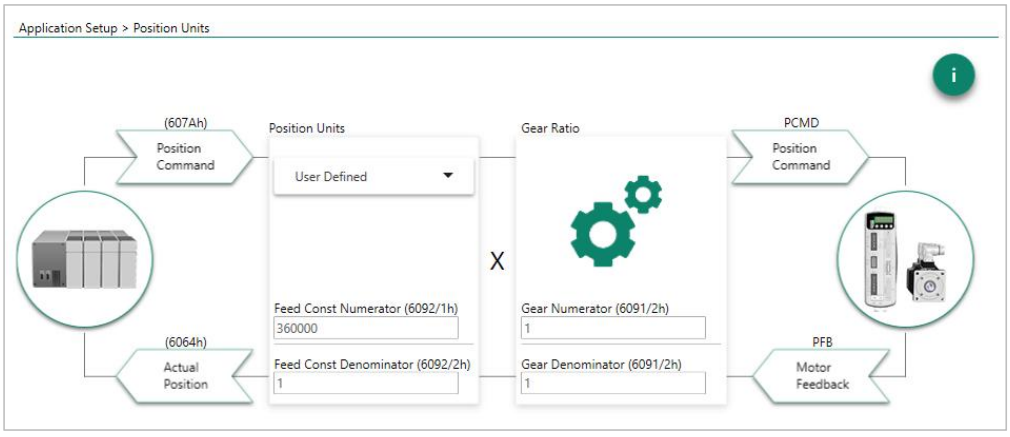


figure6-9 ServoStudio 2 – Application Setup Wizard – Position Unit

Displayed when Interface Mode is EtherCAT

Application Setup – Inputs/Outputs

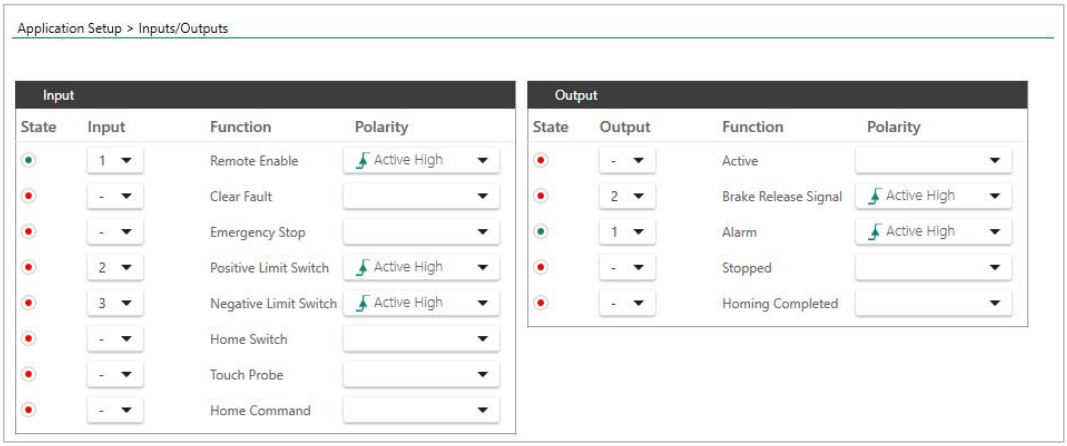


figure6-10 ServoStudio 2 – Application Setup Wizard – Inputs/Outputs

Displayed when Interface Mode is:

- EtherCAT
- Pulse Train
- USB

Application Setup – Homing

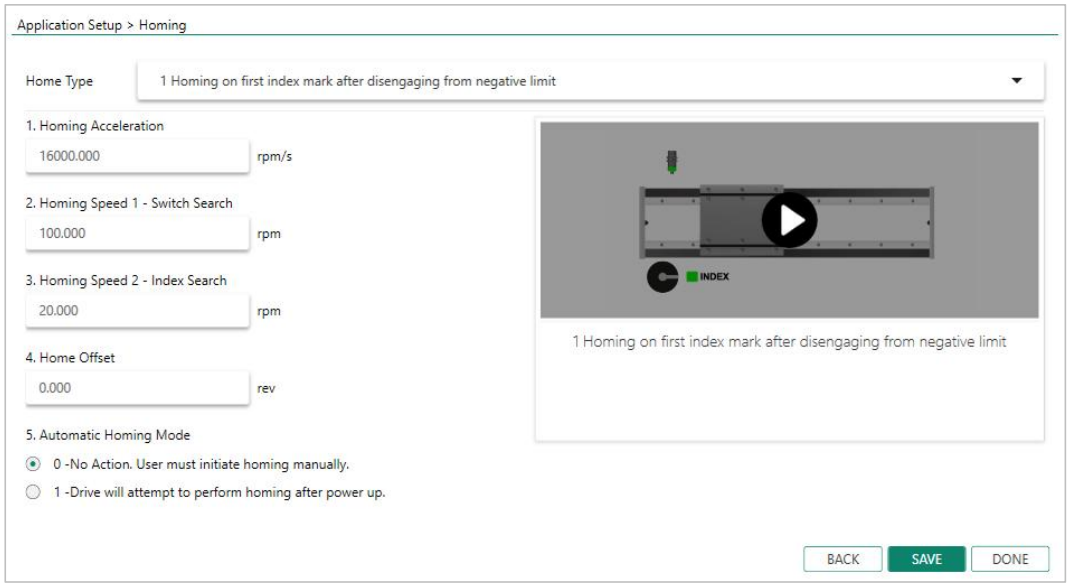


figure6-11 ServoStudio 2 – Application Setup Wizard – Homing

Displayed when Interface Mode is:

- EtherCAT
- Pulse train
- USB

Application Setup – Save

This option appears in the Application Setup – Homing step when the software is communicating with the drive.

6.3 Communication

Commissioning the drive through ServoStudio 2 requires a USB connection. Once the drive is configured, you can then connect it to a PLC or controller over an EtherCAT network.

Note

For communication through a USB connection and pulse train interface, the drive must be set to COMMODE 0.

For communication over EtherCAT networks, the drive must be set to COMMODE 1. COMMODE 1 is the drive's factory default setting.

The following parameters are used to configure and monitor communication:

VarCom	Description
COMMODE0	While COMMODE 0 is in effect: • USB communication is enabled. • EtherCAT communication is disabled. • Reference commands are accepted via serial/pulse interfaces only. • The drive can be fully controlled (enabled, motor movement, parameter modification) by ServoStudio 2.
COMMODE1	While COMMODE 1 is in effect: • EtherCAT communication is enabled. • USB communication can be used as a utility for monitoring and changing parameters with limited functionality. • Reference commands cannot be received via serial/pulse interfaces. • The drive can be fully controlled by a fieldbus device. • The drive cannot be enabled and the motor cannot be moved through ServoStudio 2. **Note**: Certain functions must be performed by means of ServoStudio 2. These functions are restricted to parameters that do not interfere with fieldbus operation. If you attempt to set a parameter that interferes with fieldbus operation, the drive will issue an error code in the digital display and/or an error message in ServoStudio 2.
BAUDRATE	Sets the serial communication bit rate between the drive and the host computer.

The ServoStudio 2 Communication screen allows you to establish communication between the host computer and the drive over a serial connection. Alternately, the first step of the Motor Setup wizard will configure communication between the host computer and the drive.

6.3.1 Serial Baud Rate

The LDHD2 default baud rate is 115200. If the setting is changed and saved in the drive's non-volatile memory, the drive will use the saved baud rate at power up.

In the event of a connectivity problem, for example, you can try using a lower baud rate.

Procedure: Modifying the Serial Baud Rate

To modify baud rate settings, the change must be made in both the drive and ServoStudio 2 software.

1. Change the baud rate in the drive:

- Go to the Terminal screen.
- Issue a command to change the baud rate; for example: **BAUDRATE 19200**
- Press **Enter**.

Communication is lost as soon as Enter is pressed, and ServoStudio 2 goes offline.

2. Change the baud rate in ServoStudio 2.

- Go to the Communication screen.
- Select the same baud rate specified in Terminal for the drive.

figure6-12 Serial Baud Rates

- Press **Connect**.

If successful, ServoStudio 2 will reconnect with the drive, and go back online.

6.4 Power Rating

Power rating parameters are pre-set and written to the drive. These parameters are manufacturer-defined and should not be manipulated by the user; if you want to make any changes to these parameters, contact Technical Support.

Use the ServoStudio 2 Power Rating screen to view current and voltage values, and set some voltage parameters.

The following parameters are used to monitor and manipulate power rating.

VarCom	Description
DICONT	Drive continuous current. Defined in hardware. Read only.
DIPEAK	Drive peak current. Defined in hardware. Read only.
OVTHRESH	The level for detection of bus over-voltage. Defined in hardware. Read only.
UVMODE	Defines how the drive will respond to an under-voltage fault.
UVRECOVER	Defines how the drive will recover from an under-voltage fault.
UVTHRESH	The level for detection of bus under-voltage condition.
UVTIME	The duration of an under-voltage condition before latching a fault.

VarCom	Description
VBUS	Bus voltage (DC).
VBUSREADOUT	The actual bus voltage of the drive. Defined in hardware. Read only.

6.5 Feedback

When the motor is selected from the ServoStudio 2 Motor Library, motor feedback parameters are pre-set and written to the drive. These parameters are manufacturer-defined and should not be manipulated by the user; if you want to make any changes to these parameters, contact Technical Support.

FEEDBACKTYPEdefines the type of motor feedback used in the drive application.

The LDHD2 supports various motor feedback technologies and devices, including:

- BiSS-C encoder
- EnDat encoder
- Incremental A-quad-B encoder, with or without Hall sensors

6.5.1 Incremental Encoder

Types and Resolution

The LDHD2 supports several types of incremental encoders.

The following parameters are used to configure and monitor incremental encoders.

VarCom	Description
MENCTYPE	The type of encoder being used on the motor.
MENCRES	The resolution of the encoder, in number of lines per revolution of the motor. For an incremental encoder, MENCRES × 4 equals the number of encoder counts per revolution.

The LDHD2 monitors all encoder signal wires, and generates an A/B Line Break fault (**r4** on the 7-segment display) if any wire is broken.

Hall Signals

The LDHD2 supports single-ended (or open-collector) Hall signals.

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

VarCom	Description
HALLSTYPE	The type of Hall signals.
HALLS	Reads the state of the Hall signals.
HALLSINV	Inverts the polarity of individual Hall signals associated with motor phases UVW.

The LDHD2 monitors the state of the Hall signals, and will generate an Illegal Halls fault (**r6** on the 7-segment display) if either state 000 or 111 is detected.

Encoder Index

Encoders often have an additional channel, referred to as a marker channel, zero pulse, or index channel. This channel outputs one pulse per revolution, and is typically an extremely narrow pulse equal to about one-quarter of the width of an A or B channel pulse, but may be wider. The encoder index can be used for homing (absolute position reference) and for commutation alignment.

You can also use the command Find Index in the ServoStudio 2 Motor Feedback screen to determine the position of the index signal.

The following parameter is used to set and monitor the encoder index.

VarCom	Description
MENCZPOS	The encoder index position.

The LDHD2 monitors the index signal wires, and will generate an Index Line Break fault (**r5** on the 7-segment display) if any wire is broken.

Phase Finding

The Phase Finding procedure is used to initialize commutation for incremental encoder systems.

Note The Phase Finding procedure can be used only on a balanced axis; it cannot be used for unbalanced mechanics, such as a vertical Z-axis. In addition, it cannot be used when gantry mode is in effect.

You can also use the command Find Phase in the ServoStudio 2 Motor Feedback screen to determine the correct commutation.

The following parameters are used to configure phase finding.

VarCom	Description
PHASEFINDMODE	The method to be used for the commutation phase finding.
PHASEFIND	Starts the commutation initialization procedure for incremental encoder systems.
PHASEFINDGAIN	Adjusts the gain of the phase finding mechanism.
PHASEFINDI	Adjusts the current of the phase finding mechanism.
PHASEFINDTIME	The duration of the phase finding mechanism in a soft start.

6.5.2 BiSS-C Interface

BiSS is an open interface for sensors and actuators. The BiSS-C standard allows vendors of such feedback devices to define a small set of commands that will cause the feedback device to perform certain functions. BiSS-C implementation in the drive is fully bidirectional.

The following commands are used to configure and monitor a BISS-C feedback device.

VarCom	Description
BISSCFIELDS	Sets the number of bits allocated for transmission of position data within a BiSS-C packet, and the number of effective bits. It is applicable for both rotary and linear encoders. The values used for the command arguments are taken from the information found in the datasheet provided by the encoder manufacturer.
BISSCINFO	Returns information about the BiSS-C device.

6.5.3 EnDat 2.x Bidirectional Interface

The EnDat interface is a digital, bidirectional interface for encoders. It is capable of transmitting position values from incremental and absolute encoders as well as transmitting or updating information stored in the encoder, or saving new information. The serial transmission method requires only four signal lines. The data is transmitted in synchronism with the clock signal from subsequential electronics. The type of transmission (e.g., position values, parameters, diagnostics) is selected by mode commands that the subsequential electronics send to the encoder.

LDHD2 supports the EnDat 2.1 communication protocol, which is a subset of the EnDat 2.2 protocol. All EnDat 2.2 capable devices support the 2.1 protocol, including the commands and queries that are relevant to LDHD2; accordingly, all EnDat 2.2 capable devices will work with LDHD2.

EnDat 2.x can be used with the LDHD2 in following ways:

- EnDat 2.x Communication Only: for setups in which the drive relies only on the serial data from the feedback device as the source of position information.

Notes

LDHD2 does not support the ability to query and set parameters during position-feedback operations.

LDHD2 communication rate is 2 MHz. (To modify the communication rate, refer to VarCom FEEDBACKBR.)

Initialization of the EnDat encoder takes about 2.5 seconds; during this process the message "ENDAT initialization incomplete" will be displayed if the drive status is queried (using command ST).

The +5 VDC supply to the EnDat encoder must be switched off during (re)initialization. During the EnDat initialization, the LDHD2 switches off the +5 VDC it supplies to the encoder. However, if the encoder receives +5 VDC from a different source, and it is not switched off, initialization is likely to fail.

6.5.4 Encoder Simulation Output

An encoder simulation output, also referred to as an equivalent encoder output (EEO) or a buffered encoder output, is available on the I/O interface (C4).

The following parameters are used to configure simulation.

VarCom	Description
ENCOUTMODE	Switches the encoder simulation on or off, and sets the functionality.
ENCOUTRES	The resolution, in equivalent lines-per-revolution, of the encoder simulation output.
ENCOUTZPOS	The index offset value of the encoder simulation output.

6.6 Motion Units

The LDHD2 has configurable units of acceleration, velocity and position, for both linear and rotary motor systems. The unit definitions can be a user preference or a property of the specific motor being used.

Use the ServoStudio 2 Motion Units screen for viewing and defining motion units.

The following parameters are used to monitor and manipulate motion units.

VarCom	Description
UNITSROTPOS	The units of position variables in a rotary system.
UNITSROTVEL	The units of velocity variables in a rotary system.
UNITSROTACC	The units of acceleration and deceleration variables in a rotary system.
UNITSLINPOS	The units of position variables in a linear system
UNITSLINVEL	The units of velocity variables in a linear system.
UNITSLINACC	The units of acceleration and deceleration variables in a linear system.
PNUM PDEN	Conversion factors of the user-defined unit. They are used to multiply the motor revolution (rotary motors) or the motor pitch (linear motors), according to the type of motor (MOTORTYPE).
FBGDS	The conversion factor of the fieldbus device's drive shaft revolution.
FBGMS	The conversion factor of the fieldbus device's gear shaft revolution.

6.7 Current Foldback

The current foldback is a mechanism used by LDHD2 to protect the drive and motor from overheating due to excessive current. Current foldback is set separately for the drive and for the motor.

Current foldback limits the root mean square (rms) value of current to the drive and/or the motor.

When the motor is selected from the ServoStudio 2 Motor Library, current foldback parameters are pre-set and written to the drive. These parameters are manufacturer-defined and should not be manipulated by the user; if you want to make any changes to these parameters, contact Technical Support.

Use the ServoStudio 2 Current Foldback task screen for viewing and configuring motor and drive foldback parameters.

The following parameters are used to monitor and manipulate foldback properties.

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 delay time
MFOLDT	Motor foldback time constant
MFOLDR	Motor foldback recovery time
MFOLDDIS	Motor foldback enabled/disabled

6.8 Digital Inputs

The LDHD2 digital inputs. have a propagation delay up to 1 millisecond.

Use the ServoStudio 2 Digital I/Os screen to configure and view the state of the digital inputs.

The following parameters are used to configure and monitor the digital inputs.

VarCom	Description
IN	Reads the state of a specified digital input.
INPUTS	Reads the state of all digital inputs.
INMODE	Defines the functionality of the digital input.
ININV	Inverts the polarity of a specified input.

ServoStudio 2 includes a Drive Script tool for programming instructions for digital inputs. These scripts can modify drive behavior while a machine is in operation, such as increasing or reducing acceleration, initiating a movement, setting a variable, or switching operation modes. Refer to *Digital Input Activation of Drive Scripts* in the ServoStudio 2 Reference Manual.

6.9 Digital Outputs

The LDHD2 digital outputs have a propagation delay up to 1 millisecond.

Use the ServoStudio 2 Digital I/Os screen to configure and view the state of the digital outputs.

The following parameters are used to configure and monitor the digital outputs.

VarCom	Description
OUT	Reads the state of a specified digital output.
OUTPUTS	Reads the state of all digital outputs
OUTMODE	Defines the functionality of the digital output

6.10 Disable Mode

The disabling of the drive may be the result of an explicit command from the motion controller or the drive's own response to a fault condition. When the drive becomes disabled, the Disable Mode function can be used in certain cases to bring the motor to a fast stop before power to the motor is shut off. This reduces the amount of motor coasting.

Use the ServoStudio 2 **Emergency Stop** screen to select the methods and parameters to be used for stopping the motor when the drive becomes disabled.

The Disable mode function consists of two mechanisms:

- **Active Disable** brings the motor to a stop by means of a controlled deceleration to zero velocity, and then disables the drive. Active Disable cannot be applied when the drive is operating in a current control mode (OPMODE 2 or OPMODE 3).
- **Dynamic Brake** holds the motor while the drive is disabled by applying only the motor's back-EMF to the stopping current; it can therefore be used even in the event of feedback loss.

VarCom	Description
DISMODE	Defines how the drive will respond when it becomes disabled.
DISMODE0	No active disabling; no dynamic braking.
DISMODE1	No active disabling; dynamic braking on fault only.
DISMODE2	No active disabling; dynamic braking on any disable.
DISMODE3	Active disabling on fault*; no dynamic braking.
DISMODE4	Active disabling on fault*; dynamic braking on fault only.
DISMODE5	Active disabling on fault*; dynamic braking on any disable.

Note Faults that require immediate disable (to prevent drive damage) and feedback faults that might cause a commutation error (runaway motor condition) cannot issue Active Disabling.

Three parameters affect the behavior of the disabling and braking.

VarCom	Description
DISSPEED	Defines the velocity threshold below which the motor is considered stopped and the Active Disable timer starts the countdown to disable. The motor velocity must remain below this threshold for at least 50 ms for the motor to be considered stopped.
DISTIME	Defines the continuous time the motor must remain below DISSPEED before the drive is disabled. The DISTIME counter begins only after motor velocity has been below DISSPEED for at least 50 ms.

VarCom	Description
DECSTOP	Defines the deceleration rate of the ramp down.

6.10.1 Active Disable

Active Disable prevents motor coasting while the axis is disabled.

The Active Disable mechanism brings the motor to a stop by means of a controlled ramp down to zero velocity, and then disables the drive.

Note Active Disable cannot be applied when the drive is in a current control mode (OPMODE 2 or OPMODE 3); it works in all other operation modes.

Figure 6-13shows how motor coasting occurs when Active Disable is not used. As soon as the drive is disabled, the velocity command is set to zero. The actual velocity then decreases as a function of the inertia and friction.

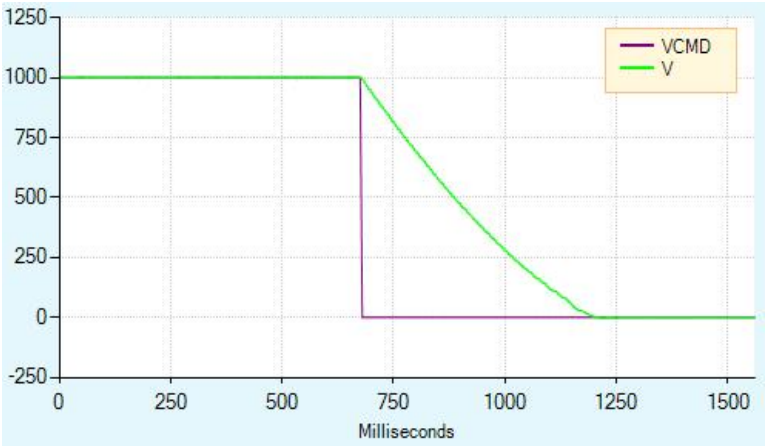


figure6-13 Disabling Without Active Disable

Figure 6-14illustrates what happens when Active Disable is in effect. As soon as the drive receives the disable command, the velocity command is ramped down to zero, and only then is the drive disabled.

