FLEXI PRO Servo Drive

User Manual

120/240 VAC and 400/480 VAC

Revision 5.1
Firmware 1.4.4

SEE IT BEFORE IT HAPPENS
MOTOR POWER COMPANY

Revision History

Document Revision	Date	Remarks
5.1	Nov. 2013	Updated: Ordering info; Standards compliance; Pin assignment diagrams; controller and machine interface wiring diagrams; EnDat guidelines; faults; GUI changes.
5.0	Sep. 2013	Updates and revisions. Firmware 1.4.x.
4.2	May 2013	No changes. Adjusted for Help.
4.1	Mar. 2013	Minor corrections
4.0	Feb. 2013	Major revision
3.2	Oct. 2012	Wiring updates and minor corrections,
3.1	Oct. 2012	Revision 3.1
3.0	Sep. 2012	Revision 3.0 (internal release)

Firmware Revision	Software (GUI) Revision
1.4.4	1.4.4.x

Note: If an earlier firmware revision is installed in your FLEXI PRO drive, contact your Account Manager or Technical Support.

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Technical Support

If you need assistance with the installation and configuration of the FLEXI PRO drive, contact Motor Power Company technical support: info@motorpowerco.it

Customer Service

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For technical support, contact: info@motorpowerco.it

To order products, contactinfo@motorpowerco.it

For all other inquiries regarding FLEXI PRO drives or other Motor Power Company products, contact: info@motorpowerco.it

Warranty

The warranty is valid for 30 months from the date of shipment and applies only if material or workmanship is found to be defective. The warranty will be invalid if the customer fails to install, operate or maintain the product in accordance with the instructions in this user manual.

During the warranty period, the owner must pay the cost of shipping the product to the factory for repair, and Motor Power Company will pay for shipping the repaired product to the customer.

After the warranty period has expired, all shipping costs will be the responsibility of the customer.

Before returning the product, the customer must first request a Return Materials Authorization (RMA) number from Motor Power Company by email to info@motorpowerco.it

The complete Warranty Statement can be found in the Terms and Conditions document on the Motor Power Company website: www.motorpowerco.com

Contents

1 Introduction

1.1 Documentation

1.1.1 About This Manual

This manual describes the FLEXI PRO Servo Drive.

It provides the information required for installation, configuration and basic operation of the FLEXI PRO unit.

This document is intended for persons who are qualified to transport, assemble, commission, and maintain the equipment described herein.

1.1.2 Documentation Set for FLEXI PRO

This manual is part of a documentation set. The entire set consists of the following:

- **FLEXI PRO Quick Start Guide**. Basic setup and operation of the drive.
- **FLEXI PRO User Manual**. Hardware installation, configuration and operation.
- **FLEXI PRO VarCom Reference Manual**. Parameters and commands used to program the FLEXI PRO.
- **FLEXI PRO CANopen for CAN and EtherCAT Drives Reference Manual.** FLEXI PRO implementation of CANopen protocol for CAN and EtherCAT.

1.2 Ordering Information

For ordering the FLEXI PRO, refer to the following diagram.

For inquiries about product availability, contact Motor Power Company.

FPRO – 006 2A AP 1

FLEXI PRO Servo Drive

Rating		
	120/240 VAC	
	Cont [A rms]	Peak [A rms]
1D5	1.5	4.5
003	3	9
4D5	4.5	18
006	6	18
008	8	28
010	10	28
013	13	28
020	20	48
024	24	48
	400/480 VAC	
	Cont [A rms]	Peak [A rms]
003	3	9
006	6	18
012	12	24
020	20	60
030	30	70

AC and Controller Input Power Supply	
2A	Input Single Phase 120 L-L VAC +10% -15% 50/60 Hz Input Single Phase 240 L-L VAC +10% -15% 50/60 Hz Input Three Phase 120-240 L-L VAC +10% -15% 50/60 Hz
4D	AC Input Power Supply: - Input Three Phase 400 L-L VAC +10% -15% 50/60 Hz - Input Three Phase 480 L-L VAC +10% -15% 50/60 Hz 24 VDC input for control board power supply

Interface Options	
AP *	Analog Voltage, Pulse Train Ref, USB, RS232
AF *	Analog Voltage, Pulse Train Ref, CANopen, USB, RS232
EC **	EtherCAT, USB, RS232
PB ***	PWM Power Block

* Standard configuration with one analog input
** Standard configuration with two analog inputs
*** PB0 and PWM power block do not have analog input option

Analog Input	
0	Power block
1	One analog input, 16 bit
2	Two analog inputs, 14 bit each

Figure 1-1. FLEXI PRO Ordering Options

1.3 Safety

1.3.1 Safety Overview

Only qualified persons may perform the installation procedures. You do not need to be an expert in motion control to install and operate the drive system. However, you must have a basic understanding of electronics, computers, mechanics, and safety practices.

The FLEXI PRO utilizes hazardous voltages.
Be sure the drive is properly grounded.

Before you install the FLEXI PRO, review the safety instructions in the product documentation. Failure to follow the safety instructions may result in personal injury or equipment damage.

1.3.2 Safety Symbols

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

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

	**Caution**	ISO 7000-0434 (2004-01)
	**Warning**. Dangerous voltage.	IEC 60417-5036 (2002-10)
	Protective earth; functional ground	IEC 60417–5019 (2006-08)
	Caution, hot surface	IEC 60417-5041 (2000-10)

1.3.3 Safety Instructions

- Read all available product documentation before assembling and commissioning. Incorrect handling of this product may cause personal injury and/or damage to equipment. Adhere strictly to the installation instructions and requirements.
- 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 618005-1.) Motor should be connected to protective earth by independent earthing conductor rated not less than the motor phase wire. This product contains static sensitive components that can be damaged by incorrect handling. Avoid contact with high insulating materials (artificial fabrics, plastic film, etc.). Place the product on a conductive surface. Ground yourself (discharge any possible static electricity build-up) by touching an unpainted, metal, grounded surface.
- Keep all covers and cabinet doors shut during operation. Otherwise, potential hazards may cause personal injury and/or damage to equipment.
- During operation the product has electrically charged components and hot surfaces. The heat sink can reach temperatures of 90°C. Control and power cables can carry a high voltage, even when the motor is not rotating.
- To avoid electric arcing and hazards to personnel and electric contacts, never disconnect or connect the product while the power source is energized.
- After removing the power source from the equipment, wait at least 5 minutes before touching or disconnecting sections of the equipment that normally carry electrical charges (e.g., capacitors, contacts, screwed connections). For safety, measure the electrical contact points with a meter before touching the equipment. Wait until the voltage drops below 30 VAC before handling components.
- Provide a power mains disconnect device in according with local regulations.
- Before testing and setting up, the manufacturer of the machine must generate a hazard analysis for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.

- Since the drive meets IP20 according to IEC 60529, and type 1 according to UL 50, the end user must select an enclosure that permits safe operation of the drive. The enclosure must meet at least IP54 according to IEC 60529, and at least type 2 according to UL 50, and be made of metal or material with rating flammability of 5 VA, and not have any openings in the bottom.
- Since the leakage current to PE is greater than 3.5 mA, compliance with IEC61800-5-1 and UL 508C 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 than10 mm^2. Use the drive mount screws and the PE connection screws to meet this requirement.
- Wiring of green color with or without one or more yellow stripes must not be used except for protective bonding.
- Power cables should be rated at least 600V, 75°C.
- **Do not use the STO function until this functionality has been approved.** The STO input is functional but not yet independently certified. Motor Power Company is preparing the final circuit design updates to be submitted for formal (SIL 2) (Pl d) (Cat 2) STO certification. These updates will not change the wiring or functional operation.
- Drives with a suspended load must have an additional mechanical safety block (such as a motor-holding brake). The drive cannot hold the load when STO is active. Serious injury could result if the load is not properly safeguarded.

1.4 Standards Compliance

The FLEXI PRO has been tested and according to the following standards.

Standard	Directive/Description	Certif. Mark
IEC 61800-5-1	**Low Voltage Directive 2006/95/EC** Adjustable speed electrical power drive systems.	
IEC 61800-3	**Electromagnetic Compatibility (EMC) Directive 2004/108/E** Adjustable speed electrical power drive systems.	
EN 50581	**European Regulations 2011/65/EU RoHS (Restriction of Hazardous Substances)** Technical documentation required for declaring compliance with the applicable substance restrictions.	
UL 508C	**Power Conversion Equipment.** Open or enclosed equipment that supplies power to control a motor or motors operating at a frequency or voltage different than that of the input supply.	
CSA C22.2 NO. 14-10	**Industrial Control Equipment** Control and protective devices, and accessory devices, rated at not more than 1500V, for starting, stopping, regulating, controlling, or protecting electric motors, generators, heating apparatus, or other equipment used to control an industrial process that is intended to be installed and used in non-hazardous locations.	
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)
UL Underwriters Laboratory
CSA Canadian Standards Association
EU European Parliament and Council of the European Union

1.5 Unpacking

The package contains the FLEXI PRO drive only.

1. Open the package and remove all packing materials.
2. Check to ensure there is no visible damage to the FLEXI PRO drive. If damage is detected, notify the carrier immediately.

2 Product Description

2.1 Product Overview

The FLEXI PRO is a full-featured, high-performance servo drive featuring innovative technologies and industry-leading power density.

Refer to the part number diagrams in the section *Ordering Information* for the various options for the FLEXI PRO drive.

The 120/240V product models are shown in Figure 2-1:

FLEXI PRO-020 FLEXI PRO-024	FLEXI PRO-008 FLEXI PRO-010 FLEXI PRO-013	FLEXI PRO-4D5 FLEXI PRO-006	FLEXI PRO-1D5 FLEXI PRO-003

Figure 2-1. FLEXI PRO Product Models (120/240 VAC)

The 400/480V product models are shown in Figure 2-1:

FLEXI PRO-012

FLEXI PRO-003
FLEXI PRO-006

Figure 2-2. FLEXI PRO Product Models (400/480 VAC)

2.2 Technical Specifications

2.2.1 Dimensions

The various models of the FLEXI PRO are housed in one of three frames. The exterior dimensions of the FLEXI PRO are shown in Figure 2-3, Figure 2-4 and Figure 2-5.

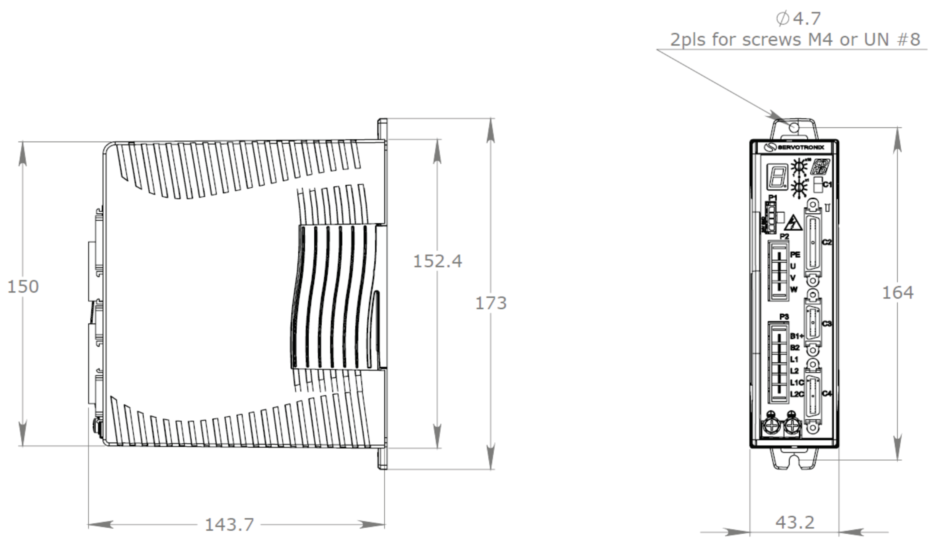


Figure 2-3. FLEXI PRO-1D5/FLEXI PRO-003 – 120/240 VAC – Dimensions (mm)

Note: FLEXI PRO-1D5 (shown here) does not have fan. FLEXI PRO-003 has fan.

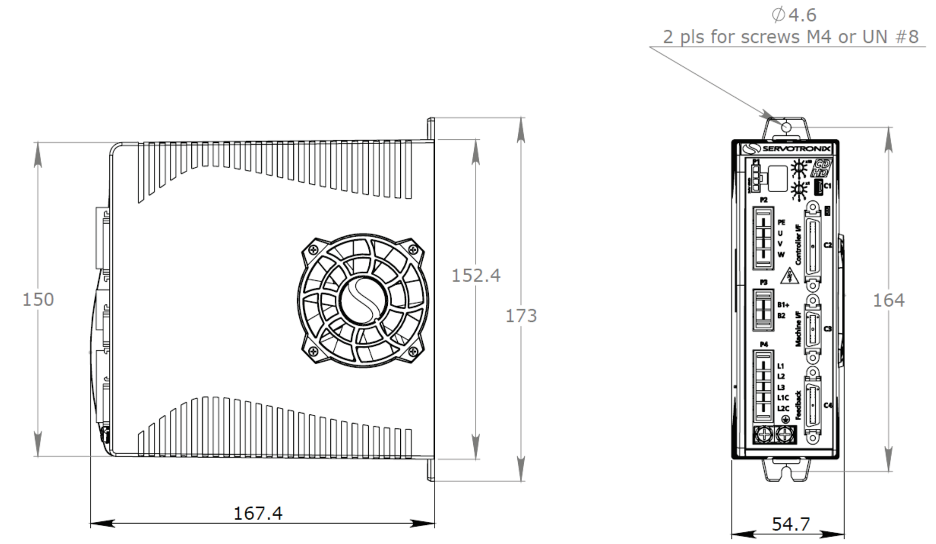


Figure 2-4. FLEXI PRO-4D5/FLEXI PRO-006 – 120/240 VAC – Dimensions (mm)

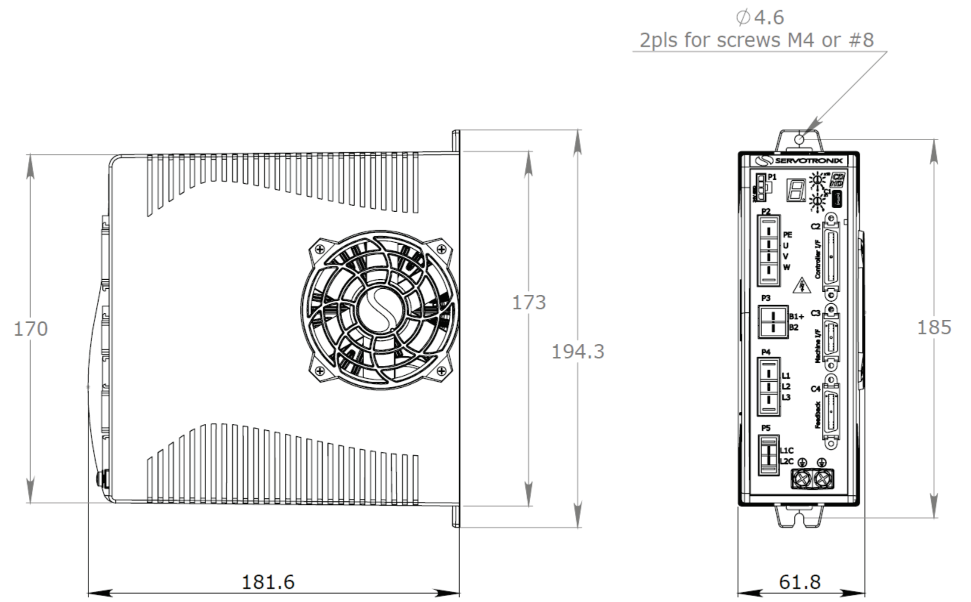


Figure 2-5. FLEXI PRO-008/FLEXI PRO-010/FLEXI PRO-013 – 120/240 VAC – Dimensions (mm)

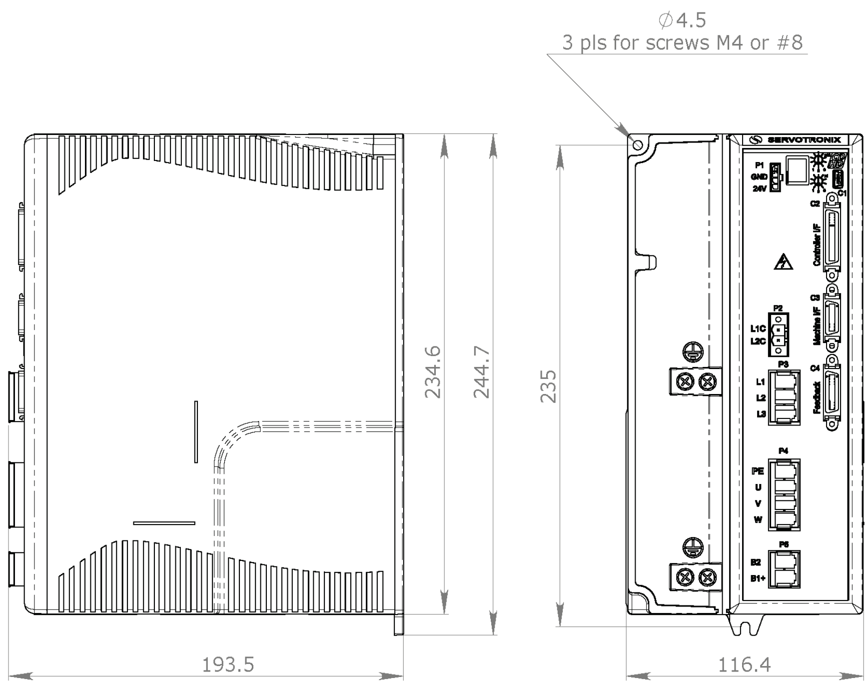


Figure 2-6. **FLEXI PRO-020/FLEXI PRO-024 – 120/240 VAC – Dimensions (mm)**

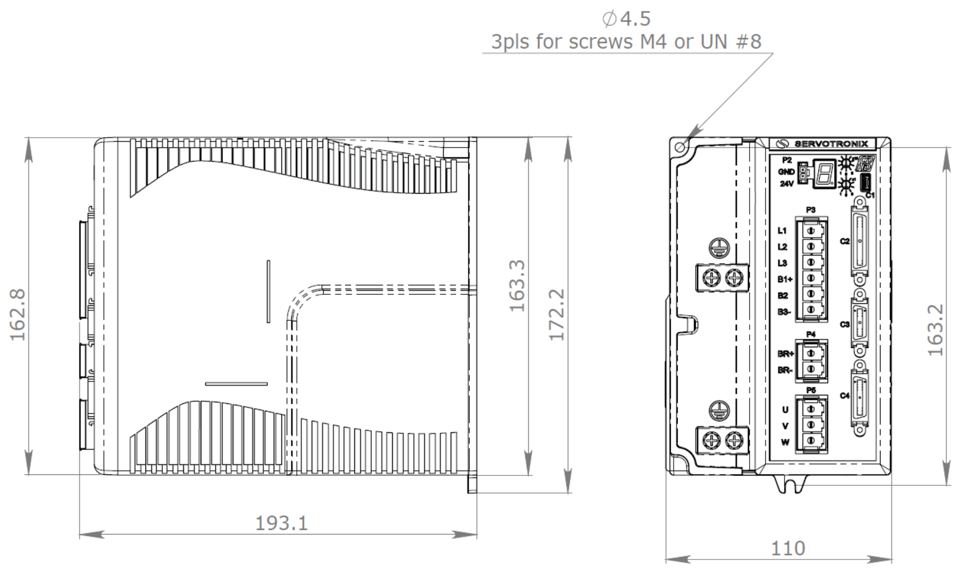


Figure 2-7. **FLEXI PRO-003/FLEXI PRO-006 – 400/480 VAC – Dimensions (mm)**

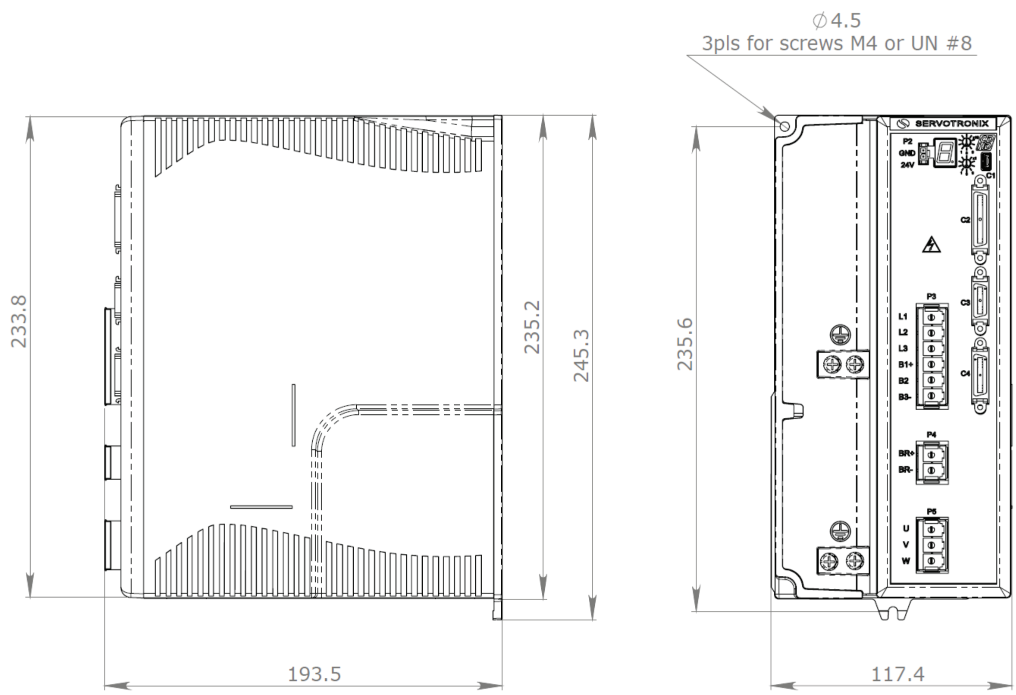


Figure 2-8. FLEXI PRO-012 – 400/480 VAC – Dimensions (mm)

2.2.2 Mechanical and Electrical Specifications

Table 2-1. Mechanical & Electrical Specifications – FLEXI PRO-1D5/FLEXI PRO-003 – 120/240 VAC

Single Phase 120/240 VAC	Specification	FLEXI PRO-1D5	FLEXI PRO-003
Ratings			
Input Power Circuit (L1, L2)	Voltage (VAC Line-Line) Nominal ±10%	120/240	120/240
	Line Frequency (Hz)	50/60	50/60
	120/240 VAC	1 Phase	1 Phase
	Continuous Current (1 ph A rms)	2.5	5
	Line Fuses (FRN-R, LPN, or equivalent) (A)	4	6
	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
STO (Safe Torque Off)	STO Power Supply (VDC)	24 ±10%	24 ±10%
STO Fuse (Time Delay)	120 or 240 VAC (A)	1.5	1.5
Motor Output (U, V, W)	Continuous Output Current (A rms)	1.5	3
	Continuous Output Current (A peak)	2.12	4.24
	Peak Output Current (A rms) for 2 seconds	4.5	9
	Peak Output Current (A peak) for 2 seconds	6.3	12.72
	kVA at 120 VAC	0.28	0.44
	kVA at 240 VAC	0.37	0.74
	PWM Frequency (kHz)	16	16
Soft Start	Max. Surge Soft Start Current (A)	7	7
	Max. Charge Time (ms)	350	350
Power Circuit Loss	W		
Control Circuit Loss	W	5	5
Total Power Loss	W		
Hardware			
Unit Weight	kg	0.7	0.75
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	18
	Main Circuit AC Inputs (AWG)	18	18
	PE Ground Screw	M4	M4
Clearance Distance	Side-to-Side (mm)	15	15
	Top/Bottom (mm)	50	50
Voltage Trip			
	Under-Voltage Trip (Nominal) (VDC)	100	100
	Over-Voltage Trip (VDC)	420	420

Single Phase 120/240 VAC	Specification	FLEXI PRO-1D5	FLEXI PRO-003
Power Temperature			
Fan	Normally operates at quarter power; when temperature exceeds high-speed fan trigger temperature, operates at full power	No	Yes
	Power Module Over-Temperature Fault Regulated (°C)	80 ±5%	80 ±5%
	Power Module Over-Temperature Fault Non-regulated (°C)	100 ±5%	100 ±5%
	Trigger Temperature for High Speed Fan (°C)	NA	45
External Regenerative Resistor (B1+, B2)			
External Shunt Regulator	Peak Current (A)	6.3	12.7
	Minimum Resistance (Ω)	64	31.5
	Power Rating (W)	System-dependent	System-dependent
Application Information	Internal Bus Capacitance (µF)	360	660
	VLOW (Regen Circuit Turn Off) (VDC)	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400

Table 2-2. Mechanical & Electrical Specifications – FLEXI PRO-4D5/FLEXI PRO-006 – 120/240 VAC

Single and Three-Phase 120/240 VAC	Specification	FLEXI PRO-4D5	FLEXI PRO-006
Ratings			
Input Power Circuit (L1, L2, L3)	Voltage (VAC Line-Line*) Nominal ±10%	120/240	120/240
	Line Frequency (Hz)	50/60	50/60
	120 VAC	1 Phase or 3 Phase	1 Phase or 3 Phase
	240 VAC	1 Phase	1 Phase
	Continuous Current (1/3 ph A rms)	8.5/4	10/5.8
	Line Fuses (FRN-R, LPN, or equivalent)	10	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
STO (Safe Torque Off)	STO Power Supply (VDC)	24 ±10%	24 ±10%
STO Fuse (Time Delay)	120 or 240 VAC (A)	1.5	1.5

Single and Three-Phase 120/240 VAC	Specification	FLEXI PRO-4D5	FLEXI PRO-006
Motor Output (U, V, W)	Continuous Output Current (A rms)	4.5	6
	Continuous Output Current (A peak)	6.63	8.48
	Peak Output Current (A rms) for 2 seconds	18	18
	Peak Output Current (A peak) for 2 seconds	25.45	25.45
	kVA at 120 VAC	0.5	0.7
	kVA at 240 VAC	1.1	1.5
	PWM Frequency (kHz)	16	16
Soft Start	Max. Surge Soft Start Current (A)	7	7
	Max. Charge Time (ms)	250	250
Power Circuit Loss	W		
Control Circuit Loss	W	5	5
Total Power Loss	W		
Hardware			
Unit Weight	kg	0.97	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)	16	16
	Main Circuit AC Inputs (AWG)	16	16
	PE Ground Screw	M4	M4
Clearance Distance	Side-to-Side (mm)	15	15
	Top/Bottom (mm)	50	50
Voltage Trip			
	Under-Voltage Trip (Nominal) (VDC)	100	100
	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	Yes	Yes
	Power Module Over-Temperature Fault Regulated (°C)	80 ±5%	80 ±5%
	Power Module Over-Temperature Fault Non-regulated (°C)	100 ±5%	100 ±5%
	Trigger Temperature for High Speed Fan (°C)	45	45
External Regenerative Resistor (B1+, B2)			
External Shunt Regulator	Peak current (A)	25.5	25.5
	Minimum resistance (Ω)	16	16
	Power Rating (W)	System-dependent	System-dependent
Application Information	Internal Bus Capacitance (µF)	1120	1120
	VLOW (Regen Circuit Turn Off) (VDC)	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400

*Line to Line: L1 to L2, or L1 to L3 or L2 to L3

Table 2-3. Mechanical & Electrical Specifications – FLEXI PRO-008/FLEXI PRO-010/ FLEXI PRO-013 – 120/240 VAC

Single and Three Phase 120/240 VAC	Specification	FLEXI PRO-008	FLEXI PRO-010	FLEXI PRO-013**
Ratings				
Input Power Circuit (L1, L2, L3)	Voltage (VAC Line-Line*) Nominal ±10%	120/240	120/240	120/240
	Line Frequency (Hz)	50/60	50/60	50/60
	120/240 VAC	1/3 Phase	1/3 Phase	3 Phase
	Continuous Current (3 ph A rms)	5	8	10
	Line Fuses (FRN-R, LPN, or equivalent)	10	10	15
	Withstand Voltage (Primary to Earth)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)
Control Circuit Input Power (L1C, L2C)	120 ±10 or 240 ±10 VAC	1 Phase	1 Phase	1 Phase
Logic Input Fuse (Time Delay)	120 or 240 VAC (A)	0.5	0.5	0.5
STO (Safe Torque Off)	STO Power supply (VDC)	24 ±10%	24 ±10%	24 ±10%
STO Fuse (Time Delay)	120 or 240 VAC (A)	1.5	1.5	1.5
Motor Output (U, V, W)	Continuous Output Current (A rms)	8	10	13
	Continuous Output Current (A peak)	11.31	14.14	18.38
	Peak Output Current (A rms) for 2 seconds	28	28	28
	Peak Output Current (A peak) for 2 seconds	39.56	39.56	39.56
	kVA at 120 VAC	1.1	1.3	1.7
	kVA at 240 VAC	1.7	2.2	2.8
	PWM Frequency (kHz)	8	8	8
Soft Start	Max. Surge Soft Start Current (A)	15	15	15
	Max. Charge Time (ms)	350	350	350
Power Circuit Loss	W			
Control Circuit Loss	W	5	5	5
Total Power Loss	W			
Hardware				
Unit Weight	kg	1.15	1.15	1.15
Connection Hardware	PE Ground Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm
Wire Size	Control Circuit (AWG) up to 3 meters	24-28	24-28	24-28
	Main Circuit Motor Lines (AWG)	14	14	14
	Main Circuit AC Inputs (AWG)	14	14	14
	PE Ground Screw	M4	M4	M4
Clearance Distance	Side-to-Side (mm)	15	15	15
	Top/Bottom (mm)	50	50	50
Voltage Trip				
	Under-Voltage Trip (nominal) (VDC)	100	100	100
	Over-Voltage Trip (VDC)	420	420	420

Single and Three Phase 120/240 VAC	Specification	FLEXI PRO-008	FLEXI PRO-010	FLEXI PRO-013**
Power Temperature				
Fan	Normally operates at quarter power; when temperature exceeds high-speed fan trigger temperature, operates at full power	Yes	Yes	Yes
	Power Module Over-Temperature Fault Regulated (°C)	80 ±5%	80 ±5%	80 ±5%
	Power Module Over-Temperature Fault Non-regulated (°C)	100 ±5%	100 ±5%	100 ±5%
	Power Module Over-Temperature Fault (°C)	100	100	100
	Trigger Temperature for High Speed Fan (°C)	45	45	45
External Regenerative Resistor (B1+, B2)				
External Shunt Regulator	Peak current (A)	40	40	40
	Minimum resistance (Ω)	10	10	10
	Power Rating (W)	System-dependent	System-dependent	System-dependent
Application Information	Internal Bus Capacitance (μF)	2110	2110	2110
	VLOW (Regen Circuit Turn Off) (VDC)	380	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400	400

*Line to Line: L1 to L2, or L1 to L3 or L2 to L3

**3-Phase only

Table 2-4. Mechanical & Electrical Specifications – FLEXI PRO-020/FLEXI PRO-024 – 120/240 VAC

Three-Phase 120-240 VAC	Specification	FLEXI PRO-020	FLEXI PRO-024
Ratings			
Input Power Circuit (L1, L2, L3)	Voltage (VAC Line-Line*) Nominal ±10%	120/240	120/240
	Line Frequency (Hz)	50/60	50/60
	120/240 VAC	3 Phase	3 Phase
	Continuous Current (3 ph A rms)	20@240V	24@240V
	Line Fuses (FRN-R, LPN, or equivalent) (A)	25	30
	Withstand Voltage (Primary to Earth)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)
Control Circuit Input Power (L1C, L2C)	120 or 240 VAC	1 Phase	1 Phase
Logic Input Fuse (Time Delay)	120 or 240 VAC (A)	0.5	0.5
STO (Safe Torque Off)	STO Power supply (VDC)	24 ±5%	24 ±5%
STO Fuse (Time Delay)	24 VDC ±10%	1.5	1.5

Three-Phase 120-240 VAC	Specification	FLEXI PRO-020	FLEXI PRO-024
Motor Output (U, V, W)	Continuous Output Current (A rms)	20	24
	Continuous Output Current (A peak)	28.28	34.93
	Peak Output Current (A rms) for 2 seconds	48	48
	Peak Output Current (A peak) for 2 seconds	67.88	67.88
	kVA at 120 VAC	3	3.5
	kVA at 240 VAC	5	6
	PWM Frequency (kHz)	8	8
Soft Start	Max. Surge Soft Start Current (A)	15	15
	Max. Charge Time (ms)	1000	1000
Power Circuit Loss	W		
Control Circuit Loss	W	5	5
Total Power Loss	W		
Hardware			
Unit Weight	kg	3.2	3.2
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)	12	12
	Main Circuit AC Inputs (AWG)	12	12
	PE Ground Screw	M4	M4
Clearance Distance	Side-to-Side (mm)	5	5
	Top/Bottom (mm)	50	50
Voltage Trip			
	Under-Voltage Trip (nominal) (VDC)	100	100
	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	Yes	Yes
	Power Module Over-Temperature Fault Regulated (°C)	80 ±5%	80 ±5%
	Power Module Over-Temperature Fault Non-regulated (°C)	100 ±5%	100 ±5%
	Power Module Over-Temperature Fault (°C)	100	100
	Trigger Temperature for High Speed Fan (°C)	45	45
External Regenerative Resistor (B1+, B2)			
External Shunt Regulator	Peak current (A)	44	44
	Minimum resistance (Ω)	8.4	8.4
	Power Rating (W)	System-dependent	System-dependent
Application Information	Internal Bus Capacitance (μF)	3280	3280
	VLOW (Regen Circuit Turn Off) (VDC)	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400

*Line to Line: L1 to L2, or L1 to L3 or L2 to L3

Table 2-5. Mechanical & Electrical Specifications – FLEXI PRO-003/FLEXI PRO-006/ FLEXI PRO-012 – 400/480 VAC

Three Phase 400/480 VAC	Specification	FLEXI PRO-003	FLEXI PRO-006	FLEXI PRO-012
Ratings				
Input Power Circuit (L1, L2)	Voltage (VAC Line-Line) Nominal ±10%	380/480	380/480	380/480
	Line Frequency (Hz)	50/60	50/60	50/60
	380/480 VAC	3 Phase	3 Phase	3 Phase
	Continuous Current (3 ph A rms)	2.8@400V, 2.3@480V	5.7@400V , 4.6@480V	11.0@400V 9.2@480V
	Line Fuses (FRN-R, LPN, or equivalent) (A)	10	10	16
	Withstand Voltage (Primary to Earth)	1800 VAC (2520 VDC)	1800 VAC (2520 VDC)	1800 VAC (2520 VDC)
Control Circuit Input Power (P2)	24 VDC ±10%	24 VDC ±10%	24 VDC ±10%	24 VDC ±10%
STO (Safe Torque Off)	STO Power Supply (VDC)	24 ±10%	24 ±10%	24 ±10%
Motor Output (U, V, W)	Continuous Output Current (A rms)	3.0	6.0	12.0
	Continuous Output Current (A peak)	4.24	8.48	16.97
	Peak Output Current (A rms) for 2 seconds	9	18	24
	Peak Output Current (A peak) for 2 seconds	12.72	25.45	33.84
	kVA at 380 VAC	1.63	3.11	6.22
	kVA at 480 VAC	1.77	3.68	7.36
	PWM Frequency (kHz)	8	8	8
Soft Start	Max. Surge Soft Start Current (A)	7	7	9
	Max. Charge Time (ms)	1300	1300	1300
Power Circuit Loss	W			
Control Circuit Loss	W	5	5	5
Total Power Loss	W			
Hardware				
Unit Weight	kg	2.1	2.1	3.2
Connection Hardware	PE Ground Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm	M4/1.35 Nm
Wire Size	Control Circuit (AWG) up to 3 meters	24-28	24-28	24-28
	Main Circuit Motor Lines (AWG)	12-14	12-14	12-14
	Main Circuit AC Inputs (AWG)	12-14	12-14	12-14
	PE Ground Screw	M4	M4	M4
Clearance Distance	Side-to-Side (mm)	25	25	25
	Top/Bottom (mm)	50	50	50
Voltage Trip				

Three Phase 400/480 VAC	Specification	FLEXI PRO-003	FLEXI PRO-006	FLEXI PRO-012
	Under-Voltage Trip (Nominal) (VDC)	320	320	320
	Over-Voltage Trip (VDC)	800	800	800
Power Temperature				
Fan	Normally operates at quarter power; when temperature exceeds high-speed fan trigger temperature, operates at full power	Yes	Yes	Yes
	Power Module Over-Temperature Fault Regulated (°C)	76 ±5%	76 ±5%	76 ±5%
	Power Module Over-Temperature Fault Non-regulated (°C)	100 ±5%	100 ±5%	100 ±5%
	Trigger Temperature for High Speed Fan (°C)	40	40	40
Regenerative Resistor				
Internal Shunt Regulator (B1+,B2)	Peak Current (A)	16.8	16.8	23.9
	Resistance (Ω)	47	47	33
External Shunt Regulator (B1+, B2)	Peak Current (A)	16.8	16.8	23.9
	Minimum Resistance (Ω)	47	47	33
	Power Rating (W)	System-dependent	System-dependent	System-dependent
Application Information	Internal Bus Capacitance (µF)	410	410	820
	VLOW (Regen Circuit Turn Off) (VDC)	770	770	770
	VMAX (Regen Circuit Turn On) (VDC)	780	780	780
Brake				
	On State Voltage @ Rated Current (min) at 24 VDC Logic Power (VDC)	23.5	23.5	23.5
	Off State Leakage Current (mA)	<2	<2	<2
	Maximum Current Capability (A)	1.3A	1.3	1.3
	Short Circuit Protection	Yes	Yes	Yes
	Time to Open Maximum (ms)	20	20	20
	Time to Close Maximum (ms)	20	20	20

2.2.3 Control Specifications

Table 2-6. Control Specifications – Interface Options: Analog Voltage/Pulse Train, CANopen, USB, RS232

Feature	Specification	
Motors	DC Brushless, DC Brush	Rotary servomotors, Linear servomotors
	Auto-configuration	Automatic self-configuration of motor phasing and wire settings
Operation Mode	Selectable Modes	Current (Torque) Control Velocity Control Position Control HD Control
Current (Torque) Control	Input/Output	Current command / 3 phase PWM command
	Performance	Update rate 31.25 µs (32 kHz), Output waveform sinusoidal
	Step Response Time	Actual current reaches command in two cycles, 62.5 µs
	Control Loop	DQ, PI, Feed-forward
	Reference Command	Analog Voltage ±10 VDC, Serial RS232 or USB*, CANopen*
	Autotuning	Automatic self-tuning of current control loop parameters
Velocity Control	Input/Output	Velocity command / Current command
	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	Analog Voltage ±10 VDC, Serial RS232 or USB*, CANopen*
Position Control	Input/Output	Position command / Velocity command
	Performance	Update rate 250 µs (4 kHz)
	Control loop	PID and feed-forward
	Reference Command	Pulse and direction with electronic gearing, Serial, Serial RS232 or USB*, CANopen*
HD Control	Input/Output	Position command or Velocity command/Current command
	Performance	Update rate 250 µS (4 kHz)
	Control Loop	Nonlinear control algorithm provides very low tracking error, zero or minimum settling time and smooth movement; includes an adaptive feed-forward 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: Analog Voltage ±10 VDC, Serial RS232 or USB*, CANopen* Position: Pulse and direction with electronic gearing, Serial, Serial RS232 or USB*, CANopen*
	Auto tuning	Automatic inertia load measurement, self-tuning and optimization of HD control loop parameters. Optimal settling time up to 0-2 ms
Brake	Method	Control stops: Several Dynamic brake and Active disable options

Feature	Specification	
Display	Method	7-segment LED (green), display drive status
Electronic Gearing	Method	User define input signal ratio
GUI	User Interface	FLEXI SUITE 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
Rotary Units	Position	Revolutions, counts, degrees
	Velocity	rps, rpm, deg/s
	Acceleration/Deceleration	rps/s, rpm/s, deg/s^2
Linear Units	Position	Counts, pitch, mm, μm
	Velocity	mm/s, μm/s
	Acceleration/Deceleration	mm/s^2, μm^2/s

* Some features are not available on all models. Check the options in the section *Ordering Information*, or contact your supplier.

2.2.4 Protective Functions and Environmental Specifications

Table 2-7. Protective Functions and Environmental Specs. – All FLEXI PRO Models

Feature	Specification
Protective Functions	Partial list, Under- and over-voltage, Over-current, Drive and motor over-temperature, Motor foldback, Drive foldback, Feedback lost, Secondary feedback lost, STO signal not connected, Not configured, Circuit failure, Motor phases disconnected
Compliance	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.
	UL 508C: TÜV Rheinland certification. Power Conversion Equipment.
	REACH: EC Regulation 1907/2006 Regulation on chemicals and their safe use.
Environment	Ambient temperature: Operation 0-45°C, Storage 0-70°C
	Humidity: 10-90%
	Altitude: < 1000m. If >1000m, derate 5% per 330m
	Vibration: 1.0g
Protection class/ Pollution degree	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
Configuration	Book mounting

2.2.5 Communication Specifications

Table 2-8. Communication Specifications

Feature	Specification
CANopen*	CANopen – CiA 301 application layer and the CiA 402 device profile for drives and motion control
	Baud rate 0.5M 1M bit/s
EtherCAT*	CiA 301 application layer and the CiA 402 device profile for drives and motion control
RS232	ASCII-based, FLEXI SUITE, HyperTerminal
	Baud rate 115200 bit/s
	Maximum cable length 10 m
USB*	ASCII-based, FLEXI SUITE, HyperTerminal
	Baud rate 115200 bit/s
	Maximum cable length 3 m
Daisy Chain	Up to 8 axes Axis address setting from 0-99 using two rotary switches.
	Maximum cable length 10 m

* Some features are not available on all models. Check the options in the section *Ordering Information*, or contact your supplier.

2.2.6 I/O Specifications

Table 2-9 I/O Specifications

Feature	Specification	
First Analog Input	Voltage Range	Analog ±10 VDC differential
	Input Resolution	16 bit (14-bit on version with two analog inputs)
	Input Impedance	8 kΩ (when using two analog inputs 20k Ω.)
	Zero attenuation	200 Hz
	Band width (-3 db)	1 KHz
Second Analog Input*	Voltage Range	Analog ±10 VDC differential 14 bit
	Input Resolution	14 bit
	Input Impedance Zero attenuation Band width (-3 db)	20 kΩ 200 Hz 1 KHz
Pulse & Direction	Signal Max Input Frequency	RS 422 Line receiver 4 MHz
Equivalent Encoder Output	Signal	A-quad-B and index differential, RS422 line transmitter
	Max Output Frequency	4 MHz
8x Digital Inputs	Signal	Configurable opto-isolated. Compatible with sinking output. EtherCAT: user defined compatibility with sinking output or sourcing output.
	Voltage	24 V
	Max. Input Current	10 mA

Feature	Specification	
	Propagation Delay Time	1 ms
3x Fast Digital Inputs	Signal	Configurable opto-isolated (compatible with sinking output)
	Voltage	24 V
	Max Input Current	10 mA
	Propagation Delay Time	1 µs
4x Digital Output	Signal	Configurable open collector. Opto-isolated sinking output. EtherCAT: user defined compatibility with either opto-isolated sinking output or sourcing output.
	Voltage	24 V
	Max. Current	40 mA
	Propagation Delay Time	1 ms
2x Fast Digital Output	Signal	Configurable open collector. Opto-isolated sinking output. EtherCAT: user defined compatibility with either opto-isolated sinking output or sourcing output.
	Voltage	24 V
	Max current	10 mA
	Propagation Delay Time	1 µs
Analog Output	Signal	Configurable analog output
	Voltage Range	±10 V
	Resolution	8 bit
	Low pass filter	2 KHz
	Max. Load	100 kΩ
Secondary Feedback	Signal	A-quad-B and index differential, RS 422 line receiver
	Max. Input frequency	4 MHz (before A-quad-B)
	Min Index pulse width	1 µs
	Functions	Dual loop, Master/Slave or Handwheel
Fault Output Relay	Signal	Configurable dry contacts
	Voltage	24V
	Max. Current	1 A

* Some features are not available on all models. Check the options in the section *Ordering Information*, or contact your supplier.