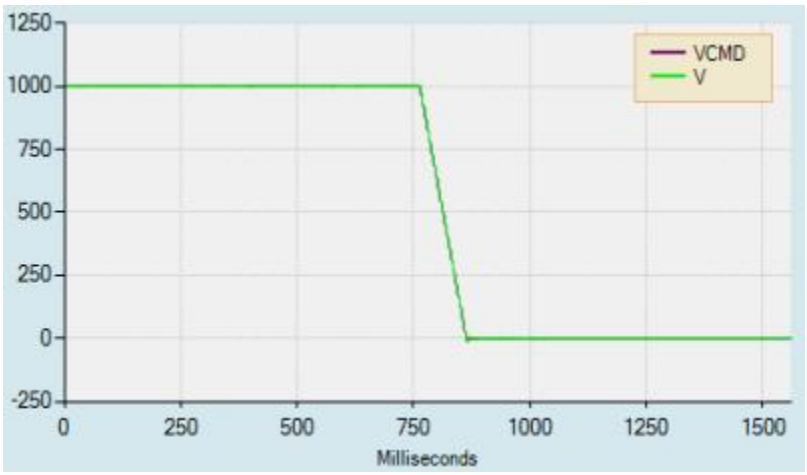


figure6-14 Disabling With Active Disable

Figure 6-15shows the effect of DISSPEED and DISTIME. In this example, DISSPEED is set to 1000, and DISTIME is set to 1 ms. After the motor speed remains below 1000 for 50 ms, and the time defined by DISTIME elapses, the drive is disabled and the motor coasts to a stop.

In this example, approximately 110 ms elapse from the time the motor velocity goes below 1000 and the time the drive is disabled.

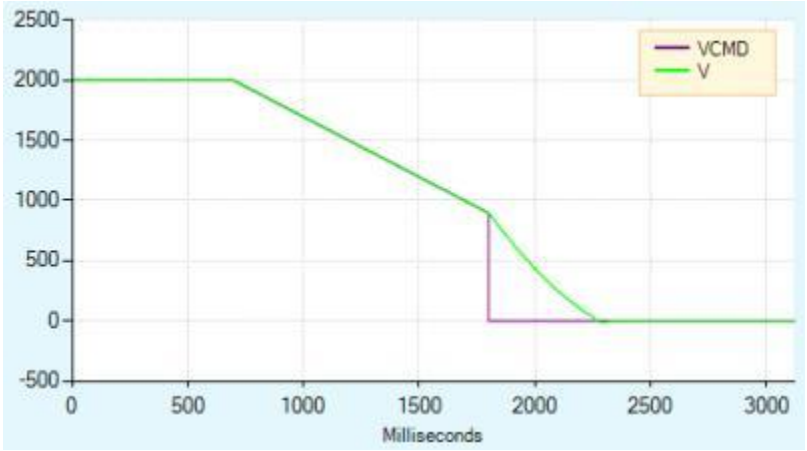


figure6-15 Effect of DISSPEED and DISTIME on Active Disable

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

If an additional disable command (VarCom **K**) is issued during the ramp down, the ramp down process is aborted and the drive is immediately disabled.

Figure 6-16shows the effect of a second disable command. In this example, DISSPEED is set to 1000, and a second disable command is issued before the motor speed has ramped down to that level.

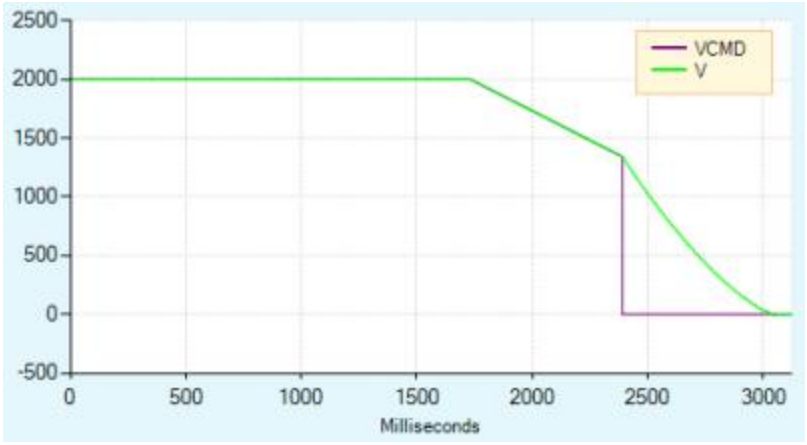


figure6-16 Effect of Second Disable Command on Active Disable

The diagram in the ServoStudio 2 Emergency Stop screen illustrates the behavior of Active Disable.

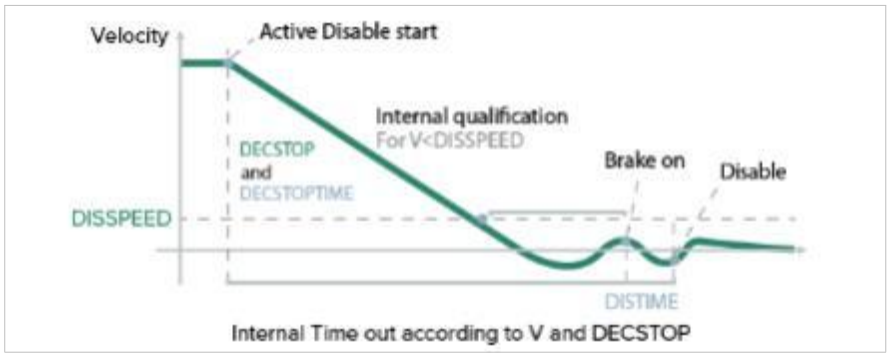


figure6-17 Disable Stop

Notes

If one of the digital outputs is configured for brake control, then the brake will be engaged as soon as the DISTIME timer begins counting.

If the internal timeout (which is calculated according to the actual velocity and DECSTOP) expires, the ramp down mechanism will also abort, as indicated by 1 in the Disable Stop diagram.

6.10.2 Dynamic Brake

Dynamic Brake is a mechanism that allows a disabled drive to hold the motor. Only the motor's back-EMF is used to apply the stopping current.

The variable ISTOP is used to set the maximum current allowed during the dynamic braking process.

Figure 6-18illustrates motor coasting, that is, no Dynamic Brake (and no Active Disable). The velocity command is set to 0 as soon as the drive is disabled. The actual velocity then decreases as a function of the system inertia and friction.

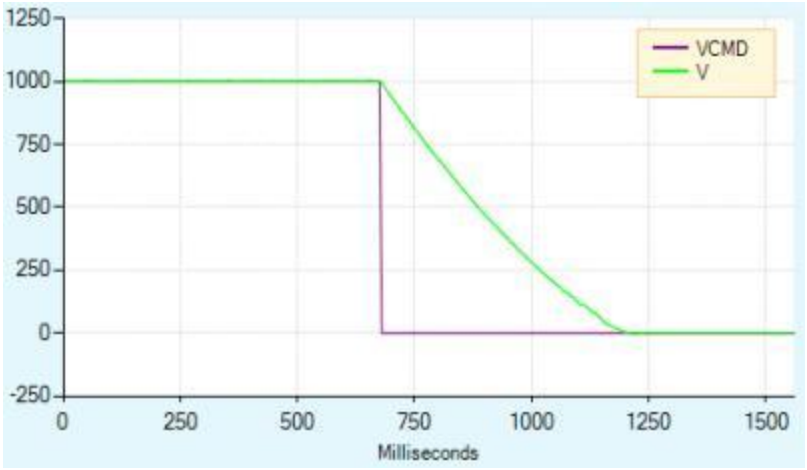


figure6-18 Motor Coasting, Without Dynamic Brake

Figure 6-19shows what happens when Dynamic Brake is in effect. As in the figure above, the velocity command is set to 0 as soon as the drive is disabled. However, the actual velocity ramps down as the braking is applied.

Unlike Active Disable, the velocity does not ramp down according to a motion profile. The ramp down rate is a function of the maximum current allowed (variable ISTOP) and the system inertia and friction.

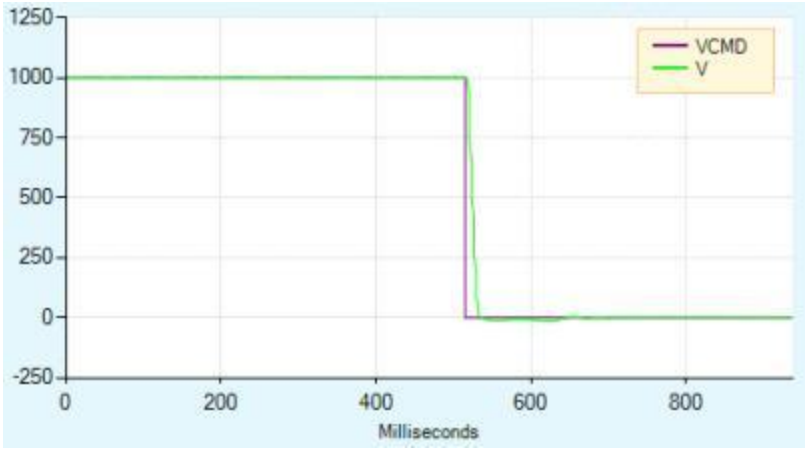


figure6-19 Dynamic Brake

Figure 6-20shows Dynamic Brake with a very low value of ISTOP. In this instance, it takes longer to bring the motor to a stop.

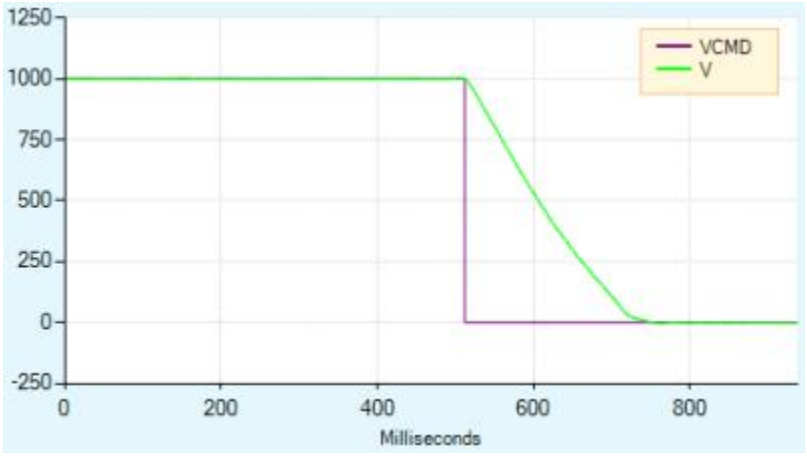


figure6-20 Dynamic Brake with Low ISTOP Value

In DISMODE 4 and DISMODE 5 both Active Disable and Dynamic Brake are supported. In these cases, Active Disable is used to bring the motor to a stop, and Dynamic Brake is activated after DISTIME.

6.11 Motor Brake Control

Refer to*Motor Brake Wiring*and to the procedure below.

The polarity of the digital output can be altered to make the drive electronics match those of the motor control circuit.

The LDHD2 disable time is programmable by means of the DISTIME parameter. When the drive receives a Disable command, it first switches off the brake output and then waits for the brake disengage time before actually becoming disabled.

The brake engage time is not programmable. When the drive receives an Enable command, it simultaneously switches on the brake output and becomes enabled.

The drive needs a maximum of 1.5 milliseconds to become enabled, while a brake typically takes tens of milliseconds to disengage.

Procedure: Configuring Digital Output to Control Brake

To configure the digital output, perform the following procedure in ServoStudio 2.

1. Define the output.

Go to the Digital I/Os screen, and set an output (e.g., Output 1) to mode 2-Brake Release Signal.

figure6-21 Digital Output Settings for Motor Brake Control

By default:

- When LDHD2 is enabled, the brake output is on.
- When LDHD2 is disabled, the brake output is off.

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

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

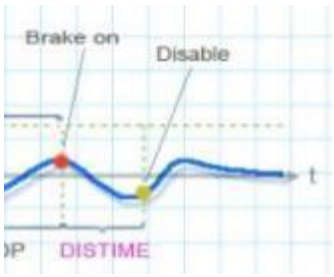


figure6-22 Active Disable Time (DISTIME)

Whenever a Disable command is executed, the LDHD2 immediately changes the brake output value, and waits the Active Disable Time (DISTIME) before disabling LDHD2 control.

Whenever a fault such as Feedback Lost occurs, the drive immediately toggles the brake output value and disables LDHD2 control.

6.12 Homing

The LDHD2 provides numerous methods for homing the motor.

The parameter HOMETYPE defines when direction of motion is reversed during homing, the homing trigger (e.g., switch, index), and other conditions.

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

Additional homing types have been defined per customer requests.

Use the ServoStudio 2 Homing screen for defining and executing the homing procedure.

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

VarCom	Description
AUTOHOME	Defines whether automatic homing will be performed at power up.
HOMEACC	The value of acceleration and deceleration during the homing process.
HOMECMD	Starts the homing process.
HOMECMD0	Stops the homing process.
HOMEOFFSET	Sets an offset, in counts, for the Home position.
HOMESPEED1	The initial velocity used in the homing process during the search for limit switches, home switches, and hard stops.
HOMESPEED2	The velocity used in the homing process during the search for the homing trigger, which may be an index pulse, a limit switch transition, a home switch transition, or another source (as defined byHOMETYPE).
HOMESTATE	Displays the current state of system homing.
HOMETYPE	Defines the type of homing process that will be performed.

6.12.1 Home at Index

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

Homing methods: HOMETYPE 1–14, 33, 34, -9, -10, -13, -14, -34, -65, -66, -97, -98

In these methods, HOMESPEED1 is used until a limit switch, home switch, or hard stop is detected.

Once the appropriate sequence of events has occurred (such as direction reversal at limit switch), the axis is moved at HOMESPEED2 to detect the index pulse(or its equivalent on absolute encoders).

6.12.2 Home at Positive Edge of Home Switch

Homing methods: HOMETYPE 24, 28

In some instances, the positive edge is reached at HOMESPEED1, which may be too fast, resulting in a less accurate home location.

To improve the homing accuracy for methods 24 and 28, it is recommended to instead use homing methods -24 and -28. These methods include a reversal of movement at HOMESPEED2 until the required event occurs.

7. Operation

7.1 Drive Enable

Caution! Enabling the drive might cause the motor to move.

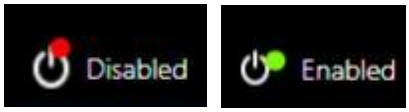
Three conditions are required for enabling the LDHD2 drive:

- No faults.
- Software Enable switch must be ON (SWEN=1)
- Remote Enable switch must be ON (REMOTE=1)

Use the ServoStudio 2 Enable & Faults screen to view and control the conditions required for enabling the drive.

The following elements provide visual indications of the drive's enabled or disabled status:

- The Enable|Disable button in the ServoStudio 2 toolbar indicates the state of the drive.



If lit, the drive is enabled (active). Power is being applied to the motor.

If not lit, the drive is disabled.

- Decimal point on the drive's digital display indicates the drive's Enable/Disable state.

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

If not lit, the drive is disabled.

7.2 Drive Operation Modes

The LDHD2 can perform in various operation modes. Each operation mode has a primary control loop (current/torque, velocity or position) and a particular type of command input.

When using VarCom instructions, the operation modes are set by the value ofOPMODE:

0 = Velocity control, using serial commands

2 = Current control, using serial commands

4 = Position control, using pulse/gearing input

8 = Position control, using serial commands

When using CAN over EtherCAT (CoE) communication, the operation modes are set by object 6060h, and reported by object 6061h.

1 = Profile Position

3 = Profile Velocity

4 = Profile Torque

6 = Homing

7 = Interpolated Position

8 = Cyclic Synchronous Position

9 = Cyclic Synchronous Velocity

10 = Cyclic Synchronous Torque

For details, refer to the LDHD2 EtherCAT Reference Manual.

7.3 Current Operation

7.3.1 Serial Current Operation

In Serial Current mode (OPMODE2), only the current loop is active, and the drive responds to instructions received via the USB.

Other than tuning the current loop, no drive variables need to be set in order to operate the drive in this mode.

In the ServoStudio 2 Motion screen, select Operation Mode – Serial Current to modify and test parameters.

7.3.2 Current Control

Note There is no need to manipulate values in the Current Loop screen, unless instructed to do so by Technical Support.

Current control loop tuning is derived from the motor properties and the bus voltage. The ServoStudio 2 Motor Setup wizard tunes the current control loop.

7.4 Velocity Operation

7.4.1 Serial Velocity Operation

In serial velocity mode (OPMODE0), the drive's current and velocity loops are active, and the drive responds to instructions received via the USB port. The commanded velocity is subject to programmable acceleration and deceleration limits.

In the ServoStudio 2 Motion screen, select Operation Mode – Serial Velocity to modify and test parameters.

7.4.2 Velocity Control

Refer to VarComVELCONTROLMODE.

- PI controller (uses KVP and KVI)
- PDFF controller(uses KVP, KVI, KVFR)
- Standard pole placement controller (uses MJ, MKT, BW, LMJR, TF)
- HD velocity loop with integrator (uses KNLD, KNLP)

HD Velocity Control with Integrator (Recommended)

Refer to VarComVELCONTROLMODE7.

Before using the HD velocity controller, first execute the ServoStudio 2 Autotuning wizard, and then manually adjust the tuning, if necessary.

You can then proceed to use the HD velocity controller.

VELCONTROLMODE 7 provides the advantages of the HD nonlinear controller for velocity control.

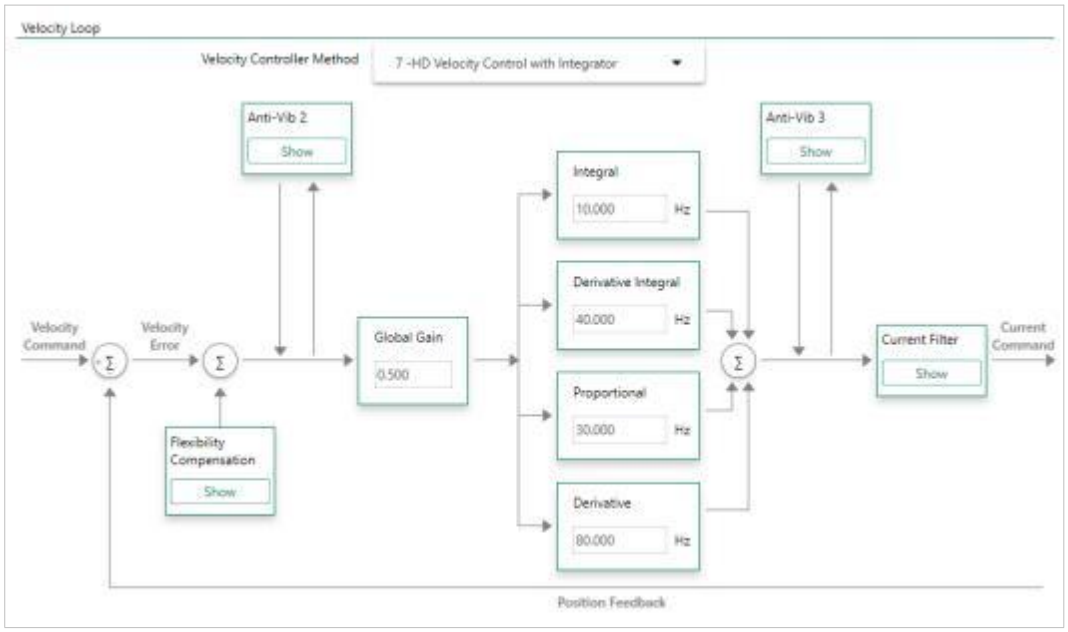


figure7-1 Velocity Control Loop – HD Velocity Control with Integrator

Proportional and Integral (PI) Controller

Refer to VarComVELCONTROLMODE0.

The following figure shows a PI controller.

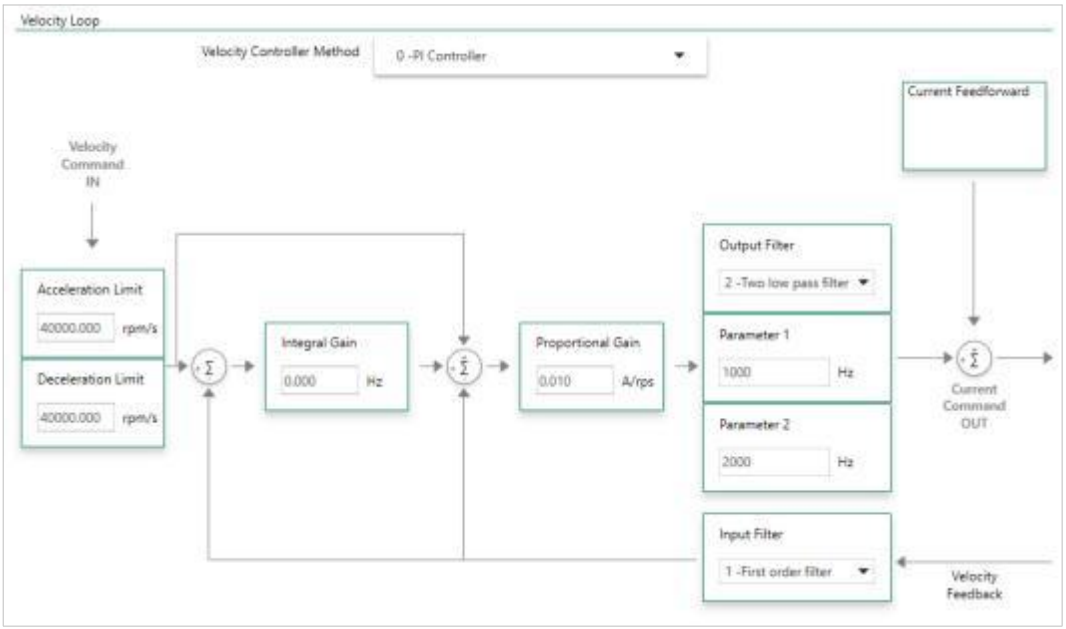


figure7-2 Velocity Control Loop – PI Controller

The PI controller is a unity feedback system with no pre-filter. The proportional gain (KVP) stabilizes the system. The integral gain (KVI) compensates for the steady state error.

The controller parameters KVP and KVI and KVFR are tuned by trial and error.

Pseudo Derivative Feedback and Feedforward (PDFF) Controller

Refer to VarComVELCONTROLMODE1.