2.2.7 Motor Feedback Specifications

Table 2-10. Motor Feedback Specifications – All FLEXI PRO Models

Motor Feedback	Specification	
General	Supply Voltage from Drive	5 VDC (7 VDC*)
	Max. Supply Current from Drive	250 mA
	Max. Cable Length	AWG 28 – 3 m AWG 24 – 10 m
Incremental Encoder	Signal	A-quad-B with or without index/Halls, 8-channel Tamagawa, RS422 or RS485 line receiver, Differential
	A-quad-B Max Input Frequency	4 MHz (before quadrature)
	Min Index Pulse Width	1 µs
Hall Sensor	Signal	Open collector single-ended (optional differential-ended)
Resolver	Signal	Sine/cosine differential
	Transformation Ratio	0.45 – 1.6
	Excitation Frequency	8 kHz
	Input Voltage from Drive	6-22 Vpp
	Max. DC Resistance	120 Ω (stator)
	Max. Drive Current	55 mA rms
	Output Voltage to Drive	10 Vpp
Sine Encoder	Signal	Sine/Cosine differential, with or without Halls
	Signal Level	1 Vpp @ 2.5 V
	Max. Input Frequency	100 kHz
	Protocols	EnDat 2.1, HIPERFACE
	Input Impedance	120 Ω
	Interpolation	Up to 65536 (16 bit)
	Effective Interpolation	Up to 16384 (14 bit)
SSI Encoder	Signal	Differential data and clock for synchronous encoders Data only for asynchronous encoders
	Protocols	Can be supported upon request EnDat 2.2, BiSS-C, other SSI
Motor Temperature	Signal	Thermal resistor PTC or NTC, User-defined fault threshold

* Some features are not available on all models. Check the options in the section *Ordering Information*, or contact your supplier.

2.3 System Wiring and Pin Assignments

For more information, refer to *Power Board Connections – 120/240 VAC.*

2.3.1 FLEXI PRO-1D5/FLEXI PRO-003 – 120/240 VAC

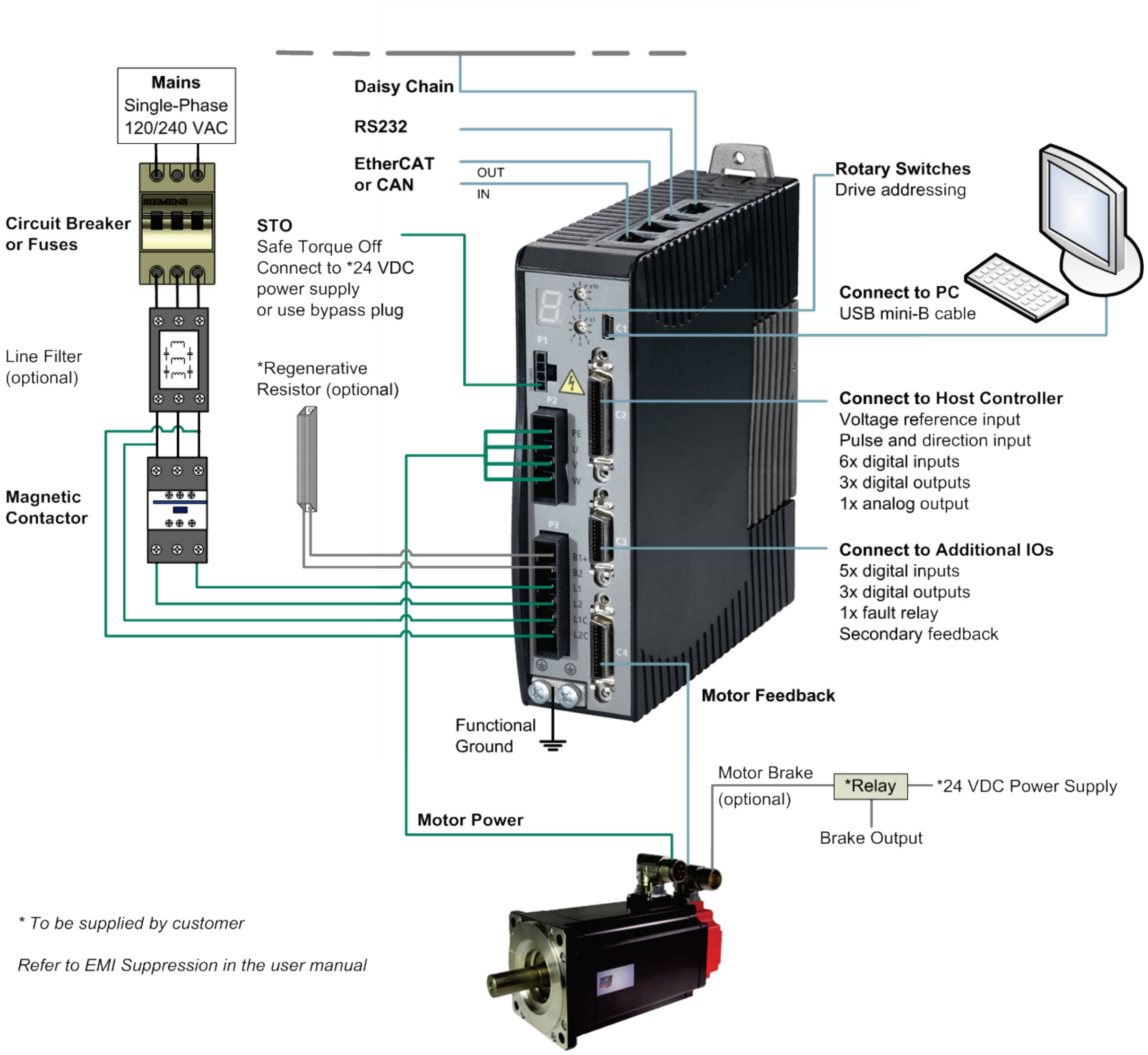


Figure 2-9. FLEXI PRO-1D5/FLEXI PRO-003 Servo System Wiring, Using Single-Phase 120/240 VAC

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

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

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

Daisy Chain C8: 0.1" IDC Female	
NELTRON 4401-10SR OR COXOC 304A-10PSAAA03 (MPC PN xxxxxxxxxx)	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	
8	
9	
10	

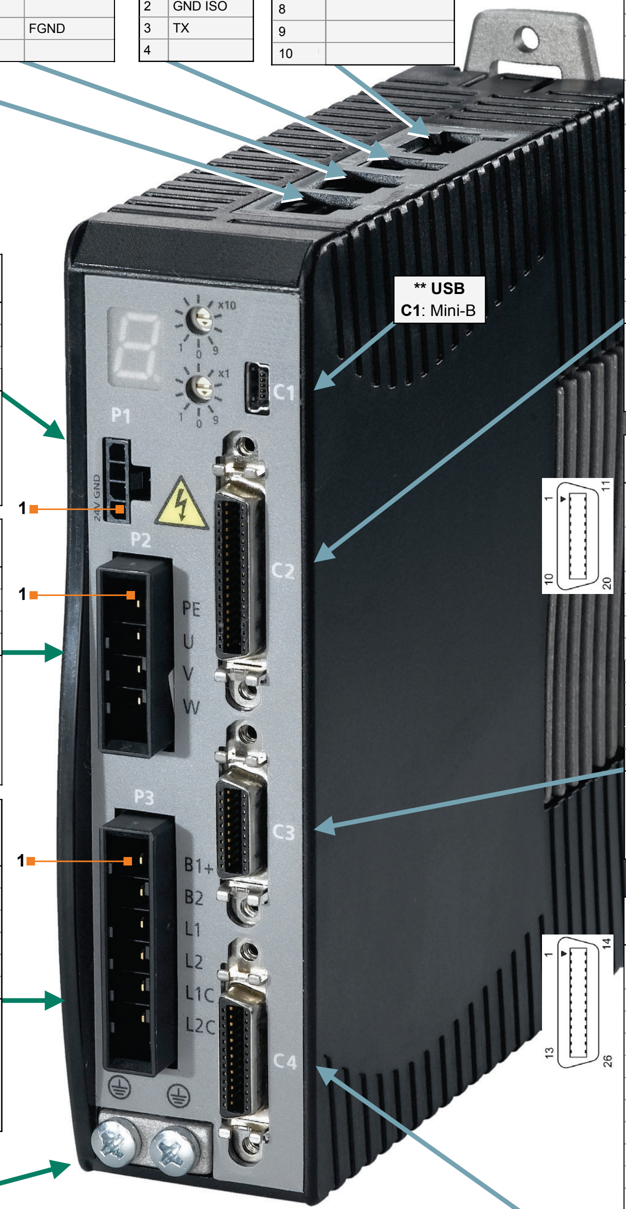
Controller I/F C2: MDR 36 Plug | 24-28 AWG			
1	24 VDC return	19	24 VDC
	*** Common output		*** Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A-	22	Equivalent encoder output A+
5	Equivalent encoder output B-	23	Equivalent encoder output B+
6	Equivalent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

Mating Connector - 3M **Solder** Plug Connector
PN 10136-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10336-52F0-008 (MPC PN xxxxxxxxxx) or equivalent.
Mating **Cable** (MPC PN xxxxxxxxxx)

STO – Safe Torque Off P1: Molex | 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	

Mating Connector type **Crimp**
Housing PN 436450400
(MPC PN xxxxxxxxxx)
4x Crimp PN 0430300001
(MPC PN xxxxxxxxxx)
Wired STO
MPC PN xxxxxxxxxx

**** USB**
C1: Mini-B



Motor P2: JST J300 | 18 AWG		
1	PE	Functional Ground
2	U	Motor Phase U
3	V	Motor Phase V
4	W	Motor Phase W

Mating Connector type **Crimp**
Housing PN F32FSS-04V-KX
(MPC PN xxxxxxxxxx)
4x Crimp PN SF3F-71GF-P2.0
(MPC PN xxxxxxxxxx)
Mating Connector type **Spring**
PN 04JFAT-SBXGF-I
(MPC PN xxxxxxxxxx)

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

Mating Connector - 3M **Solder** Plug Connector
PN 10120-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10320-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

AC Input and Regeneration P3: JST J300 | 18 AWG		
1	B1+	DC Bus +
2	B2	Regen Bus -
3	L1	AC Phase 1
4	L2	AC Phase 2
5	L1C	Logic AC Phase 1
6	LC2	Logic AC Phase 2

Mating Connector Type **Crimp**
Housing PN F32FSS-06V-KX
(MPC PN xxxxxxxxxx)
6x Crimp PN SF3F-71GF-P2.0
(MPC PN xxxxxxxxxx)
Mating Connector Type **Spring**
PN 06JFAT-SBXGF-I
(MPC PN xxxxxxxxxx)

Functional Ground PE: Terminal M4
M4 ring or spade terminal

Feedback C4: MDR 26 Plug | 24-28 AWG			
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	** 8V supply
6	Resolver sine +	19	Resolver sine -
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine +	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Mating Connector - 3M **Solder** Plug Connector
PN 10126-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10326-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

*	*Refer to ordering information*
**	*CAN and EtherCAT models only*
***	*EtherCAT models only*
MPC	*Motor Power Company*
Highlighted PN	*Supplied with FPRO*

Crimping tool	Molex 0638190000 (P1) or equivalent
Crimping tool	YRF-880 (P2, P3)
Extraction tool	EJ-JFAJ3 (P2, P3)
Key for spring connector	J-FAT-OT

4/40 insert threads on C2, C3, C4

Figure 2-10. Pin Assignments on FLEXI PRO-1D5/FLEXI PRO-003

2.3.2 FLEXI PRO-4D5/FLEXI PRO-006 – 120/240 VAC

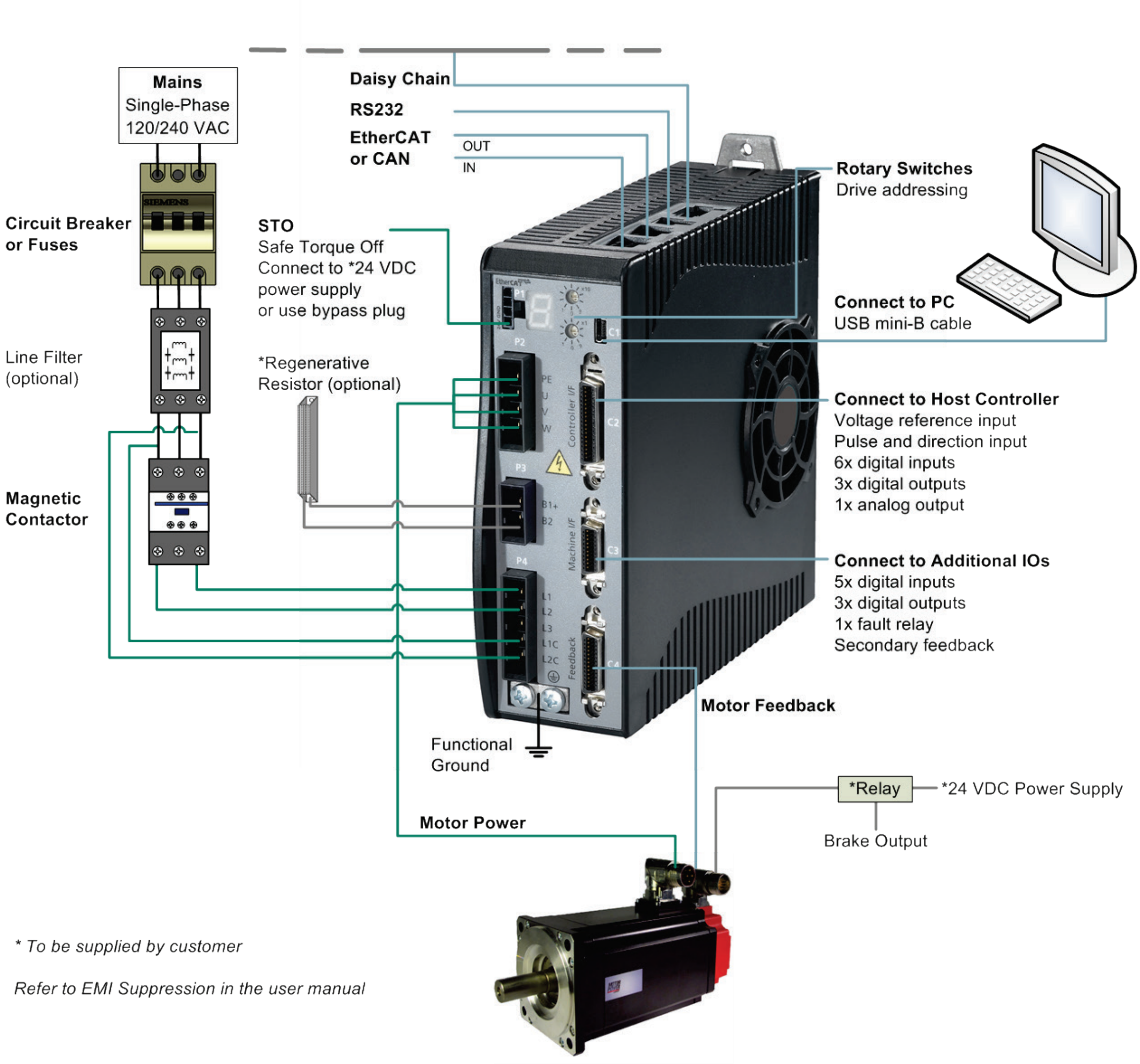


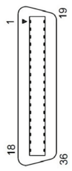
Figure 2-11. FLEXI PRO-4D5/FLEXI PRO-006 Servo System Wiring, Using Single-Phase 120/240 VAC

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

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

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

Daisy Chain C8: 0.1" IDC Female	
NELTRON 4401-10SR OR COXOC 304A-10PSAAA03 (MPC PN xxxxxxxxxx)	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	
8	
9	
10	



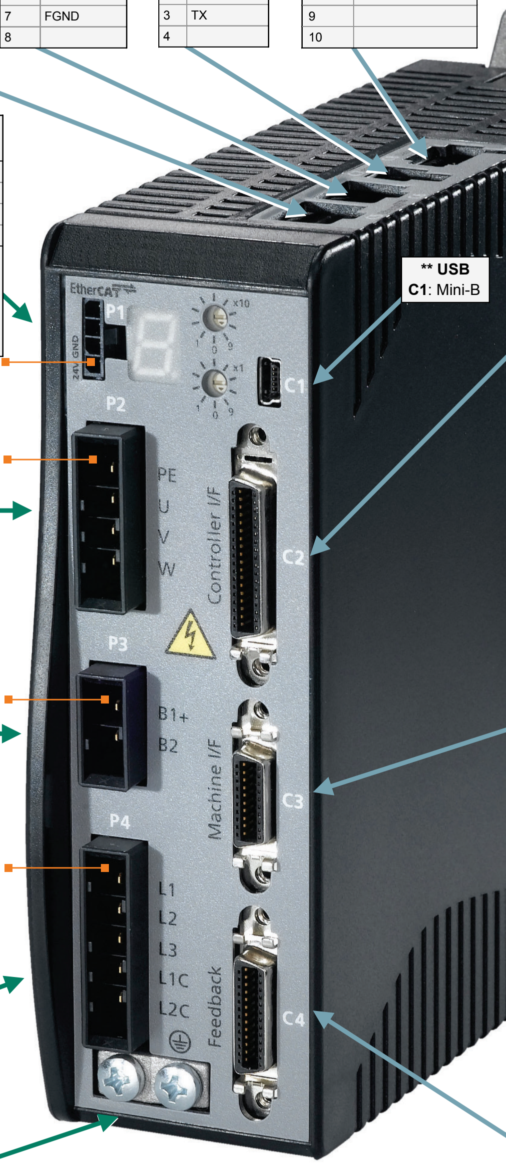
Controller I/F C2: MDR 36 Plug | 24-28 AWG			
1	24 VDC return	19	24 VDC
	*** Common output		*** Common input
2	Digital output 1	20	Digital input 2
3	Digital input 1	21	
4	Equivalent encoder output A-	22	Equivalent encoder output A+
5	Equivalent encoder output B-	23	Equivalent encoder output B+
6	Equivalent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

Mating Connector - 3M **Solder** Plug Connector
PN 10136-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10336-52F0-008 (MPC PN xxxxxxxxxx) or equivalent.
Mating **Cable** (MPC PN xxxxxxxxxx)

STO – Safe Torque Off P1 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	

Mating Connector type **Crimp**
Housing Molex PN 436450400 or equiv.
(MPC PN xxxxxxxxxx)
4x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)
Wired STO
MPC PN xxxxxxxxxx

**** USB**
C1: Mini-B

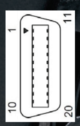


Motor P2: JST J300 | 16 AWG		
1	PE	Functional Ground
2	U	Motor Phase U
3	V	Motor Phase V
4	W	Motor Phase W

Mating Connector type **Crimp**
Housing PN F32FSS-04V-KX
(MPC PN xxxxxxxxxx)
4x Crimp PN SF3F-71GF-P2.0
(MPC PN xxxxxxxxxx)
Mating Connector type **Spring**
PN 04JFAT-SBXGF-I
(MPC PN xxxxxxxxxx)

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

Mating Connector - 3M **Solder** Plug Connector
PN 10120-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10320-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

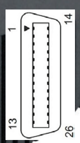


Regeneration P3: JST J300 | 16 AWG		
1	B1+	DC Bus +
2	B2	Regen Bus -

Mating Connector Type **Crimp**
Housing PN F32FSS-02V-KX
(MPC PN xxxxxxxxxx)
2x Crimp PN SF3F-71GF-P2.0
(MPC PN xxxxxxxxxx)
Mating Connector Type **Spring**
Not available

AC Input P4: JST J300 | 16 AWG		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3
4	L1C	Logic AC Phase 1
5	LC2	Logic AC Phase 2

Mating Connector Type **Crimp**
Housing PN F32FSS-05V-KX
(MPC PN xxxxxxxxxx)
5x Crimp PN SF3F-71GF-P2.0
(MPC PN xxxxxxxxxx)
Mating Connector type **Spring**
PN 05JFAT-SBXGF-I
(MPC PN xxxxxxxxxx 4)



Feedback C4: MDR 26 Plug | 24-28 AWG			
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	** 8V supply
6	Resolver sine +	19	Resolver sine -
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine +	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Mating Connector - 3M **Solder** Plug Connector
PN 10126-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10326-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

Functional Ground PE: Terminal M4
M4 ring or spade terminal

*	*Refer to ordering information*
**	*CAN and EtherCAT models only*
***	*EtherCAT models only*
MPC	*Motor Power Company*
Highlighted PN	*Supplied with FPRO*

Crimping tool	Molex 0638190000 (P1) or equivalent
Crimping tool	YRF-1070 (P2, P3, P4)
Extraction tool	EJ-JFAJ3
Key for spring connector	J-FAT-OT

4/40 insert threads on C2, C3, C4

Figure 2-12. Pin Assignments on FLEXI PRO-4D5/FLEXI PRO-006

2.3.3 FLEXI PRO-008/FLEXI PRO-010/FLEXI PRO-013 – 120/240 VAC

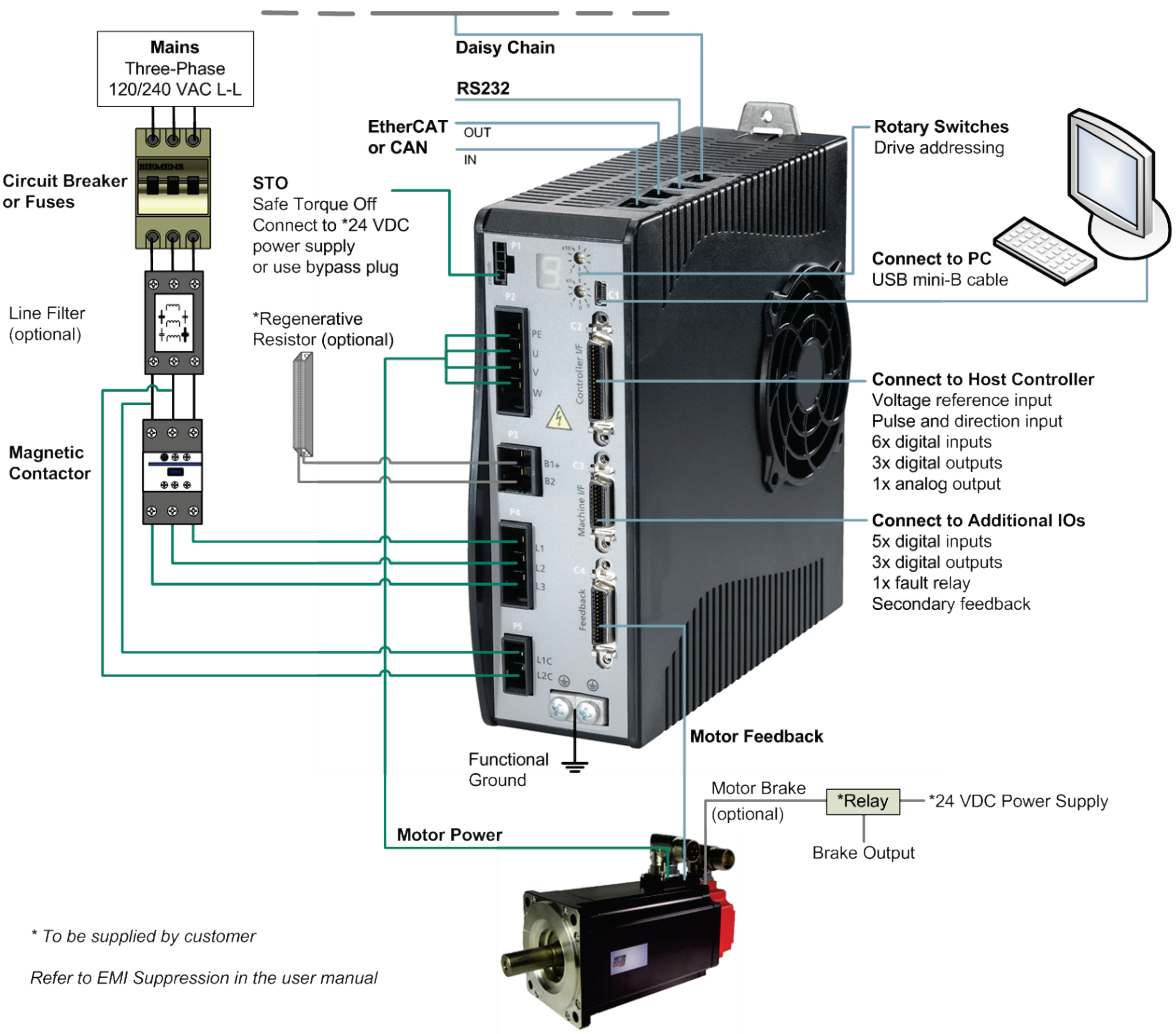


Figure 2-13. FLEXI PRO-008/FLEXI PRO-010/FLEXI PRO-013 Servo System Wiring, Using Three-Phase 120/240 VAC

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

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

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

Daisy Chain	
C8: 0.1" IDC Female	
NELTRON 4401-10SR OR COXOC 304A-10PSAAA03 (MPC PN xxxxxxxxxx)	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	
8	
9	
10	

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

Mating Connector - 3M **Solder** Plug Connector
PN 10136-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10336-52F0-008 (MPC PN xxxxxxxxxx) or equivalent.
Mating **Cable** (MPC PN xxxxxxxxxx)

** USB
C1: Mini-B

STO – Safe Torque Off	
P1 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	

Mating Connector type **Crimp**
Housing Molex PN 436450400 or equiv.
(MPC PN xxxxxxxxxx)
4x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)
Wired STO
MPC PN xxxxxxxxxx

Motor		
P2: JST J400 | 14 AWG		
1	PE	Functional Ground
2	U	Motor Phase U
3	V	Motor Phase V
4	W	Motor Phase W

Mating Connector Type **Crimp**
Housing PN J43FSS-04V-KX
(MPC PN xxxxxxxxxx)
4x Crimp PN SJ4F-71GF-M3.0
(MPC PN xxxxxxxxxx)

Regeneration		
P3: JST J400 | 14 AWG		
1	B1+	DC Bus +
2	B2	Regen Bus -

Mating Connector Type **Crimp**
Housing PN J42FSC-02V-KX
(MPC PN xxxxxxxxxx)
2x Crimp PN SJ4F-71GF-M3.0
(MPC PN xxxxxxxxxx)

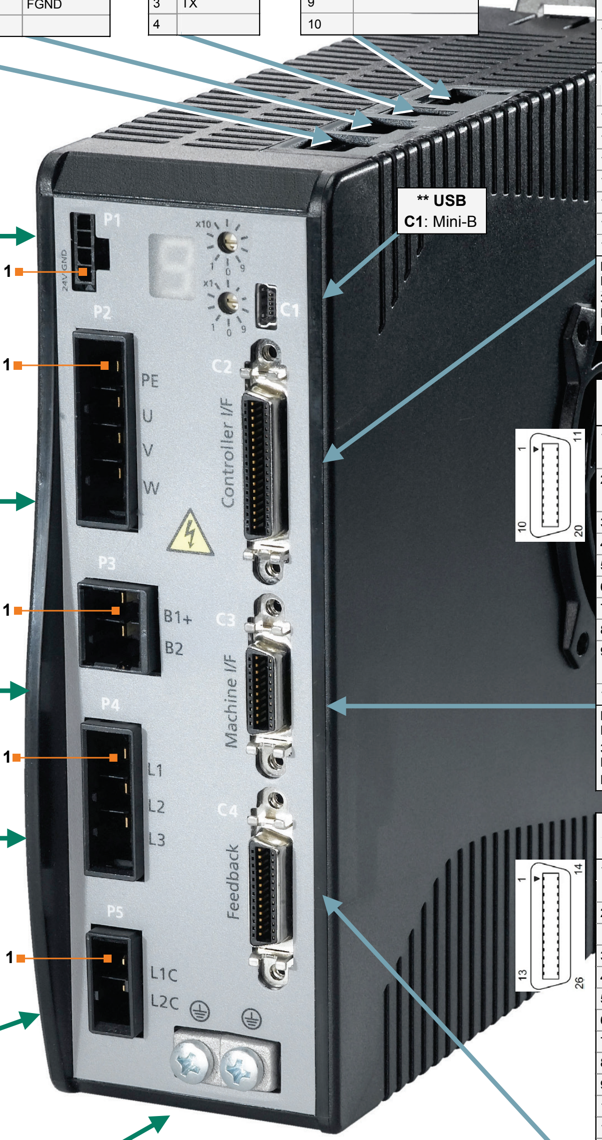
Main AC Input		
P4: JST J400 | 14 AWG		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3

Mating Connector Type **Crimp**
Housing PN J43FSS-03V-KX
(MPC PN xxxxxxxxxx)
3x Crimp PN SJ4F-71GF-M3.0
(MPC PN xxxxxxxxxx)

Logic Power AC Input		
P5: JST J300 | 16 AWG		
1	L1C	AC Phase 1
2	L2C	AC Phase 2

Mating Connector type **Crimp**
Housing PN F32FSS-02V-KX
(MPC PN xxxxxxxxxx)
2x Crimp PN SF3F-71GF-P2.0
(MPC PN xxxxxxxxxx)

Functional Ground
PE: Terminal M4
M4 ring or spade terminal



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

Mating Connector - 3M **Solder** Plug Connector
PN 10120-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10320-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

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

Mating Connector - 3M **Solder** Plug Connector
PN 10126-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10326-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

*	*Refer to ordering information*
**	*CAN and EtherCAT models only*
***	*EtherCAT models only*
MPC	*Motor Power Company*
Highlighted PN	*Supplied with FPRO*

Crimping tool	Molex 0638190000 (P1) or equivalent
Crimping tool	YRF-1130 (P2, P3, P4) YRF-1070 (P5)
Extraction tool	EJ-JFAJ4 (P2, P3, P4) EJ-JFAJ3 (P5)

4/40 insert threads on C2, C3, C4

Figure 2-14. Pin Assignments on FLEXI PRO-008/FLEXI PRO-010/FLEXI PRO-013

2.3.4 FLEXI PRO-020/FLEXI PRO-024 – 120/240 VAC

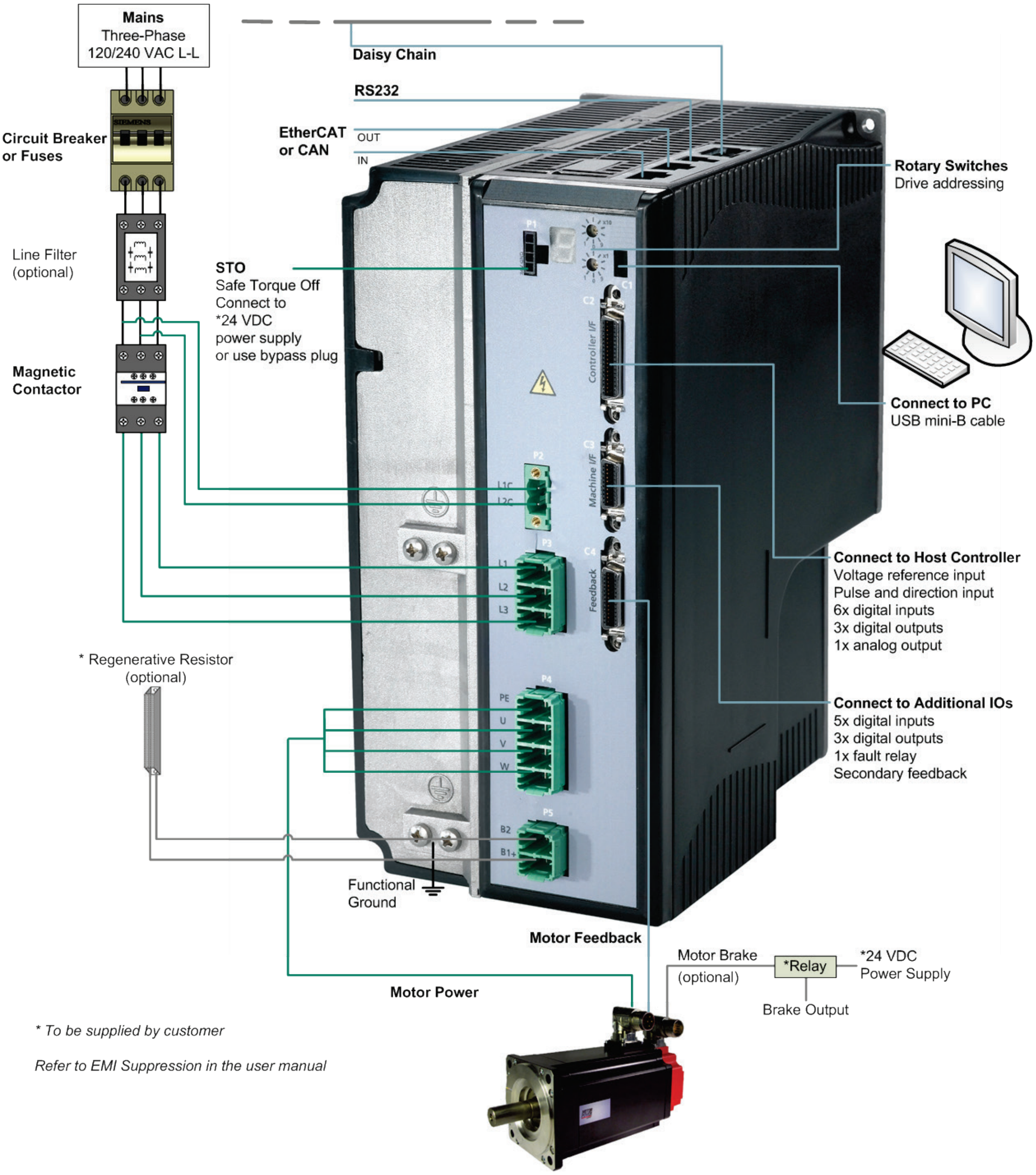


Figure 2-15. FLEXI PRO-020/FLEXI PRO-024 Servo System Wiring, Using Three-Phase 120/240 VAC

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

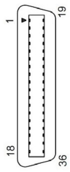
* EtherCAT Out **C6**: RJ45 OR * CAN Out **C6**: RJ45	
1	CANH
2	CANL
3	FGND
4	
5	
6	
7	FGND
8	

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

Daisy Chain **C8:** 0.1" IDC Female	
NELTRON 4401-10SR OR COXOC 304A-10PSAAA03 (MPC PN xxxxxxxxxx)	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	
8	
9	
10	

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

Mating Connector - 3M **Solder** Plug Connector
PN 10136-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10336-52F0-008 (MPC PN xxxxxxxxxx) or equivalent.
Mating **Cable** (MPC PN xxxxxxxxxx)



STO – Safe Torque Off **P1 26-28 AWG**	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	

Mating Connector type **Crimp**
Housing Molex PN 436450400 or equiv.
(MPC PN xxxxxxxxxx)
4x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)
Wired STO
MPC PN xxxxxxxxxx

**** USB**
C1: Mini-B

Logic Power AC Input **P2**: Phoenix | **16 AWG**		
1	L1C	AC Phase 1
2	L2C	AC Phase 2

Mating Connector
PN FKC 2.5/2-STF-5.08 (1873207)
(MPC PN xxxxxxxxxx)

Main AC Input **P3**: Phoenix | **12-13 AWG**		
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3

Mating Connector
PN SPC 5/3-STCL-7,62 (1718494)
(MPC PN xxxxxxxxxx)

Motor **P4** Phoenix | **10-11 AWG**		
1	PE	Functional Ground
2	U	Motor Phase U
3	V	Motor Phase V
4	W	Motor Phase W

Mating Connector
PN SPC 5/4-STCL-7,62 (1718504)
(MPC PN xxxxxxxxxx)

Regeneration **P5** Phoenix | **14 AWG**		
1	B2	Regen Bus -
2	B1+	DC Bus +

Mating Connector
PN SPC 5/2-STCL-7,62 (1718481)
(MPC PN xxxxxxxxxx)

Functional Ground
PE: Terminal M4
M4 ring or spade terminal

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

Mating Connector - 3M **Solder** Plug Connector
PN 10120-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10320-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

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

Mating Connector - 3M **Solder** Plug Connector
PN 10126-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10326-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

*	*Refer to ordering information*
**	*CAN and EtherCAT models only*
***	*EtherCAT models only*
MPC	*Motor Power Company*
Highlighted PN	*Supplied with FPRO*

Crimping tool	Molex 0638190000 (P1)

4/40 insert threads on C2, C3, C4

Figure 2-16. Pin Assignments on FLEXI PRO-020/FLEXI PRO-024

2.3.5 FLEXI PRO-003/FLEXI PRO-006 – 400/480 VAC

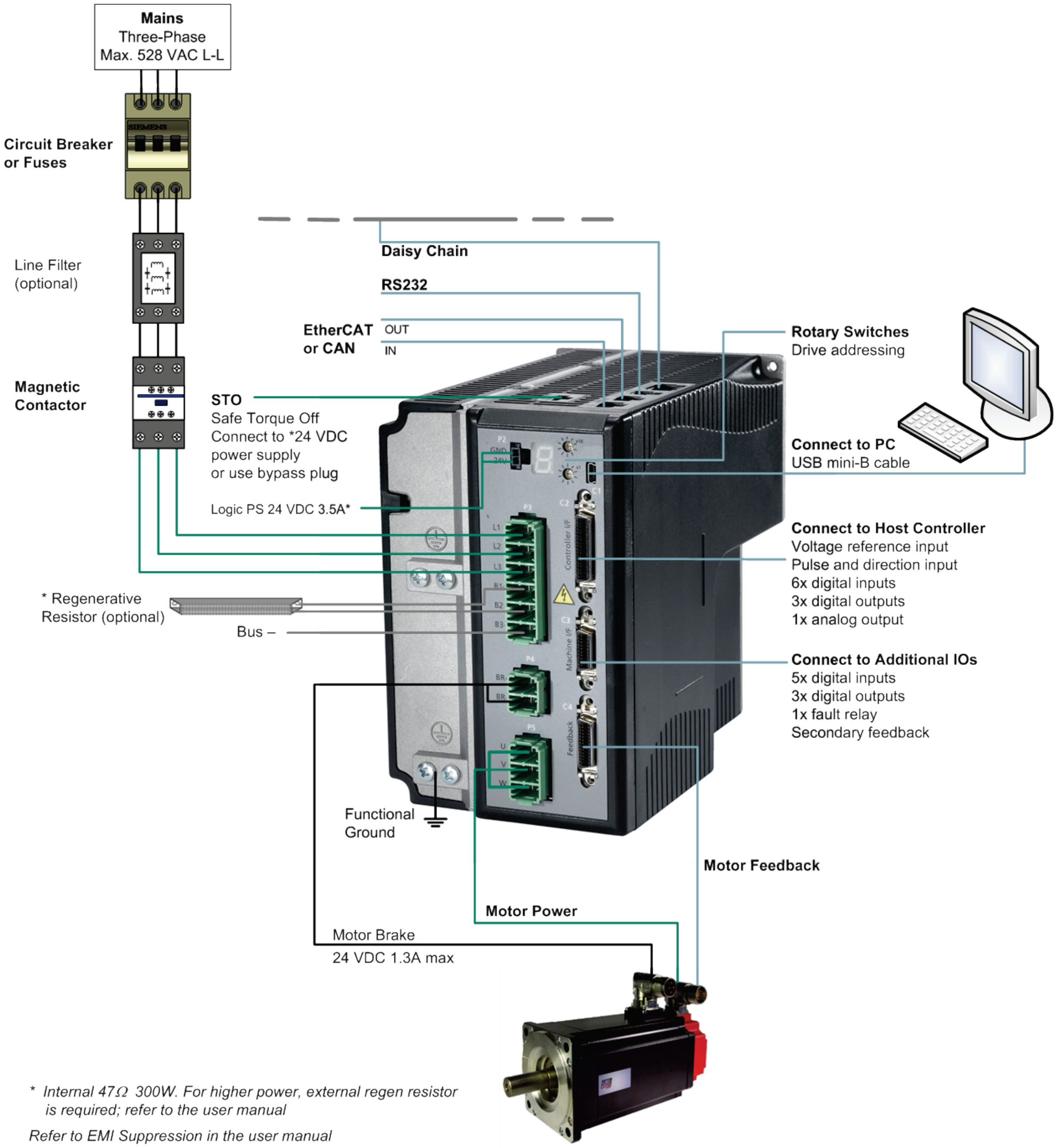


Figure 2-17. FLEXI PRO-003/FLEXI PRO-006 – Servo System Wiring – 400/480 VAC, 3-Phase

* EtherCAT In
C5: RJ45

OR

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

* EtherCAT Out
C6: RJ45

OR

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

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

Daisy Chain	
C8: 0.1" IDC Female	
NELTRON 4401-10SR OR COXOC 304A-10PSAAA03 (MPC PN xxxxxxxxxx)	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	
8	
9	
10	

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

Mating Connector - 3M **Solder** Plug Connector
PN 10136-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10336-52F0-008 (MPC PN xxxxxxxxxx) or equivalent.
Mating **Cable** (MPC PN xxxxxxxxxx)

STO – Safe Torque Off	
P1 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	

Mating Connector type **Crimp**
Housing Molex PN 436450400 or equiv.
(MPC PN xxxxxxxxxx)
4x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)
Wired STO
MPC PN xxxxxxxxxx

Logic Power 24V Input	
P2 26-28 AWG	
1	24 VDC (logic in)
2	Ground (24 VDC return)

Mating Connector Type **Crimp**
Housing Molex PN 436450200 or equiv.
(MPC PN xxxxxxxxxx)
2x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)

** USB
C1: Mini-B

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

Mating Connector
PN SPC 5/6-STCL-7,62 (1718520)
(MPC PN xxxxxxxxxx)

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

Mating Connector - 3M **Solder** Plug Connector
PN 10120-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10320-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