The following figure shows a PDFF controller. Like the PI controller, it has an integral gain (KVI) and a proportional gain (KVP), with the addition of a feedforward, KVFR.

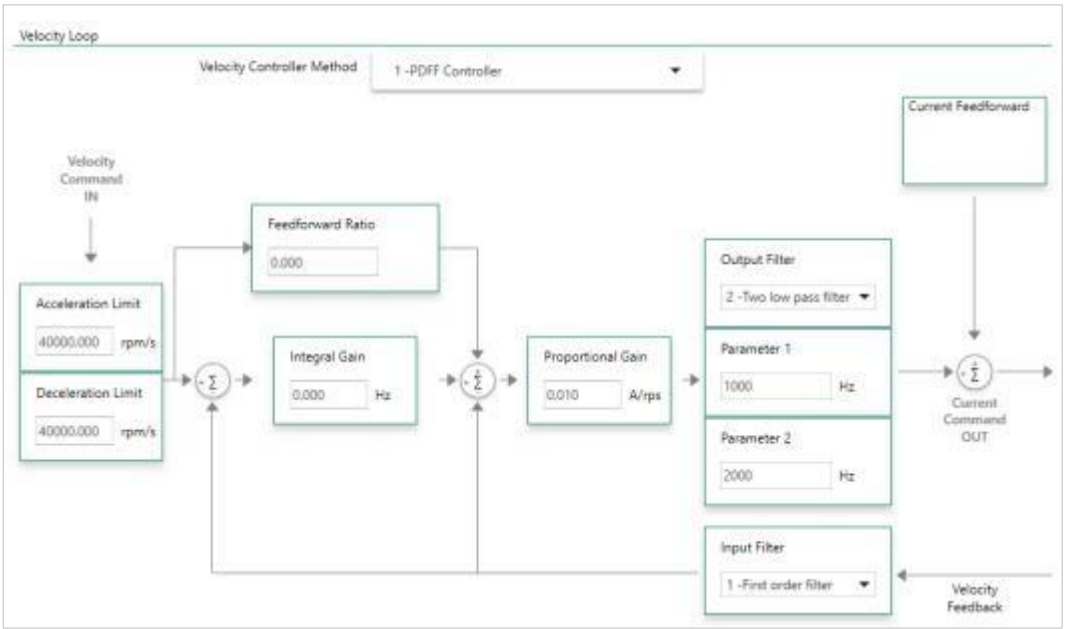


figure7-3 Velocity Control Loop – PDFF Controller

When an application requires maximum responsiveness, less integral gain is required, and KVFR can be set to a higher value. When an application requires maximum low-frequency stiffness, KVFR is set to a lower value, which allows much higher integral gain without inducing overshoot. This will also cause the system to be slower in responding to the command. A mid-range KVFR value is usually suitable for motion control applications.

PDFF is a generalized controller. The controller parameters KVP , KVI and KVFR are tuned by trial and error.

Standard Pole Placement (PP) Controller

Refer to VarComVELCONTROLMODE2.

For PP controller tuning, only two parameters are needed: load inertia ratio (LMJR) and closed-loop system bandwidth (BW).

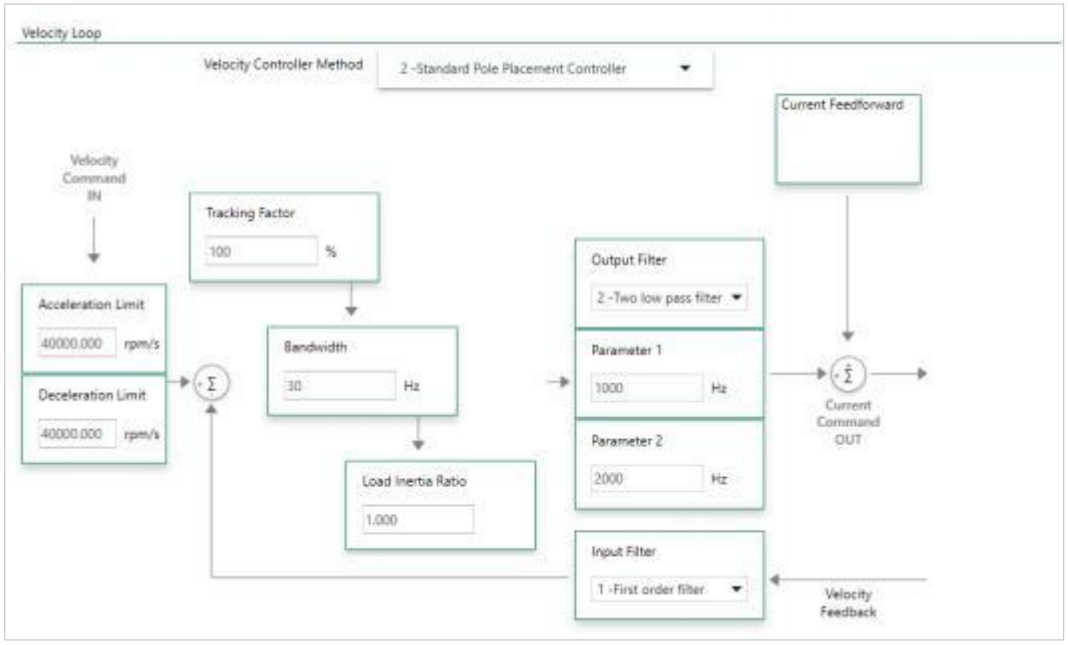


figure7-4 Velocity Control Loop – Standard PP Controller

For the controller design, it is not necessary to know the load inertia. The parameter can be easily tuned, as described in the following procedure.

Use the following procedure to manually tune the PP Velocity Controller.

Procedure: Manual Tuning of the PP Velocity Controller

Manual tuning includes the initial steps of load inertia estimation, and the subsequent steps to design the optimum controller.

In ServoStudio 2, go to the Terminal screen or a Terminal tab, and execute the steps using standard ASCII protocol.

Alternately, use the ServoStudio 2 Scope screen to execute and record motion, and evaluate and adjust the parameters.

1. Set the operation mode to serial velocity: OPMODE 0.

2. Set the velocity compensator to standard pole-placement: VELCONTROMODE 2.

3. Enable the drive: EN.
4. Set the desired bandwidth. It is recommended to begin with a low value (10 Hz), and gradually increase it.
5. Set the load inertia ratio to zero: LMJR 0.
   The load inertia value LMJR is expressed as a percentage of the rotor inertia.

   The range for LMJR is 0 to 10,000. It represents a range of load: rotor inertia ratios ranging from 0:1 to 100:1. For example, to set a 10:1 ratio between the load inertia and the motor inertia, use the command LMJR 1000. At this point the step response should have the maximum overshoot, but the control loop should be stable (low gains).
6. Activate the recording mechanism to record the velocity command, the current command, and the actual (feedback) velocity:
   RECORD 1 1024 "VCMD ICMD V
7. Jog the motor at a constant low speed: J [value1]
   For example, start with the command J 150
8. Activate the recording trigger: RECTRIG VCMD [value2] 20 1.

   value2 should be greater than value1 in the previous step; for example: RECTRIG VCMD 200 20 1.
9. Jog the motor at a value higher than specified in the RECTRIG command. This is actually the step command. The higher the step, the better the results. The step should not be less than 300 (rpm). For example: J 500.
10. The recording takes about half a second. After this period, reduce the motor speed.
11. Verify that the recording process is terminated: RECDONE
12. Display the recorded data by dumping to the serial port: GET
13. Analyze the results.

    If the current command is saturated (gets absolute values of ILIM) during the process, reduce the step or reduce the bandwidth, and return to Step 6.
14. Inspect the feedback velocity:
    - If there is an undershoot or oscillations, reduce LMJR to the mean value of the present LMJR and the last LMJR which had an overshoot, and return to step 6.
    - If there is an overshoot, increase LMJR by 100, and return to Step 6.
    - Repeat the process until the overshoot is reduced to a minimum
      (The estimated load inertia may be queried by LMJR.)

7.5 Position Operation

7.5.1 Serial Position Operation

The LDHD2 has a dedicated mode of operation (OPMODE8) for simple positioning applications over the serial port. Serial commands are transmitted from a host computer through the serial port. The command specifies the target position and the cruise velocity, while additional motion profile information (such as acceleration, deceleration and profile type) is set up using explicit variables.

In the ServoStudio 2 Motion screen, select Operation Mode – Serial Position to modify and test parameters.

VarCom	Description
ACC	Defines the acceleration.
DEC	Defines the deceleration.
PE	Position error (also called following error). PE is the absolute calculated difference between the values of PCMD and PFB. Read only.
PCMD	The position reference command. Read only.
PFB	The actual position according to the motor feedback. Read only.

Incremental (Relative) Motion

Incremental, or relative, motion moves the motor relative to the current position. Relative motion is always in reference to the current position of the load (and motor shaft), and is useful in indexing applications, such as cut-to-length feeders and rotary tables.

The reference point is the parameter PFB, which is the actual position according to the motor feedback.

Movement can be in either direction, depending on the sign of the position value. For example, if the target position is one revolution, the motor will turn one revolution from the starting point.

VarCom	Description
MOVEINC	Command to execute an incremental position movement according to the acceleration settings in effect.

The value of PFB can be modified, or offset, using the parameter PFBOFFSET. This is useful for manual homing, or simply for testing incremental motion.

Procedure: Setting the Current Position to 0

1. Disable the drive. (PFBOFFSET can be set only when the drive is disabled.)
2. Set PFBOFFSET to 0 (zero).
3. Read PFB
4. Set PFBOFFSET to the negative value of PFB

When using counts as the position units, PFBOFFSET can be set to an integer value only, even though the actual position, PFB, is displayed as a real number, with fractions of a count (as a result of internal interpolation being executed on the encoder signal).

Absolute Motion

Absolute motion is always relative to an absolute reference point.

The reference point is the point at which PFB=0.

VarCom	Description
MOVEABS	Command to execute an absolute position movement according to the acceleration settings in effect.

End of Motion

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

VarCom	Description
PEMAX	The maximum position error allowed without producing a fault, in counts.
PEINPOS	The window of tolerance for declaring an "in position" state. The motor is considered to be in position when the value of PE (position error) is less than the value of PEINPOS (position-error tolerance). The motor is considered settled when PE (position error) has remained below PEINPOS for the time defined by PEINPOSTIME.
INPOS	Indicates Motor In Position state. Read only. When the motor is in position, INPOS=1, regardless of the state of the motion profile. As long as the motor is not in position, INPOS=0.
STOPPED	Indicates Motor Settled state. Read only. STOPPED=-1. Motion was interrupted. STOPPED=0. Motion profile in progress. STOPPED=1. Profile completed. STOPPED=2. Profile completed and INPOS=1.

7.5.2 Position Control

The LDHD2 has two position control loop options – HD (nonlinear) and linear.

HD (Nonlinear) Position Controller

The HD position controller is a proprietary algorithm that is designed to minimize position error during motion and to minimize settling time at the end of motion. This is the recommended controller. Refer to*Tuning*.

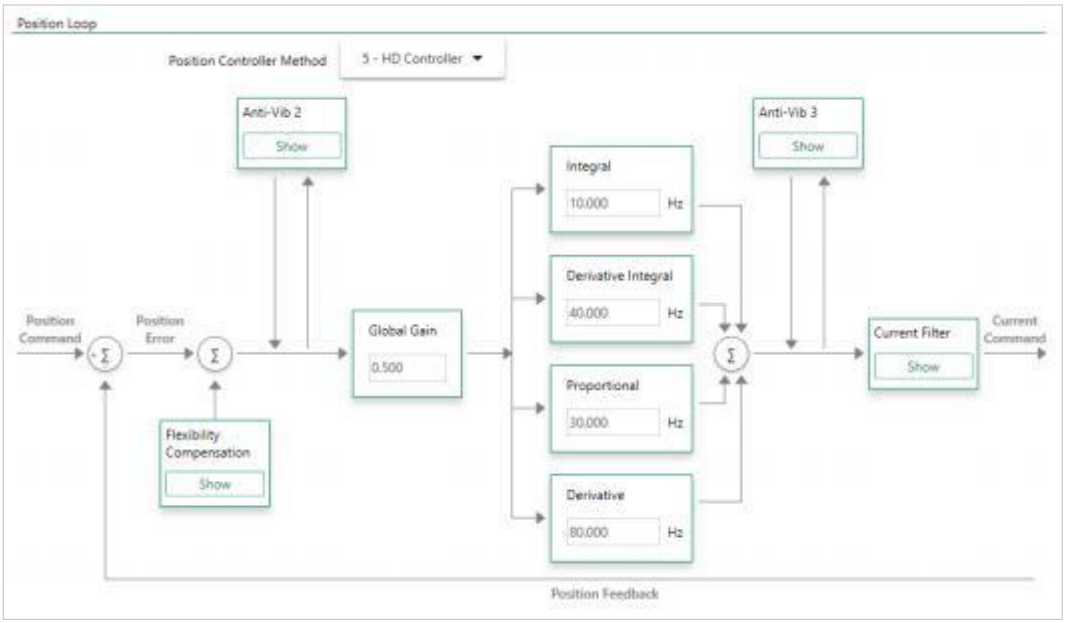


figure7-5 Position Control Loop – HD Controller

Linear Position Controller

The Linear position controller is a PID controller with feedforward, and with the option to limit the integral saturation (anti-windup).

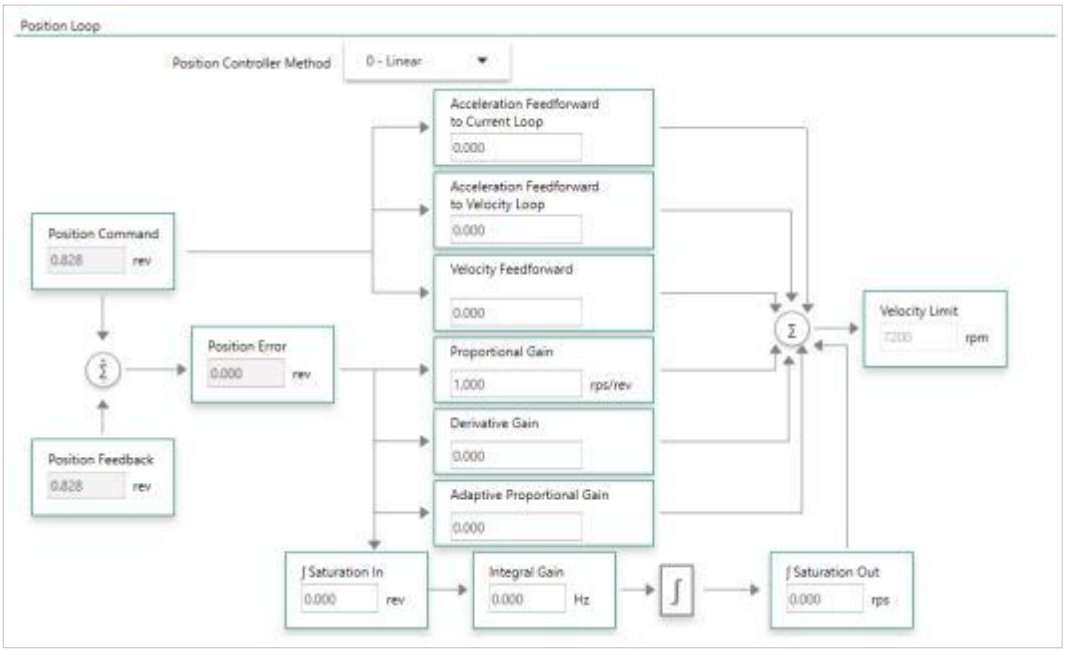


figure7-6 Position Control Loop – Linear

7.6 Gearing/Pulse Train Operation

In Gearing/Pulse Train operation mode, the drive's current, velocity and position loops are active, and the drive is synchronized to a master input command signal in the form of a pulse train. The LDHD2 can be configured to read this input signal as an encoder follower, an up/down counter, or a pulse/direction counter.

In the ServoStudio 2 Motion screen, select Operation Mode – **Gearing/Pulse Train** to modify and monitor parameters.

The various methods of gearing are defined by the parameterGEARMODE.

VarCom	Description
GEARMODE0	Encoder Following.
GEARMODE1	Pulse and Direction
GEARMODE2	CW/CCW (Up/Down)

Notes

GEARMODE 0, 1, 2:

If inputs 5 and 6 are set, respectively, to INMODE 17 and 18, signals are received instead from fast inputs 5 and 6 on the I/O interface (C4) at pins 12 and 25.

The input signal is subject to gearing calculations that allow you to set the ratio of input pulses to encoder counts. Gearing sets up a relationship between the number of input pulses (HWPEXT counts) and the position increments of the motor shaft. The rate at which position increments of the motor shaft (motor speed) occur is determined by the gearing relationship and the line frequency of the pulse train. 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 are some of the parameters used to configure and monitor the gearing.

VarCom	Description
GEAR	Activates the gearing function.
GEARIN	Numerator of the gearing ratio. The sign of the GEARIN value determines the direction of rotation.
GEAROUT	Denominator of the gearing ratio.
XENCRES	Resolution of the external pulse source.
HWPEXT	The position measured by an external feedback device.

7.6.1 Pulse and Direction

In Pulse and Direction position control, the drive is synchronized to a master input command signal in the form of a pulse train.

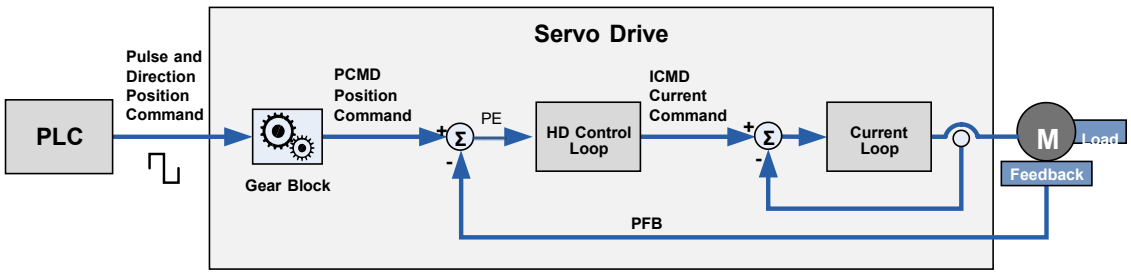


figure7-7 Pulse and Direction Position Control

The drive accepts an input pulse train in which the rising edge of each pulse increments (or decrements, depending on the direction) the external input position counter (HWPEXT) of the drive by one position count. This counter value is passed through a gearing block and becomes the position command for the motor.

The position command is compared to 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 Pulse and Direction mode, if the absolute value of GEARIN is equal to GEAROUT, and if XENCRES is equal to 4×MENCRES (that is, the motor encoder resolution after quadrature), then one pulse on the input is equivalent to one count of the motor feedback.

For example, assume that the motor encoder has a resolution of 2500 lines per revolution. Setting GEARIN=1, GEAROUT=1 and XENCRES=10000 will result in the motor making one revolution for every 10000 pulses (assuming the direction is fixed during this time).

Note The drive's homing capabilities remain available in this configuration.

Pulse and Direction Operation

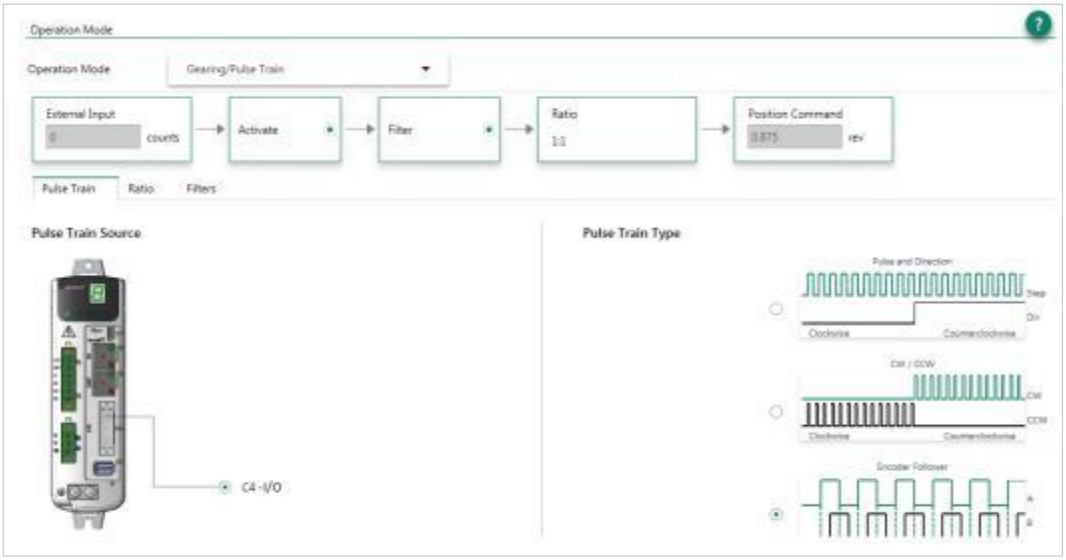


figure7-8 Settings for Pulse & Direction Commands

Step 1 – Setup and Tuning

1. Run the ServoStudio 2 Motor Setup Wizard, and make sure motor setup is successfully completed.
2. Run the ServoStudio 2 Autotuning Wizard, and make sure autotuning is successfully completed.

Step 2 – Select Pulse and Direction

1. In ServoStudio 2, go to the Operation Mode screen, and select Operation Mode-Gearing/Pulse Train (OPMODE 4)
2. In the **Pulse Train** tab, select the Pulse Train Source and Pulse Train Type:

- If using Differential:
  Select the option I/O RS422 and Pulse & Direction (P&D).
- If using Opto-Isolated:
  Select the option I/O Opto-Isolated and Pulse & Direction (P&D).
  This automatically sets the definitions for digital inputs 5 and 6.