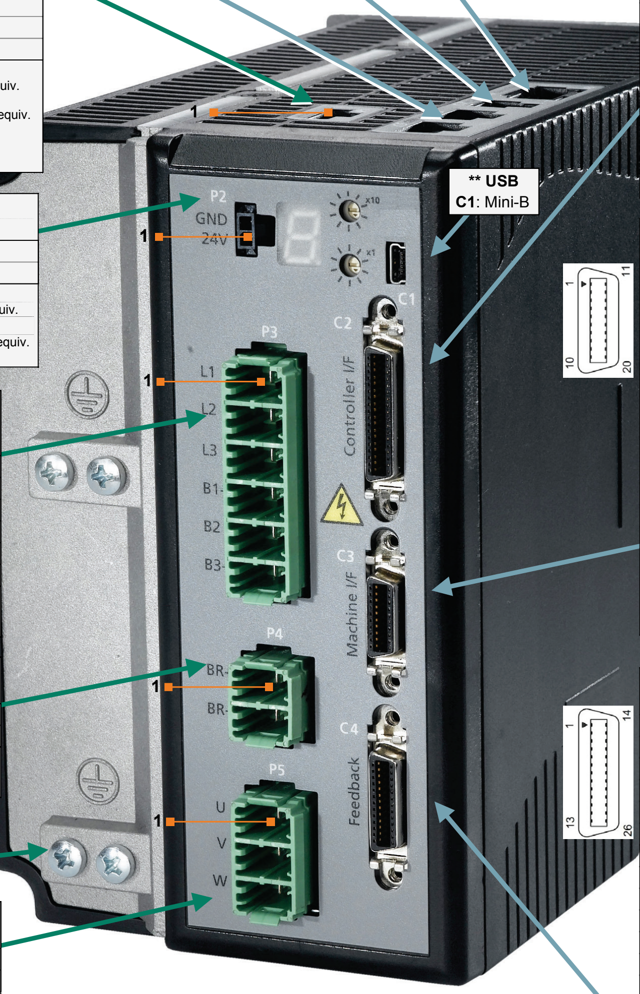
Brake		
P4: Phoenix | **14-17 AWG**		
1	BR+	Motor Brake +
2	BR-	Motor Brake -

Mating Connector
PN SPC 5/2-STCL-7,62 (1718481)
(MPC PN xxxxxxxxxx)

Functional Ground
PE: Terminal M4
M4 ring or spade terminal

Motor		
P5: Phoenix | **12-14 AWG**		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W

Mating Connector
PN SPC 5/3-STCL-7,62 (1718494)
(MPC PN xxxxxxxxxx)



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

Mating Connector - 3M **Solder** Plug Connector
PN 10126-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10326-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

*	*Refer to ordering information*
**	*CAN and EtherCAT models only*
***	*EtherCAT models only*
MPC	*Motor Power Company*
Highlighted PN	*Supplied with FPRO*

Crimping tool	Molex 0638190000 (P1, P2)

4/40 insert threads on C2, C3, C4

Figure 2-18. FLEXI PRO-003/FLEXI PRO-006 – Pin Assignments – 400/480 VAC

2.3.6 FLEXI PRO-012 – 400/480 VAC

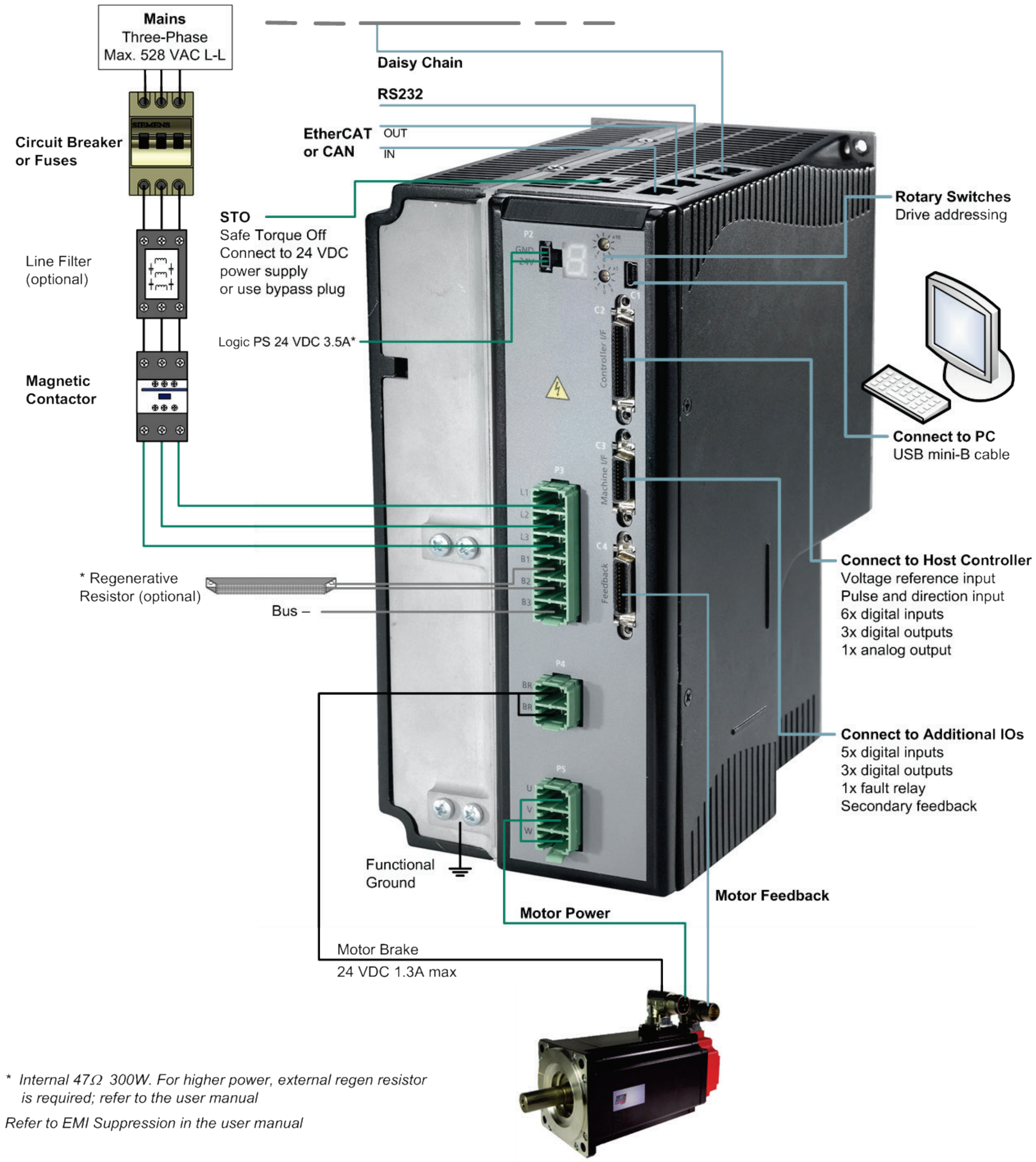


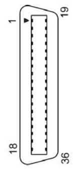
Figure 2-19. FLEXI PRO-0012 – Servo System Wiring – 400/480 VAC, 3-Phase

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

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

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

Daisy Chain C8: 0.1" IDC Female	
NELTRON 4401-10SR OR COXOC 304A-10PSAAA03 (MPC PN xxxxxxxxxx)	
1	DC Shield
2	
3	RXD
4	GND
5	TXD
6	GND
7	
8	
9	
10	



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

Mating Connector - 3M **Solder** Plug Connector
PN 10136-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10336-52F0-008 (MPC PN xxxxxxxxxx) or equivalent.
Mating **Cable** (MPC PN xxxxxxxxxx)

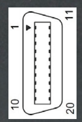
STO – Safe Torque Off P1 26-28 AWG	
1	24 VDC (STO enable)
2	Ground (24 VDC return)
3	
4	

Mating Connector type **Crimp**
Housing Molex PN 436450400 or equiv.
(MPC PN xxxxxxxxxx)
4x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)
Wired STO
MPC PN xxxxxxxxxx

**** USB**
C1: Mini-B

Logic Power 24V Input P2 26-28 AWG	
1	24 VDC (logic in)
2	Ground (24 VDC return)

Mating Connector Type **Crimp**
Housing Molex PN 436450200 or equiv.
(MPC PN xxxxxxxxxx)
2x Crimp Molex PN 0430300001 or equiv.
(MPC PN xxxxxxxxxx)



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

Mating Connector - 3M **Solder** Plug Connector
PN 10120-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10320-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

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

Mating Connector
PN SPC 5/6-STCL-7,62 (1718520)
(MPC PN xxxxxxxxxx)

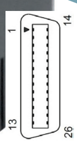
Brake P4: Phoenix | 14-17 AWG		
1	BR+	Motor Brake +
2	BR-	Motor Brake -

Mating Connector
PN SPC 5/2-STCL-7,62 (1718481)
(MPC PN xxxxxxxxxx)

Functional Ground
PE: Terminal M4
M4 ring or spade terminal

Motor P5: Phoenix | 12-14 AWG		
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W

Mating Connector
PN SPC 5/3-STCL-7,62 (1718494)
(MPC PN xxxxxxxxxx)



Feedback C4: MDR 26 Plug | 24-28 AWG			
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	** 8V supply
6	Resolver sine +	19	Resolver sine -
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine +	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Mating Connector - 3M **Solder** Plug Connector
PN 10126-3000PE (MPC PN xxxxxxxxxx) or equivalent
3M Solder Plug Junction Shell
PN 10326-52F0-008 (MPC PN xxxxxxxxxx) or equivalent
Mating **Cable** (MPC PN xxxxxxxxxx)

*	*Refer to ordering information*
**	*CAN and EtherCAT models only*
***	*EtherCAT models only*
MPC	*Motor Power Company*
Highlighted PN	*Supplied with FPRO*

Crimping tool	Molex 0638190000 (P1, P2)

4/40 insert threads on C2, C3, C4

Figure 2-20. FLEXI PRO-012 – Pin Assignments – 400/480 VAC

2.4 Controller Interface Wiring

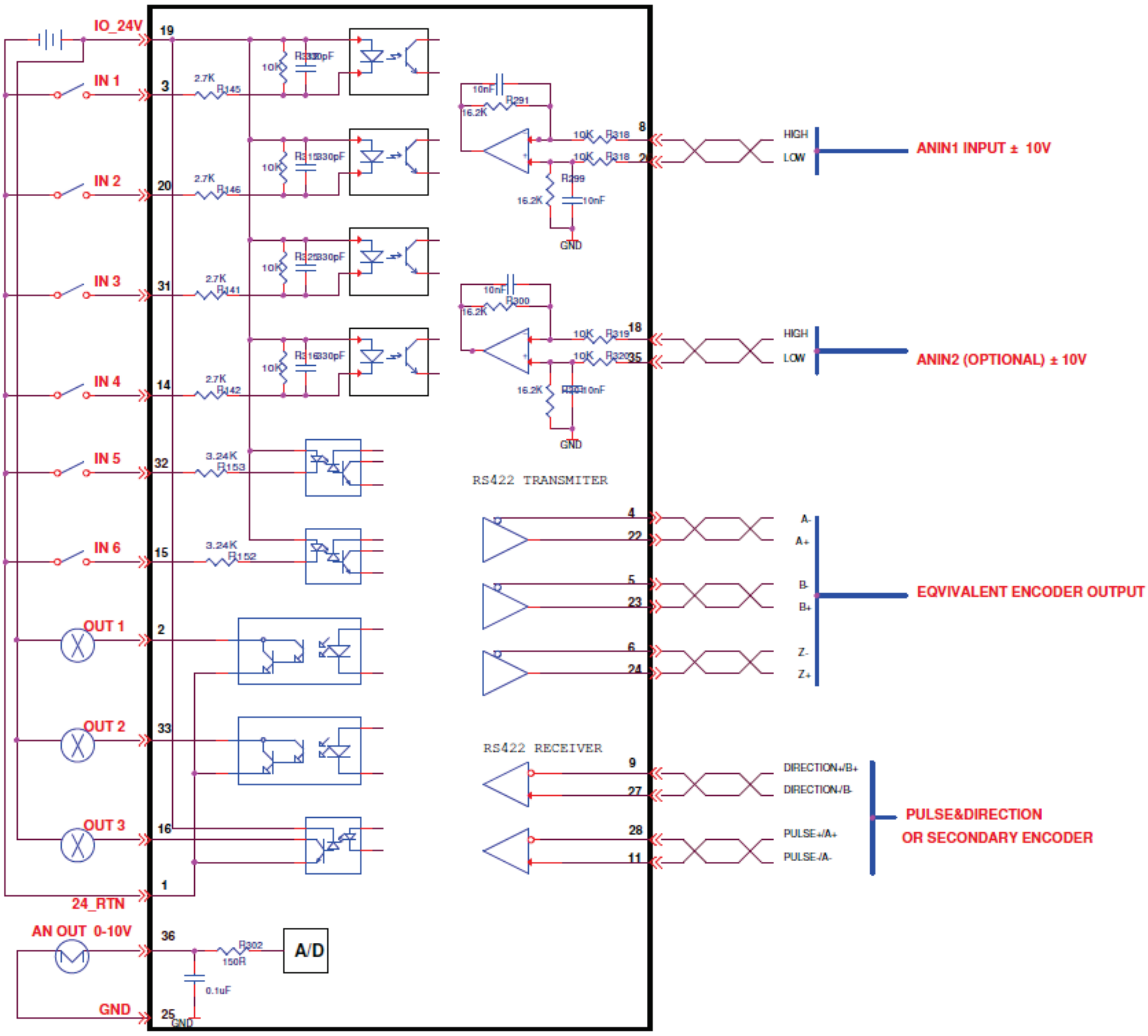


Figure 2-21. Controller Interface Wiring – AP/AF Models

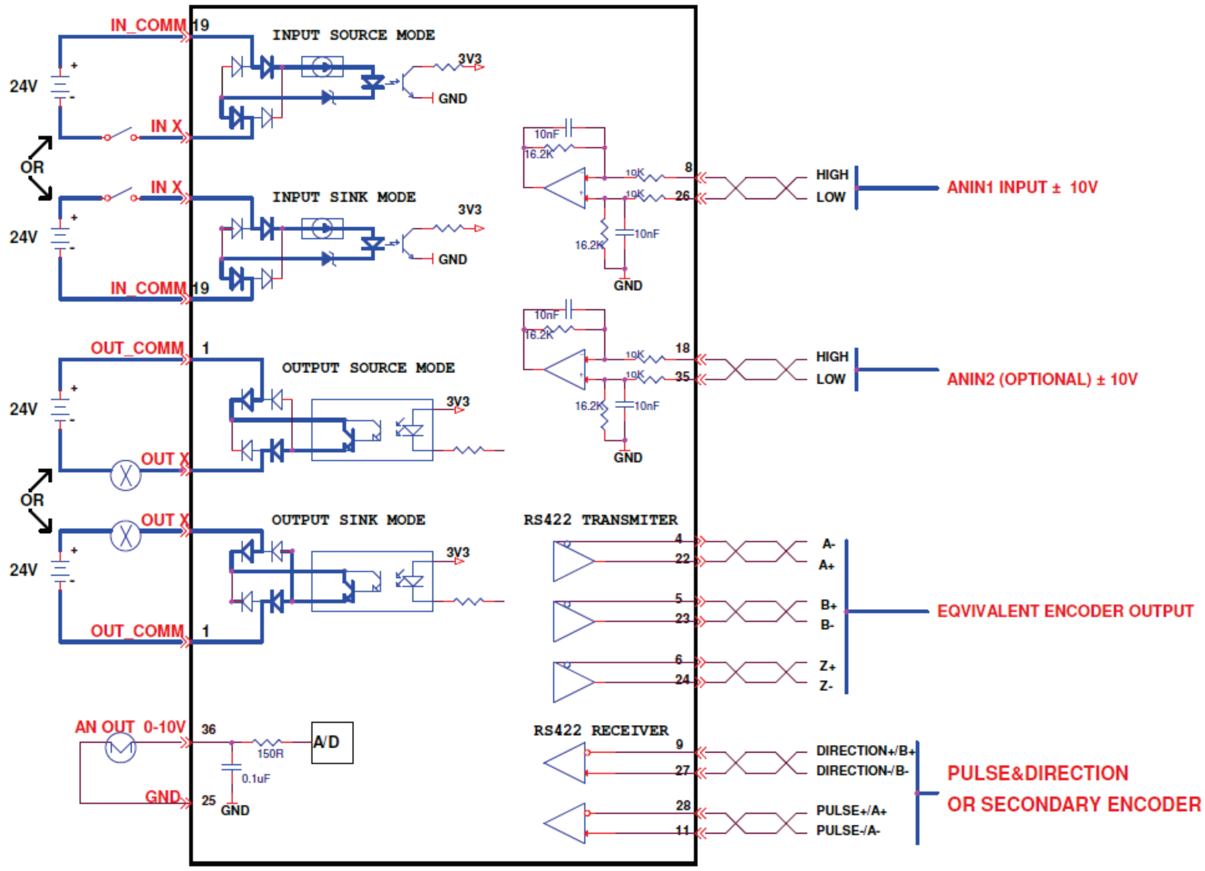


Figure 2-22. Controller Interface Wiring – EC/PN Models

2.5 Machine Interface Wiring

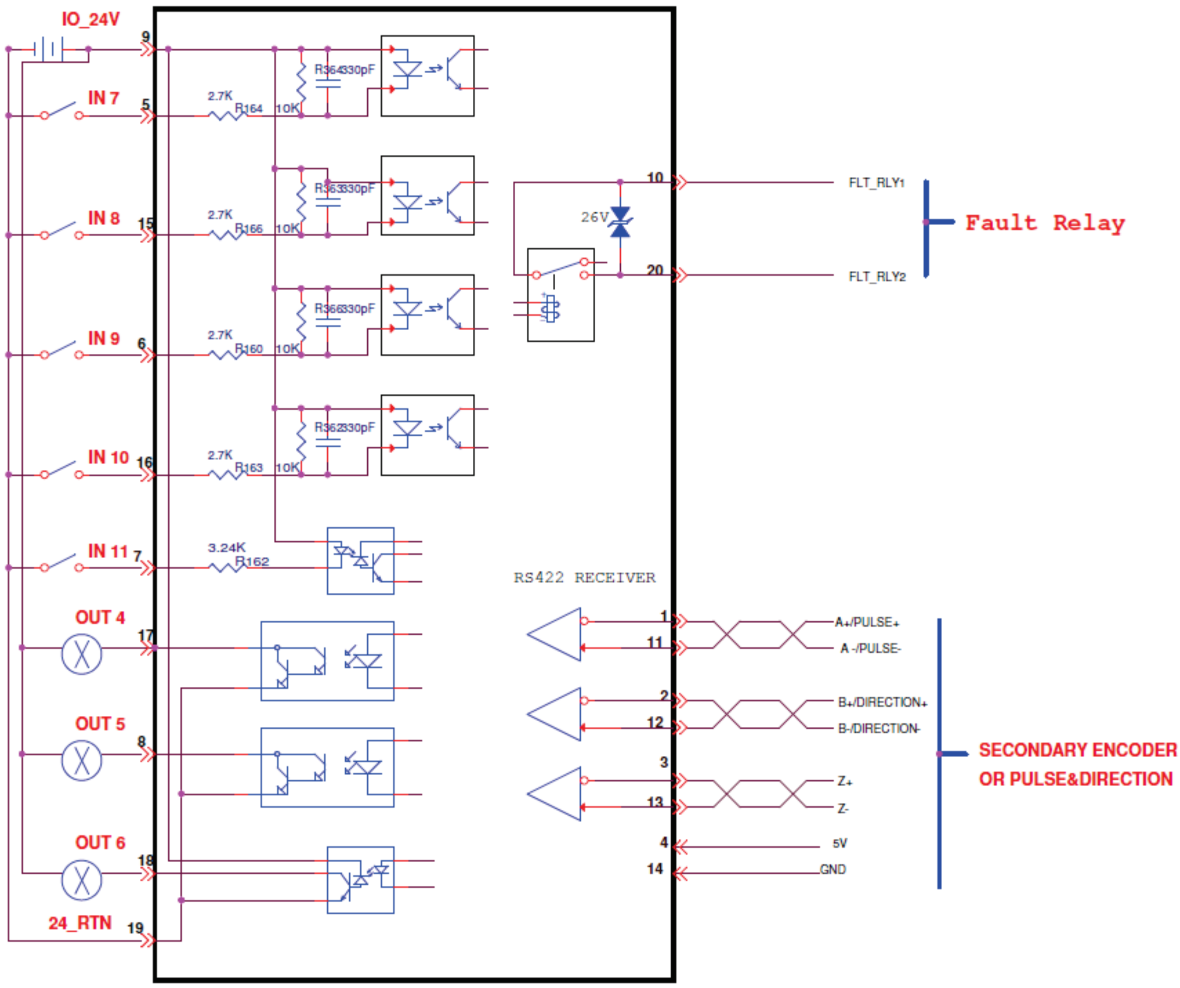


Figure 2-23. Machine Interface Wiring Diagram – AP/AF Models

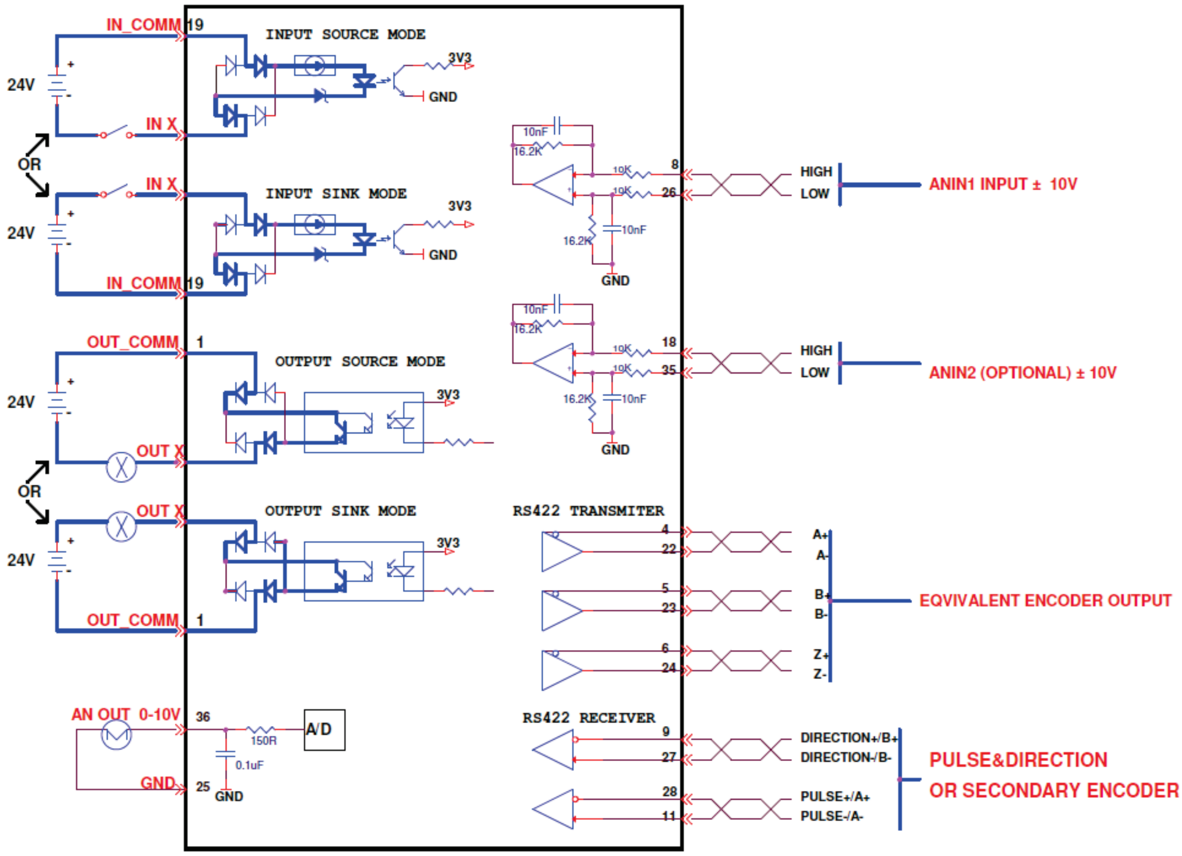


Figure 2-24. Machine Interface Wiring Diagram – EC/PN Models

3 Installation

3.1 Installation Overview

Perform the following steps to install and setup a FLEXI PRO system.

1. Mount the FLEXI PRO.

2. Make all electrical connections:

- Controller I/Os and/or Machine I/Os
- Motor feedback
- Fieldbus devices, if required
- Safe torque off (STO), or bypass using jumpers
- Motor
- Regeneration resistor, if required
- Motor brake, if required
- AC input voltage.

3. Set the drive address using the rotary switches.

4. Connect the drive to the PC.

5. Power up the drive and the PC.

6. Install FLEXI SUITE software.

7. Using FLEXI SUITE, configure and test the drive.

3.2 Preparation

3.2.1 Hardware and Tools

All required hardware and tools are specified in the diagrams in the section *System Wiring and Pin Assignments.*

Connectors and tools that are supplied with the FLEXI PRO are also indicated in those diagrams, and in the table below:

Table 3-1. Required Tools (if not using ready-made cable assemblies)

120/240 VAC Models	
Item	**FLEXI PRO-1D5** **FLEXI PRO-003**
Crimping tool	Molex 0638190000 (P1)
Crimping tool	YRF-880 (P2, P3)
Extraction tool	EJ-JFAJ3 (P2, P3)
Key for spring connector	J-FAT-OT (supplied)

Item	FLEXI PRO-4D5 FLEXI PRO-006
Crimping tool	Molex 0638190000 (P1)
Crimping tool	YRF-1070 (P2, P3, P4)
Extraction tool	EJ-JFAJ3
Key for spring connector	J-FAT-OT (supplied)
Item	**FLEXI PRO-008 FLEXI PRO-010 FLEXI PRO-013**
Crimping tool	Molex 0638190000 (P1)
Crimping tool	YRF-1130 (P2, P3, P4) YRF-1070 (P5)
Extraction tool	EJ-JFAJ4 (P2, P3, P4) EJ-JFAJ3 (P5)
Item	**FLEXI PRO-020 FLEXI PRO-024**
Crimping tool	Molex 0638190000 (P1)
400/480 VAC Models	
Item	**FLEXI PRO-003 FLEXI PRO-006 FLEXI PRO-012**
Crimping tool	Molex 0638190000 (P1, P2)

Crimping

Prior to crimping, strip 2 mm at the end of wire, as shown in Figure 3-1.

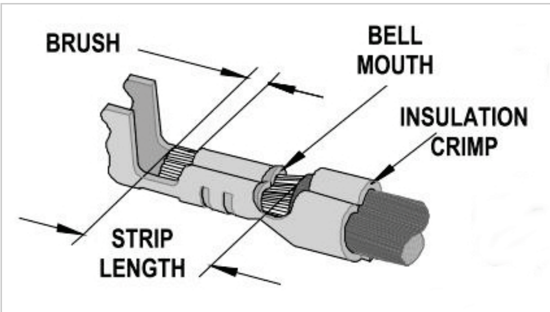


Figure 3-1. Stripped Wire in Crimp Pin

In addition, you will need:

- A small slotted screwdriver for setting switches.
- M4 ring or spade terminal for grounding.

To connect the FLEXI PRO to the host computer via serial communication, you will need one of the following:

- USB 2.0 A to Mini-B cable (USB interface)
- 4p4c plug and cable (RS232 interface)

To connect the FLEXI PRO to the host computer or host PLC via fieldbus:

- RJ45 cables (CAN interface or EtherCAT)

3.2.2 Computer System

The following computer system and software are required:

- 2 GHz CPU
- 1 MB RAM
- 1000 MB available on hard drive (after .net 4 is installed)
- USB port for connecting to the drive
- Operating system: Windows XP-SP3, or Windows 7
- Recommended screen resolution for FLEXI SUITE is 1280x800.
  Minimal resolution is1024x768.
- **FLEXI SUITE**, the graphical software interface for configuring and testing the drive. Download from the Motor Power Company website or contact Technical Support.
- **.Net4** (for details, refer to .NET Framework System Requirements). If .NET 4 is not installed on the computer, FLEXI SUITE will guide you through the installation, but will not install it automatically.

3.2.3 Files for Fieldbus Devices

- **EDS file** for FLEXI PRO (if using CAN protocol) on controller. Download from the Motor Power Company website or contact Technical Support.
- **XML file** for FLEXI PRO (if using EtherCAT protocol) on controller. Download the Motor Power Company website or contact Technical Support.

3.3 EMI Suppression

3.3.1 CE Filtering Techniques

The FLEXI PRO drive complies with the CE standards specified in the section *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.

3.3.2 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 FLEXI PRO 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 FLEXI PRO 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 bus bar to achieve high-frequency grounding. When connecting high frequency grounds, use the shortest braid possible.

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.

3.3.3 Shielding and Bonding

Motor and feedback cables must be shielded in order to minimize noise emissions and increase the immunity levels of the drive system. The shield should be connected to ground at both ends.

The proper bonding of shielded cables to a grounded surface is imperative for minimizing noise emissions and increasing immunity levels of the drive system. 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 cables should have the shield exposed as close to the drive as possible. This exposed 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, for example with a shielding busbar.

For cables entering a cabinet, connect shields on all 360° of the cable.

Lines between servo drives and filters and external brake resistor must be shielded.

#	Port Description	Connected to	Cable Type
1	AC Power	AC Mains (via filter)	Unshielded
2	STO	STO Socket	Unshielded
3	Motor Power	Motor Power	Shielded
4	Motor Feedback	Motor Feedback	Shielded
5	Controller I/F	PLC/Host/Controller	Shielded
6	Machine I/F	PLC/Host/Controller	Shielded
7	CAN In & Out	PLC/Host/Controller	Shielded
8	USB	PC	Shielded
9	RS232	PC	Unshielded
10	Regen	Regeneration Resistor	Unshielded
11	Daisy Chain	Other Drives	Unshielded
12	GND	Protected Ground	

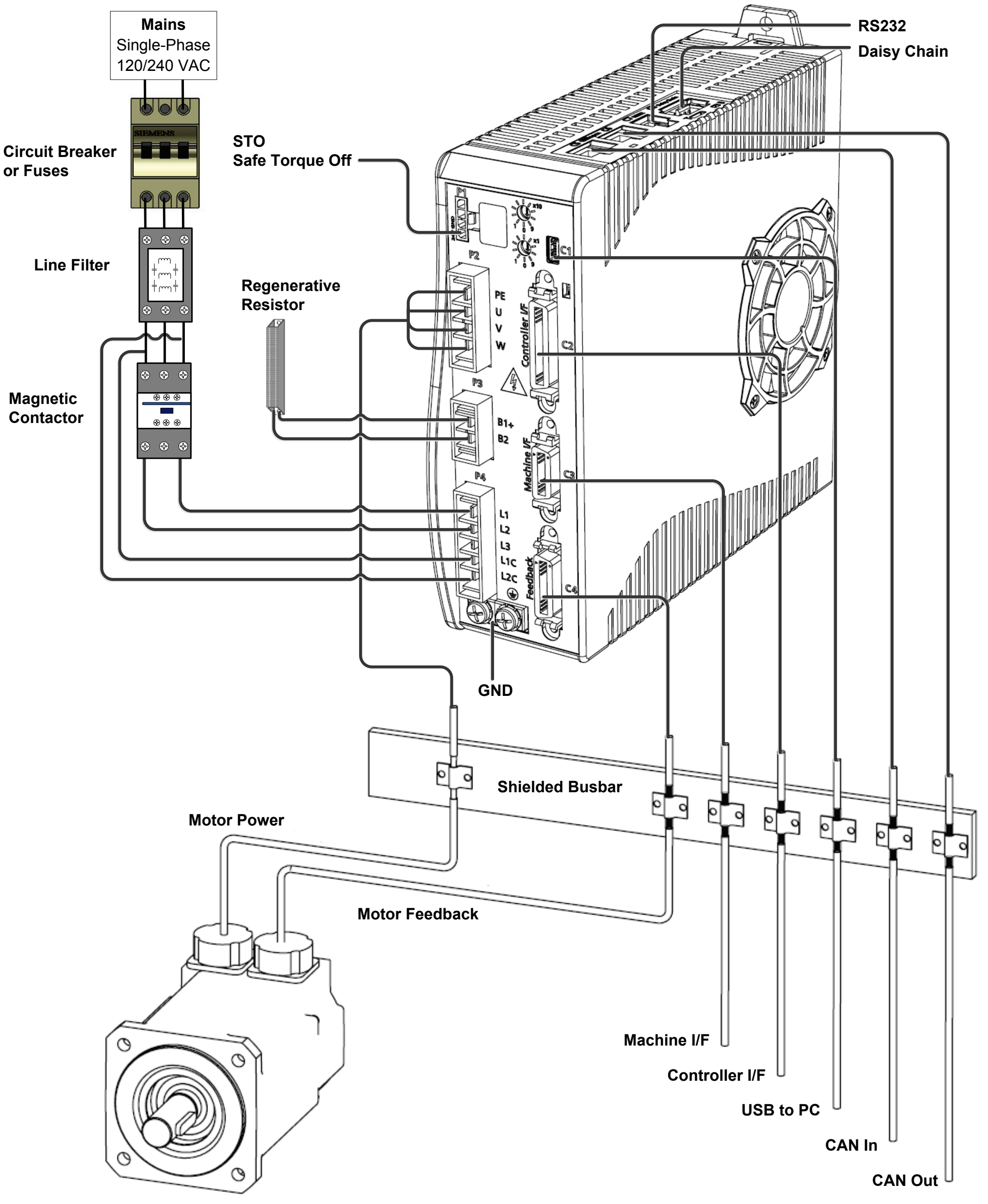


Figure 3-2. FLEXI PRO Shielding and Bonding

3.3.4 Input Power Filtering

The FLEXI PRO electronic system components require EMI filtering in the input power leads to meet the CE/EMC requirements for the industrial environment. This filtering blocks conducted type emissions from exiting onto the power lines and provides a barrier for EMI on the power lines.

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- or three-phase. One input line filter can be used for multi-axis control applications.

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 connection. All ground connections must be tied 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.

3.3.5 Motor Line Filtering

Motor line filtering using ferrite cores might be necessary for CE compliance of FLEXI PRO systems. This additional filtering can increase the reliability of the system. Poor non-metallic enclosure surfaces and lengthy, unbonded (or unshielded) motor cables that couple noise line-to-line (differential) are just some of the factors that lead to the necessity of motor lead filtering.

Motor lead noise may be either common-mode or differential. The common-mode conducted currents occur between each motor lead and ground (line-to-ground). Differential radiated currents exist from one motor lead to another (line-to-line). The filtering of the lines feeding the motor provides additional attenuation of noise currents that enter surrounding cables and equipment I/O ports in close proximity.

3.3.6 I/O Signal Filtering

I/O filtering may be desirable (depending on system installation, application, and integration with other equipment). To avoid unwanted signals entering and disturbing the drive system or other associated equipment, place ferrite cores on I/O lines.

3.3.7 Additional EMI Suppression Recommendations

Route power and control cables 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 90°.

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 full 360° of the shields. No portion of the cabling should be unshielded. Never divide a cable across a terminal strip.

For differential inputs for analog signals, use twisted-pair, shielded signal lines, connecting shields on both ends.

3.4 Electrical System Considerations

3.4.1 Fusing

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes, so fusing is required.

- **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 0 to 30A, class J, 3 poles: CH30J3
  - Ferraz: Ultrasafe fuse holders, fuse size 0 to 30A, class J, 3 poles: US3J3I

3.4.2 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 than10 mm² be used. Use the PE terminal and the PE connection screws to meet this requirement.

3.4.3 Residual Current Protective Device (RCD)

In compliance with standards IEC 60364-4-41 Regulations for Installation and IEC 60204 Electrical Equipment of Machinery, residual current protective devices (RCD) can be used provided the requisite regulations are met.

RCDs which are sensitive to all currents must be used in order to detect any DC fault current.

To protect against direct contact (with motor cables shorter than 5 m), it is recommended that each drive be protected individually using a 30 mA RCD, which is sensitive to all currents.

3.5 Mechanical Installation

3.5.1 Mounting the FLEXI PRO

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

For mounting dimensions, refer to Figure 2-3.

3.5.2 Mounting Multiple Units

When multiple FLEXI PRO units are mounted side-by-side within a cabinet or enclosure, the recommended spacing is 10 mm. When mounting units top-to-bottom, the recommended spacing is 50 mm for all models.

It is important to maintain an ambient temperature within the enclosure that does not exceed 45°C. If FLEXI PRO units are mounted on a backplane, also make sure the backplane temperature does not exceed 45°C .

3.6 Control Board Connections

The control board has the same interfaces on all FLEXI PRO models:

- USB Communication – C1 (*Exception*: AP models do not have a USB port.)
- Controller I/Os – C2
- Machine I/Os – C3
- Motor Feedback – C4
- Fieldbus Devices (optional) – C5 and C6
- RS232 Communication – C7
- Daisy Chain – C8
- Drive Address Rotary Switches

The connectors for interfaces C2, C3 and C4 can be fastened by either latch or screw. The FLEXI PRO has 4/40 insert threads on these interfaces.

3.6.1 Controller I/Os

Controller I/Os are connected through interface **C2** on all FLEXI PRO models.

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

Unused pins must remain unwired.

To preserve isolation of the digital I/Os, connect a 24 VDC source to pin 19. Connect the return of the 24 VDC supply to pin 1, which functions as the ground path for the outputs.

Note: **AP/AF Models:** The 24 VDC supply and return can be connected on either the Controller interface (C2) or the Machine interface (C3), but it is not necessary to connect it on both.

Notes: EC/PN Models:

- Common output on the Controller interface (C2) and the Machine interface (C3) are connected internally.
- Common input on the Controller interface (C2) and the Machine interface (C3) are connected internally.
- User can connect outputs as source or sink.
- User can connect inputs as source or sink.
- Refer to the Controller Interface Wiring schematic diagram for **EC/PN Models** in the section *Controller Interface Wiring*, and the FLEXI PRO System Wiring – Pin Assignments diagram for **EC/PN Models** in the section *System Wiring and Pin Assignments.*

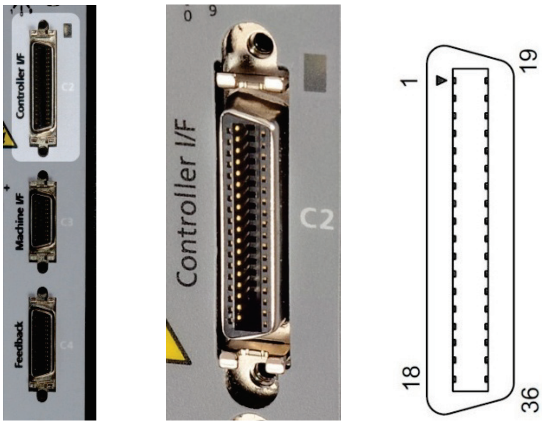


Figure 3-3. Controller I/O Interface

Refer to the controller interface wiring diagram in Figure 2-21.

Table 3-2. Controller I/O Interface

Pin	Function	Description	Pin	Function	Description
1	24 VDC return	AP/AF Models: Return of the user-supplied 24 VDC	19	24 VDC	AP/AF Models: User supplied 24V, for I/O biasing
	Common output	EC/PN Models		Common input	EC/PN Models
2	Digital output 1	Opto-isolated programmable digital output. Read using OUT1	20	Digital input 2	Opto-isolated programmable digital input. Read using IN2
3	Digital input 1	Opto-isolated programmable digital input. Read using IN1	21		
4	Equivalent encoder output A-	Low side of the equivalent encoder output signal A (RS422)	22	Equivalent encoder output A+	High side of the equivalent encoder output signal A (RS422)
5	Equivalent encoder output B-	Low side of the equivalent encoder output signal B (RS422)	23	Equivalent encoder output B+	High side of the equivalent encoder output signal B (RS422)
6	Equivalent encoder output Z-	Low side of the equivalent encoder output index (RS422)	24	Equivalent encoder output Z+	High side of the equivalent encoder output index (RS422)
7		Reserved for future use	25	Ground	Digital ground
8	Analog input 1+	High side of the differential analog command input (±10 VDC)	26	Analog input 1-	Low side of the differential analog command input (±10 VDC)
9	Direction input+	High side of the direction signal (RS422), or High side of the down count signal	27	Direction input-	Low side of the direction signal (RS422), or Low side of the down count signal
	Secondary encoder B+	High side of the Secondary encoder input signal B (RS422)		Secondary encoder B-	Low side of the secondary encoder input signal B (RS422)
10	Ground	Digital ground	28	Pulse input+	High side of the pulse signal (RS422), or High side of the master encoder signal A, or High side of the up count signal
				Secondary encoder A+	High side of the secondary encoder input signal A (RS422)
11	Pulse input-	Low side of the pulse signal (RS422), or Low side of the master encoder signal A, or Low side of the up count signal	29	Ground	Digital ground
	Secondary encoder A-	Low side of the secondary encoder input signal A (RS422)			
12			30		
13	Ground	Digital ground	31	Digital input 3	Opto-isolated programmable digital input. Read using IN3
14	Digital input 4	Opto-isolated programmable digital input. Read using IN4	32	Digital input 5	Fast opto-isolated programmable digital input. Read using IN5
15	Digital input 6	Fast opto-isolated programmable digital input. Read using IN6	33	Digital output 2	Opto-isolated programmable digital output. Read using OUT2
16	Digital output 3	Fast opto-isolated programmable digital output. Read using OUT3	34		
17			35*	Analog input 2-	Low side of the second differential analog input (±10 VDC)
18*	Analog input 2+	High side of the second differential analog input (±10 VDC)	36	Analog output	Analog output, referenced to digital ground (0-10 VDC)

** Optional, see ordering information*

3.6.2 Machine I/Os

Machine I/Os are connected through interface **C3** on all FLEXI PRO models.

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

Unused pins must remain unwired.

To preserve isolation of the digital I/Os, connect a 24 VDC source to pin 9. Connect the return of the 24 VDC supply to pin 19, which functions as the ground path for the outputs.

Note: **AP/AF Models:** The 24 VDC supply and return can be connected on either the Controller interface (C2) or the Machine interface (C3), but it is not necessary to connect it to both.

Notes: **EC/PN Models:**

- Common output on the Controller interface (C2) and the Machine interface (C3) are connected internally.
- Common input on the Controller interface (C2) and the Machine interface (C3) are connected internally.
- User can connect outputs as source or sink.
- User can connect inputs as source or sink.
- Refer to the Machine Interface Wiring schematic diagram for **EC/PN Models** in the section *Machine Interface Wiring*, and the FLEXI PRO System Wiring – Pin Assignments diagram for **EC/PN Models** in the section *System Wiring and Pin Assignments*.

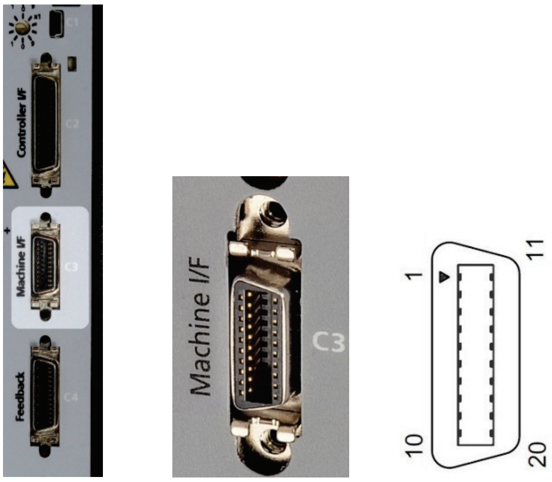


Figure 3-4. Machine I/O Interface

Refer to the machine interface wiring diagram in Figure 2-23.