Step 3 – Digital Inputs 5 and 6 Settings (Opto-Isolated inputs only)

1. Go to Drive Configuration > Digital IOs screen.
2. Make sure digital input 5 is set to 17-Pulse signal.
3. Make sure digital input 6 is set to 18-Direction signal.

figure7-9 Digital Inputs for Pulse and Direction Signals

Step 4 – Set Pulse and Direction Parameters

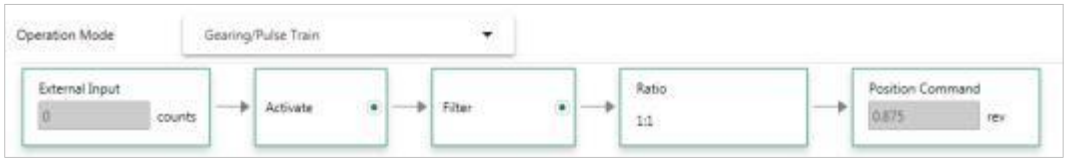


figure7-10 Pulse and Direction Operation Parameters

1. Make sure Gearing mode is enabled (GEAR=1).
2. In the **Ratio** tab, set the Input Resolution and Gearing Ratio.

   The relationship between the number of incoming pulses and the motor shaft movement is determined by the external encoder resolution (HWPEXT), and the gearing ratio (GEARIN/GEAROUT).

   For example: A PLC controller is programmed to provide 1024 line pulses as an input command to a LDHD2 system in order to make the motor rotate two revolutions. The settings are therefore:

   External Encoder Resolution = 1024

   Gear Ratio Multiplier = 2

   Gear Ratio Divider = 1

3. In the **Filters** tab, set adjust the values of the gearing filters and command smoothing filters, as needed.

   Command Smoothing Filter

   - Smoothing Filter (MOVESMOOTHMODE. Select option to activate the filter.
   - Stiff/Soft (MOVESMOOTHAVG). Drag slider to adjust value.

   Gear Command Smoothing Filter

   - Gear Noise Filter (GEARFILTMODE). Select option to activate the filter.
   - Stiff/Soft (GEARFILTDEPTH). Drag slider to adjust value.

7.6.2 CW/CCW (Up/Down) Counting

In CW/CCW (or Up/Down) system, pulses on one signal increment the motor position while pulses on the other signal decrement the motor position.

When the pulse signal is applied to the A channel, the external position counter (PEXT) increments and rotates the motor in a positive direction.

The pulse signal applied to the B channel decrements the external position counter (PEXT) and rotates the motor in a negative direction.

The line frequency and the gearing relationship determine the speed and amount of the shaft movement.

7.6.3 Encoder Follower (Master/Slave)

In Encoder Follower mode, the drive follows a quadrature encoder signal generated by a master device. The direction of motion is governed by the phase of the quadrature signals (A-lead-B or B-lead-A).

The master device can be, for example, a handwheel, a machine master encoder that is connected to the main camshaft.

If the master device is a handwheel or a master encoder, then setting XENCRES equal to the resolution of the encoder (before quadrature) and setting the gear ratio to 1 will result in the motor making one revolution for each revolution on the input.

As an example, assume the handwheel resolution is 120 lines per revolution (that is, 480 counts after quadrature). Setting GEARIN=1, GEAROUT=1 and XENCRES=120 will result in one motor revolution for each turn of the handwheel.

8. Tuning

8.1 LDHD2 HD Controller

The LDHD2 has two user-selectable position control loops – linear and HD (nonlinear).

The HD control loop is a proprietary algorithm that is designed to minimize position error during motion and to minimize settling time at the end of motion.

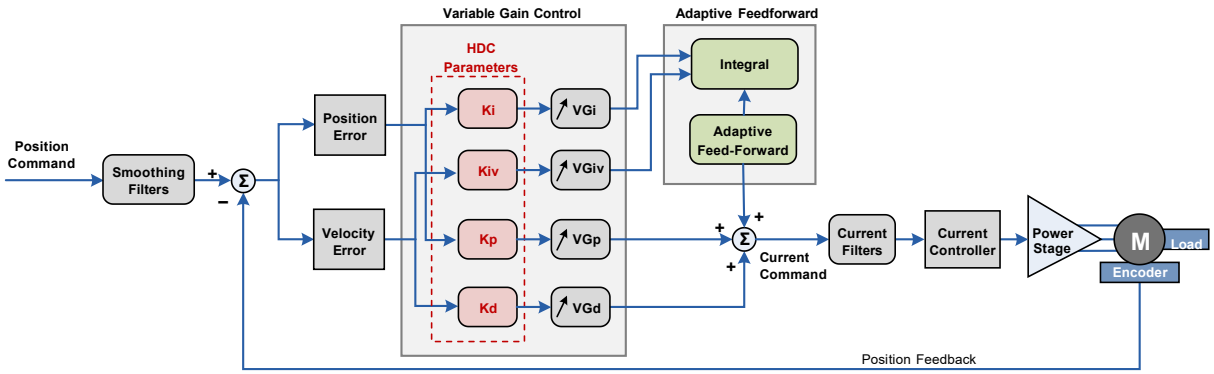


figure8-1 LDHD2 HD Controller

The HD algorithm uses a parallel configuration in which all branches are on the same level and executed during the same sampling period. On each branch a variable gain is introduced and automatically optimized for high gain and stability.

The HD controller also includes an adaptive feedforward function that is applied at the end of movement in order to achieve a zero or minimum settling time.

Furthermore, the HD controller provides low pass, notch and other filters to handle flexible and resonant systems.

The ServoStudio 2 Position Control Loop screen provides access to the HD control loop parameters that can be modified by users.

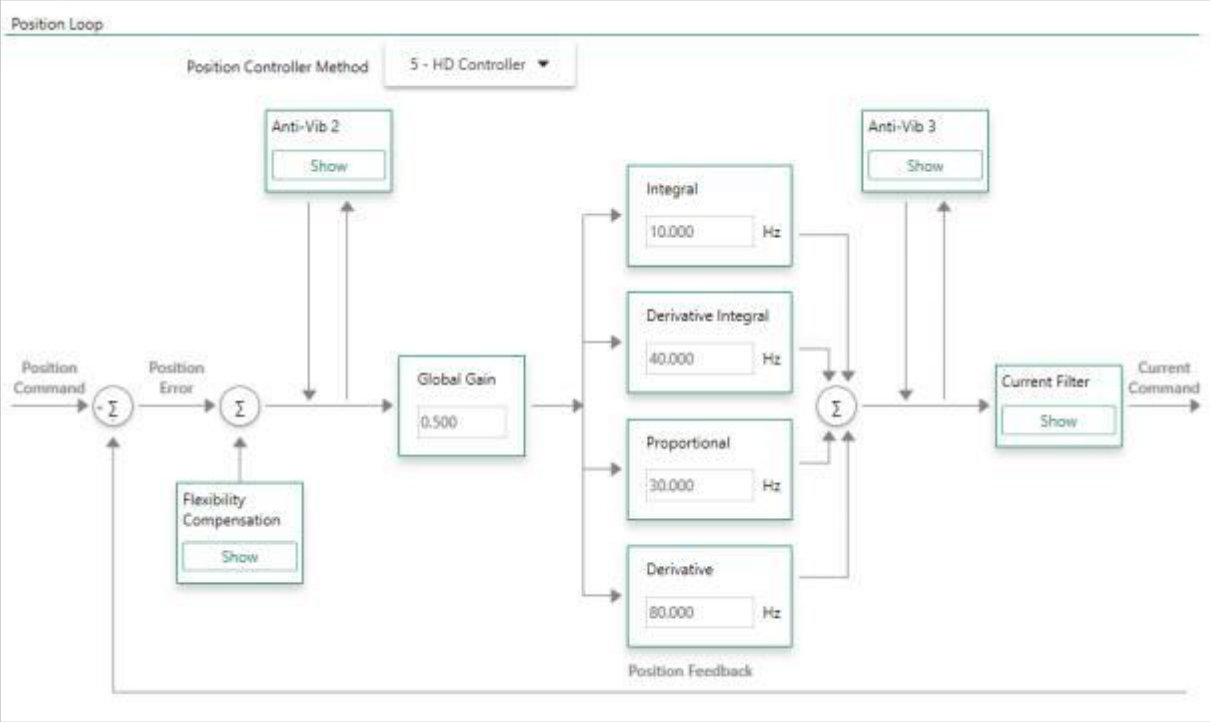


figure8-2 LDHD2 HD Control Loop

8.2 LDHD2 HD Controller Autotuning

Caution! Tuning is potentially dangerous. Before starting any tuning routines, make sure no one is within the motion envelope, and the emergency button is within your reach.

Autotuning is performed on the LDHD2's HD control loop. There is no autotuning procedure for the linear control loop.

The HD control loop parameters are initially set using the Autotuning wizard. Drive tuning performed by the wizards is usually sufficient. However, you may need to tune the control parameters manually to optimize them for particular applications. The parameters can be viewed and modified in the ServoStudio 2 **Position Loop - HD Controller** screen.

Automatic and manual tuning use similar methods. During autotuning, the quality of the movement is measured and evaluated by the drive or the software. During manual tuning, the quality of movement is evaluated by the user. In both cases, the servo control parameters are modified progressively and the value that achieves the best performance is selected.

The Autotuning wizard can also be used to optimize drive parameters to produce the most effective motion for a particular task or application.

8.3 PC-Based Autotuning

ServoStudio 2 activates the wizard for PC-based autotuning if an electronic motor nameplate is not detected at power-up.

Note The PC-based Autotuning wizard overrides the user's unit settings and works in the following units:

- Position: counts
- Velocity: rpm/s for rotary motors, and mm/s for linear motors
- Acceleration/deceleration: rpm/s2 for rotary motors, mm/s2 for linear motors

Step – LMJR Estimation

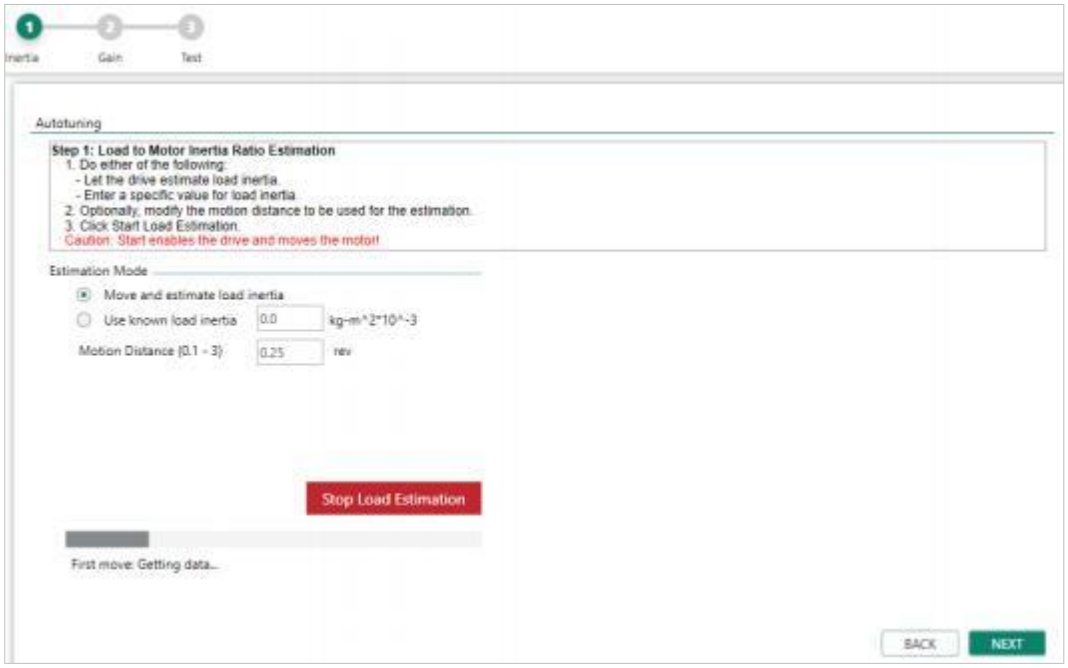


figure8-3 PC-Based Autotuning Wizard – LMJR Estimation

1. For automatic estimation, select Move and estimate load inertia.

or

If you know the inertia of the load connected to the motor, select Use known load inertia, and enter the value.

2. Optionally, modify the number of motor revolutions to be used as the motion distance during the load estimation.

3. Press Start Load Estimation.

Start enables the drive and moves the motor repeatedly!

ServoStudio 2 estimates the load currently on the motor, and displays the results.

4. Press OK to send the calculated parameters to the drive.

5. Press **Next** to continue.

Step – Gain Optimization

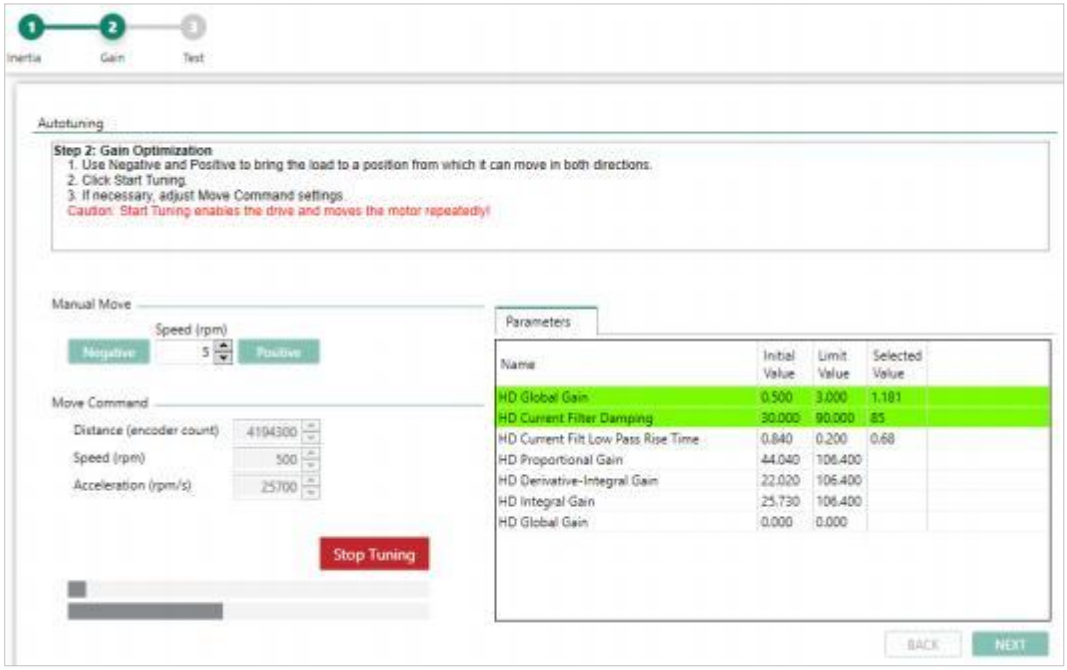


figure8-4 PC-Based Autotuning Wizard – Gain Optimization

1. The displayed Move Command values are recommended values; they have been determined according to the motor you defined in the setup. Use the Negative and Positive buttons to bring the load to a position at which the motor can safely make a full rotation in each direction.
2. If necessary, adjust the Manual Move Speed setting.
3. Press **Start**.

⚠ **Start** enables the drive and moves the motor repeatedly!

The motor moves back and forth continuously, while ServoStudio 2 tests values at intervals throughout the range for each of the control loop parameters. Once it achieves the best result, it displays the optimal value in the parameter table.

The top bar shows the progress of the parameter currently being tested.

The lower bar shows the progress of the entire process.

4. If necessary, adjust the Move Command settings, and press Start to repeat the test.

Step – Test Quality of Motion

figure8-5 PC-Based Autotuning Wizard – Test Quality of Motion

1. Press **Move and Plot** to send a current command to the drive and plot the response.

Move and Plot enables the drive and moves the motor!

2. A plot appears. The plot shows the velocity command generated by the point-to-point position profile (PTPVCMD), and the position error (PE).

The wizard also displays the Settling Time and the Position Error Window values calculated by the system.

The toolbar buttons allows you to examine the graph more closely, and to export results to a spreadsheet. These functions are also available in the ServoStudio 2 Scope screen.

3. Optionally, modify the motion settings and/or the gain setting, and repeat the test under different conditions:

- Target Position
- Cruise Velocity
- Acceleration (and Deceleration)
- HD Global Gain (KNLUSERGAIN); this is the global gain parameter for the HD control loop. A higher gain value results in stiffer control, and a lower value results in softer control.

Step – Save

To complete the autotuning process, do all of the following:

- Press **Save to Drive** to save the parameters in drive RAM to the drive's non-volatile memory.
- Press **Save to PC** to save the parameters in drive RAM to a backup file on the computer. The parameters are saved in a text file with either TXT or SSV extension. The text file can be edited using Notepad or any other text editor.
- Press **Generate Report** to create a record of system settings that can be used for future reference and/or sent to Technical Support should the need arise.

  It is recommended that you create a report whenever you complete configuration of your application, even when the system is functioning properly.

8.4 Recording and Evaluating Performance

8.4.1 Diagnostics

After autotuning has been completed, the system may display behavior that is less than optimal, such as:

- Servo motor is audibly noisy.
- Servo motor is very hot.
- Performance is not consistent.
- Foldback occurs; that is, the motor demands a level of current that drive cannot handle continuously.
- Jerk in system.
- Jerky movements.
- Excessive overshoot results in hitting application mechanical limits.

The following diagram outlines the procedures for diagnosing system behavior and applying filters to improve performance.

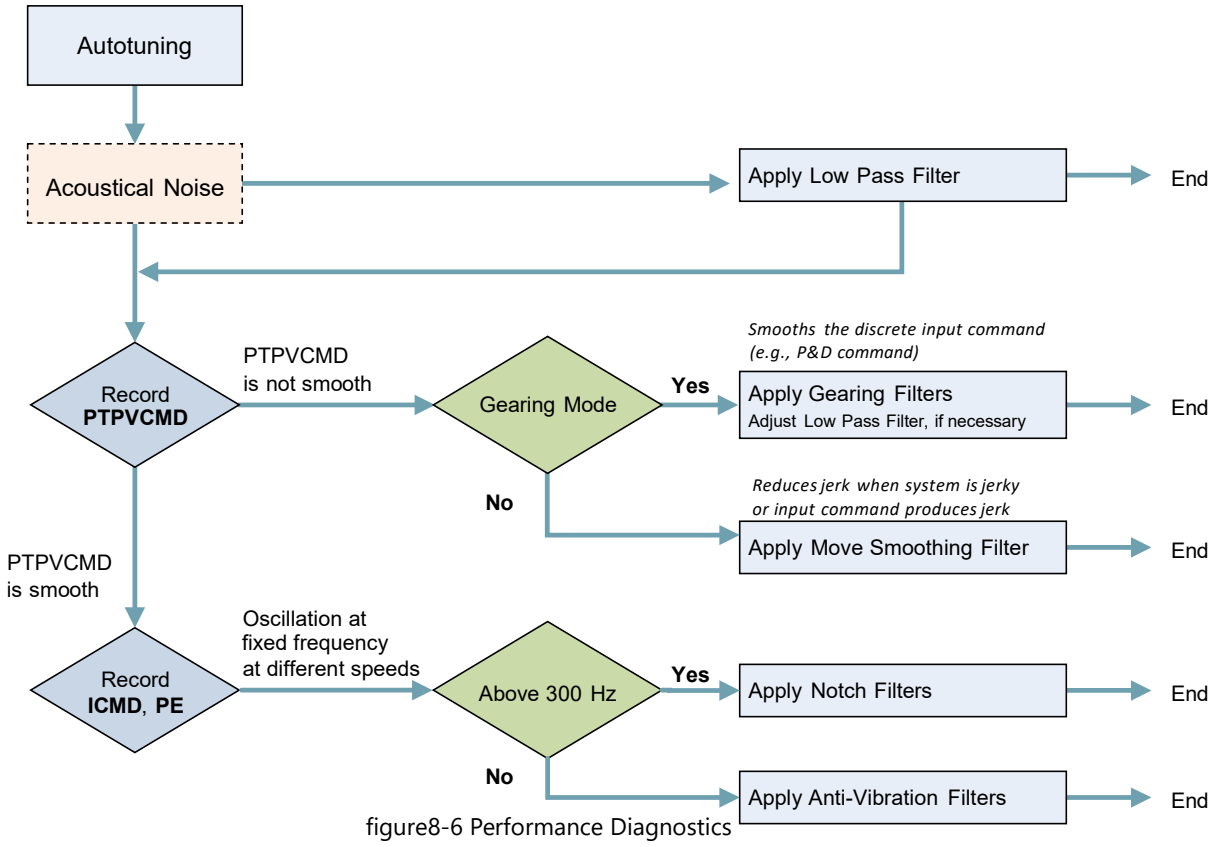


figure8-6 Performance Diagnostics

The LDHD2 recording function is used for performance verification, tuning and debugging. ServoStudio 2 provides a full-featured graphic interface for recording, plotting and measuring data. Refer to the ServoStudio 2 Reference Manual for details.

To improve or change performance of the LDHD2 system, refer to the Performance Diagnostics diagram, and manually modify and evaluate the parameters.

Procedure: Modifying and Testing a Parameter

After each modification of a parameter, do the following:

1. Make sure Operation Mode is set to **Serial Position**.
2. Execute a back/forth motion, and record PE, ICMD and PTPVCMD
3. Use the ServoStudio 2 Scope screen to plot and evaluate the recorded values.
4. Check the settling time of PE.

8.4.2 Recording Data in ServoStudio 2

Procedure: Recording Data in ServoStudio 2 – Example

1. In the ServoStudio 2 Scope screen, select the **Motion** tab.
   - Make sure Operation Mode is set to **Serial Position**.
   - Set the value of the Target Position 3 revolutions.