Table 3-3. Machine I/O Interface

Pin	Function	Description	Pin	Function	Description
1	Secondary encoder A+	High side of the secondary encoder input signal A (RS422)	11	Secondary encoder A-	Low side of the secondary encoder input signal A (RS422)
	Pulse input+	High side of the pulse signal		Pulse input-	Low side of the pulse signal
2	Secondary encoder B+	High side of the Secondary encoder input signal B (RS422)	12	Secondary encoder B-	Low side of the secondary encoder input signal B (RS422)
	Direction input+	High side of the direction signal		Direction input-	Low side of the direction signal
3	Secondary encoder Z+	High side of the secondary encoder input index (RS422)	13	Secondary encoder Z-	Low side of the secondary encoder input index (RS422)
4	Secondary encoder 5V	5 VDC supply for the secondary encoder	14	Secondary encoder ground	Ground of the 5 VDC supply for the secondary encoder.
5	Digital input 7	Opto-isolated programmable digital input. Read using IN7	15	Digital input 8	Opto-isolated programmable digital input. Read using IN8
6	Digital input 9	Opto-isolated programmable digital input. Read using IN9	16	Digital input 10	Opto-isolated programmable digital input. Read using IN10
7	Digital input 11	Fast opto-isolated programmable digital input. Read using IN11	17	Digital output 4	Opto-isolated programmable digital output. Read using OUT4
8	Digital output 5	Opto-isolated programmable digital output. Read using OUT5	18	Digital output 6	Fast opto-isolated programmable digital output. Read using OUT6
9	24 VDC	AP/AF Models: User supplied 24V, for I/O biasing	19	24 VDC return	AP/AF Models: Return of the user-supplied 24 VDC
	Common output	EC/PN Models		Common input	EC/PN Models
10	Fault relay 1	Terminal 1 of the dry contact fault relay	20	Fault relay 2	Terminal 2 of the dry contact fault relay

3.6.3 Motor Feedback

Motor Feedback uses interface **C4** on all FLEXI PRO models.

Wire the motor feedback interface according to the type of feedback device to be used in your application. Refer to the guidelines following the pinout table below.

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

Pin 25 for the motor temperature sensor is connected internally in the drive to FLEXI PRO ground.

Unused pins must remain unwired.

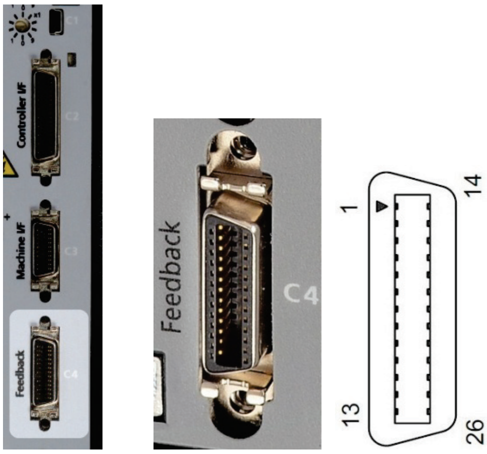


Figure 3-5. Motor Feedback Interface

Table 3-4. Motor Feedback Interface

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	**AF/EC/PN Models:** 8V supply
6	Resolver sine +	19	Resolver sine -
7	Resolver cosine +	20	Resolver cosine -
8	Resolver reference +	21	Resolver reference -
9	Sine encoder sine +	22	Sine encoder sine -
10	Sine encoder cosine +	23	Sine encoder cosine -
11	5V supply	24	Ground (5V/8V return)
12	Motor temperature sensor	25	Motor temperature sensor
13	5V supply	26	Shield

Feedback Wiring Guidelines

The following tables present the most common feedback variations. If your motor feedback does not match any one of the following, contact technical support.

The tables present the wiring pin layout. Use the **User Motor Pin#** column in these tables to record the pin numbers of your specific motor for future reference.

Use the FLEXI SUITE **Motor Setup** procedure and the **Feedback** screens to define motor feedback type, resolution, and other parameters. Refer to the sections *Motor Setup Wizard* and *Feedback*.

Table 3-5. Feedback Wiring – Resolver

Pin #	Twisted Pair	User Motor Pin#	Signal Description
6	Twisted Pair		Resolver Sine +
19			Resolver Sine -
7	Twisted Pair		Resolver Cosine +
20			Resolver Cosine -
8	Twisted Pair		Resolver Reference +
21			Resolver Reference -
12	Twisted Pair		Motor Temperature Sensor
25			Motor Temperature Sensor
24	Ground		Optional: Internal shield of each twisted pair (sine, cosine, reference)
26			Cable Shield

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

Table 3-6. Feedback Wiring – Incremental Encoder A Quad B, Index Pulse and Halls

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Incremental Encoder A+
14			Incremental Encoder A-
2	Twisted Pair		Incremental Encoder B+
15			Incremental Encoder B-
3	Twisted Pair		Incremental Encoder Z+
16			Incremental Encoder Z-
4			Hall U
17			Hall V
5			Hall W
12	Twisted Pair		Motor Temperature Sensor
25			Motor Temperature Sensor
11			+5 VDC
24			0 VDC
26			Shield

Notes: Halls are single-ended signals. If you want to use differential Hall signals, refer to the relevant wiring tables.

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

Table 3-7. Feedback Wiring – Single-Ended Halls

Pin #	Twisted Pair	User Motor Pin#	Signal Description
4			Hall U
17			Hall V
5			Hall W
11			+5 VDC
24			0 VDC
26			Shield

Notes: Halls are single-ended signals. If you want to use differential Hall signals, refer to the relevant wiring tables.

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

Table 3-8. Feedback Wiring – Incremental Encoder A Quad B, Index Pulse and Differential Halls

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Incremental Encoder A+
14			Incremental Encoder A-
2	Twisted Pair		Incremental Encoder B+
15			Incremental Encoder B-
9			Hall U+
22			Hall U-
10			Hall V+
23			Hall V-
3			Hall W+
16			Hall W-
12	Twisted Pair		Motor Temperature Sensor
25			Motor Temperature Sensor
11			+5 VDC
24			0 VDC
26			Shield

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

To use differential Halls with A quad B and index, connect the Halls to the Machine interface as follows:
Hall U+ to Machine I/F pin 1, Hall U- to Machine I/F pin 11.
Hall V+ to Machine I/F pin 2, Hall V- to Machine I/F pin 12.
Hall W+ to Machine I/F pin 3, Hall W- to Machine I/F pin 13.
Connect the encoder A, B, I, and power supply to the Motor Feedback connector.

Table 3-9. Feedback Wiring –Differential Halls Only

Pin #	Twisted Pair	User Motor Pin#	Signal Description
9			Hall U+
22			Hall U-
10			Hall V+
23			Hall V-
3			Hall W+
16			Hall W-
12	Twisted Pair		Motor Temperature Sensor
25			Motor Temperature Sensor
11			+5 VDC
24			0 VDC
26			Shield

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

Table 3-10. Feedback Wiring – Incremental Tamagawa

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Incremental Encoder A+ / Hall U+
14			Incremental Encoder A- / Hall U-
2	Twisted Pair		Incremental Encoder B+ / Hall V+
15			Incremental Encoder B- / Hall V-
3	Twisted Pair		Incremental Encoder Z+ / Hall W+
16			Incremental Encoder Z- / Hall W-
11			+5 VDC
24			0 VDC
26			Shield

Notes: Incremental encoders with Hall sensors and index pulse.
A, B and Z signals use the same wiring as Hall sensors U, V, and W.
On power up, feedback briefly sends Hall readings, and then continuously sends the A, B and Z signals.

If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-11. Feedback Wiring – Sine Encoder

Pin #	Twisted Pair	User Motor Pin#	Signal Description
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
11			+5VDC
24			0VDC
26			Shield

Notes: On every power up, the phase find procedure must be executed.

If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-12. Feedback Wiring – Sine Encoder with Halls

Pin #	Twisted Pair	User Motor Pin#	Signal Description
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
4			Hall U
17			Hall V
5			Hall W
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-13. Feedback Wiring – Sine Encoder with Index

Pin #	Twisted Pair	User Motor Pin#	Signal Description
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
3	Twisted Pair		Sine Encoder Z+
16			Sine Encoder Z-
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-14. Feedback Wiring – Sine Encoder with Index and Halls

Pin #	Twisted Pair	User Motor Pin#	Signal Description
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
3	Twisted Pair		Sine Encoder Z+
16			Sine Encoder Z-
4			Hall U
17			Hall V
5			Hall W
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-15. Feedback Wiring – Sick 5V (HIPERFACE Protocol and Sine Signal)

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		SSI Data +
14			SSI Data -
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-16. Feedback Wiring – Sick 8V (HIPERFACE Protocol and Sine Signal)

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		SSI Data +
14			SSI Data -
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
18			+8 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-17. Feedback Wiring – HEIDENHAIN (EnDat 2.x Communication Only)

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		SSI Data +
14			SSI Data -
2	Twisted Pair		SSI Clock +
15			SSI Clock -
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Refer to the section *EnDat 2.2 Bidirectional Interface.*

Table 3-18. Feedback Wiring – HEIDENHAIN (EnDat 2.x with Sine/Cosine)

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		SSI Data +
14			SSI Data -
2	Twisted Pair		SSI Clock +
15			SSI Clock -
9	Twisted Pair		Sine Encoder Sine+
22			Sine Encoder Sine-
10	Twisted Pair		Sine Encoder Cosine+
23			Sine Encoder Cosine-
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Refer to the section *EnDat 2.2 Bidirectional Interface.*

Table 3-19. Feedback Wiring – Nikon 17-bit Single Turn

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Serial Data +
14			Serial Data -
11			+5 VDC
24			0 VDC
26			Shield

Note: If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-20. Feedback Wiring – Nikon 17-bit Multiturn

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Serial Data +
14			Serial Data -
11			+5 VDC
24			0 VDC
26			Shield
			Battery Voltage
			Battery Ground

Notes: Encoder backup battery is external to the FLEXI PRO drive. Voltage must be more than 3.6 VDC. The recommended battery is lithium (ER3V: 3.6V, 1000mAh), manufactured by Toshiba Corp.

If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-21. Feedback Wiring – Incremental Tamagawa 17-bit Single Turn

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Serial Data +
14			Serial Data -
11			+5 VDC
24			0 VDC
26			Shield

Notes: A serial digital data encoder. A single-turn absolute encoder transmits absolute position data at 17-bit per revolution (131,072 count per rev).

If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-22. Feedback Wiring – Incremental Tamagawa 17-bit Single Turn

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Serial Data +
14			Serial Data -
11			+5 VDC
24			0 VDC
26			Shield

Notes: A serial digital data encoder. A single-turn absolute encoder transmits absolute position data at 17-bit per revolution (131,072 count per rev).

If the motor has an additional temperature sensor, connect pins 12 and 25.

Table 3-23. Feedback Wiring – Tamagawa 17-bit Multiturn

Pin #	Twisted Pair	User Motor Pin#	Signal Description
1	Twisted Pair		Serial Data +
14			Serial Data -
11			+5 VDC
24			0 VDC
26			Shield
			Battery Voltage
			Battery Ground

Notes: A serial digital data encoder. This is a full absolute encoder with 17-bit per revolution resolution and xx-bit multiturn counting. When the battery is disconnected, it functions as a full absolute encoder that transmits absolute position data at 17-bit per revolution.

Encoder backup battery is external to the FLEXI PRO drive. Voltage must be more than 3.6 VDC. The recommended battery is lithium (ER3V: 3.6V, 1000mAh), manufactured by Toshiba Corp.

If the motor has an additional temperature sensor, connect pins 12 and 25.

3.6.4 Fieldbus Devices (Optional)

CANopen Communication

Notes: A Kvaser interface cable, for example, enables the connection of FLEXI SUITE to a CAN port. See Figure 3-7.

FLEXI SUITE software functionality is limited when connected to a CAN port. For full software functionality, use of a serial RS232 or USB connection is recommended.

Refer to the section *Connecting FLEXI SUITE to a CAN Port.*

1. Be sure the required **EDS file** is installed in the controller. You can download the file from the Motor Power Company website or contact Technical Support.

2. Note the Termination Resistor switch located on the top of the drive next to the daisy chain connector (C8).

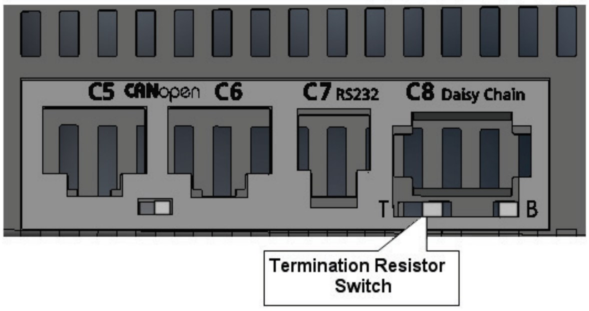


Figure 3-6. CAN Interfaces and Termination Resistor Switch

Using a small screwdriver or similar tool, set the switch to the correct position:

- **Towards T** (default): 120Ω termination resistor not in use.
- **Away from T**: Used when the drive is the last drive in a chain. The drive provides the 120Ω termination resistor between CAN high and CAN low.

3. Using any RJ45 cables:

- Connect the host to the drive on interface **C5**.
- Connect the next node to interface **C6**.

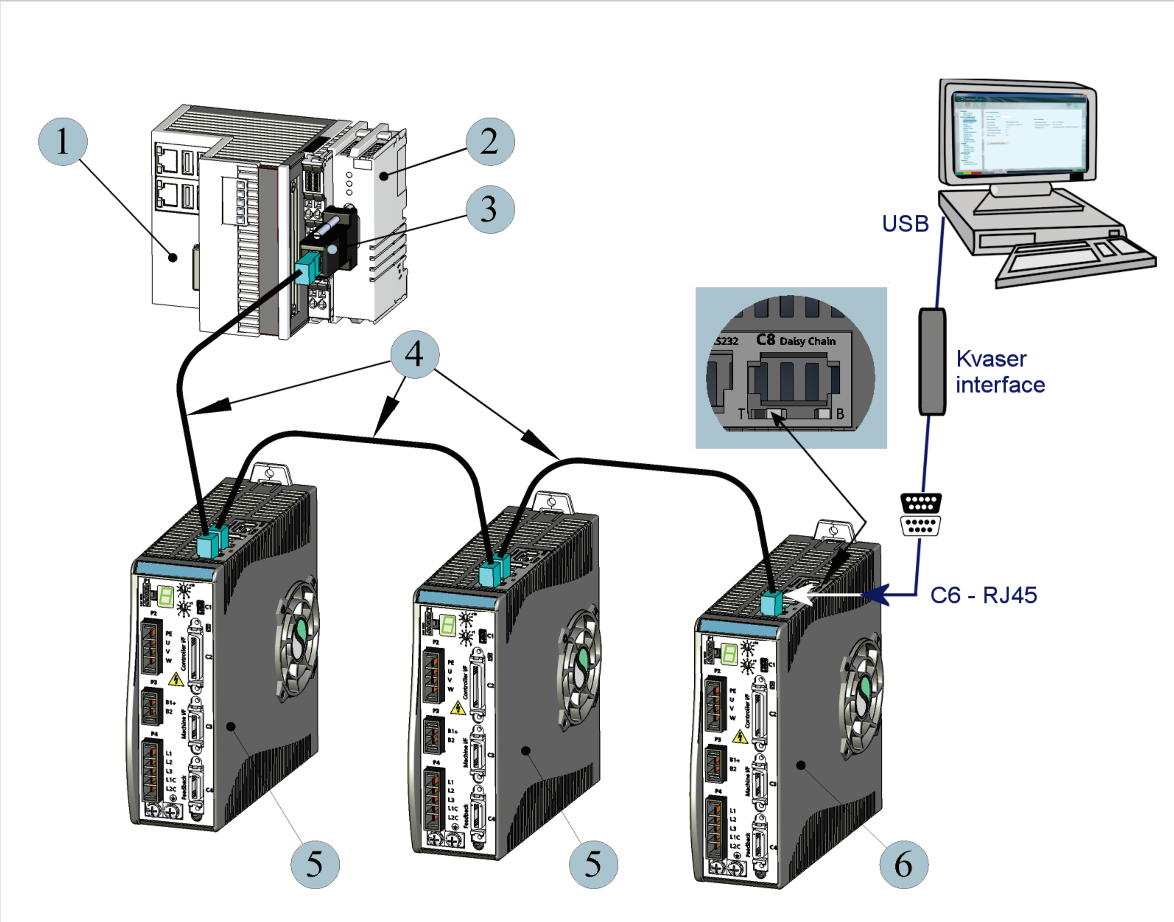


Figure 3-7. CAN Configuration Example – Kvaser Interface

<table>
<tr><td>1</td><td>PLC or embedded PC</td></tr>
<tr><td>2</td><td>CAN bus module</td></tr>
<tr><td>3</td><td>D9 to RJ45 adapter, with following pin assignments
<table>
<tr><th>FLEXI PRO RJ45 Pin</th><th>D9 Connector Pin</th><th>Function</th></tr>
<tr><td>1</td><td>7</td><td>CAN High</td></tr>
<tr><td>2</td><td>2</td><td>CAN Low</td></tr>
<tr><td>3</td><td>3</td><td>Functional Ground</td></tr>
<tr><td>4</td><td>5</td><td>CAN Shield</td></tr>
<tr><td>5</td><td>6</td><td>Functional Ground</td></tr>
</table></td></tr>
<tr><td>4</td><td>RJ45 cables</td></tr>
<tr><td>5</td><td>FLEXI PRO with internal termination set to 0Ω (towards T)</td></tr>
<tr><td>6</td><td>Last FLEXI PRO, with internal terminator set to 120Ω (away from T)</td></tr>
</table>

Note: A 120Ω termination resistor is also required at the beginning of the chain, on either the CAN bus module, or the D9 to RJ45 adapter.

For more information about the D9 to RJ45 adapter, refer to the section *Line Filters*.

For more information about FLEXI PRO implementation of CANopen protocol, refer to the *FLEXI PRO CANopen for CAN and EtherCAT Drives Reference Manual*.

EtherCAT Communication

1. Be sure you have installed the required **XML file**. You can download the file from the Motor Power Company website or contact Technical Support.
2. Using any RJ45 cables:
   - Connect the host to the drive on interface **C5**.
   - Connect the next node to interface **C6**.

Figure 3-8. EtherCAT Interfaces

For more information about FLEXI PRO implementation of CANopen protocol, refer to the *FLEXI PRO CANopen for CAN and EtherCAT Drives Reference Manual*.

3.6.5 Host Computer

On all FLEXI PRO models the drive can be connected to the host computer through either one of the following interfaces:

- **USB port**. The interface is labeled **C1** on all FLEXI PRO models (*Exception*: AP models do not have a USB port.)
  Use a USB 2.0 A to Mini-B cable.

Figure 3-9. USB Port

The first time the drive is connected to the host computer on the USB port, Windows will detect the device and display a **Found New Hardware** wizard. Refer to the section *Power Up*.

- **RS232 port**. The interface is labeled **C7** on all FLEXI PRO models.
  Use a 4p4c plug.

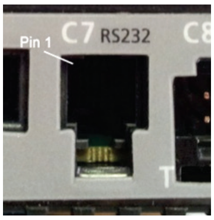


Figure 3-10. RS232 Port

Table 3-24. RS232 Interface

Pin	Pin Label	Function
1	**RX**	Receive
2	**GND ISO**	Ground
3	**TX**	Transmit
4		Unused

3.6.6 Daisy Chain

The FLEXI PRO can be addressed and controlled on a daisy-chained RS-232 line.

In a daisy-chain RS-232 configuration, all drives must be daisy-chained through the **C8** connector. Each drive must have a unique address to enable its identification on the network.

A daisy-chained drive can be assigned an address from 1 to 99 by setting the rotary switches on the drive. When configuring a daisy-chain, address 0 cannot be used.

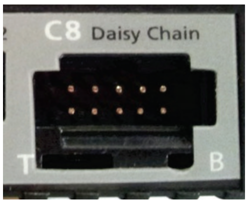


Figure 3-11. Daisy Chain Port

Table 3-25. C8 Daisy Chain Interface

Pin	Function
1	DC Shield
2	Unused
3	RXD
4	GND
5	TXD
6	GND
7-10	Unused

3.6.7 Drive Address

The FLEXI PRO has two 10-position rotary switches, accessible from the front of the unit. The switches are used to set the drive address. When there is more than one drive on a daisy-chain or CANbus network, each drive must have a unique address to enable its identification on the network.

Use the two rotary switches to set the drive address for both CAN and serial communication.

For Ethernet-based motion buses, the switch has no functional use for either the drive or the network. It can be used at the application level to identify specific drives on a network.

Each switch has 10 positions:

- The upper switch positions are set as tens: 10, 20, 30 … 90
- The lower switch positions are set as ones: 0, 1, 2 … 9

Notes: If two or more drives are connected to the network, address 0 cannot be used. Only a singular drive may have the address 0.

Two drives in the same network cannot have the same address.

Figure 3-12. Drive Address Rotary Switches

3.7 Power Board Connections – 120/240 VAC

On most FLEXI PRO 120/240 VAC models, the power board has the following interfaces:

- STO – P1
- Motor – P2 (P4 on FLEXI PRO-020/024)
- Regeneration Resistor – P3 (P5 on FLEXI PRO-020/024)
- AC Input Voltage – P3, P4 (P2, P3 on FLEXI PRO-020/024)

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.

3.7.1 STO

STO uses interface **P1** on all FLEXI PRO 120/240 models.

Warning:

Do not use the STO function until this functionality has been approved.

The STO input is functional but not yet independently certified. Motor Power Company is preparing the final circuit design updates to be submitted for formal (SIL 2) (Pl d) (Cat 2) STO certification. These updates will not change the wiring or functional operation.

Warning:

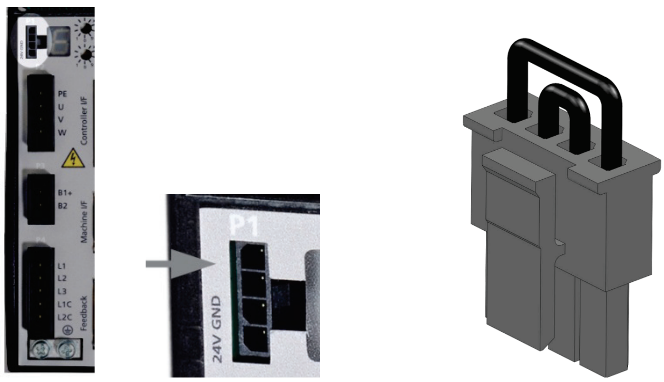
Drives with a suspended load must have an additional mechanical safety block (such as a motor-holding brake). The drive cannot hold the load when STO is active. Serious injury could result if the load is not properly safeguarded.

Safe torque off (STO) is a safety function that prevents the drive from delivering power to the motor, which can generate torque.

STO Enable and STO Return must be connected to enable FLEXI PRO operation. The STO Enable signal voltage must be 24 VDC.

Connect the STO interface.

Note: If the application does not require STO control, jumper pin 4 to pin 1, and pin 3 to pin 2, to bypass the STO.



STO Bypass

Figure 3-13. STO Interface

Table 3-26. STO Interface

Pin	Pin Label	Function
1	**24V**	STO Enable
2	**GND**	STO Return
3		24V Return, provided by the drive for use with emergency stop circuit
4		24V Supply, provided by the drive for use with emergency stop circuit

Table 3-27. STO Interface Mating Connector

Item	All Models
Manufacturer	Molex*
Housing and 4-pin crimp	436450400* and 0430300001*
Spring terminal	Not available
Wired STO	Motor Power Company CONr00000004-AS (supplied)
Wire gauge	26–28 AWG

* Or equivalent.

3.7.2 Motor

Motor uses interface **P2** on all FLEXI PRO 120/240 models.

Exception: **Motor** uses **P4** on FLEXI PRO-020/024.

Connect the motor interface.

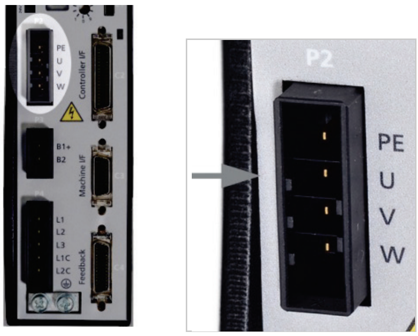


Figure 3-14. Motor Interface (shown here: FLEXI PRO-006)

Table 3-28. Motor Interface

Pin	Pin Label	Function
1	**PE**	Functional Ground (motor housing)
2	**U**	Motor Phase U
3	**V**	Motor Phase V
4	**W**	Motor Phase W

Table 3-29. Motor Interface Mating Connectors

Item	FLEXI PRO-1D5, FLEXI PRO-003
Manufacturer	JST J300
Housing and 4-pin crimp	F32FSS-04V-KX and SF3F-71GF-P2.0
Spring terminal	04JFAT-SBXGF-I (supplied)
Wire gauge	18 AWG

Item	**FLEXI PRO-4D5, FLEXI PRO-006**
Manufacturer	JST J300
Housing and 4-pin crimp	F32FSS-04V-KX and SF3F-71GF-P2.0
Spring terminal	04JFAT-SBXGF-I (supplied)
Wire gauge	16 AWG
Item	**FLEXI PRO-008, FLEXI PRO-010, FLEXI PRO-013**
Manufacturer	JST J400
Housing and 4-pin crimp	J43FSS-04V-KX (supplied) and SJ4F-71GF-M3.0 (supplied)
Spring terminal	Not available
Wire gauge	14 AWG
Item	**FLEXI PRO-020, FLEXI PRO-024**
Manufacturer	Phoenix Contact
Spring terminal	SPC 5/4-STCL-7,62 (1718504) (supplied)
Wire gauge	10-11 AWG

3.7.3 Regeneration Resistor

Regen uses interface **P3** on all FLEXI PRO 120/240 VAC models.

Exception: **Regen** uses **P5** on FLEXI PRO-020/024.

Note: On models FLEXI PRO-1D5 and FLEXI PRO-003, **Regen** and **AC Input Voltage** are combined on one connector.

If the application requires a regeneration (regen) resistor, connect the regen resistor between terminals B1+ and B2.

Figure 3-15. Regen Interface (shown here: FLEXI PRO-006)

Table 3-30. Regen Interface

FLEXI PRO-1D5, FLEXI PRO-003 FLEXI PRO-4D5, FLEXI PRO-006 FLEXI PRO-008, FLEXI PRO-010 FLEXI PRO-013	Pin	Pin Label	Function
P3	1	**B1+**	DC bus +
	2	**B2**	Regen bus -
FLEXI PRO-020, FLEXI PRO-024	**Pin**	**Pin Label**	**Function**
P5	1	**B2**	Regen bus -
	2	**B1+**	DC bus +

Table 3-31. Regen Interface Mating Connectors

Item	FLEXI PRO-4D5, FLEXI PRO-006
Manufacturer	JST J300
Housing and 2-pin crimp	F32FSS-02V-KX (supplied) and SF3F71-GF-P2.0 (supplied)
Spring terminal	Not available
Wire gauge	16 AWG
Item	**FLEXI PRO-008, FLEXI PRO-010, FLEXI PRO-013**
Manufacturer	JST J400
Housing and 2-pin crimp	J42FSC-02V-KX (supplied) and SJ4F-71GF-M3.0 (supplied)
Spring terminal	Not available
Wire gauge	14 AWG
Item	**FLEXI PRO-020, FLEXI PRO-024**
Manufacturer	Phoenix Contact
Spring terminal	SPC 5/2-STCL-7,62 (1718504) (supplied)
Wire gauge	14 AWG

Table 3-32. AC Input Voltage/Regen Interface Mating Connector

Item	FLEXI PRO-1D5, FLEXI PRO-003
Manufacturer	JST J300
Housing and 6-pin crimp	F32FSS-06V-KX and SF3F-71GF-P2.0
Spring terminal	06JFAT-SBXGF-I (supplied)

Wire gauge	18 AWG

3.7.4 AC Input Voltage

The AC Input interfaces and connectors vary among FLEXI PRO 120/240 VAC models.

- FLEXI PRO-1D5 and FLEXI PRO-003: One connector for bus power and logic power uses interface **P3**.
- FLEXI PRO-4D5 and FLEXI PRO-006: One connector for bus power and logic power uses interface **P4**.
- FLEXI PRO-008, CHDH-010 and FLEXI PRO-013: Two connectors – a connector for bus power uses interface **P4**, and another connector for logic power uses interface **P5**.
- FLEXI PRO -020/024: Two connectors – a connector for bus power uses interface **P3**, and another connector for logic power uses interface **P2**.

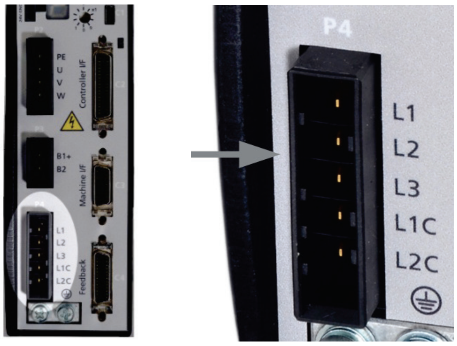


Figure 3-16. AC Input Voltage Interface (shown here: FLEXI PRO-006)

Make the following connections:

1. Connect the AC input voltage ground wire to the PE terminal, located on the FLEXI PRO front panel. Use an M4 ring or spade terminal.

Figure 3-17. Ground Terminals

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

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.

Note: On models FLEXI PRO-1D5 and FLEXI PRO-003, Regen and AC Input Voltage are combined on one connector. Since these models support only single-phase AC, they do not have a L3 terminal for bus power.

Table 3-33. AC Input Voltage Interface

FLEXI PRO-1D5 FLEXI PRO-003	Pin	Pin Label	Function
P3	3	**L1**	AC Phase 1
	4	**L2**	AC Phase 2
	5	**L1C**	Logic AC Phase 1
	6	**LC2**	Logic AC Neutral
FLEXI PRO-4D5 FLEXI PRO-006	**Pin**	**Pin Label**	**Function**
P4	1	**L1**	AC Phase 1
	2	**L2**	AC Phase 2
	3	**L3**	AC Phase 3
	4	**L1C**	Logic AC Phase 1
	5	**LC2**	Logic AC Neutral
FLEXI PRO-008 FLEXI PRO-010 FLEXI PRO-013	**Pin**	**Pin Label**	**Function**
P4	1	**L1**	AC Phase 1
	2	**L2**	AC Phase 2
	3	**L3**	AC Phase 3
P5	1	**L1C**	Logic AC Phase 1
	2	**LC2**	Logic AC Neutral
FLEXI PRO-020 FLEXI PRO-024	**Pin**	**Pin Label**	**Function**
P3	1	**L1**	AC Phase 1
	2	**L2**	AC Phase 2
	3	**L3**	AC Phase 3
P2	1	**L1C**	Logic AC Phase 1
	2	**LC2**	Logic AC Neutral

Table 3-34. AC Input Voltage Interface Mating Connectors

Item	FLEXI PRO-1D5, FLEXI PRO-003
Manufacturer	JST J300
Housing and **6-pin** crimp (includes Regen)	F32FSS-06V-KX and SF3F-71GF-P2.0
Spring terminal	06JFAT-SBXGF-I (supplied)
Wire gauge	18 AWG
Item	**FLEXI PRO-4D5, FLEXI PRO-006**
Manufacturer	JST J300
Housing and **5-pin** crimp	F32FSS-05V-KX and SF3F-71GF-P2.0
Spring terminal	05JFAT-SBXGF-I (supplied)
Wire gauge	16 AWG
Item	**FLEXI PRO-008, FLEXI PRO-010, FLEXI PRO-013**
Manufacturer	JST J300
Housing and **3-pin** crimp	J43FSS-03V-KX (supplied) and SJ4F-71GF-M3.0 (supplied)
Spring terminal	Not available
Wire gauge	14 AWG
Item	**FLEXI PRO-020, FLEXI PRO-024**
Manufacturer	Phoenix Contact
Spring terminal	SPC 5/3-STCL-7,62 (1718494) (supplied)
Wire gauge	12-13 AWG

3.7.5 Brake (Optional)

The FLEXI PRO 120/240 VAC models do not have sufficient amperage to activate a motor brake. The FLEXI PRO can be connected to a motor brake via a relay, as shown in the example below. The selection of power supply, relay and diodes depends on the specification of the actual motor brake used in your application.

In this example, the following specifications are assumed:

- Motor brake is 24V and requires less than 1A.
- Motor brake is connected to FLEXI PRO digital input 1.
- Diodes: D1 and D2 PN 1N4002 (Vr 100 V).
- Relay: 24 V < 50mA
- Relay coil: > 500 Ω

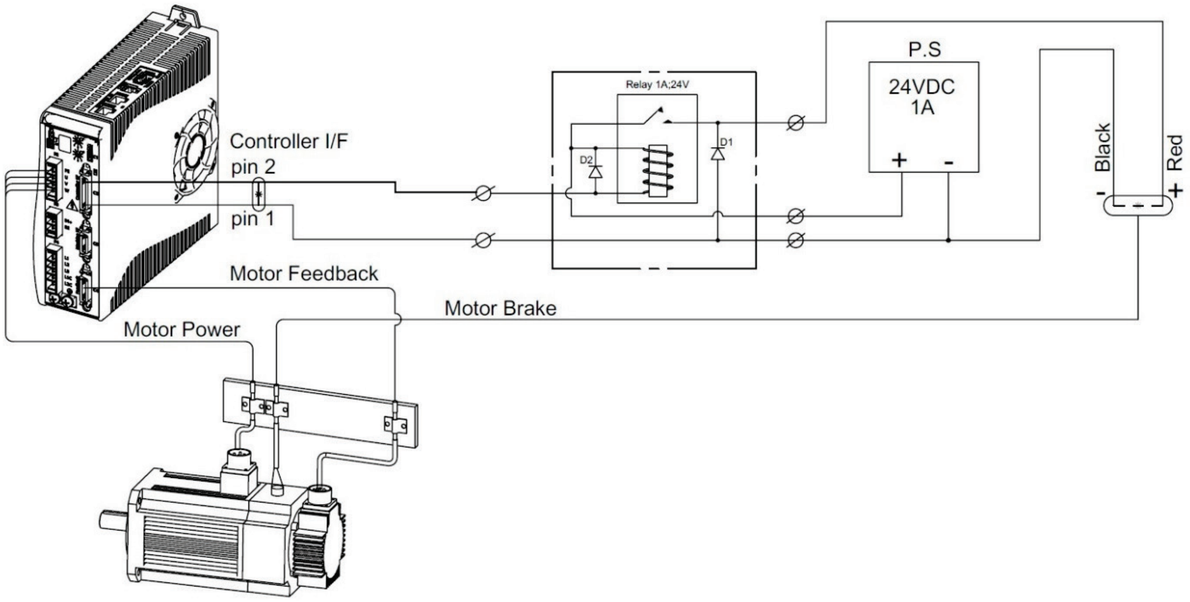


Figure 3-18. Motor Brake Wiring (Example) - FLEXI PRO 120/240 VAC

Controller I/F Pin	Function	Description
1	24 VDC return	AP/AF Models: Return of the user-supplied 24 VDC
2	Digital output 1	Opto-isolated programmable digital output. Read using OUT1

You can connect the relay to other digital output pins on the FLEXI PRO Machine I/F or Controller I/F connector.

Refer to the controller interface wiring diagram (AP/AF Models) in Figure 2-21 and/or the machine interface wiring diagram (AP/AF Models) in Figure 2-23.

In addition, refer to the section *Motor Brake Control.*

3.8 Power Board Connections – 400/480 VAC

On all FLEXI PRO 400/480 VAC models, the power board has the following interfaces:

- STO – P1
- Logic Power 24 VDC – P2
- AC Input and Regeneration – P3
- Brake – P4
- Motor – P5

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.

3.8.1 STO

STO uses interface **P1** on all FLEXI PRO 400/480 VAC models.

Warning:

Do not use the STO function until this functionality has been approved.

The STO input is functional but not yet independently certified. Motor Power Company is preparing the final circuit design updates to be submitted for formal (SIL 2) (Pl d) (Cat 2) STO certification. These updates will not change the wiring or functional operation.

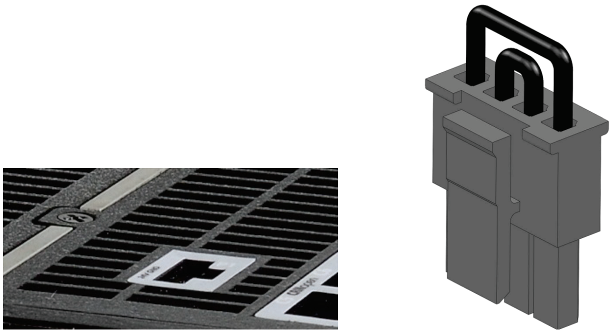
Warning:

Drives with a suspended load must have an additional mechanical safety block (such as a motor-holding brake). The drive cannot hold the load when STO is active. Serious injury could result if the load is not properly safeguarded.

Safe torque off (STO) is a safety function that prevents the drive from delivering power to the motor, which can generate torque.

STO Enable and STO Return must be connected to enable FLEXI PRO operation. The STO Enable signal voltage must be 24 VDC.

Note: If the application does not require STO control, jumper pin 4 to pin 1, and pin 3 to pin 2, to bypass the STO.



STO Bypass

Figure 3-19. STO Interface

Table 3-35. STO Interface

Pin	Pin Label	Function
1	24V	STO Enable
2	GND	24 VDC Return
3		
4		

Table 3-36. STO Interface Mating Connector

Item	All Models
Manufacturer	Molex*
Housing and 4-pin crimp	436450400* and 0430300001*
Spring terminal	Not available
Wired STO	Motor Power Company CONr00000004-AS (supplied)
Wire gauge	26–28 AWG

* Or equivalent.

3.8.2 Logic Power 24V Input

Logic Power 24V uses interface **P2** on all FLEXI PRO 400/480 VAC models.

This interface is used to connect an external power supply (24V 3.15A max.) that provides the logic voltage to the control board and to the motor brake circuit.

Figure 3-20. Logic Power 24V Input Interface

Table 3-37. Logic Power 24V Input Interface

Pin	Pin Label	Function
1	24V	Logic In
2	GND	24 VDC Return

Table 3-38. Logic Power 24V Input Interface Mating Connector

Item	All Models
Manufacturer	Molex
Housing and 2-pin crimp	436450200 (supplied) and 0430300001 (supplied)
Spring terminal	Not available
Wired STO	Motor Power Company CONr00000004-AS (supplied)
Wire gauge	26–28 AWG

3.8.3 AC Input and Regeneration Resistor

AC Input and **Regen Resistor** use interface **P3** on all FLEXI PRO 400/480 VAC model.

1. Connect the AC input voltage ground wire to the PE terminal, located on the FLEXI PRO front panel. Use an M4 ring or spade terminal.

Figure 3-21. Functional Ground – PE Terminal

2. Connect L1, L2 and L3 for the AC power input.
3. If the application requires a regeneration (regen) resistor, connect the regen resistor between terminals B1+ and B2.

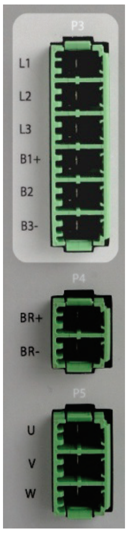


Figure 3-22. AC Input and Regeneration Resistor Interface

Table 3-39. AC Input and Regeneration Resistor Interface

Pin	Pin Label	Function
1	L1	AC Phase 1
2	L2	AC Phase 2
3	L3	AC Phase 3
4	B1+	DC Bus +
5	B2	Regen Bus
6	B3-	DC Bus -

Table 3-40. AC Input and Regeneration Resistor Interface Mating Connector

Item	All Models
Manufacturer	Phoenix Contact
Housing and 6-pin crimp	SPC 5/6-STCL-7,62 (1718520) (supplied)
Spring terminal	Not available
Wire gauge	12-14 AWG

Connecting an External Regeneration Resistor

The FLEXI PRO 400/480 VAC has an internal resistor capacity of 300W. For applications in which regeneration power is expected to be greater than 300W, an external regeneration resistor is required.

Disconnect the internal regeneration resistor wires from connector P3 (B1+ and B2). Then, connect your own external resistor to B1+ and B2, as shown in Figure 3-23.

Recommended external regeneration resistors are listed in the section *Regeneration Resistors*.

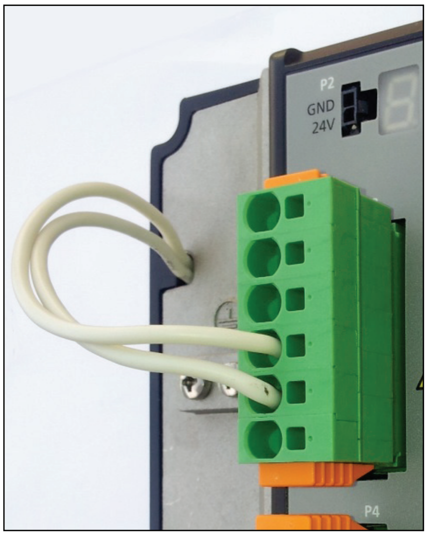


Figure 3-23. External Regeneration Resistor Wiring

3.8.4 Brake

Brake uses interface **P4** on all FLEXI PRO 400/480 VAC models.

This is the power output for the electric motor brake system.