- Set the values of the motion parameters to produce a movement at 50% of the motor's maximum speed, and 75% of the maximum acceleration required by the application. Thus, in this example:
  - Maximum speed (Cruise Velocity) is set to 1000
  - Acceleration (and Deceleration) is set to 50000
- If you need a back and forth motion, select the option Alternating.

The aim is to achieve a motion profile that has substantial durations for the acceleration, plateau, and deceleration phases.

2. In the Recorder Setup panel, select the following Record Variables:

- PTPVCMD (Position command velocity)
- ICMD (Current command)
- PE (Position error).

3. In the Recorder Setup panel, enter the sampling values and trigger variable:

- Samples: 1000
- Time Interval: 16
- Trigger: IMM

4. Make sure the drive is enabled, and then press the Move Record and Plot button in the Scope toolbar.

Note that the trace of the Position Error variable shown here is scaled by a factor of 50.

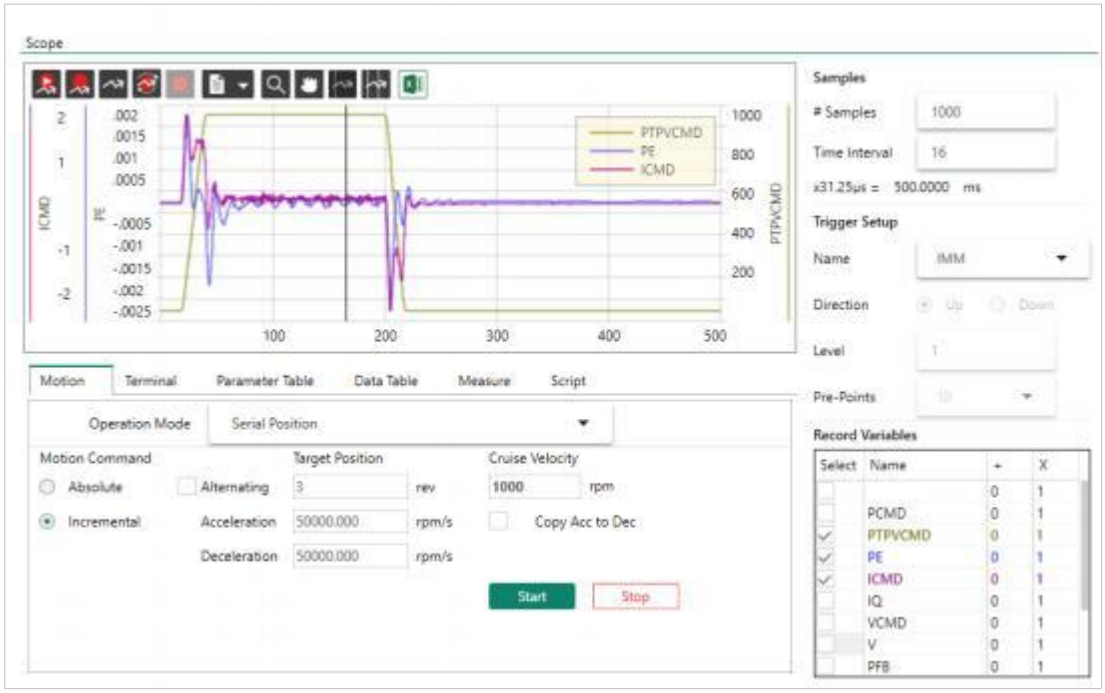
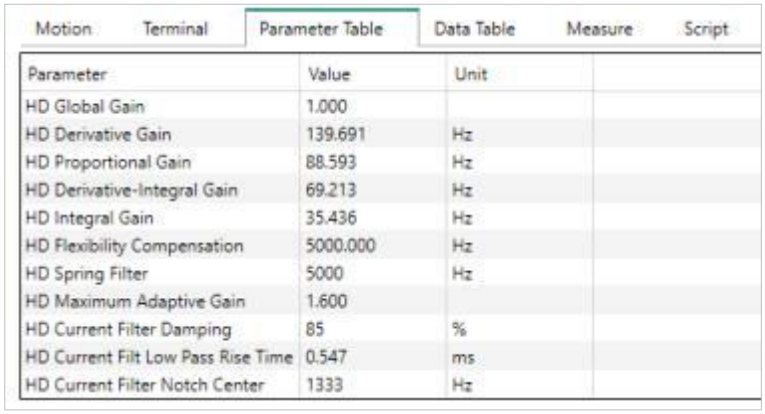


figure8-7 Motion Obtained with Default Parameter Values

5. Select the Parameter Table tab.



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

figure8-8 Parameters – Example

Parameter KNLUSERGAIN (HD Global Gain) is set to 1.000 during autotuning. For additional, manual tuning, you can often begin with this setting. If the gain is too high – as evidenced by vibrations and noise – decreasing the value of KNLUSERGAIN can help achieve a smoother movement.

6. View position error and settling time

Right-click in the recording chart pane, and select Show Settling Time.

figure8-9 Position Error (counts) and Setting Time (ms)

The acceptable range of the response (position error) is the movement (in counts) at the endpoint.

$$\text{Acceptable range: } \frac{2 \times \pi \times \text{length}}{\text{resolution} \times \text{gear}}$$

Example:

Mechanical dimension (joint length) = 0.5 m

Motor resolution: 1 rev = 17 bit = 131072 counts

Gear ratio = 1:100

$$\text{Acceptable range: } \frac{2 \times \pi \times 0.5}{131072 \times 100}$$

If motor moves 100 counts, movement at endpoint is 0.2 x 10-6 meter. Acceptable range: 50–100.

8.4.3 Recording Data in Terminal

Procedure: Recording Data (Terminal)

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

The syntax for the recording instruction is:

RECORD {*sample time*} {*num points*} {*var1*} [*var2*] [*var3*]

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

Records 100 points for VCMD, V, and ICMD every 1 milliseconds

Note that variables must be preceded by a quotation mark (").

2. Use the command RECTRIG to define the variable and conditions that triggers the recording.

The syntax for the recording trigger instruction is:

RECTRIG {*var*} [*level*] [*pre-trig*] [*above*|*below*]

Note If the specified number of pre-trigger points is greater than the number of points actually recorded prior to the trigger, the pre-trigger segment of the recording will include the value of the variable before motion began.

For example, record a Jog (J) that goes to 1000 rpm starting from zero with an acceleration of 10000 rps/s; specify the record level at 1 rpm, the direction as Up, 128 pre-trigger points and a time interval of 1. Since there will not be 128 points of pre-trigger motion, the record data will be packed with zeros (zero velocity command before the motion).

3. Use the variable RECDONE (recording finished) and/or RECING (recording in progress) to determine whether recorded data is available.

4. Set variable GETMODE to 0. Then use the command GET to retrieve the recorded data in a comma-separated variable (CSV) ASCII format.

Function	VarCom	Description
Recording Activation Commands	RECORD	Defines the variables to be recorded and the recording time span and sample time.
	RECTRIG	Defines the triggering condition for starting a recording, and also pre-trigger duration.
	RECOFF	Turns active recording off.
Recording Utility Information	RECLIST	Lists all the variables that can be recorded by the record function.
	RECTRIGLIST	Lists all the options for triggering the recording.
Status Flags	RECRDY	Indicates that a recording is armed and ready.
	RECING	Indicates that a trigger condition has occurred and that a recording is active.
	RECDONE	Indicates that the recording is completed
Data Retrieval	GETMODE	Defines the format for the recorded data (binary/ASCII)

Function	VarCom	Description
	GET	Retrieves the recorded data

8.4.4 Evaluating PTPVCMD

Note *Not fully updated for ServoStudio 2.*

Parameter PTPVCMD (position command generator velocity) reports the derivative of the position command profile in velocity units. PTPVCMD is useful for recording and viewing the actual velocity and the velocity command, which is available only as a derivative of the position profile.

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

Note

VCMD is the output velocity command of the linear controller.
VCMD is not used in HD (nonlinear) control.

The following figure shows an example of a PTPVCMD recording that indicates poor performance.

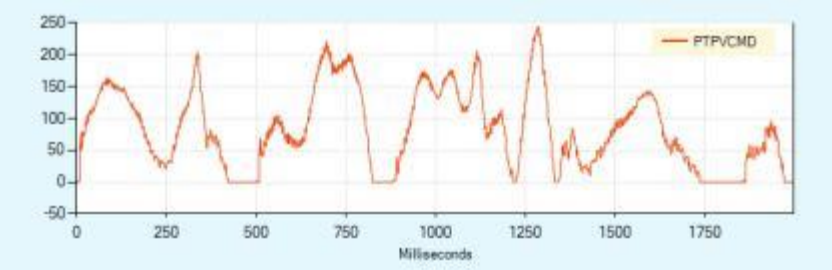


figure8-10 PTPVCMD Poor Result

8.4.5 Evaluating ICMD and/or PE Oscillations

Note *Not fully updated for ServoStudio 2.*

The following figure shows an example of oscillations in ICMD (current command) and PE (position error) that indicate poor performance.

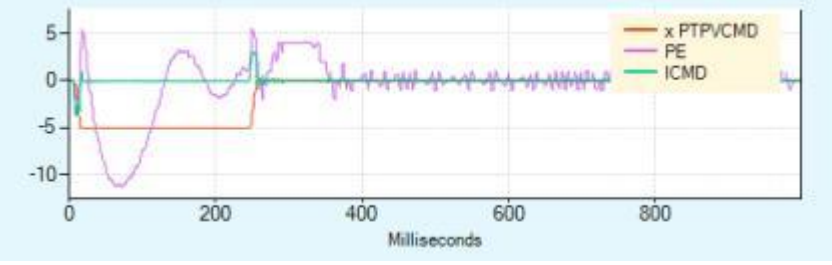


figure8-11 ICMD and PE Poor Result

To determine whether the oscillations are greater than 300 Hz, use the ServoStudio 2 FFT function on the PE or ICMD recording:

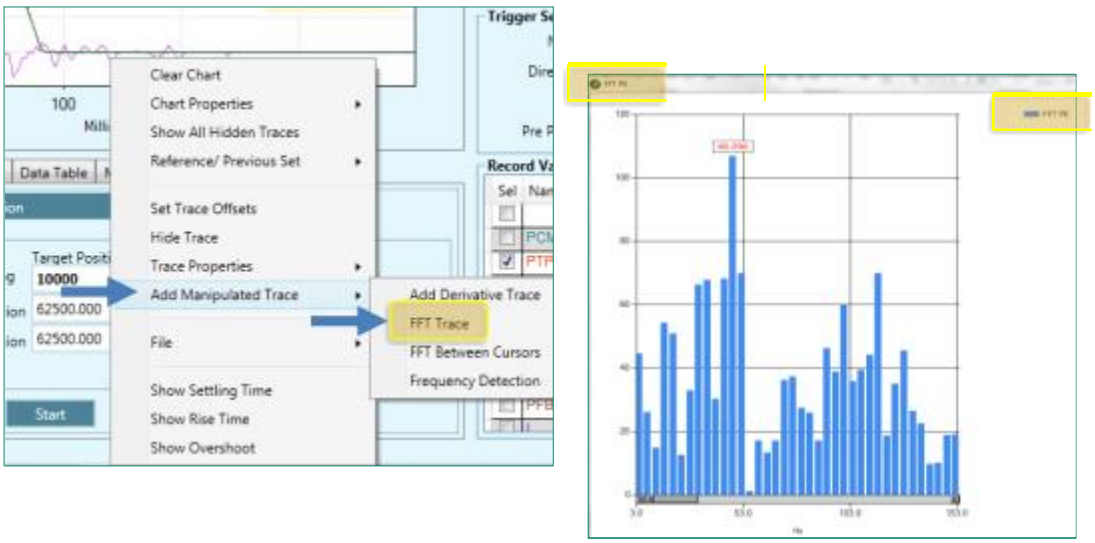


figure8-12 FFT Trace Evaluation

8.5 Gearing Filters

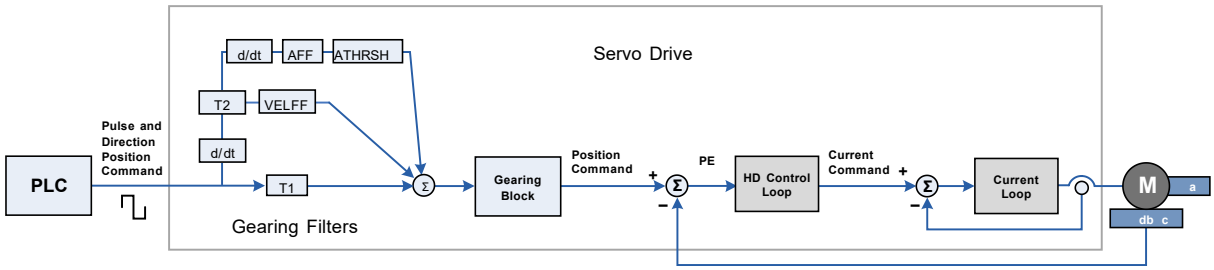
Note *Not fully updated for ServoStudio 2.*

Gearing filters may be useful if the system displays characteristics such as:

- Pulse and direction command has a low resolution
- Coupling between motor and load is not stiff
- Movement is too short
- Motor is noisy after tuning
- Current is very choppy during settling
- Motor temperature is unusually high

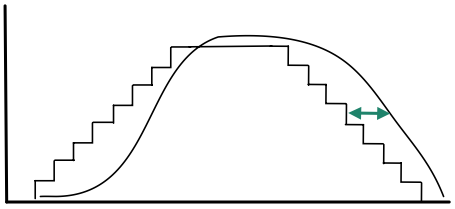
Before applying gearing filters, make sure GEARINMODE = 1

When a system has multiple axes, gearing filter values must be the same for all axes.



T1	GEARFILTT1	Gearing filter depth
T2	GEARFILTT2	Gearing filter velocity and acceleration depth
ATHRSH	GEARACCTHRESH*	Gearing acceleration threshold
VELFF	GEARFILTVELFF*	Gearing filter velocity feedforward
AFF	GEARFILTAFF*	Gearing filter acceleration feedforward
	* Use default values. Contact Technical Support if necessary.	

figure8-13 Gearing Filters



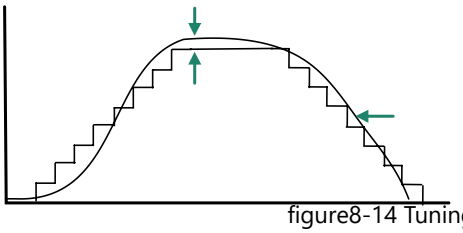
Gearing Filter – Example 1

Increasing GEARFILTT1 smooths the input command PTPVCMD, but adds a delay.

Recommended values:

GEARFILTT1 = ~2 × input step width

GEARFILTT2 = 2 × GEARFILTT1



Gearing Filter – Example 2

Increasing GEARFILTT2 and VELFF compensates for the delay, but adds overshoots.

If GEARFILTVELFF = GEARFILTT2, there is no delay.

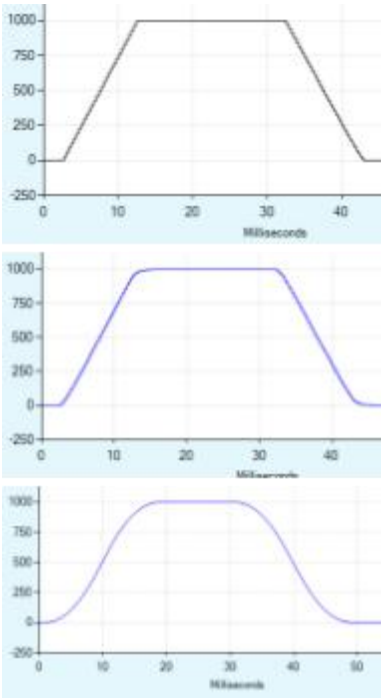
figure8-14 Tuning Gearing Filters

8.6 Move Smoothing Filter

Note *Not fully updated for ServoStudio 2.*

HD control provides three options for smoothing the position command, as defined by the parameterMOVESMOOTHMODE.

To apply a smoothing filter to an external reference command, such as a pulse train or EtherCAT, certain bits inMOVESMOOTHSRCmust first be set.



MOVESMOOTH 0:
No smoothing of the position command profile.

MOVESMOOTH 1:
Low pass smoothing of profile (in hertz) based on MOVESMOOTHLPFHZ.
The lower the value, the greater the smoothing.

MOVESMOOTH 2:
S-curve by averaging (in ms) based on MOVESMOOTHAVG.
Time extends the average.
Binary values (2, 4, 8, 32, 64, 128, 256)

figure8-15 Smoothing Filters

8.7 Notch Filters

Note *Not fully updated for ServoStudio 2.*

Notch filters can be used to eliminate high frequency oscillations that may occur in systems having a flexible link between motor and load, such as:

- Ball screw linear slide with coupling
- Belt drive
- Harmonic drive

Oscillations usually occur during the first steps in tuning (feedback gain). Tuning is done by checking the frequency of the oscillation, and setting the notch accordingly. Once notch parameters are set, the tuning procedure can continue.

HD control notch filters are used at any time during tuning to damp oscillations at a fixed frequency greater than 300 Hz:

- NLNOTCHCENTER(HD Current Filter – Notch Filter Center)
- NLNOTCHBW(HD Current Filter – Notch Filter Bandwidth)

A second set of HD control notch filters (NOTCH2CENTER and NLNOTCH2BW) is available through Terminal, but does not appear in the ServoStudio 2 control loop screen.

8.8 Anti-Vibration Filters

Note *Not fully updated for ServoStudio 2.*

Anti-Vibration Overview

The HD control anti-vibration function is based on proprietary control algorithms and serves to suppress vibrations at constant frequencies.

The vibration suppression function runs in a closed loop, detecting oscillations as they occur, and damping them immediately. Actively damping load oscillations significantly reduces the time it takes for a heavy load or an end effector to settle at the target position. Although the position error at the encoder level may be higher, the overall performance of the system, as evaluated at load position, is significantly improved.

A typical example is a load fixed to a servo controlled motor by means of a shaft that has a certain amount of flexibility. If the servo control of the motor is set for near-zero position error during movement, then the load will oscillate strongly. Every change in the acceleration (jerk) will apply a perturbation, resulting in oscillations of the load. While the stiff HD control loop will overcome these oscillations at motor position level, the load will still oscillate strongly.

The anti-vibration function can handle systems with an oscillation frequency of up to 100 Hz.

The following diagram shows the four phases of the vibration suppression process.

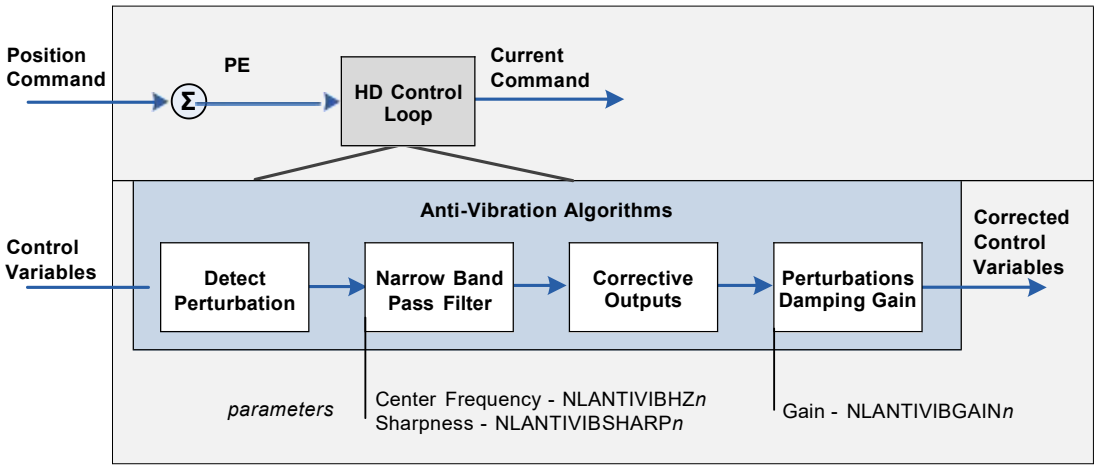


figure8-16 Anti-Vibration Filters

Phase 1: The perturbations induced to the system are detected using various control variables, such as position error and current, as input. A perturbation value is calculated for use in the next phase.

Phase 2: The perturbation value is passed through a narrow band pass filter in order to select the perturbations that are induced by the system oscillations. The center frequency and the width of the band pass filter are set, respectively, by the parameters NLANTIVIBHZn and NLANTIVIBSHARP*n*.

Phase 3: Corrective outputs to be added to the control variables are calculated.

Phase 4: Corrective outputs are added to control variables using a damping gain (parameter NLANTIVIBGAIN*n*).

Anti-Vibration Tuning Procedure

After autotuning, more anti-vibration tuning may be required.

If an additional vibration frequency needs to be suppressed, the turning process can be repeated using the second set of anti-vibration filters.

The following table shows the parameters whose values are modified by the tuning procedures.

HD Anti-Vibration Filter	Parameter	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
Damping Gain 2	NLANTIVIBGAIN2	0	0 to 99
Damping Gain 3	NLANTIVIBGAIN3	0	0 to 6

Note Although parameters NLANTIVBHZ, NLANTIVIBSHARP and NLANTIVIBGAIN are still available, they are not recommended for use.

Step 1 – Setting the Narrow Band Filter (NBF)

1. Set the narrow band center frequency.

- Execute a movement and measure the resonance (oscillation frequency) of the current command (ICMD):
  - In the Scope screen, right-click on the ICMD plot.
  - Select FFT and Derivative.
  - Select FFT Trace.

  The FFT trace will look like this, for example:

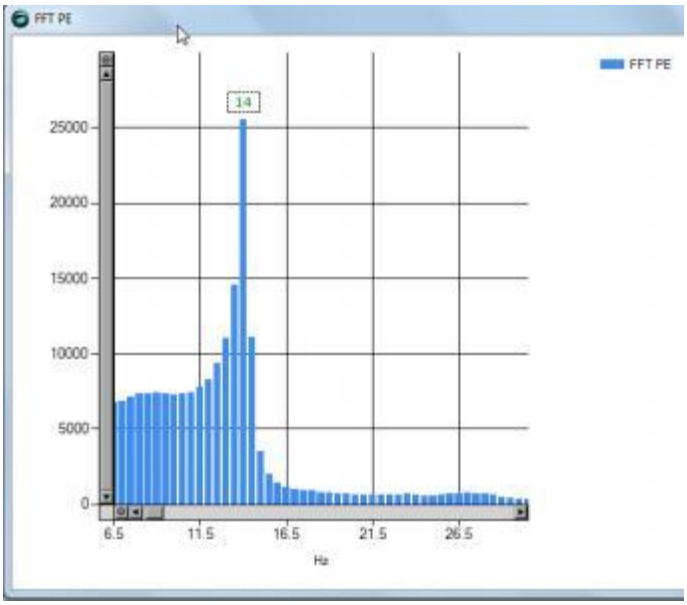


figure8-17 FFT Trace

- Set the value of parameter NLANTIVIBHZn to the peak, or dominant, resonance, in Hertz. In the example shown here, the value is 14 Hz.

2. Set the narrow band center sharpness (width).

- Set the value of parameter NLANTIVIBSHARPn according to the resonance sharpness (width) of the narrow band filter.

  Estimate the width by visually comparing the graph in the FF Trace dialog box to the graph below, which shows the frequency response of the NBF as a function of the value of NLANTIVIBSHARPn. Typical setting values range from 0.1 to 1.0.

The following diagram shows the narrow band filter frequency response.

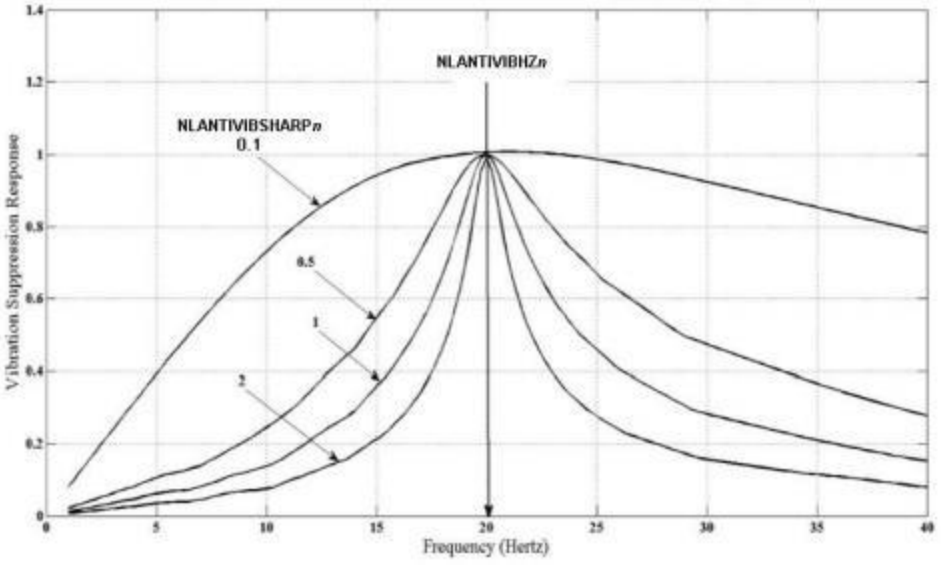


figure8-18 Frequency response as a function of NLANTIVIBSHARPn for 20 Hz center frequency

Step 2 – Tuning the Damping Gain

Increase parameter NLANTIVIBGAIN*n* until optimal damping is achieved.

- At each increment, record the current command (ICMD) and check the oscillation damping.

  Optimal damping of the system is obtained for the best damped current oscillations.

Note If, while increasing this parameter, a high frequency vibration appears, slightly reduce the adaptive global gain (KNLUSERGAIN).

Anti-Vibration Tuning – Example

Note Plots of some variables are scaled (indicated by "x").

Without the vibration suppression tuning, position error and current oscillate, and settling time is very long.

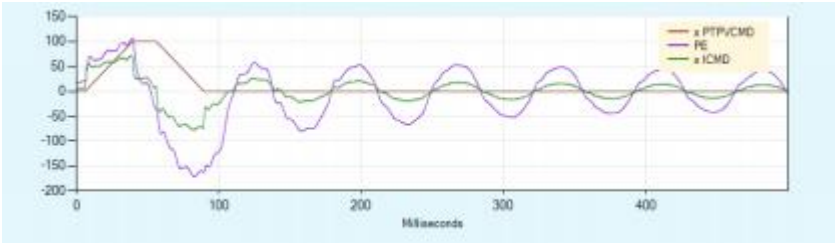


figure8-19 Without vibration suppression, oscillation of position error and current

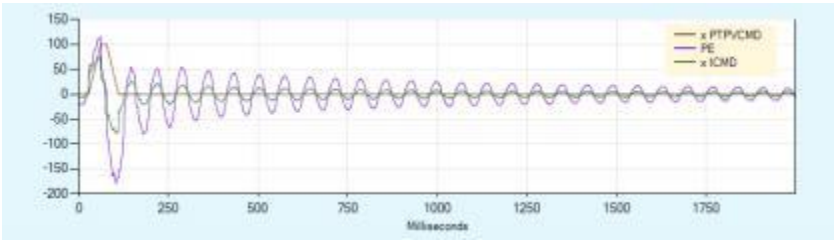


figure8-20 Without vibration suppression, long settling time

figure8-21 Settling time – no anti-vibration tuning

To damp the oscillations and reduce settling time, the following parameters are set:

- NLANTIVIBHZ2 = 14 Hz, frequency of the measured resonance.
- NLANTIVIBSHARP2 = 0.5, width estimated according to the sharpness displayed in the FFT trace.
- NLANTIVIBGAIN2 = 8, determined by manually increasing the value from 0, until best settling time is achieved.

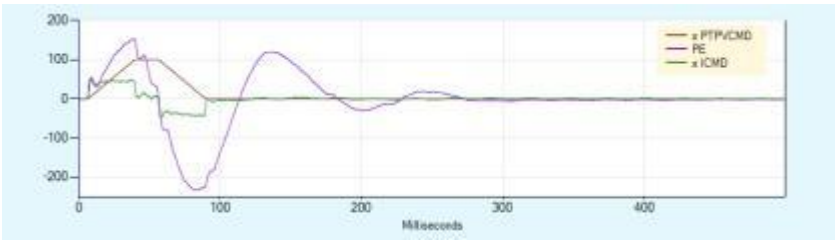


figure8-22 Tuning for vibration suppression, less oscillation of position error and current

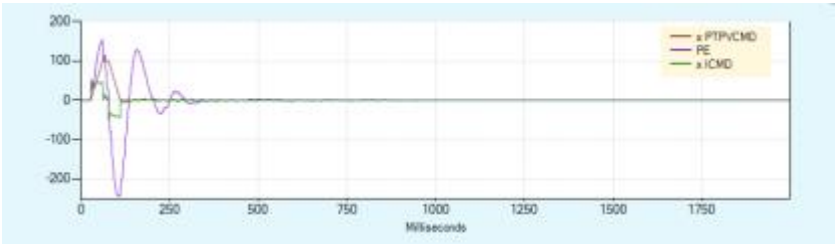


figure8-23 Tuning for vibration suppression, faster settling time

figure8-24 Settling time – with anti-vibration tuning

8.9 Gains – Manual Tuning

Note | *Not fully updated for ServoStudio 2.*

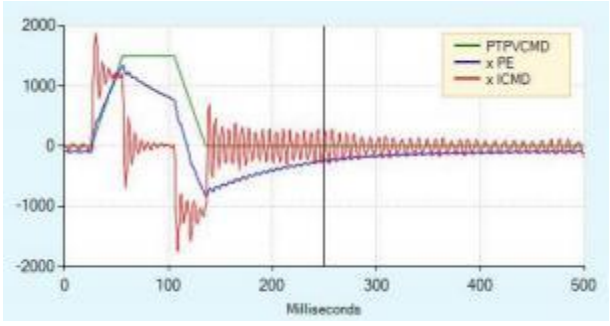
KNLD - Derivative Gain

1. Set KNLP to half the value that was set by default.
2. Set KNLI and KNLIV to zero.
3. Increase KNLD until oscillations of ICMD are observed.

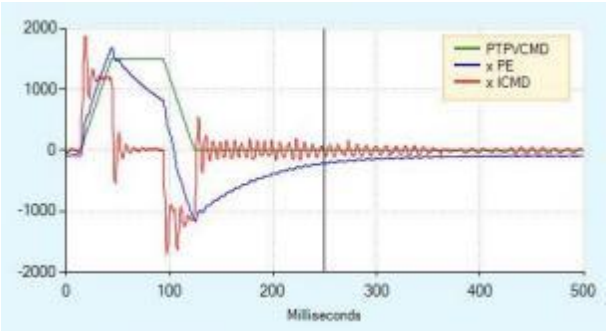
The acceptable level of ICMD ripple depends on the system, primarily the load. It can often be judged by the acoustical noise.

Light loads (LMJR < 2): 5% of rated current may be normal.

Higher loads (LMJR > 2): 10% of rated current may result in acceptable ripple.



KNLD value too high



KNLD selected value

figure8-25 Derivative Gain Tuning

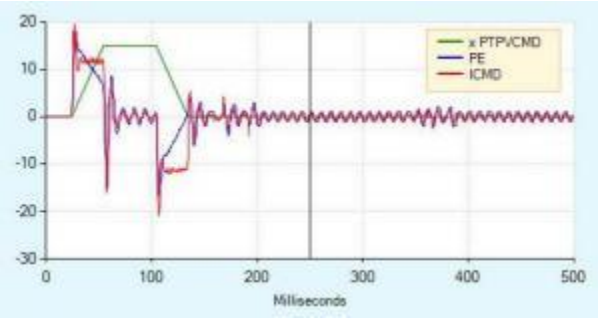
KNLIV - Derivative-Integral Gain

Increase KNLIV until position error (PE) begins to oscillate.

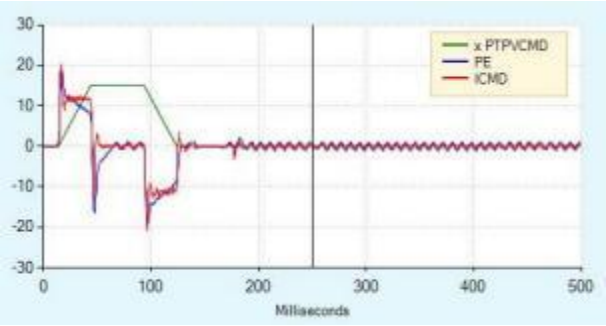
Increasing KNLIV reduces the position error, reduces sensitivity to external perturbations, and reduces the steady state position error at stop (if exists).

Best tuning: Position error decreases as fast as possible after each movement phase transition (jerk), without oscillations during transition between phases; no overshoot of position error; oscillations at stop are acceptable (±1 encoder count).

Best settling time: If possible, increase KNLIV until position error returns to 0 before the end of the deceleration phase.



KNLIV value is too high; vibrations at stop are too strong; overshoot of position error



KNLIV selected value; good settling time

figure8-26 Derivative-Integral Gain Tuning

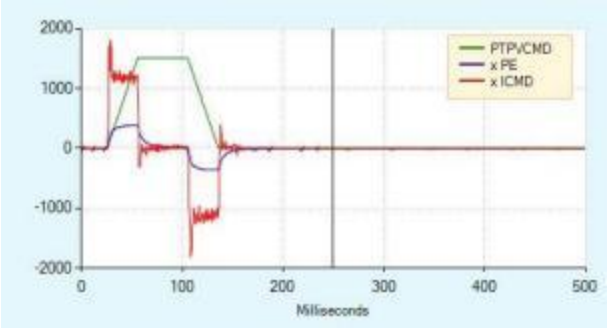
KNLP - Proportional Gain

Increase KNLP until position error (PE) begins to oscillate.

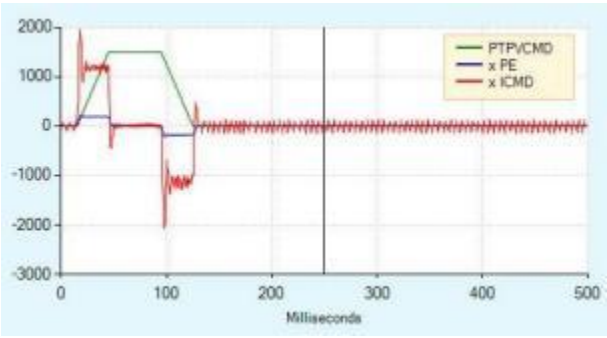
As the value of KNLP increases, the shape of the position error become square, reflecting the constant values during acceleration and deceleration.

As the KNLP proportional gain gets higher, the position error reaches a steady value during each phase of the movement (acceleration, plateau, deceleration).

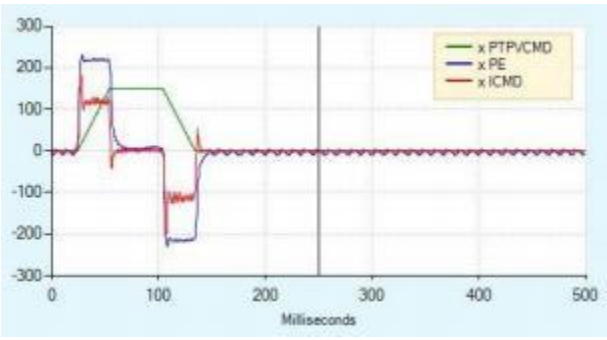
Best tuning: Graph is as square as possible, indicating the position error is constant during each phase of movement, and there are no oscillations during the transition between phases (acceleration to plateau, plateau to deceleration, deceleration to stop).



PE gets flatter during acceleration and deceleration



KNLP value too high; vibrations at stop



KNLP selected value

figure8-27 Proportional Gain Tuning

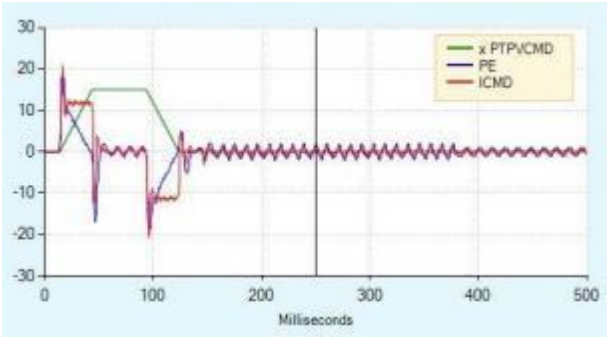
KNLI - Integral Gain

KNLI is used to reduce the position error during movement and at stop.

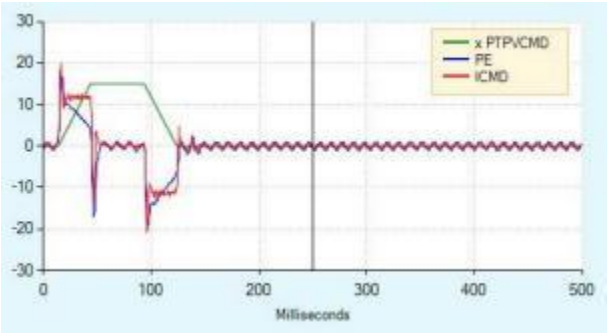
Best tuning: Maximum value that does not create overshoot or oscillations.

Best settling time: If possible, increase KNLI until position error returns to 0 before the end of the deceleration phase.

Result: Position error is slightly reduced; oscillations at stop are acceptable (±1 encoder count); no overshoot of position error at end of deceleration phase (stopping point).



KNLI value too high; position error oscillations at stop; overshoot of position error



KNLI selected value

figure8-28 KNLI Tuning

8.10 Flexibility Compensation Tuning

Note *Not fully updated for ServoStudio 2.*

The flexibility compensation parameters reduce the vibrations induced to the load by abrupt changes in acceleration (jerk), and reduce tracking error. They also serve to minimize overshoot and settling time.

- NLPEAFF(HD Flexibility Compensation), defined in Hertz, is set according to the rigidity of the system. Rigid systems require a high value. Systems with high load inertia and flexible couplings require lower values; the normal range is 400 to30 Hz). If not used, set to 5000 Hz.
- NLAFFLPFHZ(HD Spring Filter), defined in Hertz, applies a low pass filter on the acceleration of the command position used to perform the compensation. This acceleration is calculated from the input command position, and may be noisy if the input command position has a relatively low resolution, as for example a pulse train input. Application of the low pass filter NLAFFLPFHZ smooths the calculated acceleration of the command position, and should be used whenever noisy operation is observed while applying the parameter NLPEAFF.

Best tuning: Typically, the highest frequency is 400 Hz. Thus, for heavily loaded and flexible systems, typical range for NLPEAFF is 400 to 30 Hz.

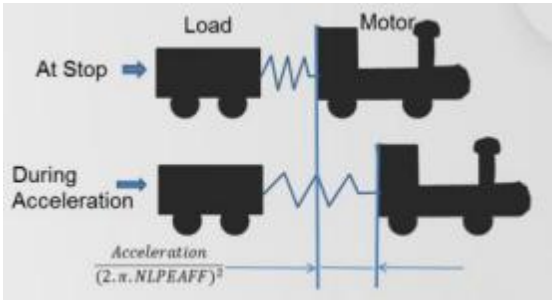


figure8-29 Plant Flexibility

Procedure: Flexibility Compensation Tuning

1. Set NLAFFLPFHZ = 3×KNLD
2. Start with highest value of NLPEAFF, and reduce until the best result for the application is achieved. Criteria may be either settling time or position error.

8.11 Tuning Issues – Q&A

When should a notch filter be used?

If your plant has a high frequency vibrations, and produces shrieking or honking sounds when you raise the gain.

Although system performance is good, the system produces a lot of acoustical noise at low speeds. What should be done?

Tune the system at a high speed, reduce global gain KNLUSERGAIN, increase low pass filter rise time NLFILTT1, and then increase NLMAXGAIN.

The system has flexibility, and overshoots at the end of the movement. How can overshoot be eliminated?

Use a low value of acceleration filter NLAFFLPFHZ and decrease NLPEAFF. This will create an undershoot before the stop and eliminate the overshoot.

9. Troubleshooting

9.1 Report Generator

Before contacting Technical Support, create a report of application settings by means of the Report Generator in ServoStudio 2. The information contained in the report files will enable Technical Support to troubleshoot your problem and provide assistance.

In general, it is strongly recommended that you create a report whenever you complete configuration of your application, even when the system is functioning properly.

The Report Generator option can be accessed in ServoStudio 2 in two locations:

- Autotuning wizard (final step)
- Backup & Restore screen

9.2 Faults and Warnings

If the LDHD2 is connected to a host computer via a serial connection, it communicates fault codes to the computer by means of a text message. This message is saved in a fault history log (FLTHIST) in the drive's non-volatile memory, so that the fault history is not lost when power is removed from the drive.

- Warnings are not considered faults and do not disable operation. The system automatically clears the warning state when the condition that generated the warning no longer exists.
- Faults occur when settings or conditions may cause improper operation of the drive/motor and/or equipment damage. Faults automatically disable the drive, and a fault status is indicated on the drive's display and in the software interface.

  The drive fault status is generally latched, and the drive cannot be enabled until the fault status is explicitly cleared. Only if the fault condition no longer exists can the fault status be cleared. It is done by either of the following:

  - Toggling the drive enable. This is done either by executing a drive disable command (K) followed by the enabled (EN) command or by toggling the Remote Enable input.
  - In some systems, a specific drive input is defined as Alarm Clear. In this case, toggling the input will clear the fault.

  When the fault condition no longer exists, the drive is reenabled.
- Fatal faults. Some faults are referred to as fatal faults since they disable almost all drive functions (including communications) and prevent the drive from being enabled. This condition is typical of faults due to internal failures, such as a watchdog event or a failure of an internal power source. Fatal faults require intervention by Technical Support.

VarCom	Description
CLEARFAULTS	Clears all latched faults.
FLT	Returns a list of faults latched by the drive.
FLTHIST	Returns the contents of the fault buffer.
K|EN	Disable drive | Enable drive
READY	Indicates whether drive is ready to be enabled.
REMOTE	Indicates the state of the external hardware enable input.
ST	Returns detailed drive status messages.

9.3 Fieldbus Status LEDs

Interfaces C2 and C3 each have two LEDs that indicate the fieldbus status when communicating on an EtherCAT network.

figure9-1 EtherCAT Ports and LEDs

Green	Flashing – Communication activity
	Not lit – No communication activity
Orange	Steadily lit – Operational (OP) state
	Slow flashing – Safe-Operation (SAFEOP) state
	Fast flashing – Pre-Operational (PREOP) state
	Very fast flashing – Bootstrap (BOOT) state
	Not lit – Initial (INIT) state

9.4 Digital Display – Warning Codes

_ Realtime Overload Warning

Definition	Realtime Overload Warning
Type	Warning
Message #	WRN 36
Description	Drive has detected that CPU is close to its computational limit.
Action required	

b Multi-turn Encoder Battery Low Voltage

Definition	Absolute Multi-turn Encoder Battery Low Voltage Warning
Type	Warning
Message #	WRN 22
Description	The voltage level of the absolute multi-turn encoder backup battery has dropped below 3.15V.
Action required	Replace the battery as soon as possible. If the battery is replaced while drive power is on, encoder position information is retained. If power to the battery is shut off before the battery is replaced, issue the command MTTURNRESET to reset the multi-turn position after battery power is restored.

c Regen Resistor Overload

Definition	Regen Resistor Overload
Type	Warning
Message #	WRN 34
Description	Regeneration resistor is overloaded.
Action required	

F Drive Foldback Warning
Motor Foldback Warning

Definition	Drive Foldback Warning Motor Foldback Warning
Type	Warning
Message #	WRN 2 WRN 3
Description	Drive foldback current dropped below the drive foldback current warning threshold (MIFOLDWTHRESH). Or, motor foldback current dropped below the motor foldback current warning threshold (IFOLDWTHRESH).
Action required	Check the drive-motor sizing. This warning can occur if the drive is under-sized (under-powered) for the application.