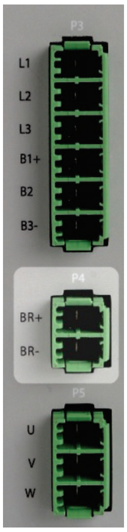


Figure 3-24. Brake Interface

Table 3-41. Brake Interface

Pin	Pin Label	Function
1	BR+	Motor Brake +
2	BR-	Motor Brake -

Table 3-42. Brake Interface Mating Connector

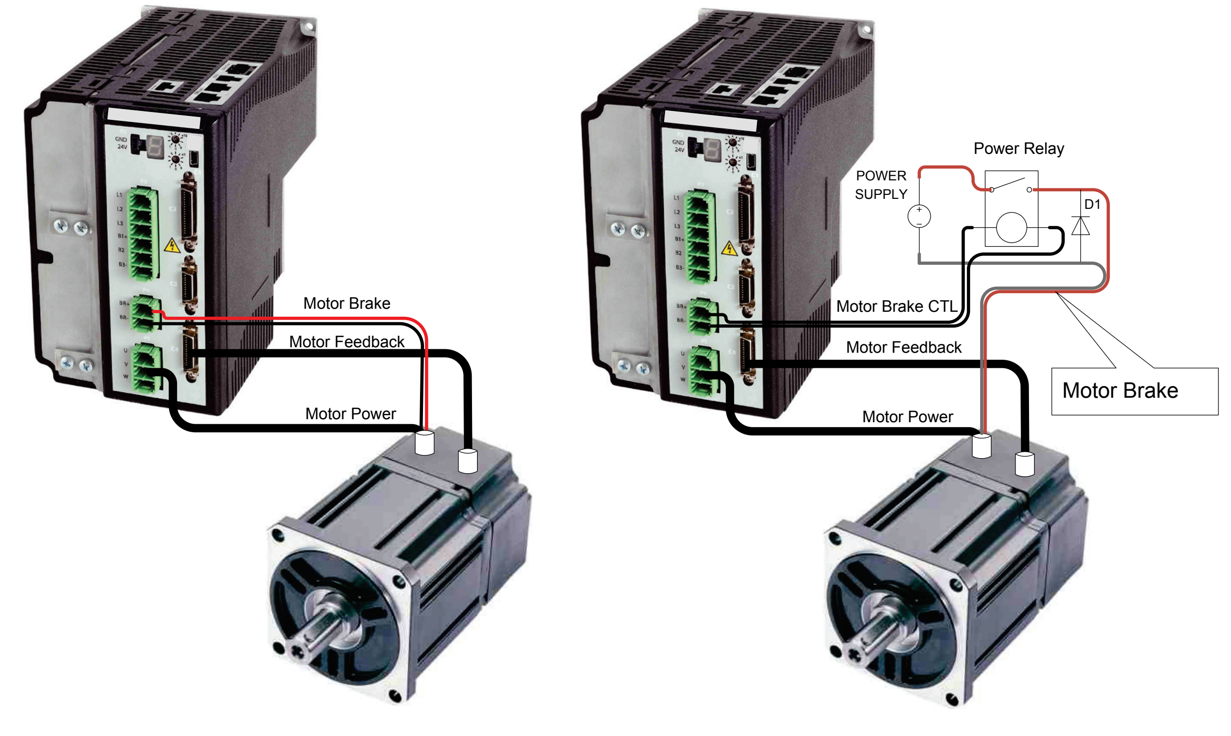
Item	All Models
Manufacturer	Phoenix Contact
Housing and 2-pin crimp	SPC 5/2-STCL-7,62 (1718481) (supplied)
Spring terminal	Not available
Wire gauge	14-17 AWG

Motor brake wiring examples are shown in Figure 3-18.

Schematic A shows wiring for a motor brake that requires 24 VDC and less than 1A.

Schematic B shows wiring with an external relay, which is required for a motor brake that requires more than 1A. It also indicates how to connect a high current brake device with an external power supply.

- D1 (freewheel diode): Should be selected in accordance with the motor brake coil parameters; fast diodes, such as UF1005/ MUR160 or similar, are generally recommended for this type of application.
- Power relay coil: 24 VDC, holding current <1A



Schematic **A** Schematic **B**

Figure 3-25. Motor Brake Wiring (Examples) - FLEXI PRO 400/480 VAC

Refer to the section *Motor Brake Control.*

3.8.5 Motor

Motor uses interface **P5** on all 400/480 VAC models:

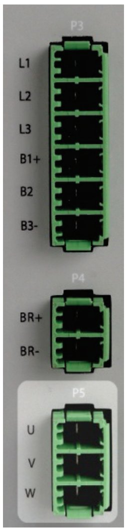


Figure 3-26. Motor Interface

Table 3-43. Motor Interface

Pin	Pin Label	Function
1	U	Motor Phase U
2	V	Motor Phase V
3	W	Motor Phase W

Table 3-44. Motor Interface Mating Connector

Item	All Models
Manufacturer	Phoenix Contact
Housing and 3-pin crimp	SPC 5/3-STCL-7,62 (1718494) (supplied)
Spring terminal	Not available
Wire gauge	12-14 AWG

3.9 Software Installation

1. Install FLEXI SUITE software on the host computer.
2. When installation is complete, start FLEXI SUITE from the Windows Start menu or the shortcut on your desktop.

3.10 Power Up

1. After completing the hardware connections, 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.

2. The first time the drive is connected to the host computer on the USB port, Windows detects the device and displays a **Found New Hardware** wizard.

   Browse to and select the **Drivers** folder. The path will vary, depending on the computer's operating system and the location selected for software installation; for example:

   - \Program Files (x86)\Motor Power Company\FLEXI SUITE\Drivers
   - \Program Files\Motor Power Company\FLEXI SUITE\Drivers

   The wizard will automatically select and install the driver file.

3. Look at the 7-segment display on the FLEXI PRO front panel.

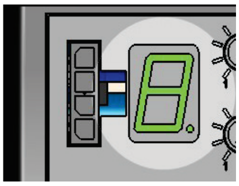
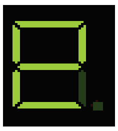


Figure 3-27. 7-Segment LED Status Display

Upon initial power up, the status display shows a flashing **e,** indicating a Parameter Memory Checksum Failure.



This fault will be cleared once the drive is configured and the parameters are saved in the drive's non-volatile memory.

The digital display provides various indications of drive operation, such as operation modes, drive enable status, and fault conditions.

For more information, refer to the section *Drive Status 7-Segment Display*.

4 FLEXI SUITE Software

4.1 Software Overview

FLEXI SUITE is a graphic user interface (GUI) provided with the FLEXI PRO to enable setup, configuration and tuning of the drive.

FLEXI SUITE allows you to program the drive parameters specifically for the motor to which the FLEXI PRO is connected, and for the particular operation that the drive will be performing in the machine.

Note: For proper graphic display of FLEXI SUITE:

- Recommended screen resolution is 1280x800. Minimal resolution is 1024x768.
- Windows 7 **Display** settings must set to **Smaller – 100% (Default)**.

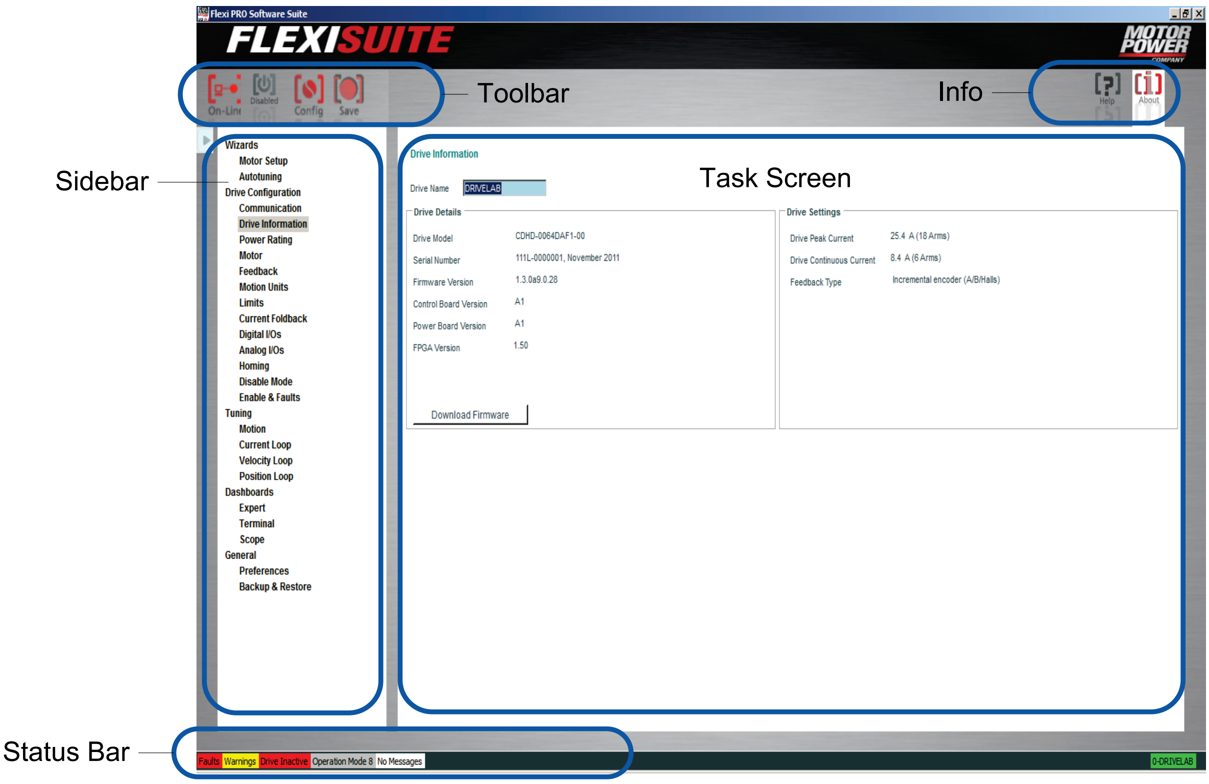


Figure 4-1. FLEXI SUITE Software

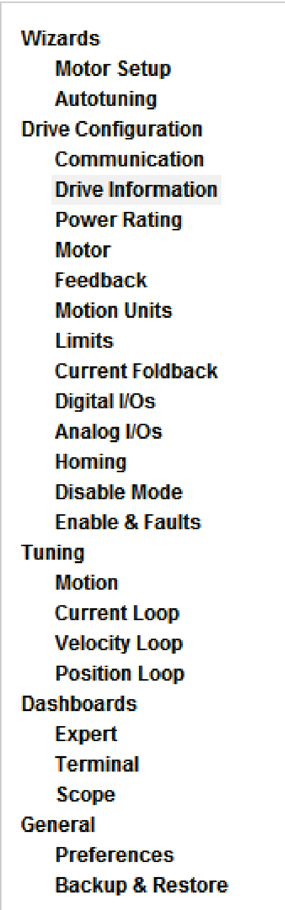
FLEXI SUITE provides two primary ways for setting up the FLEXI PRO servo drive.

- Using the Motor Setup Wizard, which takes you step-by-step through the basic configuration process. The Autotuning Wizard can be used after the basic configuration is completed, to tune the HD control loop.
- Using each setup screen individually, to access and define specific drive functions.

4.1.1 Interface Elements

The FLEXI SUITE application has four function areas:

Toolbar	Contains quick access buttons for frequently used functions.  **Offline|Online** – Toggles FLEXI SUITE between online and offline states, and indicates the state of the connection. Refer to the section *Online and Offline*. **Enable|Disable** – Enables and disables the drive, and indicates the state of the drive. Refer to the section *Enabling the Drive*. Refer also to VarCom EN and VarCom K. **Configuration** – Triggers the internal drive configuration. The CONFIG command is required after certain variables are modified. Refer to VarCom CONFIG. When the 7-digit display shows **-1**, CONFIG is required. **Save** – Saves the parameters currently in the drive RAM to non-volatile memory. It is recommended to use **Save** after configuring parameters to keep values in non-volatile memory. Refer to the section *Managing Parameters*.
	 **Help** – Online help for FLEXI SUITE software. Also includes help for FLEXI PRO hardware and VarCom. In addition, use **F1** or the right-click shortcut menu to activate Help for the currently selected field. **About** – Software version information.

Sidebar	Contains a navigation menu to the various FLEXI SUITE screens. 
	The sidebar can be hidden or displayed using the Arrow button.
Task Screen	Displays various interactive screens for viewing, setting and testing parameters and drive configurations. These screens are described in detail in other sections throughout this manual.
Status Bar	 Displays the status of the drive. ■ **Faults.** This segment of the status bar is **green** as long as no faults exist; it is **red** whenever a fault exists. Click **Faults** to open the Enable & Faults screen. Right-click to clear faults. ■ **Warnings**. This segment of the status bar is **green** as long as no warnings exist; it is **yellow** whenever a warning exists. Click **Warnings** to open the Enable & Faults screen. Right-click to clear faults. ■ **Drive Status**. This segment of the status bar is green when the drive is enabled (active); it is red when the drive is disabled (inactive). Click to open the Enable & Faults screen. Right-click **Drive Active** to disable drive. ■ **Operation Mode**. This segment is gray. It indicates the currently defined operation mode. Right-click to select and change the operation mode.

	■ **Messages**. Notifications from FLEXI SUITE that do not require immediate attention. They are saved and displayed upon request; you can continue normal work without viewing them. Click **New Messages** to see the full text. Right-click **New Messages** to delete all messages in the log. For more information about warnings and faults, refer to the chapter *Troubleshooting.*

4.1.2 Help Shortcut

Right-click on any field, button or menu item in FLEXI SUITE opens a Help shortcut menu. The shortcut menu provides access to the most common functions associated with the selected element, depending on context.

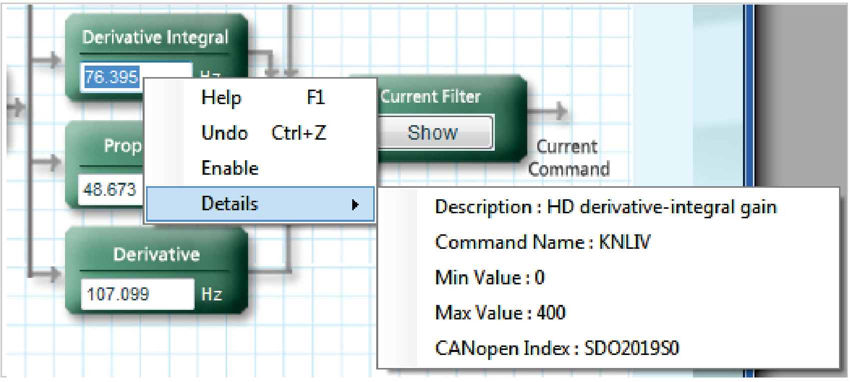
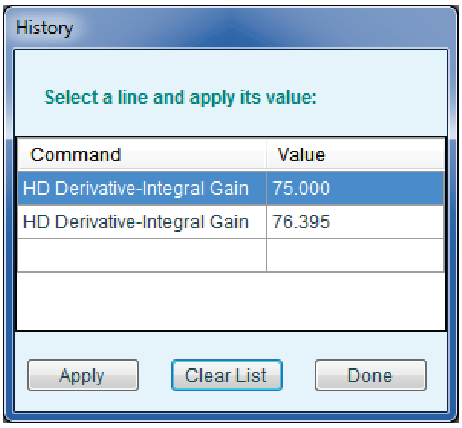
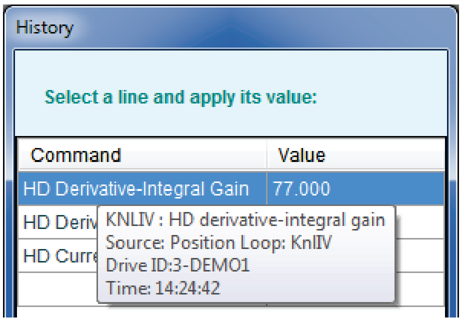


Figure 4-2. Right-Click Help Shortcuts

Help	**F1 –** Activates online help for the currently selected screen element.
Enable | Kill	Toggles the Enable/Disable state of the drive.
Undo	**Ctrl+Z –** Opens a History dialog box, which shows all parameters whose values you have changed manually in the current working session. To reapply a previously used value, select the parameter command line, and click **Apply** to restore the parameter value and send it to the drive. 

<table>
<tr><td></td><td>Hover over a parameter name for additional information, such as the time the value was changed and the drive to which it was applied.
When working with more than one drive, be sure to note to which drive the parameter value was applied. A value can be reapplied to a drive, or sent to a different drive.

</td></tr>
<tr><td>Config</td><td>Displayed when the drive requires configuration. Sends a configuration command (CONFIG) command to the drive.</td></tr>
<tr><td>Clear Faults</td><td>Displayed when faults exist. Sends a clear faults command (CLEARFAULTS) to the drive.</td></tr>
<tr><td>Details</td><td>Description – A brief description of the parameter.
Command Name – The VarCom equivalent.
Min/Max Value – Indicates the minimum and maximum values allowed for the parameter.
CANopen Index – The comparable CANopen object.</td></tr>
</table>

4.1.3 Schematic Diagrams

FLEXI SUITE uses schematic diagrams in many of the configuration and tuning screens to help you visualize and correctly set values for required parameters.

Hover over a parameter field to view its description and VarCom equivalent.

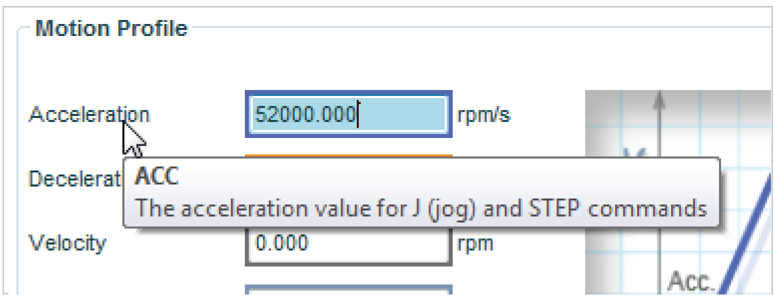


Figure 4-3. Tooltip

Some of the fields in these screens are read-only. Their values are entered automatically according to the motor defined in the Motor screen and/or settings defined elsewhere in the software.

Other fields in these schematic screen are configurable (read/write). After entering or modifying a value, press **Enter** to send the value to the drive. For more information about working with configurable fields, refer to the section *Parameter Values*.

4.1.4 Parameter Values

Throughout FLEXI SUITE, you will work with fields containing configurable (read/write) drive parameters.

Whenever you begin entering a parameter value, the field turns blue.

Once you press **Enter**, the value in the field is sent to drive.

- If the value entered is valid, the field reverts to white.

  The displayed format of the value might be slightly different than what you entered; for example, if you enter 10, the drive might return 10.00.

- If the value entered is invalid, the last valid value is displayed.

Fields that are gray are read-only. Their values cannot be modified.

4.2 Wizards

FLEXI SUITE includes three wizards, or interactive utilities, that guide you through complex tasks.

- **Motor Setup Wizard**

  The Motor Setup wizard takes you step-by-step through the most basic setup and configuration process. Refer to the section *Motor Setup Wizard*.

- **Autotuning Wizard**

  The Autotuning wizard takes you through a procedure to autotune the various control loops. Refer to the section *Autotuning Wizard*.

- **New Motor Wizard**

  The New Motor wizard is a series of dialog boxes that allow you to define a motor and its set of parameters. Refer to the section *New Motor Wizard*.

4.3 Dashboards

FLEXI SUITE has several dashboards. These screens contain a combination of function panes and panels, which allow experienced users to work more efficiently.

- Terminal
- Scope
- Expert

4.3.1 Terminal

The **Terminal** screen allows you to send VarCom instructions to the drive, and read the drive’s responses. It also includes a **Watch** panel that allows experienced users to monitor parameters.

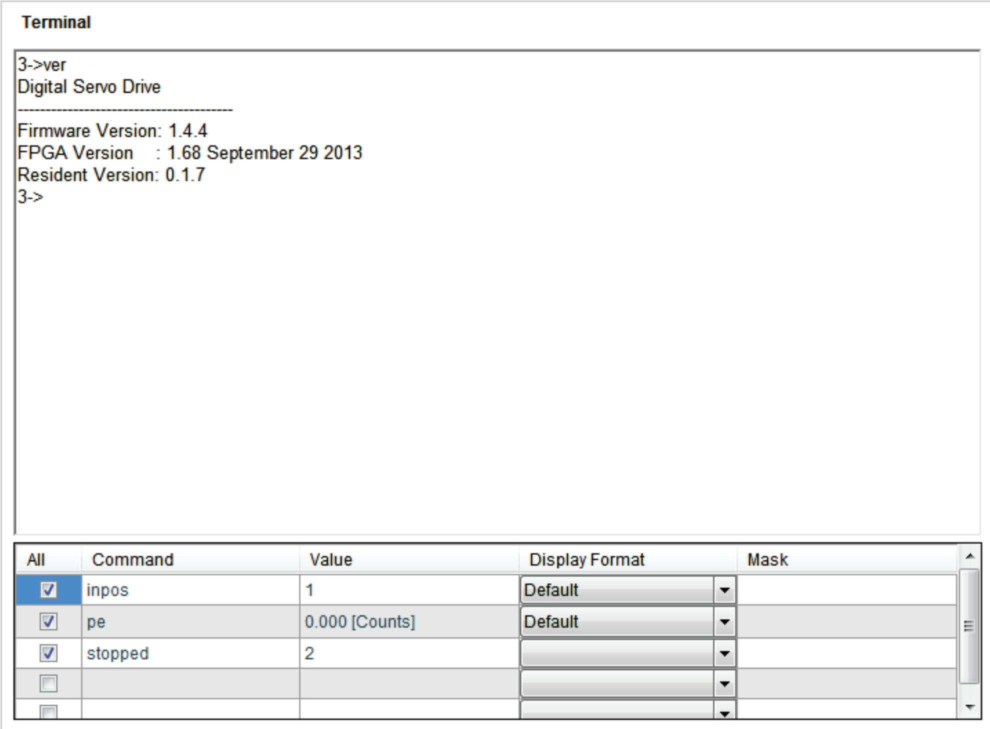


Figure 4-4. FLEXI SUITE – Terminal Dashboard

FLEXI SUITE provides two methods that reduce the need for command memorization and keyboard input:

- **Autocompletion:** An autocompletion system (IntelliSense) allows you to access commands and descriptions of their functions. IntelliSense can be disabled in the Preferences screen.

  When you begin typing a command, a list of available drive commands is displayed based on the characters typed.

Note: When FLEXI SUITE is communicating with the drive through a CAN port, only the variables and commands that have comparable CAN objects are displayed.

- **History:** Use the **Up** arrow key to show a list of all command strings that have been sent to drive in the present session (i.e., since FLEXI SUITE was last opened).

When a command in the autocomplete or history list is highlighted:

- Press **Enter** to sends the command to drive.
- Press **spacebar** to edit the command.

Right-click anywhere in the Terminal panel to access two additional functions:

- **Clear Terminal**: Deletes the contents of the Terminal.
- **Save to File**: Prompts you to save the contents as a text file.

Watch Panel

The **Watch** panel is used to monitor drive variables. The rate at which variables are updated is dependent on the load on the serial communications link and on the Refresh Rate of Data From Drive setting in the Preferences screen.

All	Select or clear an individual checkbox to start or stop monitoring a specific variable. Click the header **All** to select or clear all variables listed.
Command	Use this field to enter the name of the drive variable whose value you want to monitor. Click the header **Command** to sort the list alphabetically. Once alphabetized, click the header to reverse ascending/ descending order.
Value	The value of the watched variable is displayed in this field.
Display Format	Select the format that is used for displaying the value: default, Binary Decimal or Hexadecimal.
Mask	Use this field to enter a value that will be logically ANDed with the parameter value.

4.3.2 Scope

The **Scope** screen allows you to perform the following tasks:

- Configure recording settings, record data from the drive, and display the data according to your preferences.
- Generate motion in order to record data related to that specific motion. Commands can be sent to the drive via the **Move Record and Plot** buttons in the Scope toolbar, or via the **Terminal** tab.
- Program and run scripts using the **Script** panel.

Refer to the section *Data Recording* for detailed information.

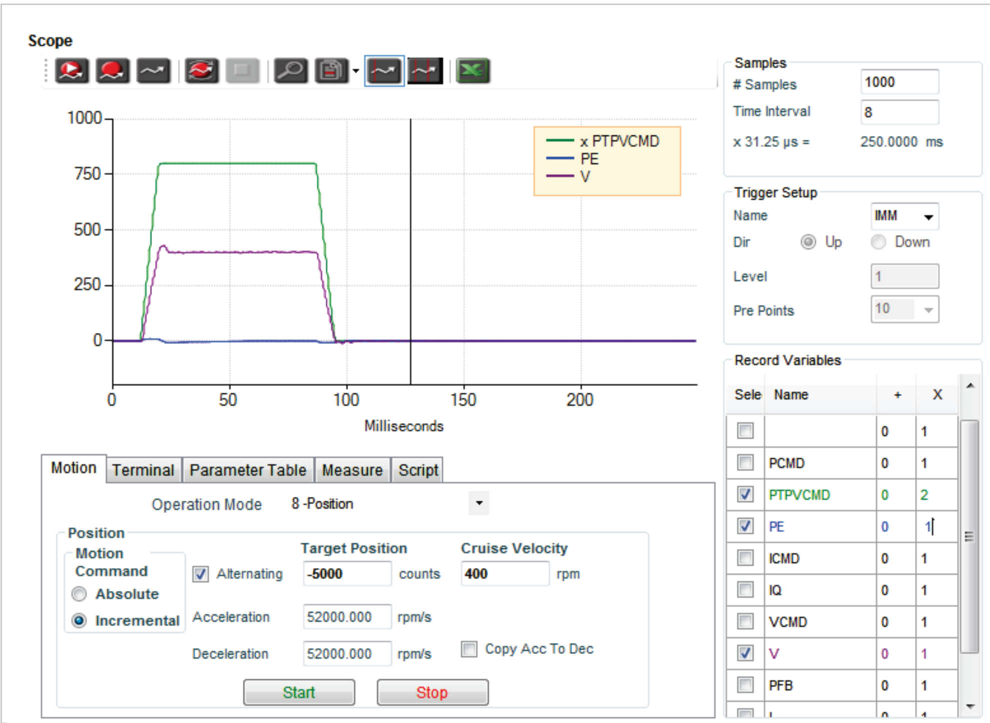


Figure 4-5. FLEXI SUITE – Scope Dashboard

4.3.3 Expert

The **Expert** screen allows experienced users to perform the following tasks:

- Send commands to the drive using the **Terminal** panel.
- Change operation mode and initiate motion using the **Motion** panel.
- Monitor parameters using the **Watch** panel.
- View and manipulate parameters using the **Parameters** panel.
- Set recording properties using the **ScopeChart** panel.
- Program and run scripts using the **Script** panel.

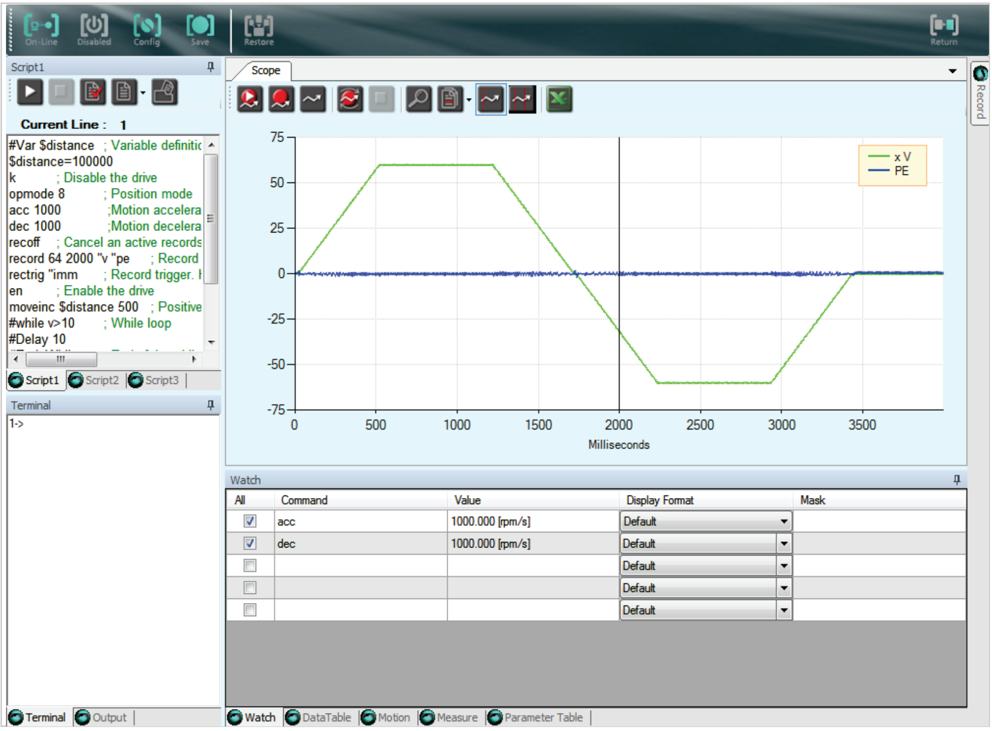


Figure 4-6. FLEXI SUITE – Expert Dashboard

The Expert toolbar has two additional buttons:

	**Restore** – Resets the Expert screen to the default layout.
	**Return** – Closes the Expert screen and reopens the standard FLEXI SUITE interface. Alternately, use the **X** at the top right for the Return function.

The Expert screen has dockable panels, which can be visible, hidden or floating.

	Click to autohide the panel to the edge of the screen. Small tab/s remain visible. Hovering over the tabs opens the panel.
	Indicates the panel is hidden. Click to keep the panel visible.

Double-click the top border of a panel to make it float. Double-click again to redock a floating panel.

Alternately, click the top border of a panel and drag it to any location on the desktop. If a panel has been dragged to a floating position, it must be dragged back into position. Clicking its top border causes it to close.

To restore the default layout of panels in Expert Studio, use the Restore button on the Expert View toolbar.

To save a personalized layout of panels in Expert Studio, do the following:

- From the ScopeChart toolbar, open the Chart Options menu,
  or right-click anywhere in the ScopeChart panel.
- Select Windows Layout > **Save Layout**.

To load a saved personalized layout of panels in Expert Studio, do the following:

- From the ScopeChart toolbar, open the Chart Options menu,
  or right-click anywhere in the ScopeChart panel.
- Select Windows Layout > **Load Layout**.

[Terminal | Output] Panel

Terminal Tab

Refer to the section *Terminal*.

Output Tab

The Output tab shows data generated by the **#Print** command in a script.

Scope Panel

Refer to the section *Data Recording*.

[Watch | Data Table | Motion | Measure | Parameter Table] Panel

Watch Tab

Refer to the section *Watch Panel*.

Data Table Tab

A table that displays the data used for plotting the chart.

Motion Tab

Refer to the section *Operation Modes***.**

Measure Tab

Refer to the section *Measure Tab*.

Parameter Table Tab

Refer to the section *Managing Parameters.*

Script Panel

FLEXI SUITE includes a simple scripting language that allows the FLEXI PRO to perform logical and control tasks that can run independently. Such tasks include:

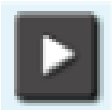
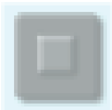
- Send commands to the drive.
- Read and set values in the drive.
- Define variables and perform simple operations on their values.
- Issue commands according to status or conditions.
- Control program flow.
- Plot recorded data
- Save and restore drive parameters.

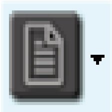
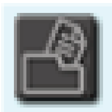
The scripting language, commands and syntax are described fully in the chapter *Scripting*.

Script Tab

Each script opens in its own tab. Any number of scripts can be open and in use.

The Script tab includes a toolbar with a number of buttons:

	**Run** – Validates and then runs a script.
	**Stop** – Halts a running script.
	**Validate** – Checks the syntax of a script to make sure all script commands are valid. Highlights any errors. It does not check the validity of FLEXI PRO VarCom instructions.

	**File** – Click the arrow to access the file options: ■ **Open** – Opens a saved script file. Also Ctrl+O ■ **Save** – Saves the script to a file. Also Ctrl+S ■ **Save As** – Saves the script under a different filename. ■ **Dump** – Retrieves all parameters from drive memory. Can be used for viewing and modifying parameter values, followed by Run to send new values to drive. Refer to VarCom DUMP. ■ **Copy** – Ctrl+C ■ **Paste** – Same as Ctrl+V ■ **Clean Script** – Selects and deletes all contents of script tab. ■ **Close Script** – Closes script without saving contents. ■ Font Size – Gives you a choice of four sizes for displaying the script text. ■ Intellisense – Toggles the autocompletion system (IntelliSense). Refer to the section *Preferences*. ■ Run Selection –Executes only the lines currently selected in the script. ■ Firmware Upgrade – Refer to the chapter *Firmware Upgrade.* Script file options can also be accessed by right-clicking anywhere in a Script tab.
	**New Script** – Opens a new tab for a new script.

FLEXI SUITE provides two methods that reduce the need for command memorization and keyboard input:

- **Autocompletion:** An autocompletion system (IntelliSense). When you begin entering a command, a list of available drive commands is displayed based on the characters typed. IntelliSense can be disabled in the Preferences screen.
- **History:** Use the **Up** arrow key to show a list of all command strings that have been sent to drive in the present session (i.e., since FLEXI SUITE was last opened).

When a command in the autocomplete or history list is highlighted:

- Press **Enter** to send the command to the drive.
- Press **spacebar** to edit the command.

4.4 Preferences

The **Preferences** screen allows you to modify file names and locations, runtime options, and other FLEXI SUITE default settings.

The Preferences screen has two tabs: Basic and Advanced.

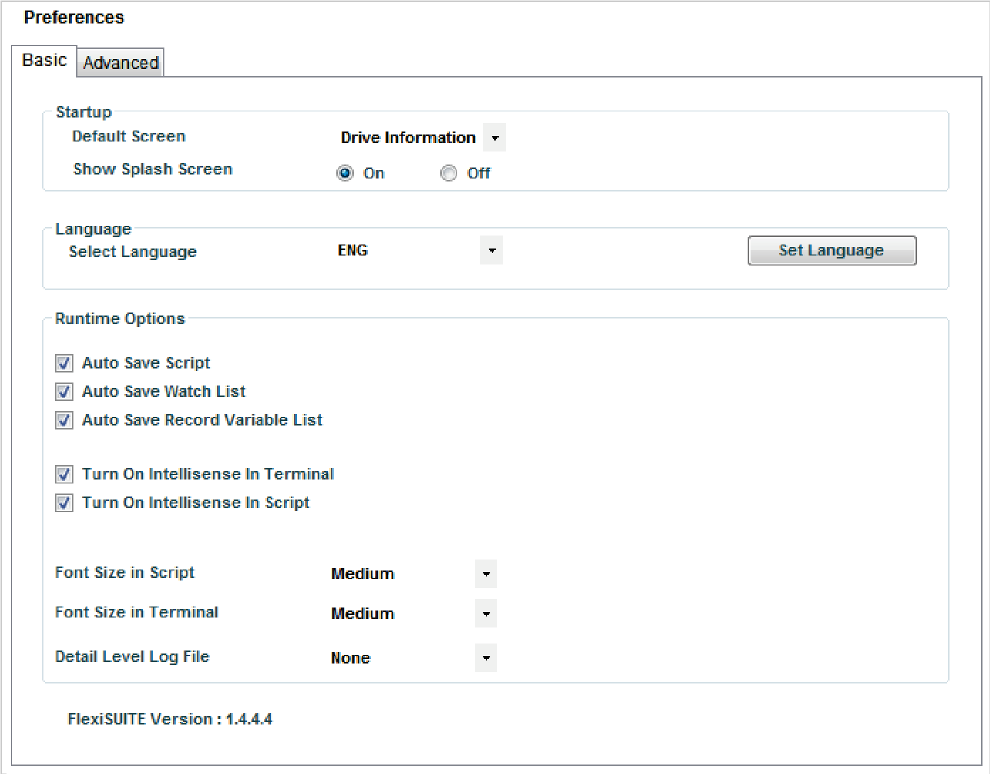


Figure 4-7. FLEXI SUITE – Preferences Screen – Basic Settings

Startup	**Default Screen** – The task screen that is displayed when FLEXI SUITE is activated. It can be any of the screens listed in the sidebar. By default, Drive Information is the default screen. **Show Splash Screen** – Defines whether the FLEXI SUITE splash screen is displayed when FLEXI SUITE is activated.
Load Language	**Select Language** – Defines the interface language (currently English or Chinese) **Load Language** – Activates the interface in the selected language.
Configuration Files	The names and locations of files used by FLEXI SUITE. For Expert users only.
Runtime Options	**Auto Save** options – For Expert users. Selected elements will be automatically saved and restored the next time FLEXI SUITE is opened, even if they were not explicitly saved before closing FLEXI SUITE.
	Turn On IntelliSense in Terminal: Activates auto-selection and auto-complete when working in Terminal panel. Opens and displays list of available drive commands that can be selected based on the characters entered.
	Turn on IntelliSense in Script – Activates auto-selection and auto-complete when working in Script panel. Opens and displays list of available drive commands that can be selected based on the characters entered.
Font Size in Script	Defines the size of the text displayed in the Script panes.

Font Size in Terminal	Defines the size of the text displayed in the Terminal screen or panel.
Detail Level Log File	Determines the type and amount of information to be included in log files.
FLEXI SUITE Version	The version of the FLEXI SUITE software.
Save As	Saves Preference settings in a new file.

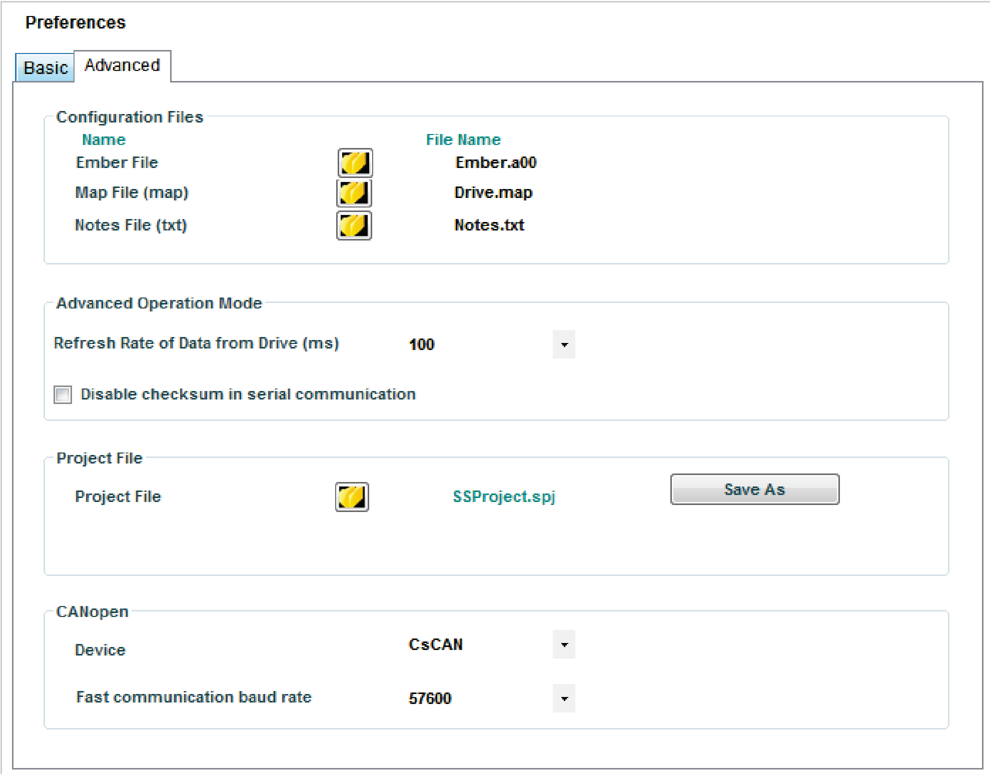


Figure 4-8. FLEXI SUITE – Preferences Screen – Advanced Settings

Configuration Files	The names and locations of files used by FLEXI SUITE. For Expert users only.
Advanced Operation Mode	**Refresh Rate of Data from Drive** – Sets the rate at which variable values are refreshed on screen. This includes both user-defined watched variables and system-defined variables which may trigger warnings or faults. Defined in milliseconds. Refer to the section *Watch Panel*. **Disable Checksum in Serial Communication.** Refer to *Serial Communication.*
Project File	A project file contains all settings currently defined in FLEXI SUITE, and any autosaved data.
CANopen	**Device**: CsCAN or Kvaser Leaf interface. If CsCAN is selected, an additional option is displayed: **Fast communication baud rate**: 57600, 115200.

4.5 Connecting FLEXI SUITE to a CAN Port

FLEXI SUITE is the preferred method for configuring the drive and commissioning applications; it is strongly recommended to use a serial RS232 or USB connection for this purpose.

While it is possible to use FLEXI SUITE through a CAN connection, FLEXI SUITE has certain limitations and behavior differences when used this way.

When setup for CANopen communication, FLEXI SUITE has the following notable differences:

- **Operation Mode**: FLEXI SUITE shows standard CAN operation modes. However, the 7-segment display on the drive shows numbers that reflect the serial communication operation modes, as defined in the drive firmware.
- **Motion Units**: FLEXI SUITE uses standard CAN units of motion, as selected by the user, However, in instances of CAN units, the FLEXI SUITE screens display only the values, and do not include the type of unit.
- **Terminal**: Only VarCom variables and commands that have comparable CAN objects can be used in Terminal mode.

Other functionality limitations and differences are noted in the documentation, where applicable.

To define CANopen communication in FLEXI SUITE, refer to the section *CANopen Connection.*

5 Configuration

5.1 Parameters

This section presents the main concepts and functions related to the configuration and operation of the FLEXI PRO drive.

5.1.1 Configuration Parameters

Drive functionality is configured using various commands and variables, which are transmitted over the communication bus. The terms *variables* and *parameters* are used interchangeably; *drive parameter set* refers to the set of variables that are specifically defined for a particular application.

Commands and variables are identified by a mnemonic (VarCom) name. For example, MPOLES is the mnemonic used to read and write the setting for the number of motor poles.

VarCom instructions, which are used with serial communications, are detailed in the *FLEXI PRO VarCom Reference Manual*.

Some variables are read-only, while others allow read/write access. Variables can be stored in the FLEXI PRO's non-volatile (flash) memory for use at each power-up.

In general, drives are shipped from the factory with motor parameters set to zero and application parameters set to their default values.

5.1.2 Managing Parameters

Drive Memory

The FLEXI PRO 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 FLEXI PRO 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.

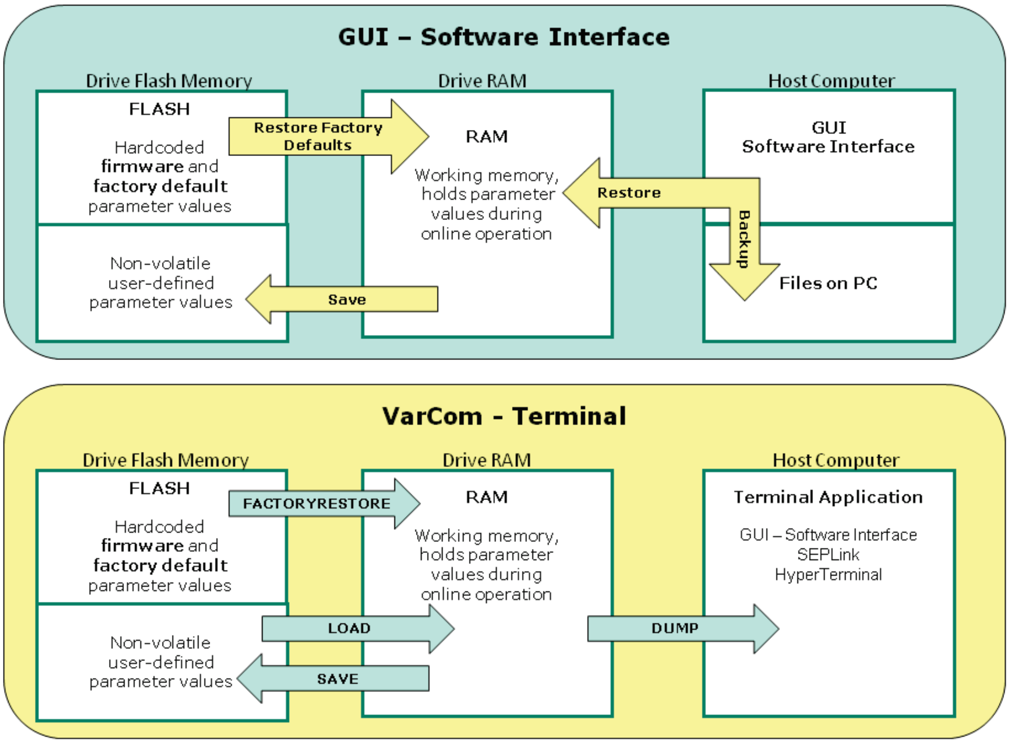


Figure 5-1. Memory and Commands for Managing Parameters

In FLEXI SUITE, drive parameters may be saved to non-volatile memory at any time by clicking on the **Save** button on the toolbar.