H Motor Over-Temperature

Definition	Motor Over-Temperature
Type	Warning
Message #	WRN 6
Description	Motor is overheated.
Action required	

L1 Hardware Positive Limit Switch is Open

Definition	Hardware Positive Limit Switch is Open
Type	Warning
Message #	WRN 15
Description	Positive hardware limit switch is activated.
Action required	

L2 Hardware Negative Limit Switch is Open

Definition	Hardware Negative Limit Switch is Open
Type	Warning
Message #	WRN 16
Description	Negative hardware limit switch is activated.
Action required	

L3 Hardware Positive and Negative Limit Switches are Open

Definition	Hardware Positive and Negative Limit Switches are Open
Type	Warning
Message #	WRN 17
Description	Positive and negative hardware limit switches are both activated.
Action required	

L4 Software Positive Limit Switch is Tripped

Definition	Software Positive Limit switch is Tripped
Type	Warning
Message #	WRN 18
Description	Positive software limit switch is activated. PFB > POSLIMPOS and POSLIMMODE = 1
Action required	

L5 Software Negative Limit Switch is Tripped

Definition	Software Negative Limit Switch is Tripped
Type	Warning
Message #	WRN 19
Description	Negative software limit switch is activated. PFB < POSLIMNEG and POSLIMMODE = 1
Action required	

L6 Software Limit Switches are Tripped

Definition	Software Limit Switches are Tripped
Type	Warning
Message #	WRN 20
Description	Positive and negative software limit switches are activated. PFB > POSLIMPOS and PFB < POSLIMNEG and POSLIMMODE = 1
Action required	

o Bus AC Supply Line Disconnected

Definition	Bus AC Supply Line Disconnected
Type	Warning
Message #	WRN 32
Description	At least one phase of the main power for the bus supply is not connected.
Action required	

r Offset and/or Gain Adjustment Values Detected After SININIT

Definition	Offset and/or Gain Adjustment Values Detected After SININIT
Type	Warning
Message #	WRN 27
Description	Significant offset and/or gain adjustment values were detected after SININIT. The values that trigger this warning are half the value of those used to declare a fault. Although the system may continue to function, these values indicate the existence of a problem, which may worsen over time.
Action required	Check the encoder and associated hardware. These values suggest some degradation in either electronics (e.g., encoder, drive) or wiring (e.g., increased wire resistance, increased leakage between wires). The problem must be analyzed and repaired.

t Power Stage Over-Temperature
Control Board Over-Temperature
Integrated Power Module Over-Temperature

Definition	Power Stage Over-Temperature Control Board Over-Temperature Integrated Power Module Over-Temperature
Type	Warning
Message #	WRN 5 WRN 9 WRN 38
Description	The temperature on the power board and/or on the control board and/or the power module (IPM) has exceeded the preset limit.
Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact Technical Support.

u Under-Voltage

Definition	Under-Voltage
Type	Warning
Message #	WRN 4
Description	The bus voltage is below the minimum value. If the value of variable UVMODE is 1 or 2, and the drive is enabled, an under-voltage warning is issued.
Action required	Check that the main AC voltage supply is connected to the drive and is switched on. The under-voltage limit can be read with the UVTHRESH command.

9.5 Digital Display – Fault Codes

The fault codes are presented here in alphanumerical order, using the following format:

Definition	Short name. Used in ServoStudio 2.
Type	Specifies Fault or Fatal fault. Types of faults are explained inFaults and Warnings.
Active disable	Indicates whether the Active Disable function can be triggered by the fault. Refer toDisable Mode.
Message #	The fault message number displayed in Terminal.
Description	Describes the status or fault indicated by the code.
Action required	Describes the recommended steps for correcting the fault.

-5 Motor Setup Failed

Definition	Motor Setup Failed
Type	Fault
Active disable	No
Message #	FLT 44
Description	Motor Setup procedure failed. MOTORSETUPST will show the cause. This fault disables the drive.
Action required	Check phase and motor wiring. Make sure the correct feedback type is selected. Check MOTORSETUPST for hints.

-1 Not Configured

Definition	Not Configured
Type	Fault
Active disable	Not applicable
Message #	FLT 12
Description	Drive configuration required. CONFIG is required after the value of any of certain parameters is modified. CONFIG is also required after certain parameters are sent to the drive, even if their value has not been changed.
Action required	Set drive parameters and/or and execute CONFIG.

_ Realtime Overload Fault

Definition	Realtime Overload Fault
Type	Fault
Active disable	No
Message #	FLT 89
Description	CPU has exceeded its computational limit. Realtime execution takes longer than 31.25 µs. This fault disables the drive.
Action required	Contact Technical Support

= [3 bars] Watchdog Fault

Definition	Watchdog Fault
Type	Fault
Active disable	No
Message #	FLT 38
Description	Generally occurs due to an unforeseen circumstance. The drive is inoperable until power is cycled.
Action required	Switch the drive off and on again. If the detected error persists, contact Technical Support.

A4 CAN Supply Fault

Definition	CAN Supply Fault
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 32
Description	A problem with the internal voltage supply for the CAN bus. This fault disables the drive.
Action required	The drive probably needs repair. Contact Technical Support.

b Drive Locked

Definition	Drive Locked
Type	Fatal fault
Active disable	Not applicable
Message #	FLT 1
Description	Security code and key do not match. Drive cannot be enabled.
Action required	Contact Technical Support.

b1 PLL Synchronization Failed

Definition	PLL (Phase-Locked Loop) Synchronization Failed
Type	Fault
Active disable	No
Message #	FLT 48
Description	Controller synchronization signal is missing or not stable. The fault is detected only when synchronization is enabled by SYNCSOURCE command. This fault disables the drive.
Action required	Check for controller synchronization signal. Check the cable connection and wiring.

e Parameter Memory Checksum Failure

Definition	Parameter Memory Checksum Failure
Type	Fault
Active disable	Not applicable
Message #	FLT 2
Description	The non-volatile memory used to store drive parameters is empty or the data is corrupted. This fault is displayed upon initial power up. The fault will be cleared once the drive is configured and the parameters are saved in the drive's non-volatile memory. This fault may also occur during power off if SAVE operation has not completed.
Action required	Reconfigure the drive, or download the parameter set, and save the parameters. If problem persists, contact Technical Support.

E Failure Writing to Flash Memory

E	Flashing
Definition	Failure Writing to Flash Memory
Type	Fatal fault
Active disable	Not applicable
Message #	FLT 13
Description	An internal problem accessing the flash memory. Drive cannot be enabled.
Action required	Contact Technical Support.

e101 FPGA Config Failed

Definition	FPGA Config Failed
Type	Fatal fault
Active disable	Not applicable
Message #	FLT 5
Description	The code for the FPGA did not load. Drive cannot be enabled.
Action required	Contact Technical Support.

e105 Self-Test Failed

Definition	Self-Test Failed
Type	Fatal fault
Active disable	Not applicable
Message #	FLT 33
Description	The power-up self-test failed. Drive cannot be enabled.
Action required	Contact Technical Support.

e106 Control EEPROM Fault

Definition	Control EEPROM Fault
Type	Fatal fault
Active disable	Not applicable
Message #	FLT 6
Description	A problem accessing the EEPROM on the control board. Drive cannot be enabled.
Action required	Contact Technical Support.

e107 Power EEPROM Fault

Definition	Power EEPROM Fault
Type	Fatal fault
Active disable	Not applicable
Message #	FLT 7
Description	A problem accessing the EEPROM on the power board. Drive cannot be enabled.
Action required	Contact Technical Support.

e108 Vbus Measure Circuit Failed

Definition	Vbus Measure Circuit Failed
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 8
Description	A failure occurred in the circuit that measures bus voltage. This fault disables the drive.
Action required	Reset faults. If the fault persists, the drive probably needs repair. Contact Technical Support.

e109 Current-Sensors Offset Invalid

Definition	Current-Sensors Offset Invalid
Type	Fault
Active disable	No
Message #	FLT 43
Description	The calculated offsets for the current sensors are out of range. This fault disables the drive.
Action required	Reset faults. If the fault persists, the drive probably needs repair. Contact Technical Support.

e120 FPGA Version Mismatch

Definition	FPGA Version Mismatch
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 47
Description	FPGA version does not match the firmware version. This fault disables the drive.
Action required	Update either FPGA version or drive version.

e121 Internal Error

Definition	Internal Error
Type	Fault
Active disable	No
Message #	FLT 70
Description	Internal error due to an endless while loop or a numerical issue. This fault disables the drive.
Action required	Contact Technical Support.

e123 MTP Read Failure

Definition	Motor Plate Read Failed
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 85
Description	Motor type nameplate data cannot be read. This fault disables the drive.
Action required	Reconnect the feedback device. Make sure the motor type nameplate data is present.

e124 SAVE and Power Cycle Required

Definition	SAVE and Power Cycle Required
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 86
Description	Parameter was changed, and requires SAVE and power cycle to take effect. This fault disables the drive.
Action required	SAVE and then cycle power to the drive.

e125 Fieldbus Version Mismatch

Definition	Fieldbus Version Mismatch
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 93
Description	EtherCAT - the Microblaze version does not match the version specified by drive. This fault disables the drive.
Action required	Make sure the correct version has been downloaded to the drive.

e126 ESI Version Mismatch

Definition	ESI Version Mismatch
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 94
Description	EtherCAT - the ESI version does not match the version specified by drive. This fault disables the drive.
Action required	Make sure the correct version has been downloaded to the drive.

e127 Digital Output Over-Current Fault

Definition	Digital Output Over-Current Detected
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 96
Description	Over-current detected on one of the digital outputs. This fault disables the drive.
Action required	Verify correct wiring of the digital outputs. Make sure the output circuit is not shorted.

e129 Feedback Type Auto-Detect Failed

Definition	Feedback type auto-detection failed.
Type	Fault
Active disable	Not Applicable
Message #	FLT 106
Description	Automatic detection of feedback type on power-up failed because neither sensAR nor HIPERFACE feedback device was detected. Feedback device is either disconnected or a different type. This fault disables the drive.
Action required	Verify the connection. Manually configure the actual type of feedback.

e131 MOTORNAME/MTP Data Mismatch

Definition	MOTORNAME and MTP data are not compatible.
Type	Fault
Active disable	Not Applicable
Message #	FLT 108
Description	Drive may have been configured previously for another, different motor. This fault disables the drive.
Action required	Clear MOTORNAME and clear faults. Perform tuning with parameters for the connected motor.

e132 Firmware Version is Not Supported by this Drive

Definition	The drive firmware is not supported on this drive model.
Type	Fault
Active disable	Not Applicable
Message #	FLT 109
Description	Firmware version higher than 1.44.X cannot run on this drive. This fault disables the drive.
Action required	Download a compatible firmware version to the drive.

e134 ESI Vendor Mismatch

Definition	ESI Vendor Mismatch
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 110
Description	On EtherCAT. The ESI vendor data does not match the data specified by the drive. This fault disables the drive.
Action required	Make sure the correct vendor data is downloaded to drive.

F1 Drive Foldback

Definition	Drive Foldback
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 16
Description	Drive average current exceeds rated drive continuous current. It occurs after the Foldback warning has occurred.
Action required	Check motor-drive sizing. This fault can occur if the drive is under-sized (under-powered) for the application. Check that the commutation angle is correct (i.e., commutation is balanced).

F2 Motor Foldback

Definition	Motor Foldback
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 17
Description	Motor average current exceeds rated motor continuous current. It occurs after the Foldback warning has occurred.
Action required	Check the drive-motor sizing. This fault can occur if the motor is under-sized (under-powered) for the application.

F2H Pulse Train Frequency Too High

Definition	Pulse Train Frequency Too High
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 76
Description	The external pulse train frequency has exceeded the maximum specified input frequency. This fault disables the drive.
Action required	Reduce the frequency of the gearing pulses commanded from the controller.

F3 Stall Fault

Definition	Stall Fault
Type	Fault
Active disable	No
Message #	FLT 59
Description	A stall condition occurs when [I > MICONT] and [I > 0.9×ILIM] and [V < STALLVEL]. A stall fault occurs whenever a stall condition persists for a duration greater than STALLTIME. This fault disables the drive.
Action required	Remove the stall condition, and take care to prevent stall conditions.

Fb1 Fieldbus Velocity Limit Exceeded

Definition	Fieldbus Velocity Limit Exceeded
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 30
Description	A target position command from controller was rejected because it would cause motor to exceed the velocity limit. This fault disables the drive.
Action required	Enable the drive and send valid position commands.

Fb12 Fieldbus Interpolation Cycle Exceeds Sync Time

Definition	Fieldbus Interpolation Cycle Exceeds Sync Time
Type	Fault
Active disable	
Message #	FLT 120
Description	The fieldbus interpolation cycle exceeds the defined sync time.
Action required	Adjust the cycle time setting.

Fb13 Received Object Index Exceed Objects Array Size

Definition	Received Object Index Exceed Objects Array Size
Type	Fault
Active disable	No
Message #	FLT 122
Description	This fault disables the drive.
Action required	Reset the drive.

Fb2 Command Exceeds Acc/Dec Limits

Definition	Command Exceeds Acc/Dec Limits
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 66
Description	A new target position command from controller is about to cause the motor acceleration/deceleration to exceed the limits. Therefore the command is rejected and the drive faults. This fault disables the drive.
Action required	Enable the drive and send valid position commands.

Fb3 Fieldbus Cable Disconnected

Definition	Fieldbus Cable Disconnected
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 65
Description	The connection between controller and drive was removed. This fault disables the drive.
Action required	Reestablish the connection between controller and drive.

Fb4 Fieldbus Target Command Lost

Definition	Fieldbus Target Command Lost
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 69
Description	The fieldbus controller has not sent a target command in 3 consecutive instances. This fault disables the drive.
Action required	Clear the fault and allow the controller to send new commands.

Fb8 EtherCAT Packet Loss

Definition	EtherCAT Packet Loss
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 91
Description	EtherCAT packets have been lost. This fault disables the drive.
Action required	Make sure the EtherCAT master (controller) sends the packets within the time defined (by the master).

Fb9 EtherCAT State Not Operational

Definition	CAN/EtherCAT State Not Operational
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 92
Description	Drive was enabled and in an operational state prior to receiving a command to move to a lower state of communication. This fault disables the drive.
Action required	Make sure the controller does not switch to a lower state of communication while the drive is enabled.

J Velocity Over-Speed Exceeded

Definition	Velocity Over-Speed Exceeded
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 14
Description	Actual velocity exceeded 1.2 times the velocity limit. The velocity limit is set using VLIM. This fault disables the drive.
Action required	Check that VLIM is set to match the application requirements. Using velocity loop tuning, check for excessive overshoot.

J1 Exceeded Maximum Position Error

Definition	Exceeded Maximum Position Error
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 45
Description	The position error (PE) has exceeded the position error limit (PEMAX). This fault disables the drive.
Action required	Change drive tuning to improve position tracking, or increase PEMAX to allow a greater position error.

J2 Exceeded Maximum Velocity Error

Definition	Exceeded Maximum Velocity Error
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 67
Description	The velocity error (VE) has exceeded the velocity error limit (VEMAX). This fault disables the drive.
Action required	Change drive tuning to improve velocity tracking, or increase VEMAX to allow a greater velocity error.

J3 Excessive PE Value

Definition	Excessive PE Value
Type	Fault
Active disable	No
Message #	FLT 87
Description	The position error (PE) has reached the software numerical limit. This fault disables the drive.
Action required	Check tuning.

J4 Commutation Error (Motor Runaway) Condition Detected

Definition	Commutation Error (Motor Runaway) Condition Detected
Type	Fault
Active disable	No
Message #	FLT 77
Description	The motor moves in negative direction although the commanded current is positive. Commutation is incorrect. (Algebraic signs of actual current, acceleration and velocity do not match.) This fault disables the drive.
Action required	Correct MPHASE setting. Activate and improve the phase find process.

n1 Regen Over-Current

Definition	Regen Over-Current
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 29
Description	The preset current limit for regen current has been exceeded. This fault disables the drive.
Action required	Increase the value of the regen resistor.

n3 Emergency Stop Issued

Definition	Emergency Stop Issued
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 57
Description	Input defined as Emergency Stop indicator has been activated. This fault disables the drive.
Action required	Turn off the input.

n41 Power Brake Open Load

Definition	Power Brake Open Load
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 63
Description	Open load on the power brake output. This fault prevents drive from being enabled.
Action required	Make sure the power brake load cables are connected properly and are not damaged.

n42 Power Brake Short

Definition	Power Brake Short
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 64
Description	Short circuit on the power brake output. This fault disables the drive.
Action required	Replace the motor brake or the entire motor.

n45 Power Brake Fault

Definition	Power Brake Fault
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 98
Description	A fault occurred on the power brake. This fault disables the drive.
Action required	Replace the motor brake.

o Over-Voltage

o	Flashing
Definition	Over-Voltage
Type	Fault
Active disable	No
Message #	FLT 9
Description	The bus voltage exceeded the maximum value. This fault disables the drive.
Action required	Check whether a regeneration resistor is required for the application.

o15 Plus 15V Out of Range

Definition	Plus 15V Out of Range
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 36
Description	The internal +15 V supply is out of range. This fault disables the drive.
Action required	The drive probably needs repair. Contact Technical Support.

o-15 Minus 15V Out of Range

Definition	Minus 15V Out of Range
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 37
Description	The internal -15 V supply is out of range. This fault disables the drive.
Action required	The drive probably needs repair. Contact Technical Support.

o5 5V Out of Range

Definition	5V Out of Range
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 52
Description	5V is low or powering off. This fault disables the drive.
Action required	May occur during power off. If it occurs under other conditions, contact Technical Support.

o6 Logic AC Power Failure

Definition	Logic AC Power Failure
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 72
Description	The main power for the logic supply is off. This fault disables the drive.
Action required	No Action required. This is a normal response when logic power is turned off.

o7 Bus AC Supply Line Disconnect

Definition	Bus AC Supply Line Disconnect
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 78
Description	At least one phase of the main power for the bus supply is not connected. This fault disables the drive.
Action required	Check the connection of the bus AC supply. Make sure the supply is on. Refer toLINELOSSMODEand related parameters.

o8 Regen Resistor Overload

Definition	Regen Resistor Overload
Type	Fault
Active disable	No
Message #	FLT 83
Description	The regen resistor load exceeds its allowed power. This fault disables the drive.
Action required	Check whether the regen resistor properties are suited to the application.

o9 Digital Output Over-Current Fault

Definition	Digital Output Over-Current Fault
Type	Fault
Active disable	No
Message #	FLT 105
Description	Over-current at the digital output has been detected. This fault disables the drive.
Action required	Check the digital output connections.

P Over-Current

Definition	Over-Current
Type	Fault
Active disable	No
Message #	FLT 3
Description	Over-current at the drive output has been detected. This fault disables the drive. The drive allows this fault to occur up to three times in succession. When the fault occurs for the fourth time, the drive forces a delay of 1 minute before it can be reenabled.
Action required	Check for a short circuit on the motor connection. Check for excessive overshoot in the current loop.

P2 Unstable Current Loop

Definition	Unstable Current Loop
Type	Fault
Active disable	No
Message #	FLT 100
Description	An unexpected high current overshoot has been detected. This fault disables the drive.
Action required	Check and modify current controller settings.

P3 High IQ Current Detected

Definition	High IQ Current Detected
Type	Fault
Active disable	No
Message #	FLT 104
Description	The detected IQ current is greater than 120% of ILIM. This fault disables the drive.
Action required	Check and modify current controller settings.

r16 Feedback 5V Over-Current

Definition	Feedback 5V Over-Current
Type	Fault
Active disable	No
Message #	FLT 26
Description	The current supplied by the drive on the 5V primary encoder supply has exceeded the preset current limit. The drive allows this fault to occur up to 3 times in succession. After 3 faults, the drive forces a delay of 1 minute before it can be reenabled. This fault disables the drive.
Action required	The LDHD2 can source a maximum current of 320 mA to the primary encoder. Check for a short-circuit at the encoder. Check if the encoder is drawing more than the current limit

r20 Feedback Communication Error

Definition	Feedback Communication Error
Type	Fault
Active disable	No
Message #	FLT 34
Description	Communication with the feedback device did not initialize correctly. This fault disables the drive.
Action required	Check that the feedback device is wired correctly. Check that the correct encoder type (MENCTYPE) is selected.

r24 Tamagawa Init Failed

Definition	Tamagawa Init Failed
Type	Fault
Active disable	No
Message #	FLT 42
Description	The initialization process with the Tamagawa feedback device has failed. This fault disables the drive.
Action required	Check that the wiring to the encoder is correct.

r25 Pulse and Direction Input Line Break

Definition	Pulse and Direction Input Line Break
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 46
Description	One of the Pulse & Direction signals is not connected. This fault disables the drive.
Action required	Check that all signals to the P&D inputs are properly connected to the drive.

r26 Tamagawa Abs Operational Fault

Definition	Tamagawa Abs Operational Fault
Type	Fault
Active disable	No
Message #	FLT49
Description	Several faults are indicated by the feedback device and include one or more of the following: battery low/error, over-speed, counting error, multi-turn error. This fault disables the drive.
Action required	Check the battery voltage and feedback wiring. Make sure the motor did not move at a high velocity during encoder initialization.

r27 Motor Phases Disconnected

Definition	Motor Phases Disconnected
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 51
Description	One of the motor phases is disconnected. The current of one of the motor phases is effectively zero for more than 160 electrical degrees while the current command is greater than 100. This fault disables the drive.
Action required	Check the wiring of the motor phases.

r29 Multi-turn Encoder Battery Low Voltage

Definition	Absolute Multi-turn Encoder Battery Low Voltage Fault
Type	Fault
Active disable	No
Message #	FLT 56
Description	The voltage level of the absolute multi-turn encoder backup battery has dropped below 3.0V. This fault disables the drive.
Action required	Replace the encoder battery. If battery power is cut off before the battery is replaced, issue the command MTURNRESET to reset the multi-turn position after battery power is restored.

r40 SensAR Encoder Fault

Definition	SensAR Encoder Fault
Type	Fault
Active disable	No
Message #	FLT 82
Description	The drive has detected an internal fault on the sensAR encoder through communication. This fault disables the drive.
Action required	Use command SRVSNSINFO to identify the fault.

r46 sensAR Encoder Position Fault

Definition	sensAR Encoder Position Fault
Type	Fault
Active disable	No
Message #	FLT 112
Description	The returned position values are no longer considered reliable. This fault disables the drive.
Action required	Restart the drive.

r47 sensAR Over-Temperature Fault

Definition	sensAR Over-Temperature Fault
Type	Fault
Active disable	No
Message #	FLT 113
Description	The device temperature is too high. This fault disables the drive.
Action required	

r48 sensAR Power Supply Insufficient for Operation

Definition	sensAR Power Supply Insufficient for Operation
Type	Fault
Active disable	No
Message #	FLT 114
Description	The voltage supply to the device has dropped below operational value. This fault disables the drive.
Action required	Check the encoder power supply.

r49 sensAR Battery Voltage is Below Threshold

Definition	sensAR Battery Voltage is Below Threshold
Type	Fault
Active disable	No
Message #	FLT 115
Description	The battery voltage is less than the threshold value. This fault disables the drive.
Action required	Replace the encoder battery.

r50 sensAR Requires Reset Command

Definition	sensAR Requires Configuration Command
Type	Fault
Active disable	No
Message #	FLT 116
Description	sensAR requires the reset command MTTURNRESET. This fault disables the drive.
Action required	

r51 Internal Position Synchronization Failure

Definition	Internal Position Synchronization Failure
Type	Fault
Active disable	No
Message #	FLT 117
Description	Internal position synchronization of the multi-turn and single-turn modules is not functioning properly. This fault disables the drive.
Action required	Restart the drive.

r52 Multi-Turn Encoder General Failure

Definition	Multi-Turn Encoder General Failure
Type	Fault
Active disable	No
Message #	FLT 118
Description	The multi-turn module is not functioning properly. This fault disables the drive.
Action required	Restart the drive.

r53 sensAR Firmware-Hardware Mismatch

Definition	sensAR Firmware Not Compatible with sensAR Hardware
Type	Fault
Active disable	No
Message #	FLT 119
Description	The firmware version is not compatible with the sensAR hardware. This fault disables the drive.
Action required	Contact Technical Support.

t1 Power Stage Over-Temperature

Definition	Power Stage Over-Temperature
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 10
Description	The temperature on the power board has exceeded the preset limit. This fault disables the drive.
Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact Technical Support.

t2 Integrated Power Module Over-Temperature

Definition	Integrated Power Module Over-Temperature
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 39
Description	The temperature within the integrated power module has exceeded the preset limit. This fault disables the drive.
Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact Technical Support.

t3 Control Board Over-Temperature

Definition	Control Board Over-Temperature
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 40
Description	The temperature on the control board has exceeded the preset limit. This fault disables the drive.
Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact Technical Support.

u Under-Voltage

Definition	Under-Voltage
Type	Fault
Active disable	This fault can trigger the Active Disable function.
Message #	FLT 11
Description	The bus voltage is below the minimum value. If the value of variable UVMODE is 3, and the drive is enabled, an under-voltage fault is issued. This fault disables the drive.
Action required	Check that the main AC voltage supply is connected to the drive and is switched on. The under-voltage limit can be read with the UVTHRESH command.

9.6 Warning, Error and Fault Messages

The following tables present the fault, warning and error codes that may be displayed when working in Terminal.

All faults, and many warnings, are also indicated by the drive's digital display. Certain conditions generate on-screen warning messages only.

9.6.1 Warning Messages

LDHD2 drive warnings are reported in object **2011h**.

Since LDHD2 warnings are 64 bits, they have two 32-bit segments.

table9-1 Warning Codes and Messages

WRN #	Warning Message (click description for more info)	Warning Code
WRN 2	Drive Foldback Warning	00000000 00000002h
WRN 3	Motor Foldback Warning	00000000 00000004h
WRN 4	Under-Voltage	00000000 00000008h
WRN 5	Power Stage Over-Temperature	00000000 00000010h
WRN 6	Motor Over-Temperature	00000000 00000020h
WRN 9	Control Board Over-Temperature	00000000 00000100h
WRN 11	PLL Not Synchronized Phase locked loop (PLL) has not been synchronized	00000000 00000400h
WRN 15	Hardware Positive Limit Switch is Open	00000000 00004000h
WRN 16	Hardware Negative Limit Switch is Open	00000000 00008000h
WRN 17	Hardware Positive and Negative Limit Switches are Open	00000000 00010000h
WRN 18	Software Positive Limit Switch is Tripped	00000000 00020000h
WRN 19	Software Negative Limit Switch is Tripped	00000000 00040000h
WRN 20	Software Limit Switches are Tripped	00000000 00080000h
WRN 22	Multi-turn Encoder Battery Low Voltage	00000000 00200000h
WRN 32	Bus AC Supply Line Disconnected	00000000 80000000h
WRN 34	Regen Resistor Overload	00000002 00000000h
WRN 35	SensAR: Encoder Warning Drive detected a warning on SensAR.	00000004 00000000h
WRN 36	Realtime Overload Warning	00000008 00000000h
WRN 38	Integrated Power Module Over-Temperature	00000020 00000000h
WRN 40	Online LMJR Estimation Active Online LMJR estimation active.	00000080 00000000h
WRN 41	PDO Packet is Not the Expected Length (too long) PDO packet is not the expected length according to PDO mapping. It is too long.	00000100 00000000h

WRN #	Warning Message (click description for more info)	Warning Code
WRN 42	Data in RPDO is Out of Range Data in RPDO is out of range or exceeds minimum/maximum limits.	00000200 00000000h
WRN 43	Data Cannot Be Written When Drive is Enabled RPDO data cannot be written when drive is enabled.	00000400 00000000h
WRN 44	Command is Toward Positive Software Limit Command is toward negative software limit.	00000800 00000000h
WRN 45	Command is Toward Negative Software Limit Command is toward positive software limit.	00001000 00000000h
WRN 48	Default Drive Configuration The drive configuration is the default factory setting	00008000 00000000h
WRN 49	Fieldbus Target Command Lost The fieldbus controller has not sent a target command in 3 consecutive instances.	00010000 00000000h
WRN 50	I2C Failed To Read Temp Sensor	00020000 00000000h
WRN 52	Motor Compatibility Warning.	00080000 00000000h
WRN 53	Conflicting Digital Inputs On	00100000 00000000h
WRN 54	Fan Circuit Warning Fan circuit is either overloaded or disconnected	
WRN 55	Excessive Electrical Noise Warning System is generating excessive electrical noise	
WRN 56	Feedback Type Mismatch Configured feedback type and connected encoder do not match	
WRN 57	sensAR Encoder Over-Temperature Warning sensAR encoder over-temperature warning	
WRN 58	sensAR Encoder Internal Flash Failure sensAR internal flash malfunction	
WRN 59	Excessive Shaft Displacement Detected The device has detected unusually high shaft displacement	

9.6.2 Error Messages – Manufacturer-Specific

table9-2 Error Codes and Messages – Manufacturer-Specific

ERR #	Error Message	Error Code
ERR 20	Unknown command	0800 0000h
ERR 21	Unknown variable	0800 0000h
ERR 22	Checksum error	0800 0000h
ERR 23	Drive active	0800 0000h
ERR 24	Drive inactive	0800 0000h
ERR 25	Value out of range	0609 0030h
ERR 26	Value too low	0609 0032h
ERR 27	OPMODE invalid	0800 0000h
ERR 28	Syntax error	0800 0000h
ERR 29	Value too high	0609 0031h
ERR 36	Not programmable	0601 0002h
ERR 37	Not Configured	0800 0000h
ERR 38	N/A	0800 0000h
ERR 42	Flash invalid	0606 0000h
ERR 43	Recording active	0800 0000h
ERR 44	Recorded data not available	0800 0000h
ERR 45	NVRAM empty	0800 0000h
ERR 46	Value must be an even number	0800 0000h
ERR 49	Value must be a multiple of 0.25	0800 0000h
ERR 50	SAVE to flash failed	0800 0000h
ERR 51	Not available	0606 0000h
ERR 54	Command towards limit switch	0800 0000h
ERR 55	Zeroing mode active	0800 0000h
ERR 60	Motor in motion	0800 0000h
ERR 62	Communication error	0800 0000h
ERR 66	Password protected	0800 0000h
ERR 67	TM Write to EEPROM Failed	0606 0000h
ERR 68	TM communication CRC failed	0504 0004h
ERR 71	Homing type not in use	0800 0000h
ERR 72	Homing type invalid	0800 0000h
ERR 73	Homing trigger input source not set	0800 0000h
ERR 74	Homing already in progress	0800 0000h
ERR 75	Homing direction-reversal input not set. Refer to CiA402.	0800 0000h
ERR 82	Functionality already defined	0800 0000h
ERR 94	Command exceeds software limits	0800 0000h
ERR 95	Feedback invalid	0800 0000h

ERR #	Error Message	Error Code
ERR 96	Variable is not recordable	0800 0000h
ERR 97	Value must be an integer	0800 0000h
ERR 98	I/O not supported	0800 0000h
ERR 99	Active Disable in progress	0800 0000h
ERR 100	I2C bus is busy	0800 0000h
ERR 102	Another procedure is running	0800 0000h
ERR 103	Clear faults before procedure	0800 0000h
ERR 104	Motion pending	0800 0000h
ERR 105	Invalid PTP mode	0800 0000h
ERR 106	Checksum invalid	0800 0000h
ERR 107	Analog output mode invalid	0800 0000h
ERR 108	Hold mode active	0800 0000h
ERR 109	Motor commutation type invalid	0800 0000h
ERR 113	HC actual velocity out of range	0800 0000h
ERR 114	Not supported on this hardware	0800 0000h
ERR 115	Value must be a multiple of 0.125	0800 0000h
ERR 116	Fieldbus mode (COMMODE=1) active	0800 0000h
ERR 201	Current loop design failed	0800 0000h
ERR 202	MENCRES out of range	0800 0000h
ERR 204	MSPEED out of range	0800 0000h
ERR 206	MVANGLF out of range	0800 0000h
ERR 210	VLIM out of range	0800 0000h
ERR 212	MVANGLH out of range	0800 0000h
ERR 213	DICONT greater than DIPEAK	0800 0000h
ERR 214	MENCTYPE mismatch	0800 0000h
ERR 215	DIPEAK out of range	0800 0000h
ERR 216	MIPEAK out of range	0800 0000h
ERR 217	MICONT greater than MIPEAK	0800 0000h
ERR 218	VBUS out of range	0800 0000h
ERR 219	ML out of range	0800 0000h
ERR 220	MPOLES out of range	0800 0000h
ERR 221	Velocity loop design failed	0800 0000h
ERR 222	Internal dual gain present	0800 0000h
ERR 223	PHASEFIND required	0800 0000h
ERR 224	Value is not allowed	0609 0030h
ERR 225	Internal dual gain not present	0800 0000h
ERR 226	MENCTYPE invalid for linear motor	0800 0000h
ERR 227	ENCOUTRES*VLIM too high	0800 0000h

ERR #	Error Message	Error Code
ERR 228	Function invalid for this input	0800 0000h
ERR 229	MJ out of range	0800 0000h
ERR 230	MMASS out of range	0800 0000h
ERR 232	Autotuning active	0800 0000h
ERR 233	Internal config failed	0800 0000h
ERR 234	Feedback type mismatch	0800 0000h
ERR 250	Velocity config failed	0800 0000h
ERR 254	Cycle identification active	0800 0000h
ERR 255	Phase find mode invalid	0800 0000h
ERR 256	Feedback device disconnected	0800 0000h
ERR 257	Feedback device initializing	0800 0000h
ERR 260	No input assigned to touch probe	0800 0000h
ERR 261	COMMERRVTHRESH exceeds VLIM	0800 0000h
ERR 263	SensAR: The device is busy	0800 0000h
ERR 264	SensAR: Request timeout	0800 0000h
ERR 265	SensAR: Flash save failed	0800 0000h
ERR 266	SensAR: Protocol error	0800 0000h
ERR 267	SensAR: Illegal request	0800 0000h
ERR 268	SensAR: Address not aligned	0800 0000h
ERR 269	Cannot read motor nameplate data	0800 0000h
ERR 270	Cannot be set when MTPMODE>0	0800 0000h
ERR 271	Cannot be set when COMMODE>0	0800 0000h
ERR 272	POSCONTROLMODE not supported	0800 0000h
ERR 274	Cannot be issued when SFBMODE>0	0800 0000h
ERR 275	HDTUNE profile is not trapezoidal	0800 0000h
ERR 276	Not supported on this feedback	0800 0000h
ERR 277	Feedback returned too much data	0800 0000h
ERR 278	HDTUNEAVMODE invalid	0800 0000h
ERR 279	SensAR: Internal request error	0800 0000h
ERR 280	SensAR driver is occupied	0800 0000h
ERR 281	SensAR driver failed	0800 0000h
ERR 282	SensAR driver acquire timeout	0800 0000h
ERR 283	Drive is not homed	0800 0000h
ERR 284	SensAR address is out of range	0800 0000h
ERR 285	SensAR CRC error occurred	0800 0000h
ERR 286	Autotune activation failed	0800 0000h
ERR 287	Zero failed. Cannot zero if ILIM=0	0800 0000h
ERR 288	Comm feedback defaults undefined	0800 0000h

ERR #	Error Message	Error Code
ERR 289	Feedback memory not partitioned	0800 0000h
ERR 290	Cannot change in modulo mode	0800 0000h
ERR 293	MENCRES too high for this drive	0800 0000h
ERR 294	HDTUNE Vcruise too low	0800 0000h
ERR 295	HDTUNE distances not equal	0800 0000h
ERR 296	Failed to store data on flash	0800 0000h
ERR 297	Failed to read data from flash	0800 0000h
ERR 304	Use different sign for Pos and Neg	0800 0000h
ERR 305	Use same sign for Pos and Neg	0800 0000h
ERR 307	Cannot transfer data	0800 0020h
ERR 308	Positive limit switch is active	0800 0000h
ERR 309	Negative limit switch is active	0800 0000h
ERR 310	Home switch in opposite state	0800 0000h
ERR 311	Motion stopped abruptly	0800 0000h
ERR 325	Predefined and set automatically	0800 0000h
ERR 328	No serial Enable in COMMODE=1	0800 0050h
ERR 330	VLIM is less than VCRUISE	0x08000000
ERR 331	Total cycle time greater than 1 sec	0x08000000
ERR 332	Motor parameters estimation active	0x08000000
ERR 333	Uni-direction not allowed in P&D	0x08000000
ERR 334	DECSTOP less than autotune deceler	0x08000000
ERR 350	MOVESMOOTHAVG 128 max value	0x08000000
ERR 351	FOE in progress. Value not allowed	0x08000000
ERR 367	Not supported with linear control	0800 0000h
ERR 372	Function invalid for this output	0800 0000h

9.6.3 Fault Messages

table9-3 Fault Codes and Messages

FLT #	Fault Message (click description for more info)	Emergency (Fault) Error Code
FLT 1	Drive Locked	8180h
FLT 2	Parameter Memory Checksum Failure	5585h
FLT 3	Over-Current	2214h
FLT 5	FPGA Config Failed	6581h
FLT 6	Control EEPROM Fault	5581h
FLT 7	Power EEPROM Fault	5530h
FLT 8	Vbus Measure Circuit Failed	3182h
FLT 9	Over-Voltage	3110h
FLT 10	Power Stage Over-Temperature	4310h
FLT 11	Under-Voltage	3120h
FLT 12	Not Configured	6381h
FLT 13	Failure Writing to Flash Memory	5586h
FLT 14	Velocity Over-Speed Exceeded	8481h
FLT 16	Drive Foldback	2311h
FLT 17	Motor Foldback	2310h
FLT 26	Feedback 5V Over-Current	7393h
FLT 29	Regen Over-Current	3180h
FLT 30	Fieldbus Velocity Limit Exceeded	6380h
FLT 33	Self-Test Failed	5583h
FLT 34	Feedback Communication Error	7380h
FLT 36	Plus 15V Out of Range	5111h
FLT 37	Minus 15V Out of Range	5111h
FLT 38	Watchdog Fault	—
FLT 39	Integrated Power Module Over-Temperature	4080h
FLT 40	Control Board Over-Temperature	4081h
FLT 42	Tamagawa Init Failed	7382h
FLT 43	Current-Sensors Offset Invalid	2380h
FLT 44	Motor Setup Failed	7081h
FLT 45	Exceeded Maximum Position Error	8611h
FLT 46	Pulse and Direction Input Line Break	7182h
FLT 47	FPGA Version Mismatch	7090h
FLT 48	PLL Synchronization Failed	7386h
FLT 49	Tamagawa Abs Operational Fault	7388h
FLT 51	Motor Phases Disconnected	2381h
FLT 52	5V Out of Range	5180h

FLT #	Fault Message (click description for more info)	Emergency (Fault) Error Code
FLT 56	Multi-turn Encoder Battery Low Voltage	7385h
FLT 57	Emergency Stop Issued	7091h
FLT 59	Stall Fault	7121h
FLT 63	Power Brake Open Load	7112h
FLT 64	Power Brake Short	7113h
FLT 65	Fieldbus Cable Disconnected	7580h
FLT 66	Command Exceeds Acc/Dec Limits	7581h
FLT 67	Exceeded Maximum Velocity Error	8482h
FLT 69	Fieldbus Target Command Lost	7582h
FLT 70	Internal Error	FF01h
FLT 72	Logic AC Power Failure	—
FLT 76	Pulse Train Frequency Too High	FF97h
FLT 77	Commutation Error (Motor Runaway) Condition Detected	7198h
FLT 78	Bus AC Supply Line Disconnect	3183h
FLT 82	SensAR Encoder Fault	738Dh
FLT 83	Regen Resistor Overload	3199h
FLT 85	MTP Read Failure	FF02h
FLT 86	SAVE and Power Cycle Required	FF03h
FLT 87	Excessive PE Value	8689h
FLT 89	Realtime Overload Fault	FF04h
FLT 91	EtherCAT Packet Loss	818Dh
FLT 92	EtherCAT State Not Operational	F080h
FLT 93	Fieldbus Version Mismatch	7093h
FLT 94	ESI Version Mismatch	7094h
FLT 96	Digital Output Over-Current Fault	2382h
FLT 100	Unstable Current Loop	8380h
FLT 104	High IQ Current Detected	8381h
FLT 105	Digital Output Over-Current Fault	2382h
FLT 106	Feedback Type Auto-Detect Failed	7396h
FLT 108	MOTORNAME/MTP Data Mismatch	FF14h
FLT 109	Firmware Version is Not Supported by this Drive	FF16h
FLT 110	ESI Vendor Mismatch	7099h
FLT 112	sensAR Encoder Position Fault	7398h
FLT 113	sensAR Over-Temperature Fault	4380h
FLT 114	sensAR Power Supply Insufficient for Operation	3184h
FLT 115	sensAR Battery Voltage is Below Threshold	3185h
FLT 116	sensAR Requires Reset Command	7399h

FLT #	Fault Message (click description for more info)	Emergency (Fault) Error Code
FLT 117	Internal Position Synchronization Failure	3186h
FLT 118	Multi-Turn Encoder General Failure	3187h
FLT 119	sensAR Firmware-Hardware Mismatch	FF15h
FLT 120	Fieldbus Interpolation Cycle Exceeds Sync Time	7583h
FLT 122	Received Object Index Exceed Objects Array Size	—
FLT 143	Drive Parameters Set to Default Values	—

10. Accessories

10.1 Line Filters

The manufacturers and part numbers of line filters recommended for the LDHD2 are listed in the following tables.

table10-1 Recommended Line Filters for LDHD2

Drive	Manufacturer	Part Number
LDHD2-003-2A	LCR:	055M.80601.00
	LCR:	092.00623.00
	Schaffner:	FN2070-6
LDHD2-006-2A	LCR:	0923.01021.00
	LCR:	092.01023.00
	LCR:	055.81011.00
	Schaffner:	FN2070-10

10.2 Regeneration Resistors

Resistance values (Ohms, Ω) are defined by the LDHD2 servo drive. Required power is defined by the application. Therefore, each drive has several regeneration resistor options.

The manufacturers and part numbers of regen resistors recommended for the LDHD2 are listed in the following tables.

table10-2 Recommended Regen Resistors for LDHD2

Drive	Power (W)	Min. Resistance	Manufacturer	Part Number
LDHD2-003-2A	150	100 Ω	IsoTek:	ULH150 N 100 K FL500
	300		IsoTek:	ULH300 N 100 K FL500
	600		Frizlen:	FZECU400x65-100
LDHD2-006-2A	150	33 Ω	IsoTek:	ULH150 N 33 K FL500
	300		IsoTek:	ULH300 N 33 K FL500
	600		Frizlen:	FZECU400x65-33
	1000		IsoTek:	ULV1000 N 33 K FL500
	2000		Frizlen:	FZZCU600x65-33
	3000		Frizlen:	FGFKU3100602-33

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