Backup & Restore

The **Backup & Restore** screen allows you to save and load parameters to and from files on the host computer.

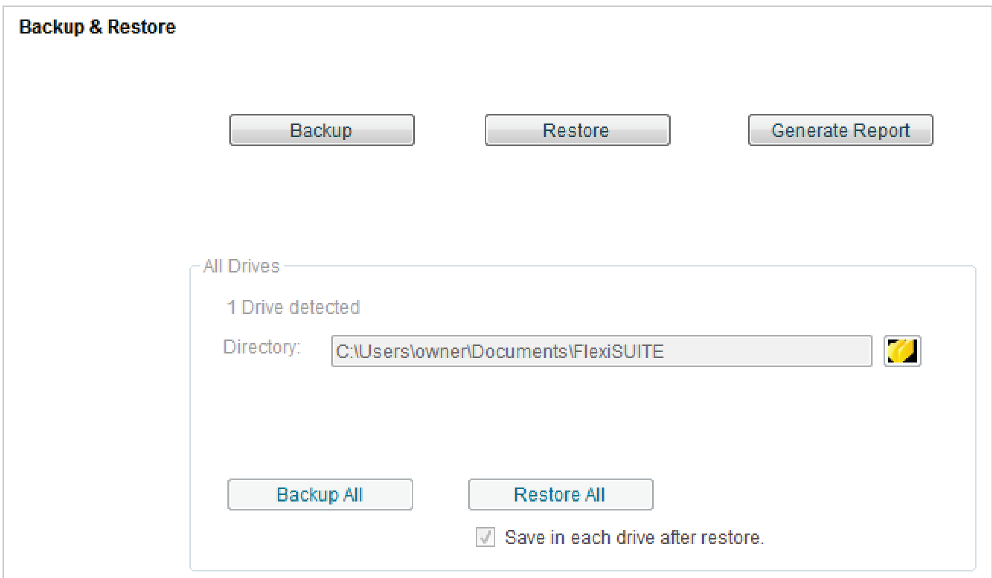


Figure 5-2. FLEXI SUITE – Backup & Restore Screen

Backup	Opens a **Save as** dialog box. Writes parameters from the drive RAM to a file on the PC. 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.
Restore	Opens an **Open** dialog box. Loads parameters from a file on the PC to the drive RAM.
Generate Report	Opens a Report dialog box, for entering information about the application and user, and includes an option to send the report by email to technical support. **Generate Report** generates a set of csv and txt files with a zip file, which can be sent to technical support and/or kept for reference. Refer to the section *Reports*.
All Drives	If FLEXI SUITE detects more than one drive, it will display parameter backup and restore options for multiple drives. Backup file names are automatically created according to the name of each drive.

Refer to VarCom SAVE, LOAD and RESTOREDEFAULTS.

Parameter Table

A **Parameter Table** appears in various FLEXI SUITE screens, such as Expert, Scope and Motor. It displays a list of parameters relevant to the operation mode in effect.

For each parameter, the table shows the present value in the drive working memory.

The tooltip on the parameter **Name** shows the corresponding VarCom mnemonic.

Right-click on a parameter line to see more information and options.

Refer to *Help Shortcut* and *Parameter Values*.

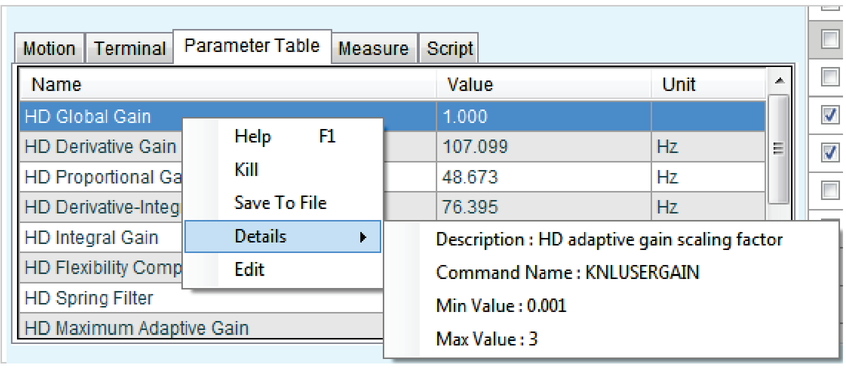


Figure 5-3. Parameter Table in Expert and Scope Screens

FLEXI SUITE provides a blank line at the bottom of the table that lets you add a parameter defined in the firmware (VarCom) and assign a value to it.
To add a parameter to the table, enter the VarCom mnemonic. FLEXI SUITE automatically displays the descriptive name, and adds a new blank line at the end of the table.

Depending on the context and changes already made on the parameter value, some or all of the following options will be displayed.

Help	**F1 –** Activates online help for the currently selected screen element.
Enable | Kill	Toggles the Enable/Disable state of the drive. This option is displayed when modification of the parameter value requires the drive to be in the disabled state.
Save to File	Saves the entire parameter table to a text file, for reference purposes only. Default location is \Users\owner\Documents\FLEXI SUITE
Details	**Description** – A brief description of the parameter. **Command Name** – The VarCom equivalent. **Min/Max Value** – The minimum and maximum values allowed for the parameter. **CANopen Index** – Where applicable, the equivalent CANopen object code.
Edit	Opens an Edit Parameter dialog box that contains the essential functions provided in the Scope screen to facilitate tuning of the motion parameter. Options enable automatic and consistent intervals for adjusting parameter values.

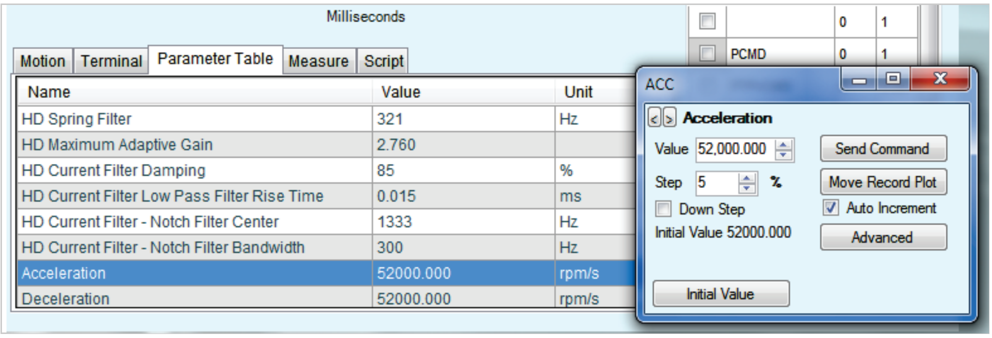


Figure 5-4. Parameter Table – Edit Parameter Dialog Box

< >	Click the left and right arrows to scroll to and access the values for each of the parameters in the table.
Value	The value of the parameter currently in the drive. Click the arrows to increase or decrease the value, according to the define Step percentage.
Step	Defines the percentage for incrementing or decrementing the parameter value.
Down Step	Defines whether the parameter is incremented or decremented in each step.
Initial Value	Restores the value of the parameter that was in effect before the Edit function was activated.
Send Command	Sends the currently displayed value to the drive.

Move Record Plot	Moves, records and plots the motion according to the newly entered value.
Auto Increment	If selected, the value is incremented according to the Step value.
Advanced	Displays two additional options: **Show Previous** - Displays the previously displayed trace in addition to the currently displayed trace. **Show Reference** - Displays the trace previously saved as a reference.

The Parameter Table in the Motor screen does not allow modification of parameter values, except for motors defined as **User Motors.**

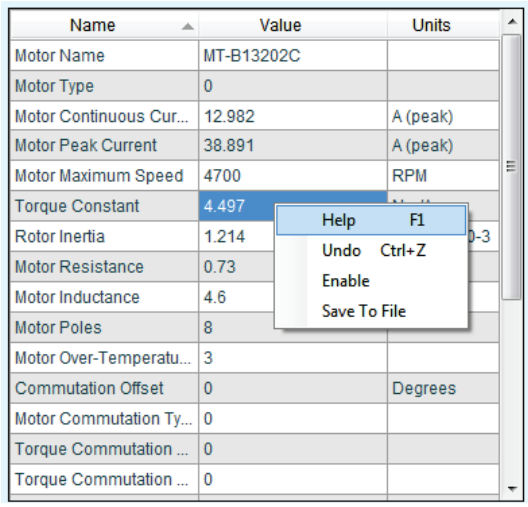


Figure 5-5. Parameter Table in Motor Screen

5.1.3 Enabling the Drive

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

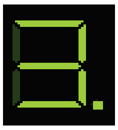
Three conditions are required for enabling the FLEXI PRO drive:

- No faults
- The **Software Enable** switch must be on. The commands EN (Enable) and K (Disable) toggle the state of Software Enable. The Enable|Disable button on the toolbar also toggles the Software Enable switch.
- The **Remote Enable** signal must be on. This signal is controlled by one of the digital inputs in the Controller I/F connector. If no input is configured for this function, the Remote Enable signal remains on, and the drive can be enabled and disabled solely by the commands EN (Enable) and K (Disable).

The following elements provide visual indications of the drive's Enabled or Disabled status:

The **Enable|Disable** button in the FLEXI SUITE toolbar indicates the state of the drive.

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



The decimal point (.) on the drive's 7-segment display indicates the drive's Enable/Disable state. If the point is displayed next to the OPMODE code, the drive is enabled.

The FLEXI SUITE **Enable & Faults** screen graphically shows the conditions required for the drive to be enabled. It allows you to clear faults and turn on Software Enable.

For more information about enabling and disabling the drive, refer to the section Enable/Disable.

5.2 Drive Configuration Sequence

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, FLEXI SUITE will prompt you to disable the drive.

Important Notes:

- It is recommended that you configure the drive using serial communication whenever possible, even if it the drive is connected to a CAN network.
- It is recommended that you perform the drive configuration according to the sequence shown in Figure 5-6. Refer to the notes that follow.
- While setting parameters, pay close attention to any warning or error messages that appear in FLEXI SUITE, and any flashing codes on the drive itself.

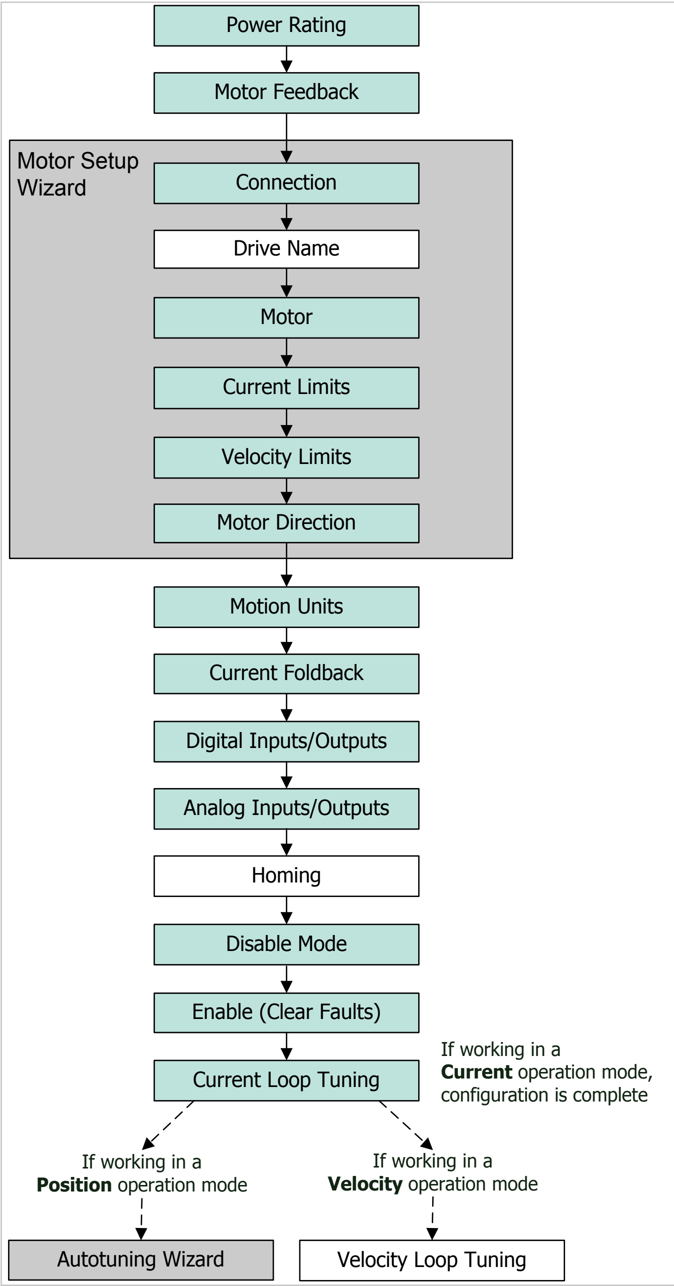


Figure 5-6. Recommended Sequence for Drive Configuration

Notes for Configuration Sequence

Power Rating	The Motor Setup Wizard assumes the bus voltage setting is 320. If the drive is being powered by 220 VAC per phase, you can skip this step. If the drive is being powered by 110 VAC per phase, you must change the setting to 160. Refer to the section *Power Rating*.
Motor Feedback	The Motor Setup Wizard assumes that the motor model number indicates a particular type of feedback. If this is not true for your motor, you must define the motor feedback before starting the Motor Setup Wizard. Refer to the section *Motor*.

Communication	Refer to the section
Drive Name	Optional**.** Refer to the section *Drive Information.* .
Motor	The Motor Setup Wizard configures the motor phasing. See note for Motor Feedback, above. Refer to the section *Motor*.
Current Limits	The Motor Setup Wizard suggests values for low, medium or high current limits; user-defined values can also be entered. Refer to the section *Limits*
Velocity Limits	The Motor Setup Wizard suggests values for low, medium or high current limits; user-defined values can also be entered. Refer to the section *Velocity Limit.*
Motor Direction	The Motor Setup Wizard simplifies the defining of rotation direction for a positive command. Otherwise, VarCom instructions are required. Refer to the section *Motor Direction*.
Motion Units	Refer to the section *Motion Units*.
Current Foldback	Refer to the section *Current Foldback.*
Digital Inputs/Outputs	Refer to the sections *Digital Inputs* and *Digital Outputs.*
Analog Inputs/Outputs	Refer to the sections *Analog Inputs* and *Analog Output.*
Homing	Refer to the section *Homing*.
Disable Mode	Refer to the section *Disable Mode.*
Enable	Needed for clearing faults. Refer to the section *Enable/Disable.*
Current Loop Tuning	The Motor Setup Wizard tunes the Current Control Loop at a basic level. This is sufficient for proceeding to the Autotuning Wizard. To achieve optimal performance, use the **Current Loop Tuning** option in the Current Loop screen. Refer to the section *Current Control Loop*.
Velocity Loop Tuning	Optional. Refer to the section *Velocity Control Loop*.
Autotuning Wizard	Refer to the section *Autotuning Wizard*.

5.3 Motor Setup Wizard

The Motor Setup Wizard provides the quickest and easiest method for getting the drive up and running. It configures only the essential parameters.

It is recommended that you use the FLEXI SUITE **Motor Setup Wizard** when connecting the drive for the first time.

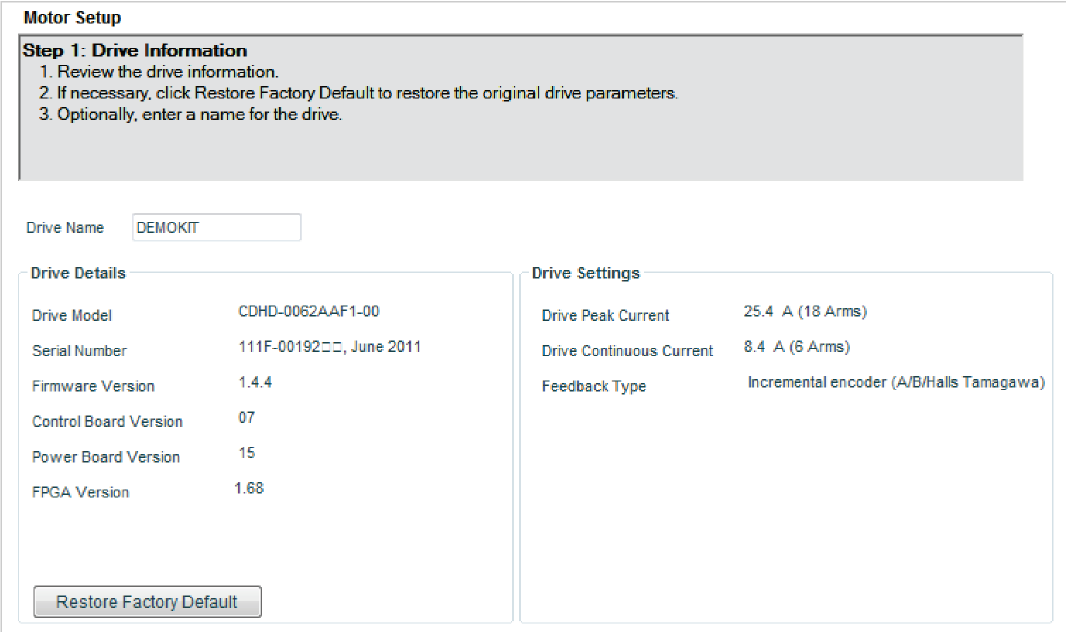


Figure 5-7. FLEXI SUITE – Motor Setup Wizard - Drive

Step 0 – Connection

Typically, the Wizard begins at Step 0. If the drive is already connected, the wizard will begin at Step 1.

To connect to the drive, click **Search & Connect**.

Alternately, enter the port settings, and click **Connect**.

For more information, refer to the section *Communication*.

Step 1 – Drive Information

1. Review the drive information.
2. Enter a name for the drive.

For more information, refer to the section *Drive Information.*

This step also includes an option to restore the drive's factory settings. This option is available in the Setup wizard only; it does not appear in the Drive Information screen.

Step 2 – 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. Click **Verify** to send parameters to the drive and test the motor configuration.

    Verify enables the drive and moves the motor!

For more information, refer to the section *Motor*.

Step 3 – Velocity and Current Limits

Motor Setup Wizard suggests values for Low, Medium or High current and velocity limits, which are rounded to 25%, 50% and 75%, respectively, of the maximum range.

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

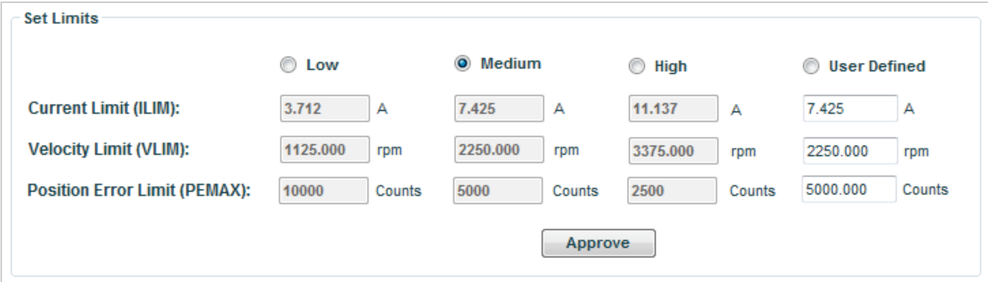


Figure 5-8. FLEXI SUITE – Motor Setup Wizard – Limits &&

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. Click **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.

For more information, refer to the sections *Velocity Limit* and *Position Limit*.

Step 4 – Move and Set Direction

The Motor Setup Wizard simplifies the process of defining the rotation direction for a positive command. Otherwise, VarCom instructions are required. For more information, refer to the section *Motor Direction* and to VarCom MPHASE and DIR.

1. To verify motor motion direction, click **Left** or **Right**.

    Left and **Right** enable the drive and move the motor!

2. To reverse the direction to match your system, click **Inverse Direction**.
3. To continue, click **Approve Direction**.

Step 5 – Save

It is recommended that you save parameters to the drive's non-volatile memory and to a file on the host computer for backup.

Do both of the following:

1. Click **Save to Drive** to save the parameters to the drive's non-volatile memory.
2. Click **Save to File** to save the parameters to a backup file on the computer.

Next Step

Once the Motor Setup Wizard is completed, the **Current** control loop is configured.

You are prompted to press the **Next** arrow to continue to the Autotuning Wizard.

You can then do either of the following:

- Tune the drive for operation in a **Position** control loop, using the Autotuning Wizard.
- Tune the drive for operation in a **Velocity** control loop, using the Velocity Loop screen.

5.4 Communication

From the FLEXI SUITE navigation sidebar, click **Communication**.

The **Communication** screen is now displayed in the task area.

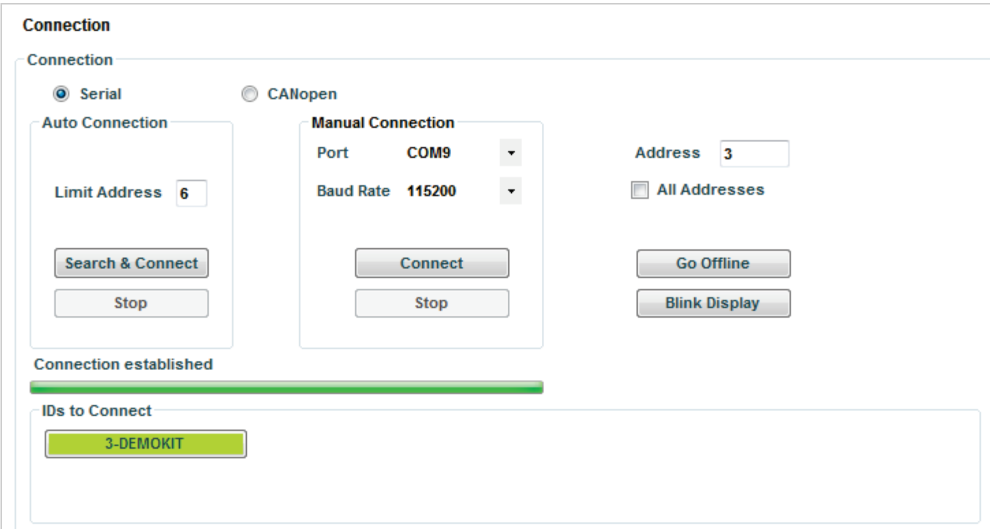


Figure 5-9. FLEXI SUITE – Communication Screen – Serial

5.4.1 Online and Offline

The Communication screen includes a Offline option. In addition, the FLEXI SUITE toolbar has an **Online|Offline** toggle button.

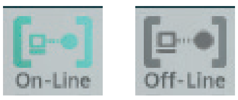


Figure 5-10. Online/Offline Mode Toggle Button

- **Offline** mode: FLEXI SUITE does not attempt to communicate with the drive.
- **Online** mode: FLEXI SUITE continually communicates with the drive to read parameters and status.

Note: It is recommended to switch to Offline mode before physically disconnecting the drive or powering off the drive.

Go Offline	To use FLEXI SUITE without connecting to the drive, click **Go Offline**.
Blink Display	To test communication between FLEXI SUITE and the drive, click **Blink Display**, and observe the 7-segment display on the drive. If communication is established, the display will flash **8.** several times.

5.4.2 Serial Connection

The Communication screen allows you to connect to the drive using serial communication protocol. Select **Serial**, and use either of the following options:

- **Auto Connection**. Click **Search & Connect**.

  The software searches all COM ports on the host computer to locate the port to which a drive is connected.

  Once the software identifies the port, it searches for all drives that may be daisy-chained to the port. Since this search can take a long time, the **Limit Address** option allows you to define the number of addresses, from 0-99 to be searched. By default, the limit is set to 6 addresses.

  The names and addresses of all drives found will be listed under **IDs to connect**.

- **Manual Connection**. Set the COM port, the baud (data transfer) rate, and the address, and Click **Connect**.

  FLEXI SUITE will establish communication with the drive on the specified port and specified address.

If **All Addresses** is selected, FLEXI SUITE will establish communication with all drives on the selected port whose ID is lower than the displayed **Limit Address** (under AutoConnection). The names and addresses of all drives found will be listed under **IDs to connect**.

If you are using a USB connection, check the Windows Device Manager to see which COM port is mapped to the Servo Drive USB device.

The drive address can be any value, from 0 to 99. The value you enter must match the drive address defined by the rotary switches (set during installation). Refer to the section *Drive Address.*

Baud Rate

The drive always powers up at baud rate 115200, even if it was changed in a previous working session.

Baud rate settings must be changed separately in the drive and in FLEXI SUITE.

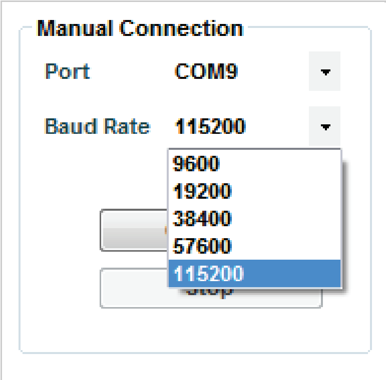


Figure 5-11. Serial Baud Rates

If you want to try using a lower baud rate, in the event of a connectivity problem for example, do the following:

1. First, change the rate in the drive:
   - Go to the Terminal screen.
   - Change the baud rate by typing, for example: **baudrate 19200**
   - Press Enter. Communication is lost as soon as Enter is pressed, and FLEXI SUITE goes offline.
2. Now, change the baud rate in FLEXI SUITE.
   - Go to the Communication screen.
   - Select the same baud rate.
   - Press **Connect**. If successful, FLEXI SUITE will reconnect with the drive, and go back online.

   Refer to VarCom BAUDRATE.

5.4.3 CANopen Connection

The Communication screen allows you to connect to the drive using CANopen communication protocol:

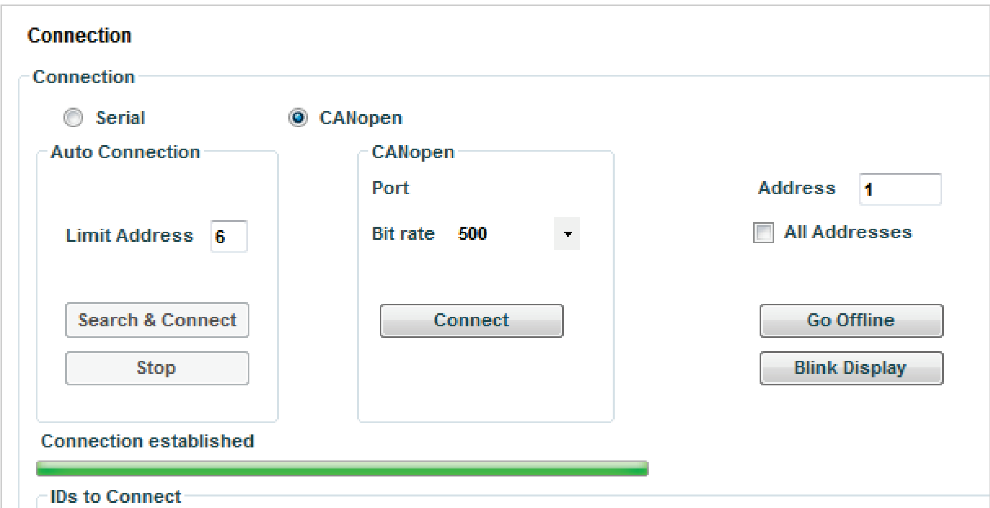


Figure 5-12. FLEXI SUITE – Communication Screen - CANopen

Note: Do not attempt to use the FLEXI SUITE **CANopen** option unless the host PC is actually connected to the drive via a CAN port.

Before you connect to the drive through a CAN port, do the following:

1. Be sure the CAN device is properly installed according to manufacturer instructions.

2. Using **Serial** connection: In the FLEXI SUITE **Terminal** screen, make sure the following settings are in effect:

COMMODE 1
CANBITRATE 3 (= 500 kbps)

These are the factory-defined default settings for CANopen drives.

3. Using **Serial** connection: In the FLEXI SUITE **Preferences** > **Advanced** screen, define the CAN device.

4. Using **Serial** connection: In the FLEXI SUITE **Communication** screen, make sure the following settings are in effect:

- **CANopen** connection
- **Bit rate** 500
- **Address** number in accordance with the address switch on the drive's font panel.

5. Click **Connect.**

Note: The Search & Connect option is not available when using CANopen communication.

Note: Even when the drive is connected to a CANopen network, drive configuration (using FLEXI SUITE software) is typically performed using the serial connection.

For more information, refer also to the sections *CANopen Communication* and *Connecting FLEXI SUITE to a CAN Port.*

5.5 Drive Information

- The **Drive Information** screen displays basic information about the FLEXI PRO, such as current rating, hardware version and firmware version. It is important to provide this information to Technical Support when asking for assistance./
- This screen also provides access to the Firmware Download utility. Refer to the chapter *Firmware Upgrade*.

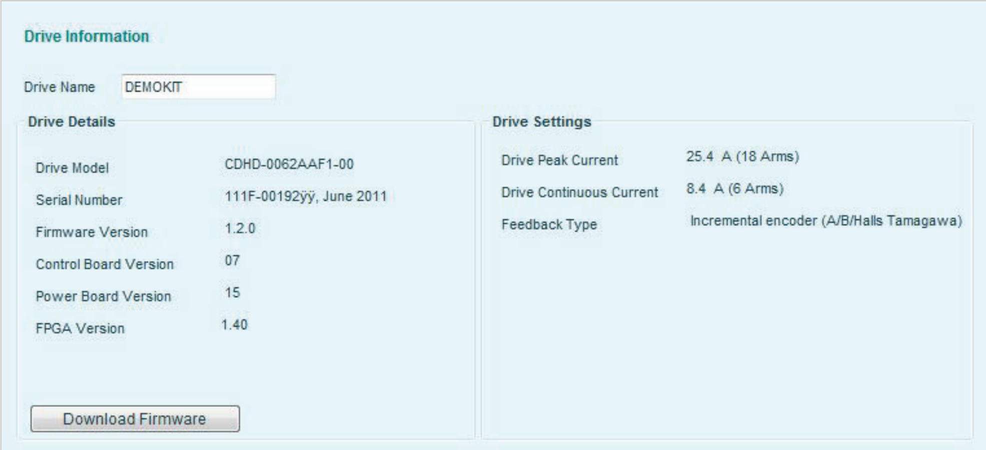


Figure 5-13. FLEXI SUITE – Drive Information Screen

Drive Name	Allows you to assign a name to the drive. The name may contain up to 15 alphanumeric characters. Other valid characters are ( ) / - . : This field is optional, but 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. Refer to VarCom DRIVENAME.
Drive Details	Hard-coded in the drive. Shows the drive model and serial number, and version numbers of firmware, control board, power board and FPGA. Refer to VarCom INFO.
Drive Settings	Hard-coded in the drive. **Drive Peak Current** – Refer to VarCom DIPEAK. **Drive Continuous Curren**t – Refer to VarCom DICONT. **Feedback Type** – Refer to VarCom FEEDBACKTYPE. If modified, CONFIG is required.
Download Firmware	Activates the installation procedure for new versions of drive firmware. Refer to the chapter *Firmware Upgrade*. This function cannot be used when FLEXI SUITE is communicating with the drive through a CAN port.

5.6 Power Rating

The **Power Rating** screen displays the drive's continuous and peak current ratings, and allows you to set the bus voltage parameters.

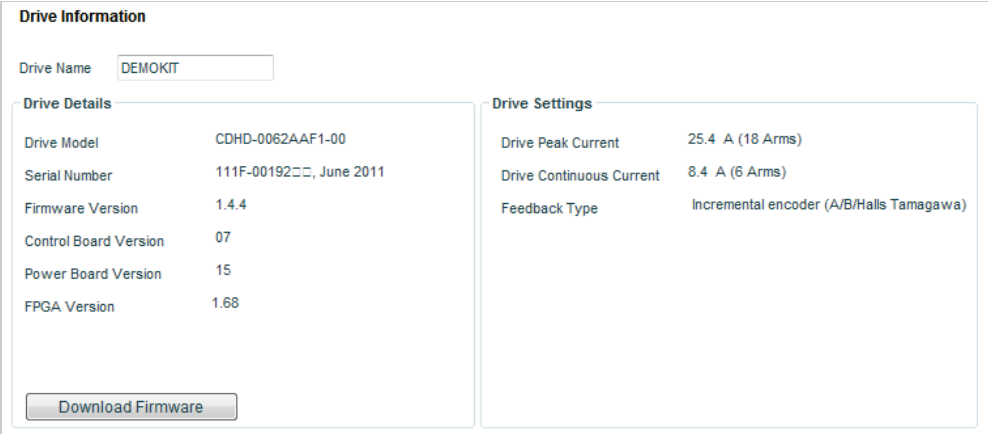


Figure 5-14. FLEXI SUITE – Power Rating Screen

Current Rating	Hard-coded in the drive. **Drive Continuous Current** – Refer to VarCom DICONT. **Drive Peak Current** – Refer to VarCom DIPEAK.
Voltage Settings	**Bus Voltage (DC)** – This setting is required for basic current loop tuning. Although the drive monitors the bus voltage, you must enter the nominal bus voltage here. Enter 320 for a drive powered by 220 VAC per phase. Enter 160 for a drive powered by 110 VAC per phase. Refer to VarCom VBUS. If modified, CONFIG is required. **Under-Voltage Time** – Specifies the amount of time an under-voltage condition will exist before latching a fault, when working in Delayed Fault Under-Voltage mode. Refer to VarCom UVTIME.. **Under-Voltage Mode** – Defines how the drive will respond to an under-voltage fault. Refer to VarCom UVMODE. **Under-Voltage Recovery** – Defines how the drive will recover from an under-voltage fault: by toggling the drive from disable to enable, or by automatically recovering, after the under-voltage condition clears. Refer to VarCom UVRECOVER
Bus Voltage Limits	Read only. Shows the actual bus voltage of the drive. Refer to VarCom VBUSREADOUT.

5.7 Motor

The **Motor** screen allows you to select a motor from the FLEXI SUITE databases (motor libraries). You can simply select the motor family and motor part number, and FLEXI SUITE will prepare the appropriate motor and feedback parameters. The screen allows you to modify and send parameters to the drive, read parameters from the drive, and save parameters.

The Motor screen also includes a wizard for defining a motor whose parameters are not available in the default sets of motor libraries.

Note: In addition to motor parameters, the motor libraries also contain the motor feedback and thermal protection parameters.

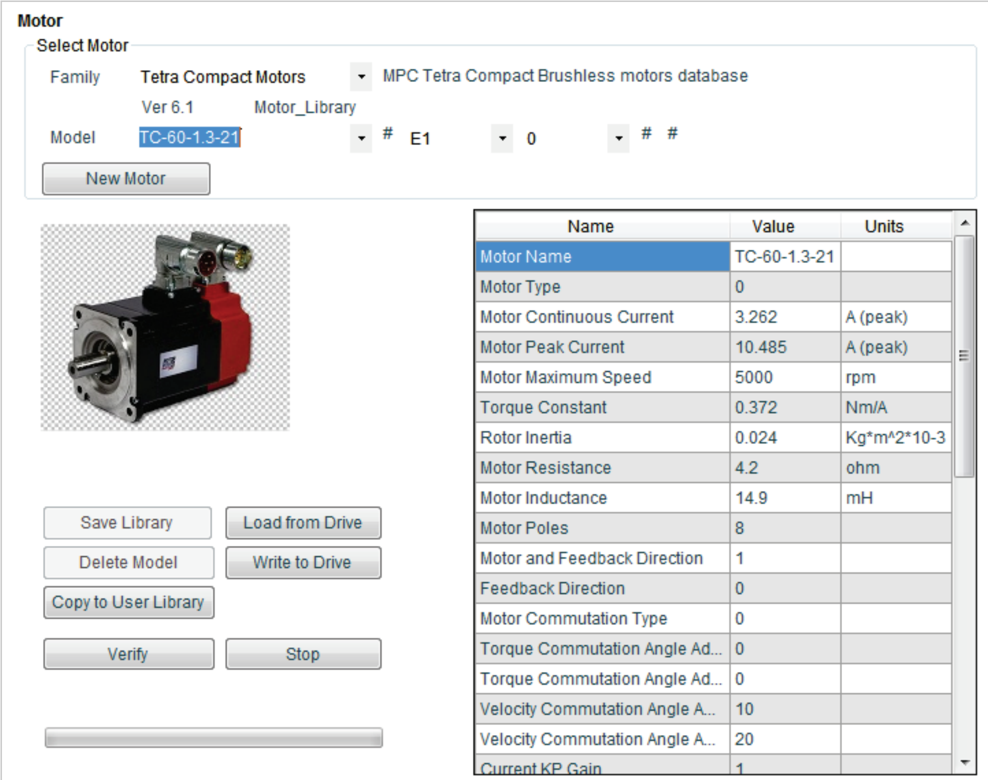


Figure 5-15. FLEXI SUITE – Motor Screen

5.7.1 Motor Selection

Motor Family	FLEXI SUITE has several databases containing predefined sets of parameters for motors. **User Motors** contains a list of motors whose parameter sets have been created by the user, either by modifying a predefined set, or by defining an entirely new set of parameters for a motor. To add a motor to this list, select Motor Family>User Motors, and then Motor Type>New. The Parameters Table then displays a list of motor properties that need to be defined.

Motor Model	A list of all models in the selected Motor Family that have a predefined set of parameters in FLEXI SUITE. For most motors, the motor catalog number is followed by a series of fields, each of which represents a segment in the motor's complete ID number, as shown on the motor's label. In each field select the option that matches the information on the motor label. If a field contains a **#** sign, you do not need to select an option, as the field is not relevant to motion. Different fields represent certain functions or capabilities of the motor, which can be seen in the tooltip for each field. Depending on your selections, you may be prompted to define the output that releases the motor brake. After selecting the motor click **Write To Drive** to write these parameter to the drive.
New Motor	Refer to the section *New Motor Wizard.*

5.7.2 Motor Parameters

Save Library	Saves the entire contents of the User Motors library to a file.
Delete Model	Deletes the currently displayed motor from the User Motors library.
Load from Drive	Displays the values of the drive's motor parameters.
Write to Drive	Writes all displayed parameters to the drive. You can also modify a parameter value and press **Enter** to send the new value to the drive.
Copy to User Library	Copies the parameter values currently displayed to the User Motors library, to enable modification.
Verify	Activates an automatic procedure for setting commutation related variables. The procedure involves finding the electrical phase and detecting the direction of motor movement, Hall switches and index crossing. The drive's 7-segment display flashes the character **A** during this procedure. When the procedure finishes successfully, the display returns to its normal state. If the procedure fails, the display shows **-5**. Refer to the section *Motor Phasing* and to VarCom MOTORSETUP.
Stop	Aborts the Verify process.
Progress bar	Shows the progress of the Verify process (which takes about 30 seconds).
Click for Details	Shows more information about the Verify process.

The **Parameter Table** displays the parameters of the selected motor as currently defined in the database, or as read from the drive. As soon as you change any Motor Model field, the values in the Parameter Table change accordingly.

The Parameter Table presents the following information:

Name	Name of the variable.
Value	Value of the variable. You can modify a parameter value and press **Enter** to send the new value to the drive. Alternately, use **Write to Drive** to send all displayed parameters to the drive.
Unit	Unit of the variable.

5.7.3 New Motor Wizard

The New Motor wizard allows you to define a motor whose parameters are not available in the default sets of motor libraries in FLEXI SUITE. 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.

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

Click on **New Motor** to activate the wizard.

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, FLEXI SUITE converts the units into the equivalent values used by the drive. These converted values are maintained in the motor library and in the drive.

Step 1 – Motor Specification

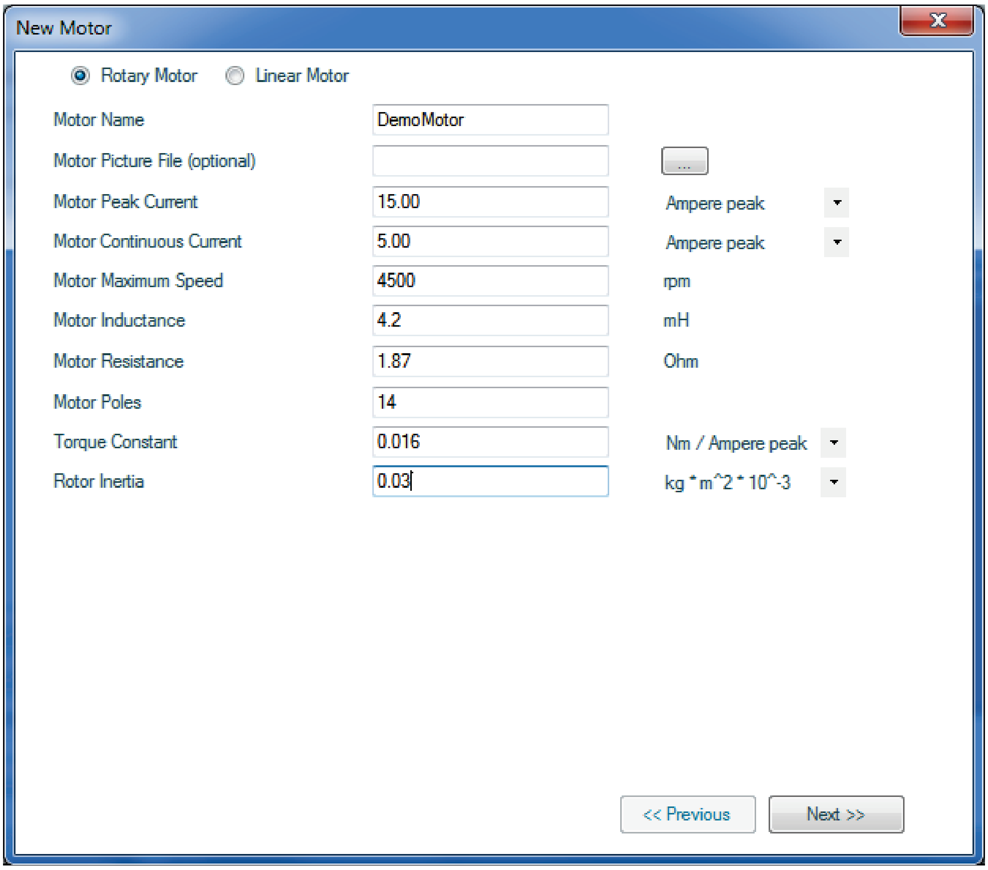


Figure 5-16. FLEXI SUITE – New Motor Definition

Parameter	Refer to VarCom
Motor Peak Current	MIPEAK
Motor Continuous Current	MICONT
Motor Maximum Speed	MSPEED
Motor Inductance	ML
Motor Resistance	MR
Motor Poles	MPOLES
Torque Constant	MKT
Rotor Inertia	MJ

Step 2 – Motor Feedback Selection

Figure 5-17. FLEXI SUITE – New Motor - Feedback

Parameter	Refer to VarCom
Feedback Type	FEEDBACKTYPE
Motor Encoder Type	MENCTYPE
Motor Encoder Resolution	MENCRES

Step 3 – Thermal Protection Definition

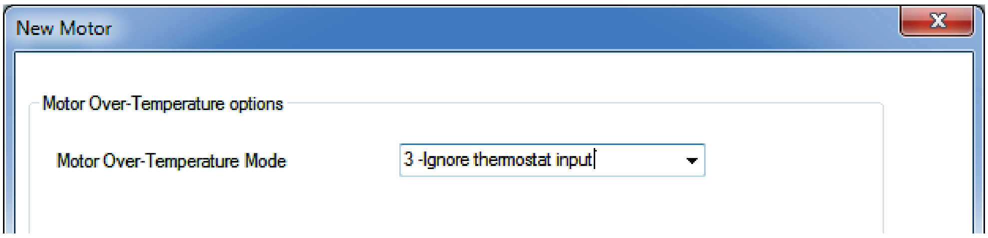


Figure 5-18. FLEXI SUITE – – New Motor – Thermal Protection

Parameter	Refer to VarCom
Motor Over-Temperature Mode	**THERMODE**

Step 4 – Verify

Verify enables the drive and moves the motor!

Do one of the following to complete the procedure, according to where the New Motor wizard was activated,

- If the New Motor wizard was activated from **Step 2 of the Motor Setup** wizard, press **Verify** to send parameters to the drive and test the motor configuration. Wait for the Motor Setup Successful message.

  Parameters are not saved to the library when the wizard is activated from the Motor Setup.

- 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 parameters to the database.
  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.

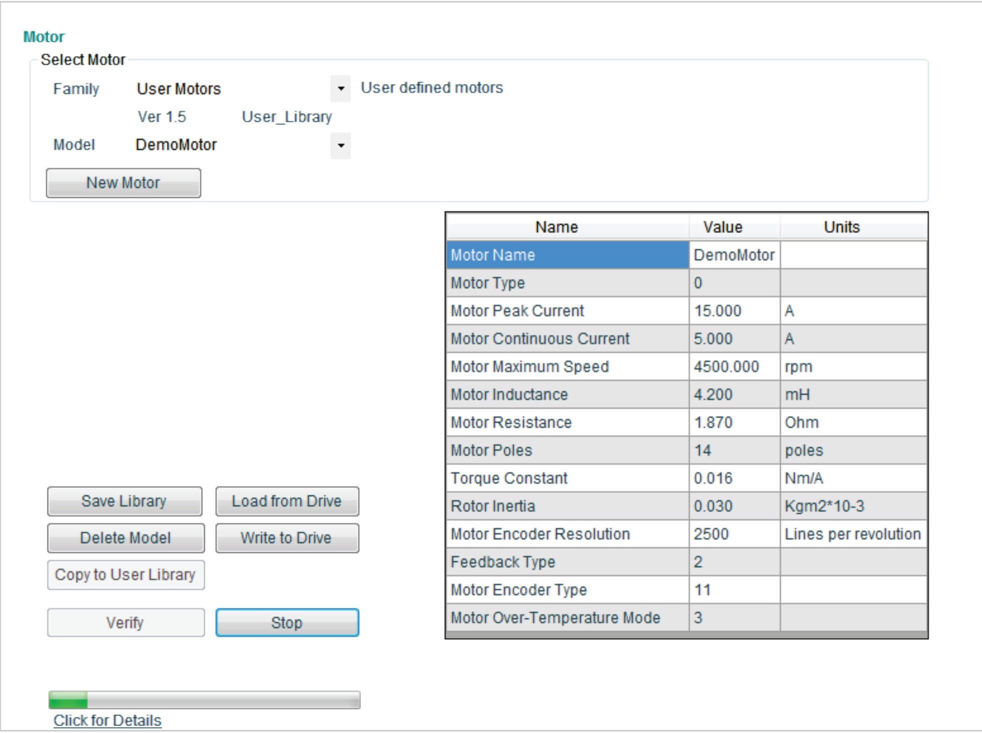


Figure 5-19. FLEXI SUITE – – New Motor – Verify

5.8 Feedback

The FLEXI PRO supports various motor feedback technologies and devices, including:

- Resolver
- Incremental A-quad-B encoder, with or without Hall sensors (or commutation tracks)
- Sine encoder
- EnDat encoder
- HIPERFACE encoder
- Nikon encoder
- Tamagawa encoders

For technical details, refer to the section *Motor Feedback Specifications.*

The variable FEEDBACK is used to define the type of motor feedback used in the drive application.

The **Feedback** screen enables you to configure the properties of the motor's feedback device, and to view the motor position. To configure feedback, select the feedback device from the Feedback options. The screen will change accordingly, enabling you to set the relevant feedback properties.

The Feedback screen also allows you to activate the encoder simulation output and set its resolution.

Note: Many motors have a predefined feedback device. Once you select a motor in the Motor screen, some of the fields in the Feedback screen will have values entered automatically.

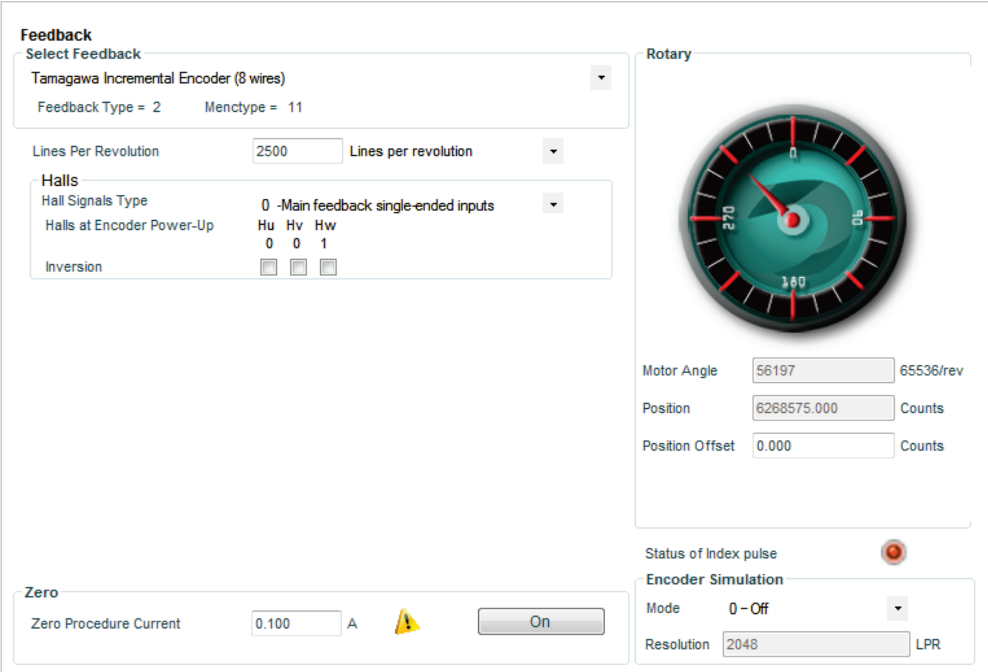
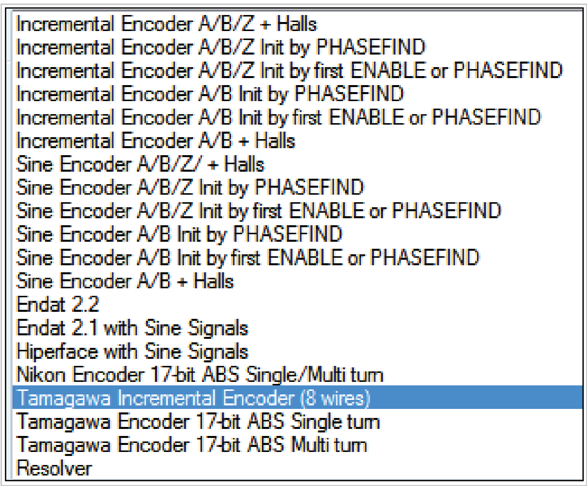


Figure 5-20. FLEXI SUITE – Feedback Screen

More information about the feedback devices and parameters defined in this screen appears later in this section.

Feedback	From the dropdown list, select the type of feedback being used in the application:  The selection automatically sets both the Feedback type and the Encoder type, as indicated on screen. Refer to VarCom FEEDBACKTYPE and MENCTYPE.

Rotary	The graphic shows motor position within one revolution. After setting the feedback resolution, you can turn the motor by hand one revolution and use this graphic to verify that one revolution of position counts has indeed occurred. The graphic also shows motor direction and helps you verify that motion direction is as expected. **Motor Angle** – Read only. The motor mechanical angle position. Refer to VarCom MECHANGLE. **Position** – The value of the position feedback. Read only. Refer to VarCom PFB. **Position Offset** – A feedback offset that is added to the internal cumulative position counter, to give the position feedback value. Refer to VarCom PFBOFFSET.
Zero	**Zero Procedure Current** – The current used for the Zero procedure. Refer to VarCom IZERO. **On** – Activates the Zero procedure, which locks the rotor in place by passing current through two phases. This is useful for determining the commutation offset (MPHASE) on motors that have a resolver or absolute encoder. Refer to VarCom ZERO.
Encoder Simulation	Enables the equivalent encoder output, and sets the resolution. Refer to the section *Encoder Simulation Output*. **Mode** – The state of the encoder simulation. Refer to VarCom ENCOUTMODE. **0** – **Off.** Encoder simulation not enabled. **1** – **Index per revolution**. Encoder simulation enabled, with an index signal (zero pulse) on each turn (or pitch, for linear motor). **2 – Index per feedback**. Encoder simulation enabled, with the index signal routed directly from the motor feedback device (by the FPGA) to the drive, regardless of the value of ENCOUTRES. This mode is intended primarily for linear motors, whose index is once per stroke. **Resolution** – The resolution, in number of lines, of the encoder equivalent output. Refer to VarCom ENCOUTRES.
Status of Index Pulse	An icon represents the state of the encoder index signal: **Red** – The encoder index signal is inactive, indicating the position is not within the index. **Green** – The encoder index signal is active, indicating the position is within the index.

The other options in this screen will change according to the selected **Feedback** type:

Lines Per Revolution	The resolution of the motor encoder. Refer to VarCom MENCRES.
Halls	The current state of the Hall commutation sensors. Read only. Refer to VarCom HALLS.
	Hall Signals Type – The source and method used for Hall sensors. Refer to VarCom HALLSTYPE.

	Inversion – Inverts the polarity of individual Hall signals associated with motor phases UVW, thereby providing correction for crossed wiring. Refer to VarCom HALLSINV,
Phase Find Process	**Find Phase** – Activates the automatic motor phasing routine. Refer to VarCom PHASEFIND. **Mode** – Refer to VarCom PHASEFINDMODE. **Phase Find Duration** – Refer to VarCom PHASEFINDTIME. **Phase Find Current** – Refer to VarCom PHASEFINDI. **Phase Find Gain** – Refer to VarCom PHASEFINDGAIN.
Index Initialization	**Find Index** – Activates the automatic index location routine. Refer to VarCom INDEXFIND. For more information, refer to the section *Encoder Index*. **Motor Encoder Index Position** – The encoder index position, in electrical degrees. Refer to VarCom MENCZPOS. **Encoder Initialization Status** – The state of the index search and initialization procedure. Read Only Refer to VarCom INDEXFINDST. **Note**: If the motor has an index but the index is not being used for commutation (for example, if the encoder type is 6 – A/B/Halls), then you do not need to specify or find the index position.
Resolver	**Resolver Conversion Bandwidth** – The resolver conversion bandwidth. High bandwidth produces better dynamic tracking and less phase lag in high frequencies. Lower bandwidth results in better noise reduction. Refer to VarCom RESBW. **Motor Resolver Poles** – The number of individual poles (not pairs) in the resolver feedback device. Refer to VarCom MRESPOLES. **Resolver Amplitude Range** – The acceptable range of resolver sine/cosine signals, expressed as a percentage, around their nominal value. Refer to VarCom RESAMPLRANGE.
Calibration	**Start –** Activates a procedure that calibrates the resolver sine/cosine signals. The calibration serves to reduce Harmonic errors in the resolver reading – Refer to VarCom SININIT. **Sine/Cosine Calibration Parameters** – (Read only) The parameters that are used for calibration of the resolver sine and cosine signals, in hexadecimal representation. Refer to VarCom SINPARAM. **Sine/Cosine Calibration Status** – (Read only) The status of the resolver calibration procedure. Refer to VarCom SINITST.

5.8.1 Incremental Encoder

Types and Resolution

The FLEXI PRO supports various types of incremental encoders.

The variable MENCTYPE defines the type of encoder being used on the motor. If this variable is modified, CONFIG is required.

The variable MENCRES defines the resolution of the encoder, in number of lines per revolution of the motor. If this variable is modified, CONFIG is required.

For an incremental encoder, the number of encoder counts per revolution is obtained by multiplying MENCRES by 4.

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

Hall Signals

The FLEXI PRO supports single-ended (or open-collector) Hall signals only. Differential Hall signals are not supported.

The variable HALLS is used to read the state of the Hall signals.

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

Encoder Index

Encoders often have an additional channel, referred to as a marker channel, zero pulse, or index channel; these are different names for the same function. 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 it can be wider. The encoder index can be used for homing (absolute position reference) and for commutation alignment.

Caution: When using Encoder Type (MENCTYPE) 0, 1 or 2, the index pulse is used by the drive for additional commutation correction. In these instances, the index position must be located and defined using the Index Initialization procedure (INDEXFIND). If the index value is not set correctly, the motor might run out of control.

To determine the position of the index signal, use the **Find Index** command in the FLEXI SUITE Motor Feedback screen, or use the VarCom INDEXFIND command.

The FLEXI PRO monitors the index signal wires, and will generate an Index Line Break fault (lights **r5** on the LED) if any wire is broken.

5.8.2 Sine Encoder

Sine encoders are very similar to incremental encoders. The difference is that sine encoders send the A and B channels to the drive as 1V peak-to-peak sine-waves while incremental encoders generate digital pulses.

5.8.3 Resolver

A resolver is a rotary transformer that is used to measure the motor shaft position. The resolver has a primary winding, and two secondaries – a sine and cosine in sync with the motor rotation. The level of voltage on the sine and cosine waves correlates to the position of the shaft within one revolution.

5.8.4 Encoder Simulation Output

An encoder simulation output, also referred to as an equivalent encoder output (EOO) or a buffered encoder output, is available on the Controller I/F connector.

- The variable ENCOUTMODE is used to turn the encoder simulation on or off, and to set the functionality.
- The variable ENCOUTRES is used to set the resolution, in equivalent lines-per-revolution, of the encoder simulation output.
- The variable ENCOUTZPOS is used to set the index offset value of the encoder simulation output.

The encoder simulation output process is described in Figure 5-21.

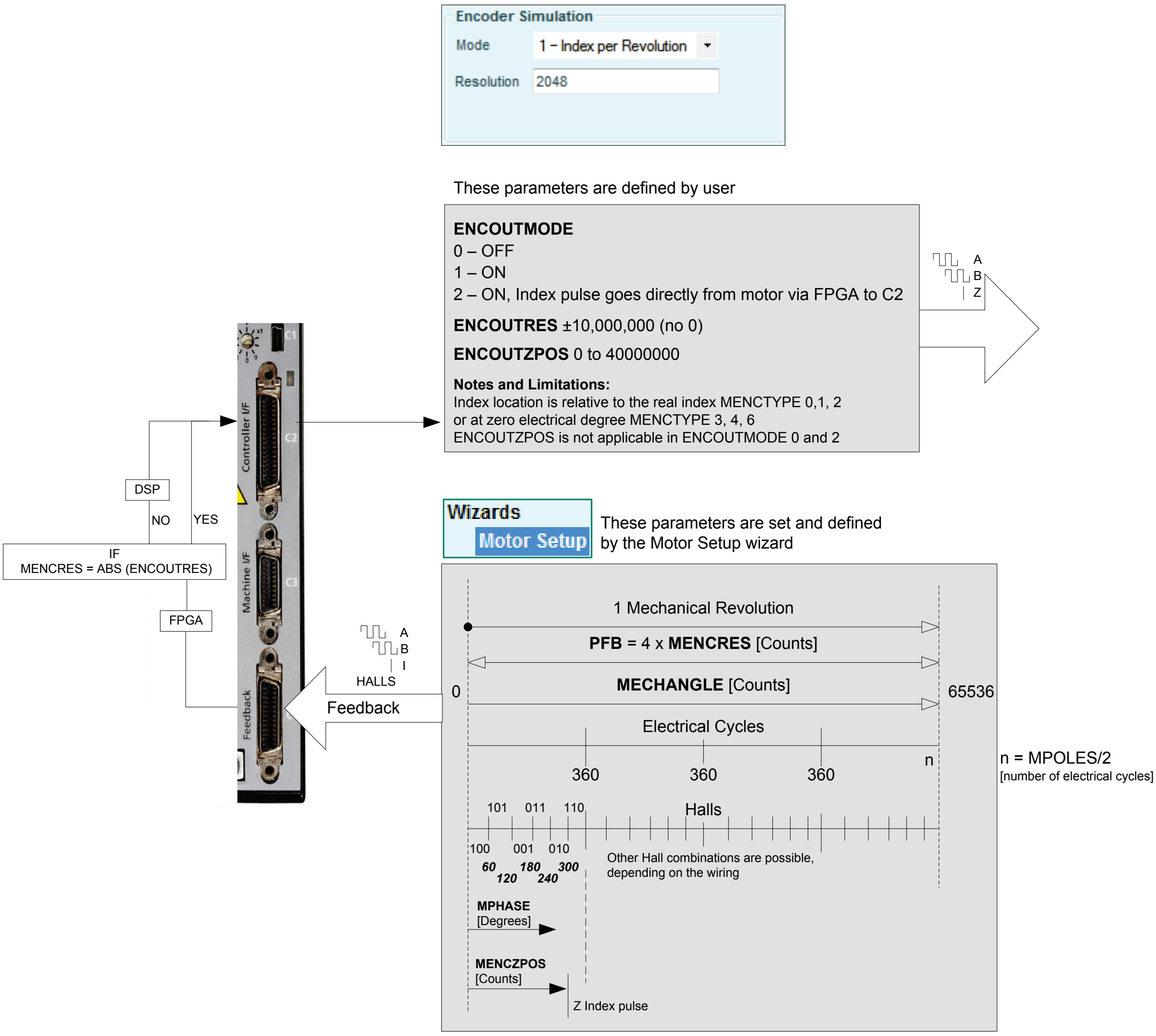


Figure 5-21. Encoder Simulation Output Process

5.8.5 EnDat 2.2 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.

FLEXI PRO 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 FLEXI PRO; accordingly, all EnDat 2.2 capable devices will work with FLEXI PRO.

EnDat 2.x can be used with the FLEXI PRO 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.
- **EnDat 2.x with Sine/Cosine**: for setups in which (a) the drive performs encoder initialization and uses the serial data for position initialization, and (b) position update during operation is derived from the sine/cosine signals.

Notes:

- FLEXI PRO does not support the ability to query and set parameters during position-feedback operations.
- FLEXI PRO communication rate is 2 MHz.

5.9 Motion Units

The **Motion Units** screen lets you select the units used for defining position and velocity. The selected unit can be a user preference or a property of the type of motor being used.

For details, refer to the section *Control Specifications.*

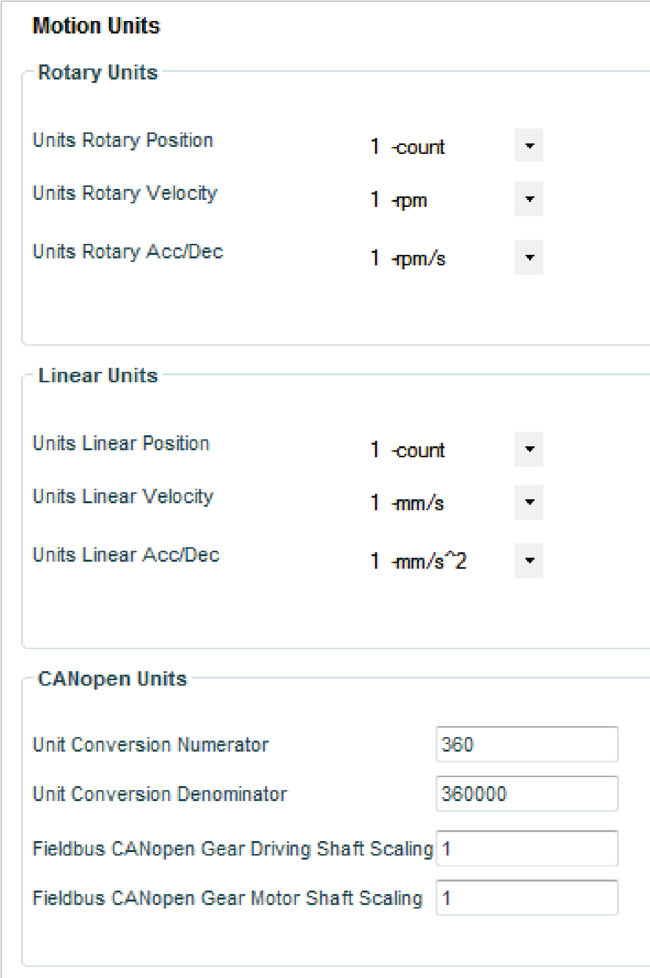


Figure 5-22. FLEXI SUITE – Motion Units Screen

Note: When FLEXI SUITE is communicating with the drive through a CAN port, the Rotary Units and Linear Units panes are not displayed.

Rotary Units	**Position**: Defines the units of position variables in a rotary system. **Velocity**: Defines the units of velocity variables in a rotary system. **Acc/Dec**: Defines the units of acceleration and deceleration variables in a rotary system. Refer to VarCom UNITSROTPOS, UNITSROTVEL and UNITSROTACC.
Linear Units	**Position**: Defines the units of position variables in a linear system. **Velocity**: Defines the units of velocity variables in a linear system. **Acc/Dec**: Defines the units of acceleration and deceleration variables in a linear system. Refer to VarCom UNITSLINPOS, UNITSLINVEL and UNITSLINACC.

CANopen Units	CANopen has two objects, each with two sub-indices, for setting the gear ratio and the feed constant values. These objects have four equivalent FLEXI PRO (VarCom) variables, which appear in this pane. By defining the gear ratio and feed contant values in FLEXI SUITE, they will be converted into values correctly recognized by a drive operating in a CANopen network. **Unit Conversion Numerator** (VarCom PNUM) and the **Unit Conversion Denominator** (VarCom PDEN) are 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 (VarCom MOTORTYPE). **Fieldbus CANopen Gear Driving Shaft Scaling** (VarCom FBGDS): The conversion factor of the fieldbus device's motor shaft revolution. **Fieldbus CANopen Gear Motor Shaft Scaling** (VarCom FBGMS): The conversion factor of the fieldbus device's **drive** shaft revolution. The relationship is as follows: $\frac{PNUM}{PDEN} \times \frac{FBGMS}{FBGDS} = \mathrm{Resolution}$ Refer to the *FLEXI PRO CANopen for CAN and EtherCAT Drives Reference Manual.*

5.10 Limits

The **Limits** screen has three tabs:

- Current Limit
- Velocity Limit
- Position Limit

5.10.1 Current Limit

The **Current Limit** screen contains a diagram that shows how the maximum current for the system is determined, and enables you to set the current limit for your application.

For instructions on using the schematic interface, refer to the section *Schematic Diagrams*.

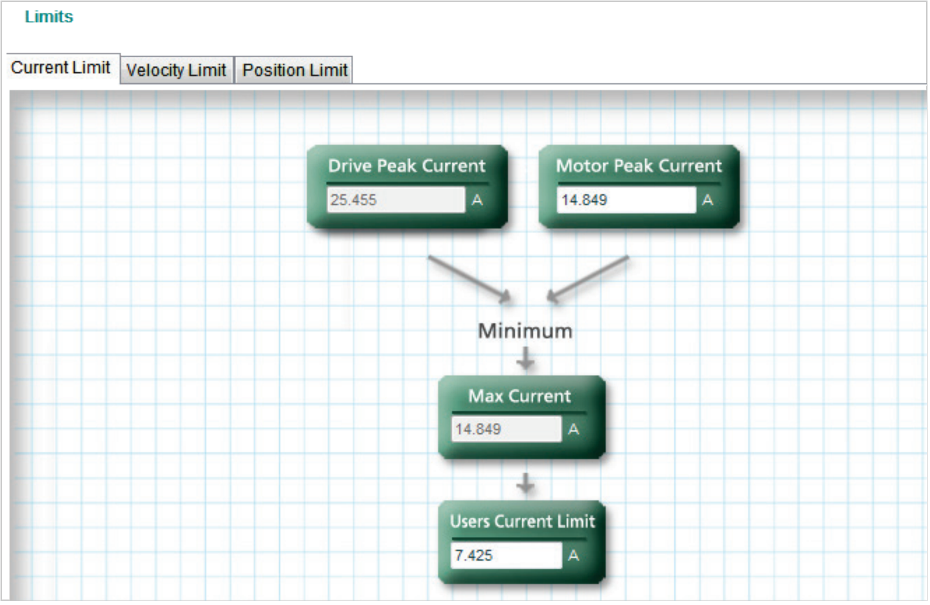


Figure 5-23. FLEXI SUITE – Current Limit Screen

Drive Peak Current	Hard-coded in the drive. Read only. Refer to VarCom DIPEAK.
Motor Peak Current	This value is obtained from the motor datasheet. It can be manipulated. Refer to VarCom MIPEAK. If modified, CONFIG is required.
Maximum Current	This value is the maximum current calculated by the software. Read only. Refer to VarCom IMAX.
User Current Limit	You can set a value lower than the Maximum Current as the application current limit. Refer to VarCom ILIM.

Analog Current Limit (Optional)

- When a second analog input is available on a FLEXI PRO unit, Analog Input 2 can be used as an analog current limit. The variable ANIN2MODE defines whether or not the drive is operating in analog current limit mode.
- The variable ANIN2ISCALE is used to scale the current limit.

The valid input voltage range for this functionality is 0-10 V, since current and current limits in the drive are positive values only. A negative analog input will be interpreted as zero.

- Effective drive current is limited to the minimum of ILIM and the analog current limit.
- The variable ILIMACT can be used to read the effective current limit (minimum of ILIM and the analog current limit).

Refer to the section *Analog Inputs*.

5.10.2 Velocity Limit

The **Velocity Limit** screen contains a diagram that shows how the maximum velocity for the system is determined, and enables you to set the velocity limit for your system accordingly.

For instructions on using the schematic interface, refer to the section *Schematic Diagrams*.

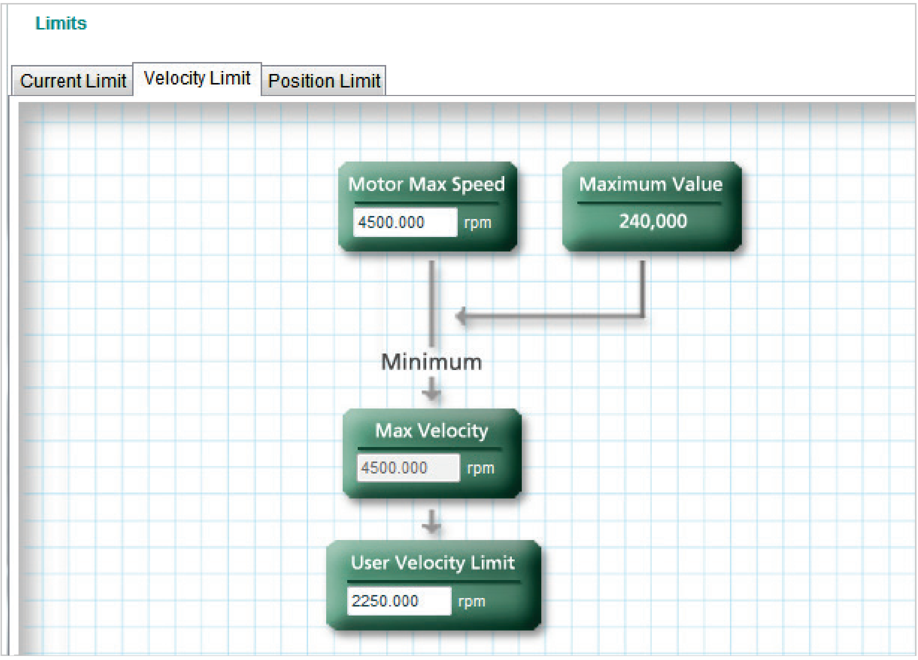


Figure 5-24. FLEXI SUITE – Velocity Limit Screen

Motor Maximum Speed	The motor maximum speed is obtained from the motor datasheet. Refer to VarCom MSPEED. If modified, CONFIG is required.
Maximum Value	The maximum speed that the FLEXI PRO is able to compute. This value is hard-coded in the drive.
Maximum Velocity	The maximum allowed motor velocity is computed according to the values of the two preceding parameters. Read only. Refer to VarCom VMAX.
User Velocity Limit	The maximum application velocity can be set up to the value defined by VMAX. Refer to VarCom VLIM. If modified, CONFIG is required.

5.10.3 Position Limit

The **Position Limit** screen contains elements that indicate the status of limit switches, and define if and how software position switches are used as motion limit switches.

For instructions on using the schematic interface, refer to the section *Schematic Diagrams*.

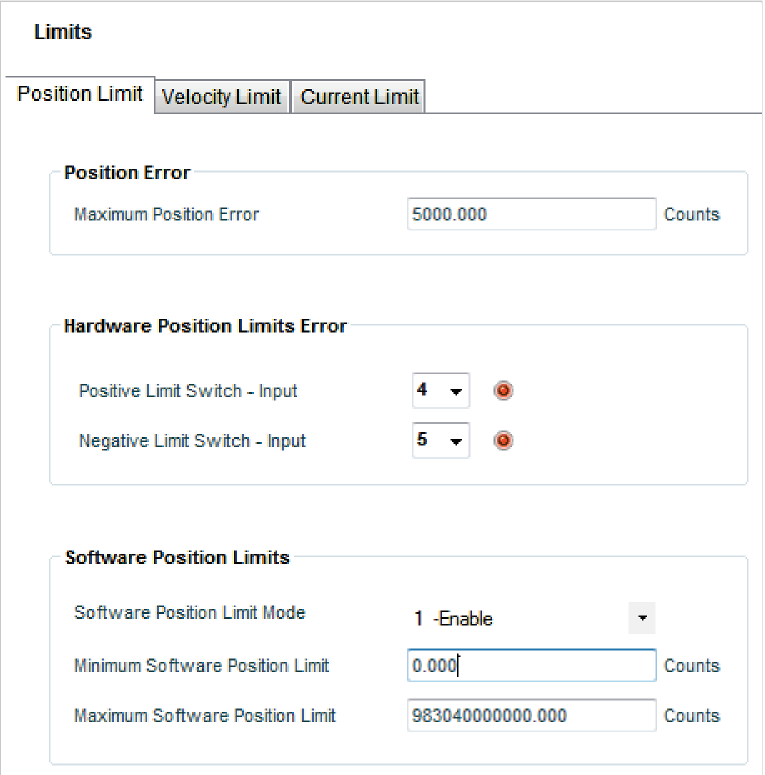


Figure 5-25. FLEXI SUITE – Position Limit Screen

Position Error	The maximum position error allowed without producing a fault; in counts. Refer to VarCom PEMAX.
Hardware Position Limits	The inputs that indicate whether position limits have been reached in the positive and negative direction. Refer to VarCom LIMSWITCHPOS and LIMSWITCHNEG.
Software Position Limits	**Mode.** Enables and disables the use of software position limits. **0** – Software position limits disabled. **1** – Software position limits enabled. Refer to VarCom POSLIMMODE. **Minimum/Maximum**. The maximum and minimum values, in counts, for the software position limits. Refer to VarCom POSLIMPOS and POSLIMNEG

5.11 Current Foldback

Current foldback is a mechanism used by FLEXI PRO to limit the root mean square (rms) value of current to the drive and/or the motor.

Current foldback is set independently for the drive and for the motor. The current foldback mechanism protects the drive and/or motor from overheating due to excessive current.

The **Foldback** screen allows you to set the foldback properties of the drive and motor, and to activate the Motor Foldback function. Drive Foldback is always activated.

For instructions on using the schematic interface, refer to the section *Schematic Diagrams*.

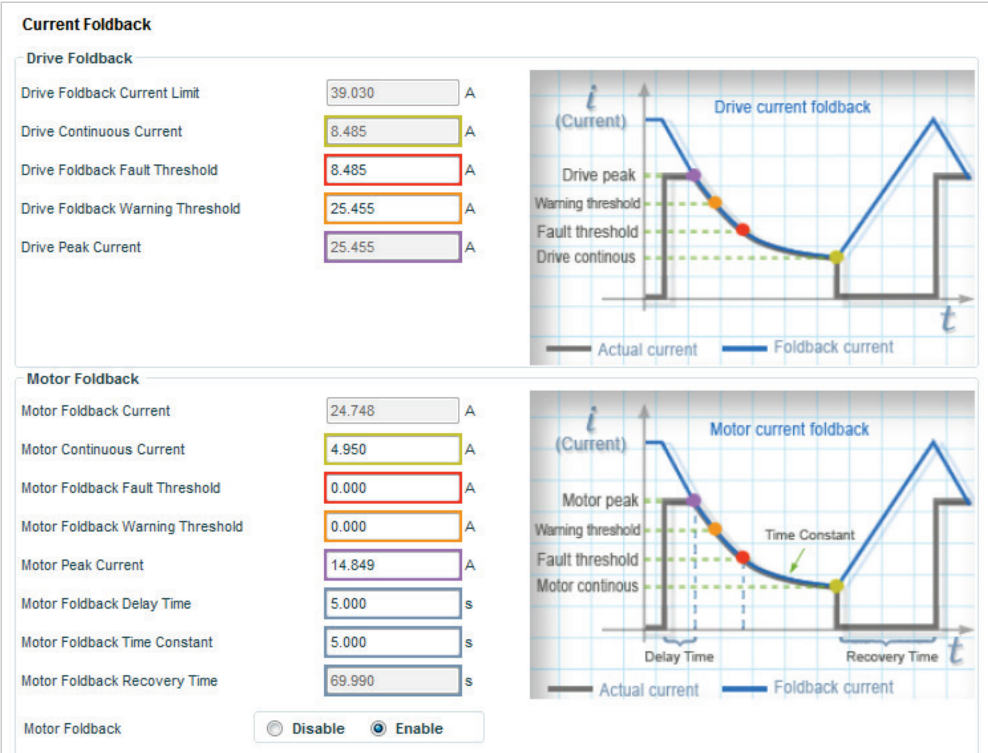


Figure 5-26. FLEXI SUITE – Current Foldback Screen

5.11.1 Drive Foldback

Drive Foldback Current	Read only. Refer to VarCom IFOLD.
Drive Continuous Current	Hard-coded in drive. Read only. Refer to VarCom DICONT.
Drive Foldback Fault Threshold	Refer to VarCom IFOLDTHRESH.
Drive Foldback Warning Threshold	Refer to VarCom IFOLDWTHRESH.
Drive Peak Current	Hard-coded in drive. Read only. Refer to VarCom DIPEAK.

5.11.2 Motor Foldback

Motor Foldback Current	Refer to VarCom MIFOLD. Read only.
Motor Continuous Current	This value is obtained from the motor datasheet. It can be manipulated. Refer to VarCom MICONT. If modified, CONFIG is required.
Motor Foldback Fault Threshold	Refer to VarCom MIFOLDTHRESH.
Motor Foldback Warning Threshold	Refer to VarCom MIFOLDWTHRESH.
Motor Peak Current	This value is obtained from the motor datasheet. It can be manipulated. Refer to VarCom MIPEAK. If modified, CONFIG is required.
Motor Foldback Delay Time	Refer to VarCom MFOLDD.
Motor Foldback Time Constant	Refer to VarCom MFOLDT.
Motor Foldback Recovery Time	Refer to VarCom MFOLDR.
Motor Foldback	Options to enable and disable the Motor Foldback function. Refer to VarCom MFOLDDIS.

5.12 Digital Inputs

The FLEXI PRO has eight regular opto-isolated inputs and three fast opto-isolated inputs.

- Regular I/Os have a propagation delay in the range of several microseconds to several tens of microseconds.
- Fast I/Os have a sub-microsecond propagation delay.

The **Digital I/Os** screen enables you to configure functionality and polarity of the digital I/Os, and to monitor the state of all digital I/Os.

The **Digital I/Os** screen has two tabs:

- Digital I/Os
- Drive Script

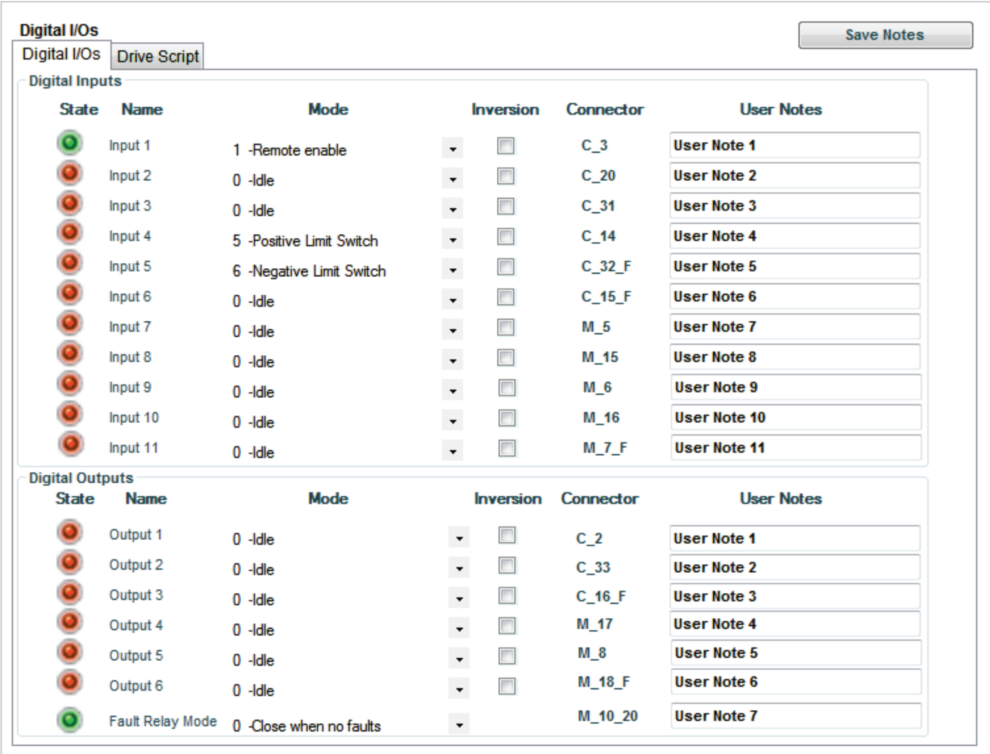
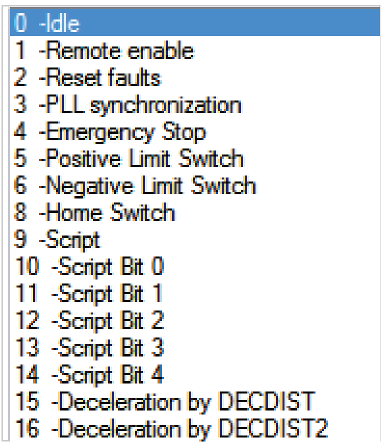


Figure 5-27. FLEXI SUITE – Digital I/Os Screen

5.12.1 Digital Inputs Configuration

The **Digital Inputs** pane enables you to configure functionality and polarity of the digital inputs, and to monitor the state of all digital inputs.

State	A graphic element that toggles between green and red to reflect the on or off state of the actual input. Refer to VarCom INPUT and INPUTS.
Name	Identifies the specific input.
Mode	Defines the functionality of the digital input. Refer to VarCom INMODE. 
	Digital input 5 includes Mode 17-Pulse signal. Digital input 6 includes Mode 18-Direction signal.

Inversion	Inverts the polarity of a digital input. Select the option to invert the polarity. As a result of inversion, the LED graphic in the software immediately changes color. Refer to VarCom ININV.
Connector	Indicates the pin number of the input on either the Controller (C) interface or the Machine (M) interface. It also indicates whether it is a fast (F) input.
User Notes	Allows you to add more specific definitions to the I/Os in your application. The **Save Notes** button saves a copy of any text you enter in the User Notes field.

5.12.2 Digital Input Activation of Drive Scripts

FLEXI SUITE **Drive Scripts** allow variations in drive behavior while a machine is running. Runtime changes, such as faster or slower acceleration, or different operation modes, can be programmed in advance and controlled by digital inputs defined for this purpose.

Drive scripts are saved in the drive, and can be viewed by means of the VarCom command DUMP.

Script Inputs

To use drive scripts, set the functionality (INMODE) of the required inputs in the Digital I/Os screen > **Digital I/Os** panel.

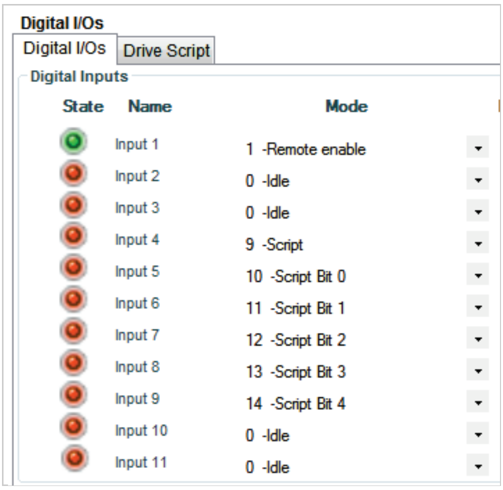


Figure 5-28. FLEXI SUITE – Digital Inputs for Scripts

- Select one input as the trigger that activates drive scripts using the option; for example, **9-Script.**
- Select up to 5 inputs that will be used to define and activate various drive scripts; for example:
  - **10**-Script Bit 0
  - **11**-Script Bit 1
  - **12**-Script Bit 2
  - **13**-Script Bit 3
  - **14**-Script Bit 4

Each input and state has a binary bit value, which is used to generate the drive script ID number (as explained below).

Drive Scripts

Use the Digital I/Os screen > **Drive Scripts** panel to define the bits whose values determine which script will run when trigger occurs.

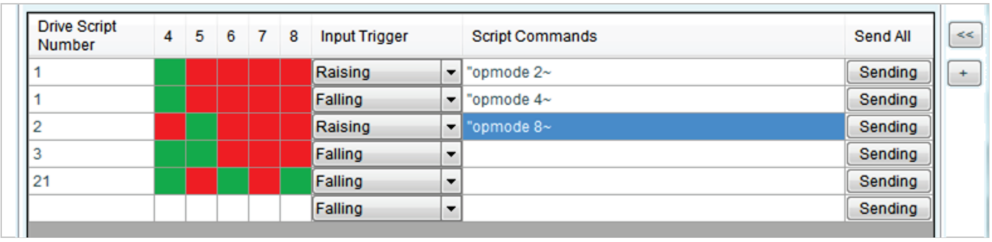
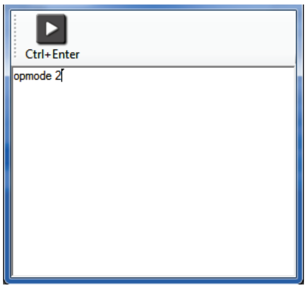


Figure 5-29. FLEXI SUITE – Digital I/Os Screen – Drive Scripts

The Drive Scripts panel opens with only one row displayed. Once data is entered in the last row, a new row is added to the table.

Drive Script Number	**Script ID** number is generated by the system according to the states defined for the physical inputs associated with the logical bits. In the example shown in the screen above: whenever input 3 changes status from 0 to 1 (rises), AND input 4 is on and inputs 5, 6, 7 and 8 are off, the drive will switch to serial current mode (OPMODE 2). Similarly, when the Bit Inputs remain as defined, but input 3 changes status from 1 to 0 (falls), the drive will switch to position mode (OPMODE 8). The Script ID number "**1**" is generated by the binary value of the bits. In this example, Input 4 represents bit 1, which is on and thus has a value of 1. The Script ID number "**21**" is generated by the binary value of bit 1 (input 4), bit 3 (input 6) and bit 5 (input 8); in other words, 1+4+8=21.
[*Bit Input state*]	The color of the cell represents the state of the physical input/logical bit (IN). ■ **Red** cell: input must be **off** for script to run. ■ **Green** cell: input must be **on** for script to run. ■ **White** cell: the input is **not defined** as a Script ID bit. ■ **Blue** cell is simply the currently selected cell. Click repeatedly on a Bit Input cell to toggle the states on/off/not defined.

Input Trigger	Each Script ID can have one or two associated scripts. One script is executed when the trigger signal rises (input state changes from off to on); the other is executed when the trigger signals falls (input state changes from on to off). Thus, up to 64 drive scripts can be defined and executed. Only one drive script is triggered and executed at a time. A drive script is executed when both of the following conditions exist: ■ The trigger signal rises or falls, as defined for the specific script. ■ The inputs associated with the bits are either on or off, as defined by the specific script.
Script Command	Double-click in the **Script Commands** cell. A Drive Script dialog box opens.  Enter a command or a set of commands. Use **Ctrl+Enter** to write to the table and close the dialog box.
Send All	Click **Send All** to send all scripts to the drive.

5.13 Digital Outputs

The FLEXI PRO has four regular opto-isolated outputs and two fast opto-isolated outputs.

- Regular I/Os have a propagation delay in the range of several microseconds to several tens of microseconds.
- Fast I/Os have a sub-microsecond propagation delay.

The **Digital Outputs** pane in the **Digital I/Os** screen enables you to configure functionality and polarity of the digital outputs, and to monitor the state of all digital outputs.

State	A graphic element that toggles between green and red to reflect the on or off state of the actual output. Refer to VarCom OUT and OUTPUTS.
Name	Identifies the specific output.

Mode	Defines the functionality of the digital output. 0 -Idle 1 -Active 2 -Brake 3 -Alarm 4 -In-Position 5 -Stopped 6 -Foldback 7 -Current Level 8 -Current Range 9 -Velocity Level 10 -Velocity Range 11 -Position Level 12 -Position Range 13 -Battery Low V Fault 14 -Warning On 15 -Faults or Disabled 16 -Battery Low V Warning or Fault 17 -Phase Find (Mode 2) OK 18 -Over-Current Fault 19 -Over-Voltage Fault 20 -Under-Voltage Fault 21 -Phase Find Required 22 -Alarm w/o Phase Find Failed 23 -Homing complete 24 -Encoder Simulation Index 25 -Zero Position After Homing Refer to VarCom OUTMODE.
Connector	Indicates the pin number of the input on either the Controller (C) interface or the Machine (M) interface. It also indicates whether it is a fast (F) input.
User Notes	Allows you to add more specific definitions to the I/Os in your application. The **Save Notes** button saves a copy of any text you enter in the User Notes field.

5.14 Analog Inputs

The FLEXI PRO supports either one 16-bit analog input or two 14-bit analog inputs. Both types of inputs are differential.

Note: One of the digits in the FLEXI PRO part number indicates whether the drive supports one or two analog inputs.

The analog input is used to send commands to the drive by means of analog voltage. The analog commands can control the velocity of the motor or the current to the motor. Analog commands can be used when the FLEXI PRO is operating in Analog Velocity mode (OPMODE 1) or Analog Current mode (OPMODE 3).

Refer to the sections *Analog Velocity Mode* and *Analog Current Mode*.

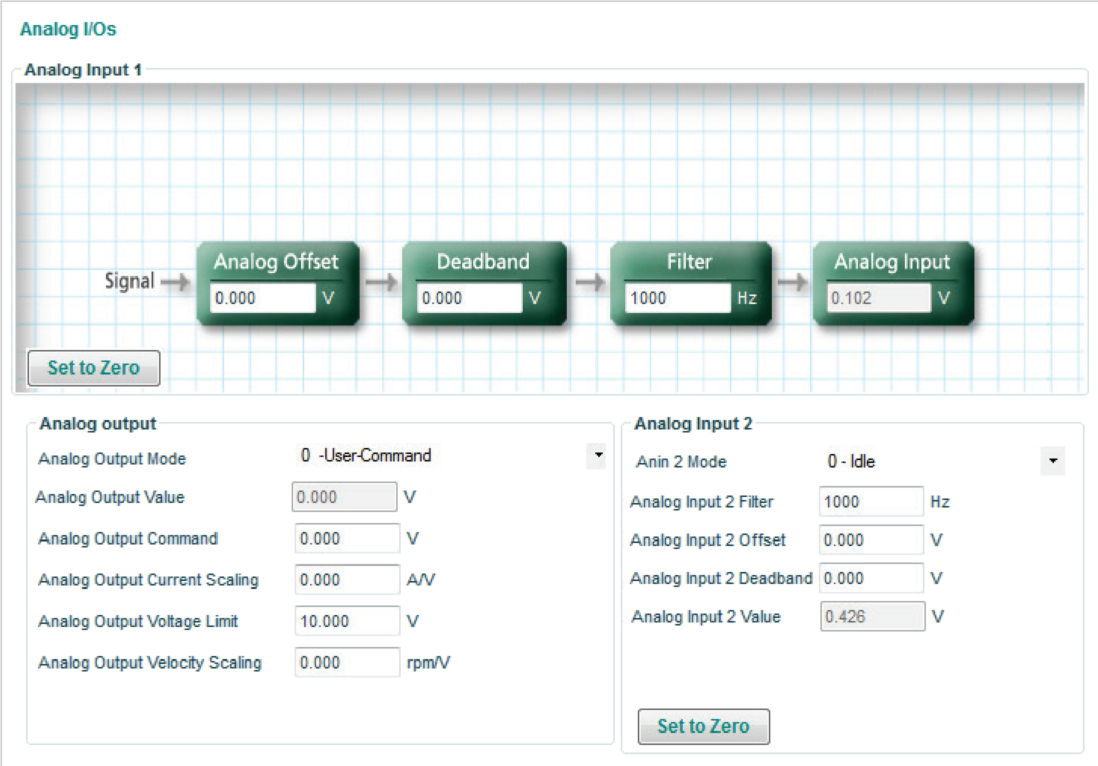


Figure 5-30. FLEXI SUITE – Analog I/Os Screen

5.14.1 Analog Input 1

The primary analog input, **Analog Input 1**, is connected at pins 8 and 26 of the Controller I/F connector. It serves as the analog command for the Analog Velocity (OPMODE 1) and Analog Current (OPMODE 3) operating modes. The functionality of this analog input cannot be changed.

The **Analog Input 1** pane in the **Analog I/Os** screen allows you to set the analog input properties and to monitor the input state.

For instructions on using the schematic interface, refer to the section *Schematic Diagrams*.

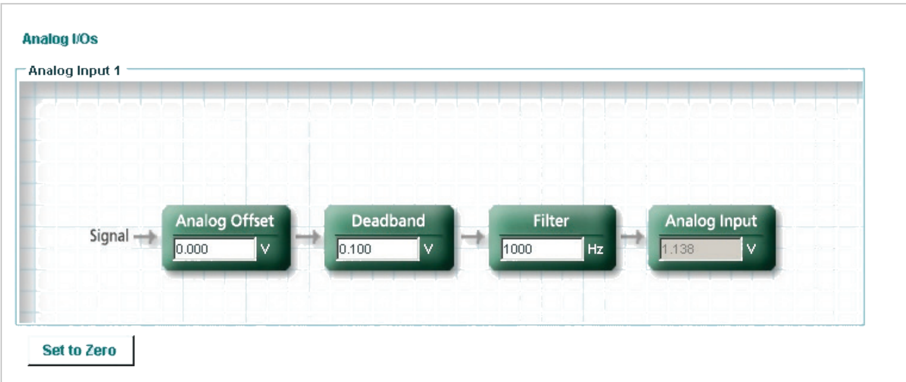


Figure 5-31. FLEXI SUITE – Analog I/Os Screen – Analog Input 1

Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN1OFFSET. The FLEXI PRO can receive an analog input signal in the range of ±10V. The drive uses the value stored in the ANIN1 variable to command the velocity of the motor or the current applied to the motor. The default correlation between the actual input signal and the value of ANIN1 is ±10V = ±10000 mV. However, some applications provide, or require, a different analog input signal range. The FLEXI PRO analog offset function (ANIN1OFFSET) modifies the range correlation of the analog input signal and the velocity loop command (ANIN1). However, the value of ANIN1 remains ±10V; the upper value cannot be greater than 10V and the lower value cannot be less than -10V. For example, if ANIN1OFFSET = 5000, an analog input signal range of ±10V equates to a command range of -5000 mV to +10000 mV. Motor movement is in response to a range of -5V to 10V on the input. ANIN1OFFSET units are defined in volts.
Deadband	The deadband range of analog input 1. Refer to VarCom ANIN1DB. The FLEXI PRO allows the setting of a deadband range for which no analog command is generated. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. If ANIN1DB = 0.6, for example, the actual deadband range is -600 mV to +600 mV, and no motor movement occurs when the analog input voltage is within this range. ANIN1DB units are defined in volts.
Filter	A low-pass filter applied to the analog input. Refer to VarCom ANIN1LPFHZ. The FLEXI PRO provides a first-order filter on the front end of the analog input. This is useful for filtering out high frequency noise from the analog input, or for limiting the rate of change of that signal. The ANIN1LPFHZ value represents the corner frequency of the filter. This filter is always present and is adjusted automatically as the analog input sampling rate changes for different operational modes. ANIN1LPFHZ is defined in hertz.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN1.
Set to Zero	The FLEXI PRO has automatic analog input zeroing function, which causes the value of the analog input 1 signal to become 0 by modifying the analog offset value. The command samples the analog input 64 times, calculates an average, and then adjusts IN1OFFSET to cancel out any input offset that may be present from such factors as drift and noise. Refer to VarCom ANIN1ZERO.

5.14.2 Analog Input 2

Analog Input 2 appears in the **Analog I/Os** screen only when the connected drive has a second analog input.

The **second analog input** is connected at pins 18 and 35 of the Controller I/F connector.

When the second analog input is set up (using ANIN2MODE) to be an analog current limit, ANIN2SCALE sets the scaling of the current limit in units of amperes per volt. Refer to the section *Analog Current Limit.*

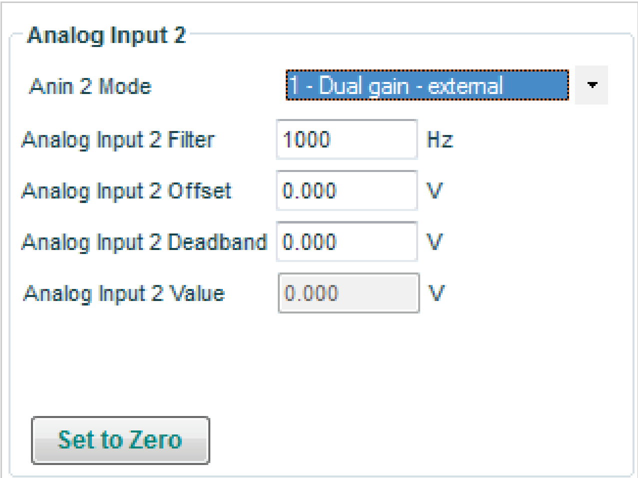


Figure 5-32. FLEXI SUITE – Analog I/Os Screen – Analog Input 2

In addition to the descriptions below, refer also to the section *Analog Input 1*.

Anin 2 Mode	Defines the functionality of the second input. Refer to VarCom ANIN2MODE
Analog Input 2 Filter	This value is a low-pass filter applied to the analog input. This is useful for filtering high frequency noise from the input, or for limiting the rate of change of that signal. Refer to VarCom ANIN2LPFHZ.
Analog Input 2 Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN2OFFSET.
Analog Input 2 Deadband	The deadband range of analog input 2. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. Refer to VarCom ANIN2DB.
Analog Input 2 Value	The voltage at the analog input. Read only. Refer to VarCom ANIN2.
Set to Zero	Causes the value of the analog input 2 signal to become 0 by modifying the analog offset value. Refer to VarCom ANIN2ZERO.

5.14.3 Using Analog Inputs as Velocity Command and Current Limit

Use the following procedure in FLEXI SUITE to configure the FLEXI PRO to work with **analog input 1** as the velocity command and **analog input 2** as the current limit.

1. Define the Operation Mode.

Activate the **Motion** screen, and select Operation mode: **Analog Velocity** (OPMODE 1).

When working in Analog Velocity mode, a signal is applied to analog input 1, and the drive translates it into a velocity command.

2. Define the Velocity command scaling.

Velocity command scaling is a user-defined ratio, which the drive uses to translate the analog input into a velocity command.

In the example shown here, scaling is set to generate a velocity command of 100 rpm per each volt.

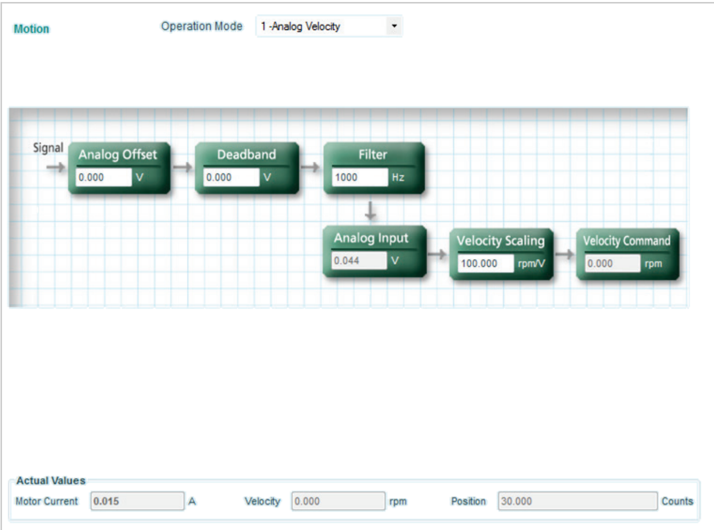


Figure 5-33. Velocity Command Scaling

3. Define the function of Analog Input 2.

Activate the **Analog I/Os** screen.

Define analog input 2 as the current limiter: in the **Analog Input 2** pane, select **Current Limit** mode (ANIN2MODE 2).

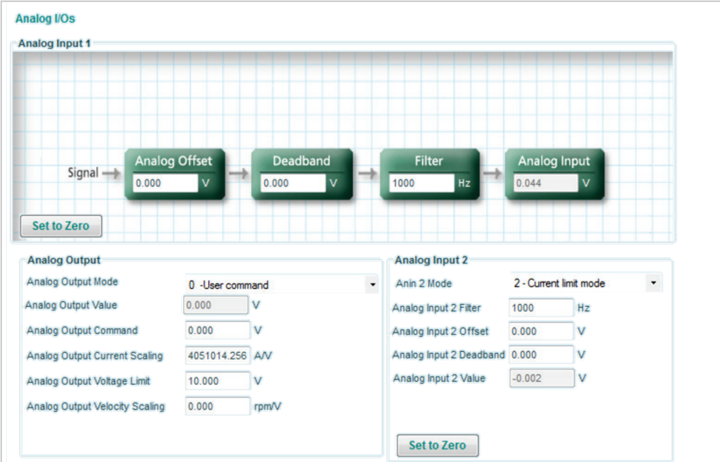


Figure 5-34. Analog Input 2 as Current Limiter

4. Define the scaling of the Analog Current command.

Activate the **Terminal** screen.

Define the parameter ANIN2ISCALE to set the scaling of the analog current command from input 2.

In the example shown here, scaling is 0.5A per each volt. The drive will calculate the current limit accordingly.

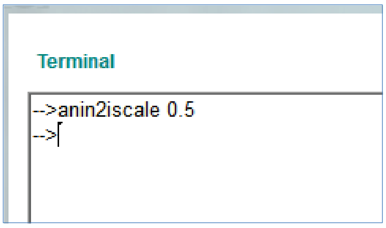


Figure 5-35. Analog Current Scaling

Note: Since both drive parameter ILIM and analog input 2 define current limit, the drive recognizes the lower value of the two as the current limit at any given time. To read the actual limit, use ILIMACT.

Note: Drive parameters ACC and DEC provide the limits for acceleration and deceleration, respectively. If analog input 1 (when used for velocity commands) generates a rate greater than ACC or DEC, the drive will not exceed the values of ACC and DEC.

5.15 Analog Output

The FLEXI PRO also has an analog output that can be set to output a voltage equivalent to the value of certain parameters.

Note: This function cannot be used when FLEXI SUITE is communicating with the drive through a CAN port.

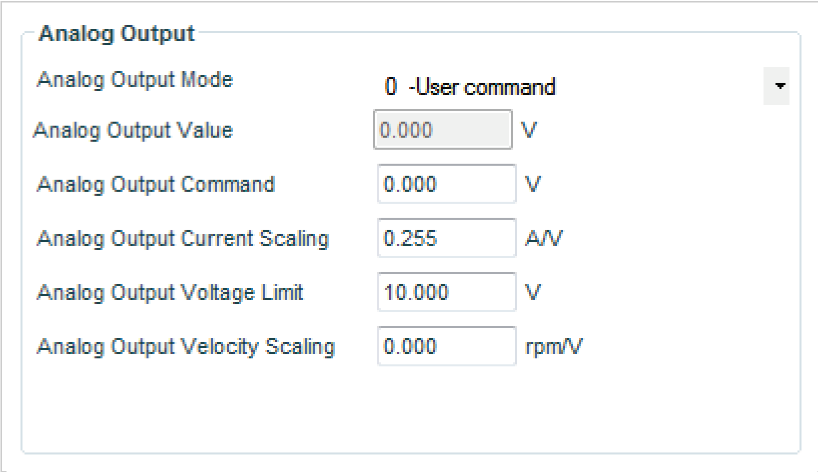
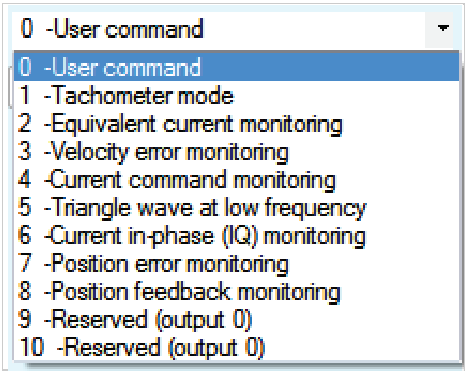


Figure 5-36. FLEXI SUITE – Analog I/Os Screen – Analog Output

Analog Output Mode	Defines the function of the analog output.  Refer to VarCom ANOUTMODE.
Analog Output Value	Displays the analog output value (in volts), as set by ANOUTMODE. Read only field. Refer to VarCom ANOUTMODE.
Analog Output Command	The analog output command (in volts) set by user in ANOUTMODE 0. Refer to VarCom ANOUTCMD.
Analog Output Current Scaling	The scaling of the analog output voltage that represents the motor current (I) or the current command (ICMD). Refer to VarCom ANOUTISCALE.
Analog Output Voltage Limit	The analog output command voltage limit for all modes. Refer to VarCom ANOUNTVSCALE.
Analog Output Velocity Scaling	The scaling of the analog output voltage that represents the actual velocity (V) or the velocity error (VE)

5.16 Enable/Disable

5.16.1 Drive Enable

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

The **Enable & Faults** screen graphically shows the conditions required for the drive to be enabled. It allows you to clear faults and turn on Software Enable.

As long as any light in the diagram is red, the drive remains disabled. When all lights are green, the drive is enabled.

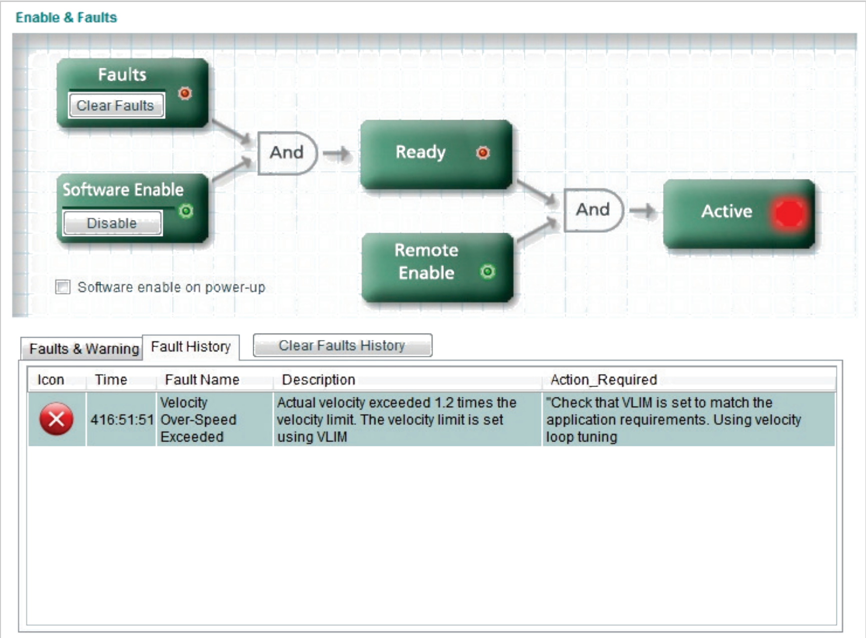


Figure 5-37. FLEXI SUITE - Enable & Faults Screen

The **Enable & Faults** screen includes the **Faults** panel which displays a list of all faults and warnings currently in effect, and a list of faults that have occurred in the present working session. For more information about warnings, faults and status messages, refer to the chapter *Troubleshooting.*

Three conditions are required for enabling the FLEXI PRO drive:

- **No Faults**. The drive can be enabled only when no faults exist. Once all faults are cleared, the drive is ready for activation (READY).
- The **Software Enable** switch must be on. This can be executed in one of the following ways:
  - The commands EN (Enable) and K (Disable) toggle the state of Software Enable.
  - The **Enable|Disable** button in FLEXI SUITE toggles the Software Enable switch, provided that no faults exist.

  By default, the drive powers up in the Software Enable **off** state. It can be set to power up in the **on** state by the variable SWENMODE. The variable SWEN returns the state of Software Enable.

Note: For SWENMODE to take effect, the variable COMMODE must be set to 0.

If Software Enable is on at power up, the drive can be enabled and disabled solely by means of the Remote Enable signal.

- The **Remote Enable** signal must be on. Remote Enable is a signal in the range of 5—24 VDC that is applied to one of the opto-isolated digital inputs in the Controller I/F connector.

  If no input is configured for this function, the Remote Enable signal remains on, and the drive can be enabled and disabled solely by the commands EN (Enable) and K (Disable).

  The variable INMODE is used to configure the input that provides the Remote Enable function. The variable REMOTE returns the state of the Remote Enable signal.

5.16.2 Clearing Faults

After a fault condition is removed, the fault remains latched until cleared by any of the following methods:

- A Clear Faults command:
  - The **Clear Faults** button in the FLEXI SUITE Enable & Faults screen.
  - The command CLEARFAULTS.
- Toggling the Enable state of the drive:
  - Toggling the **Software Enable** button in the FLEXI SUITE Enable & Faults screen.
  - Toggling the Remote Enable input.

Once all faults are cleared, the drive is ready for activation (READY).

5.16.3 Fault History

The drive stores a log of the ten most recent faults. Use the Fault History tab to view the fault log. Refer to VarCom FLTHIST.

The **Clear Faults History** button is displayed when the log contains a fault. Refer to VarCom FLTHISTCLR.

Note: When FLEXI SUITE is communicating with the drive through a CAN port, no data is displayed in the Fault History **Time** field.

5.17 Homing

The Homing screen allows you to select the methods and parameters to be used for homing the motor, and to initiate and monitor the homing process.

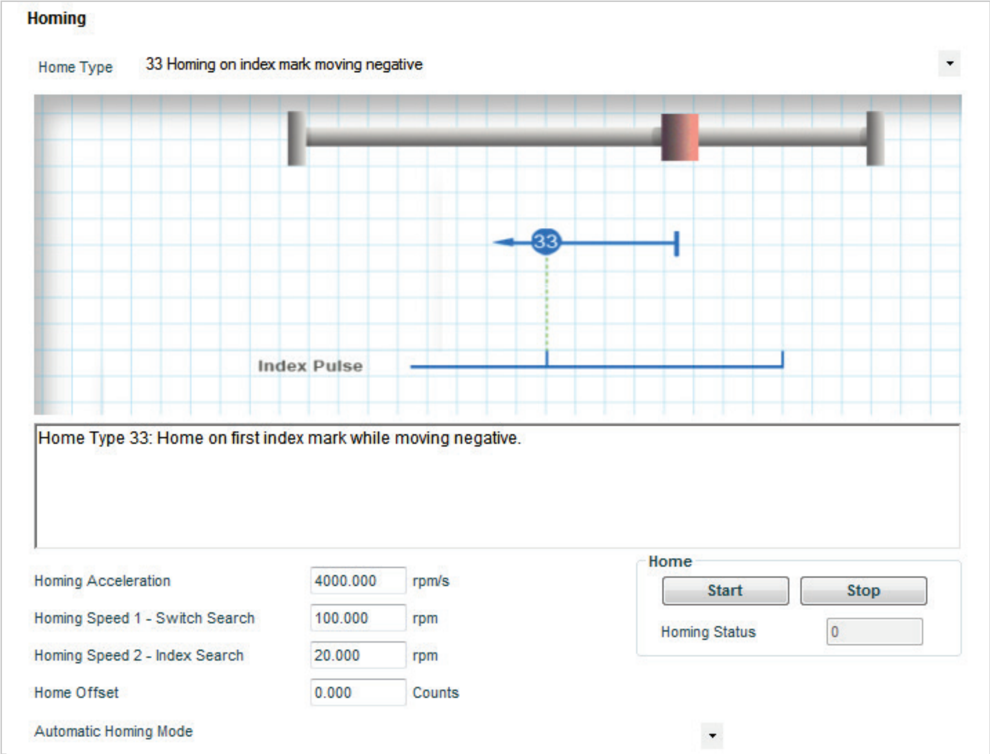


Figure 5-38. FLEXI SUITE - Homing Screen

Home Type	Allows you to select any one of 35 homing methods, per the CANopen standard. For more information about homing methods, refer to the document *CANopen Device Profile Drives and Motion Control (CiA Draft Standard Proposal 402)*.
[*graphic*]	A graphic display representing the method selected for the homing process.
[*description*]	A description of the selected homing method.
Acceleration	The value of acceleration and deceleration during the homing process. Refer to VarCom HOMEACC.
Homing Speed 1 – Switch Search	The velocity used during search for the home switch. Refer to VarCom HOMESPEED1.
Homing Speed 2 – Index Search	The velocity used during search for the index signal. Refer to VarCom HOMESPEED2.
Home Offset	Sets an offset, in counts, for the Home position. Refer to VarCom HOMEOFFSET.
Home	**Start** – Starts the homing process. Refer to VarCom HOMECMD. **Stop** – Stops the homing process.
Homing Status	Displays the current state of the system. 0 = Homing idle

	1 = Homing setup
	2 = Homing configuration
	3 = Homing initial state detection
	4 = Homing initial direction move
	5 = Homing seek first switch
	6 = Homing flip first switch move
	7 = Homing seek flip first switch
	8 = Homing seek home switch move
	9 = Homing seek home switch
	10 = Homing off home switch move
	11 = Homing seek off home switch
	12 = Homing on home switch move
	13 = Homing seek trigger conditions
	14 = Homing trigger arming
	15 = Homing seek trigger
	16 = Homing set home offset
	17 = Homing move zero position
	18 = Homing reached
	19 = Homing completed
	20 = Homing failed
	Refer to VarCom HOMESTATE

5.18 Autotuning Wizard

FLEXI PRO has two position control loop options – linear and HD (nonlinear) control. The HD control algorithm is designed to minimize position error during motion and to minimize settling time at the end of motion. The Autotuning Wizard is used to set the initial HD controller parameters.

Refer to the section *HD (Nonlinear Position) Controller.*

The 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/s^2 for rotary motors, mm/s^2 for linear motors

Step 1 – Load Estimation

1. For automatic load estimation, select **Move** and estimate load inertia.
   or
   If you know the inertia of the load connected to the motor, select **Known Load Inertia**, and enter the value.
   or
   Select the option to **start with parameters already in drive**.
2. Click **Start**.

   Start enables the drive and moves the motor!

FLEXI SUITE estimates the load currently on the motor, and displays the results.

3. Click **OK** to send the calculated parameters to the drive.
4. Click the Next arrow to continue.

Step 2 – 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. Click **Start**.

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

   The motor moves back and forth continuously, while FLEXI SUITE 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 click **Start** to repeat the test.

Step 3 – Test Quality of Motion

1. Click **Move and Plot** to send a Current command to the drive and plot the step response.

   ⚠ **Move and Plot** enables the drive and moves the motor!

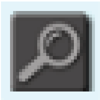
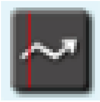
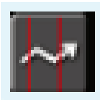
2. When the plot appears, click **Stop**.

   The graph 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.

Note: The velocity and the position error graphs are scaled so that both fit into the frame. The Y-axis is marked in units of position error (counts).

The screen includes three buttons that let you examine the graph more closely, and another button for exporting results to a spreadsheet. The functions are also provided in the FLEXI SUITE Scope screen.

	**Toggle Cursor to Zoom**	Toggles Zoom In and Zoom Out view of graph. When Zoom In is selected, a minus sign appears on the button. Using the left mouse button, click-and-drag to select an area on the graph for magnification.
	**Toggle Zoom to Cursor**	Cancels the cursor zoom. Hides/displays cursor line/s. When cursor is displayed, use left mouse button to select and position the cursor on the graph. Variable values at the cursor point are displayed in a floating box.
	**Select Cursor**	Displays a second cursor line. Click on the graph to position the second cursor.
	**View in Excel**	Copies recorded data to a temporary CSV file and opens Microsoft Excel to display it.

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 (KNLUSER); this is the global gain parameter for the HD (nonlinear position) control loop. A higher gain value results in stiffer control, and a lower value results in softer control.

Step 4 – Save

Do all of the following:

1. Click **Save to Drive** to save the parameters to the drive’s non-volatile memory.

2. Click **Save to File** to save the parameters to a backup file on the computer.

3. Click **Generate Report** to create a record of system settings that can be 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.

This screen has several options for managing the parameters:

Save to Drive	Saves the parameters to the drive’s non-volatile memory.
Generate Report	Opens a Report dialog box, for entering information about the application and user, and includes an option to send the report by email to technical support. **Report Generator** creates a set of csv and txt files with a zip file, which can be sent to technical support and/or kept for reference. Refer to the section *Reports*.
Save to File	Opens a **Save as** dialog box. Writes parameters from the drive RAM to a file on the PC. 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.

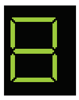
6 Motion

6.1 Operation Modes

The FLEXI PRO can work in a number of operation modes. Each operation mode has a primary control loop (current, velocity or position) and a source of the command being recognized (analog or serial input). Analog Velocity mode, for example, indicates that the primary control loop is velocity and the drive will respond to a ±10 VDC analog command applied to the main analog input.

The operation mode is set using the variable OPMODE. The mode in effect is indicated on the 7-segment display by a steadily-lit single digit, as shown in the table below.

Table 6-1. Operation Modes

Display	VarCom	Description	Drive Enabled	Drive Disabled
.		Drive enabled		
0	OPMODE 0	Serial velocity control mode		
1	OPMODE 1	Analog velocity control mode		
2	OPMODE 2	Serial current control mode		
3	OPMODE 3	Analog current control mode		
4	OPMODE 4	Master/slave gearing control mode		
8	OPMODE 8	Position control mode		

Use the **Motion** screen to choose the operation mode and to set the relevant motion settings.

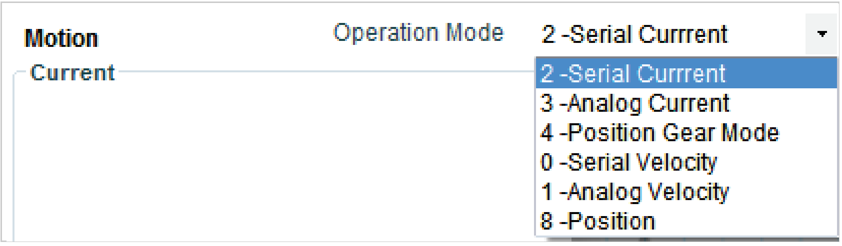


Figure 6-1. FLEXI SUITE – Motion Screen – Operation Modes

The Motion screen allows you to execute motion and to view the actual values of current, velocity and position. This is not real-time data, however, and the update rate depends on such factors as the host computer processing power and the drive mode of operation.

The schematic diagram and information displayed in the Motion screen varies according to the selected **Operation mode**.

Note: When FLEXI SUITE is communicating with the drive through a CAN port, FLEXI SUITE displays the list of standard CAN operation modes. However, the drive's 7-segment display always shows the serial communication operation modes, as defined in the drive firmware.

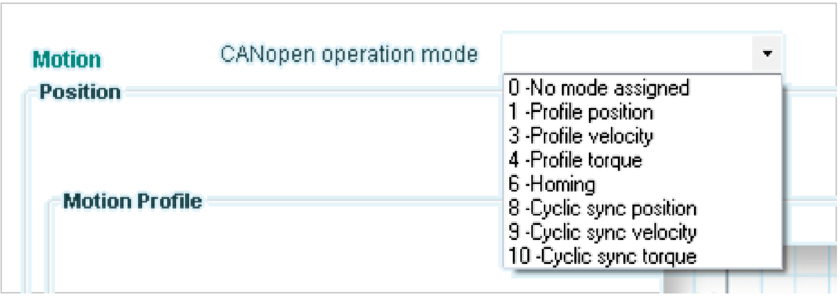


Figure 6-2. FLEXI SUITE – Motion Screen – CANopen Operation Modes

6.2 Analog Current Mode

In the Motion screen select Operation Mode **3 – Analog Current** to display the schematic and variables that affect the Analog Current command.

When operating in Analog Current mode (OPMODE 3), only the FLEXI PRO's current loop is active, and the drive responds to analog commands from the primary analog input, connected at pins 8 and 26 of the Controller I/F connector.

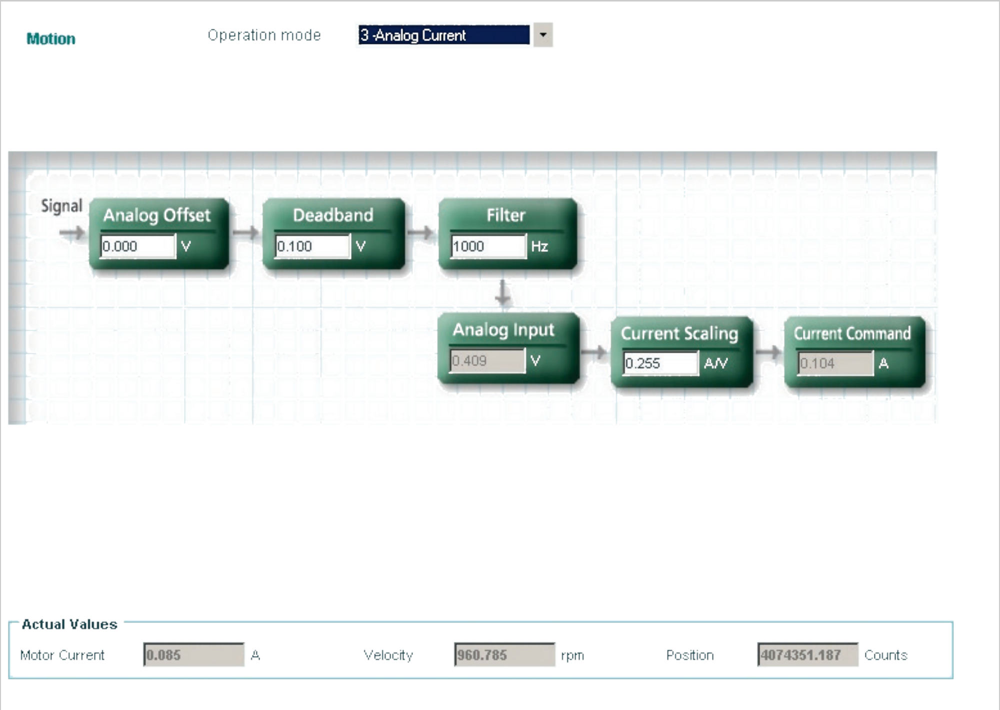


Figure 6-3. FLEXI SUITE – Motion Screen – Analog Current Mode

For instructions on using the schematic interface, refer to the section *Schematic Diagrams*.

In addition to tuning the current loop, certain drive variables need to be set.

Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN1OFFSET. The FLEXI PRO can receive an analog input signal in the range of ±10V. The drive uses the value stored in the ANIN1 variable to command the velocity of the motor or the current applied to the motor. The default correlation between the actual input signal and the value of ANIN1 is ±10V = ±10000 mV. However, some applications provide, or require, a different analog input signal range. The FLEXI PRO analog offset function (ANIN1OFFSET) modifies the range correlation of the analog input signal and the velocity loop command (ANIN1). However, the value of ANIN1 remains ±10V; the upper value cannot be greater than 10V and the lower value cannot be less than -10V. For example, if ANIN1OFFSET = 5000, an analog input signal range of ±10V equates to a command range of -5000 mV to +10000 mV. Motor movement is in response to a range of -5V to 10V on the input. ANIN1OFFSET units are defined in volts.
Deadband	The deadband range of analog input 1. Refer to VarCom ANIN1DB. The FLEXI PRO allows the setting of a deadband range for which no analog command is generated. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. If ANIN1DB = 0.6, for example, the actual deadband range is -600 mV to +600 mV, and no motor movement occurs when the analog input voltage is within this range. ANIN1DB units are defined in volts.
Filter	A low-pass filter applied to the analog input. Refer to VarCom ANIN1LPFHZ. The FLEXI PRO provides a first-order filter on the front end of the analog input. This is useful for filtering out high frequency noise from the analog input, or for limiting the rate of change of that signal. The ANIN1LPFHZ value represents the corner frequency of the filter. This filter is always present and is adjusted automatically as the analog input sampling rate changes for different operational modes. ANIN1LPFHZ is defined in hertz.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN1.

Current Scaling	Current scaling affects how the motor current varies relative to any change in voltage at the analog input command. When the first analog input is used as the command for the current loop, it is important to set the scaling, that is, the ratio of the analog input voltage to the command that the drive interprets. For example, ANIN1ISCALE = 0.1 will produce a change of 0.1A to the motor for every 1V change. Refer to VarCom ANINISCALE.
Current Command	The resulting Current command. Refer to VarCom ICMD.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.3 Analog Velocity Mode

In the Motion screen select Operation Mode **1 – Analog Velocity** to display the schematic and variables that affect the Analog Velocity command.

When operating in Analog Velocity mode (OPMODE 1), the FLEXI PRO's current **and** velocity loops are active, and the drive responds to analog commands from the primary analog input, connected at pins 8 and 26 of the Controller I/F connector.

The commanded velocity is subject to a limit on the acceleration, defined by the variable ACC.

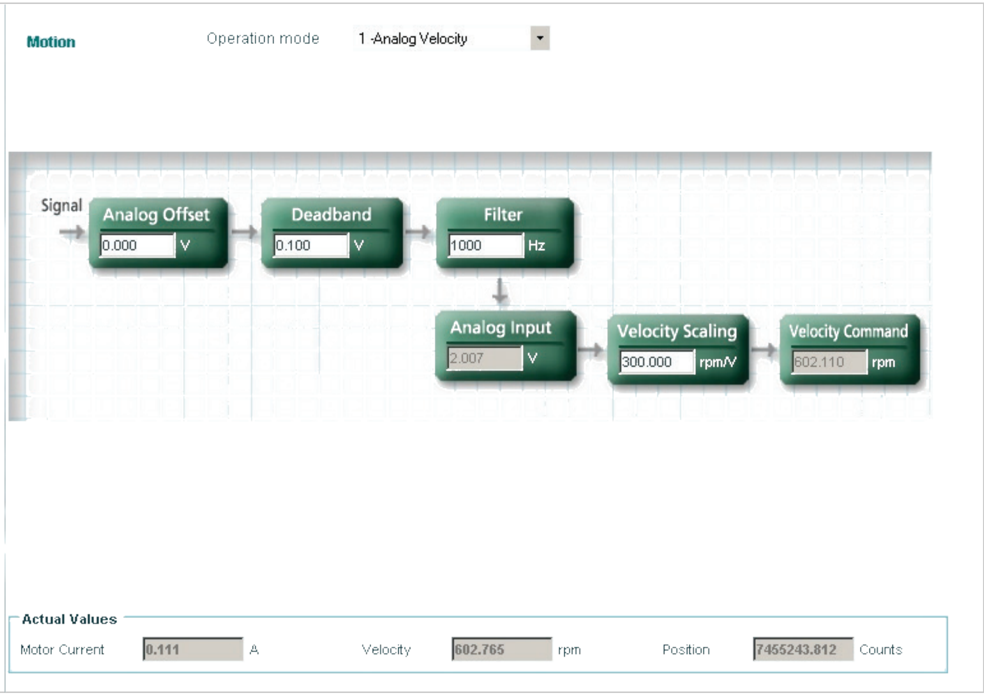


Figure 6-4. FLEXI SUITE – Motion Screen – Analog Velocity Mode

In addition to tuning the current and velocity loops, certain drive variables need to be set.

Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN1OFFSET. The FLEXI PRO can receive an analog input signal in the range of ±10V. The drive uses the value stored in the ANIN1 variable to command the velocity of the motor or the current applied to the motor. The default correlation between the actual input signal and the value of ANIN1 is ±10V = ±10000 mV. However, some applications provide, or require, a different analog input signal range. The FLEXI PRO analog offset function (ANIN1OFFSET) modifies the range correlation of the analog input signal and the velocity loop command (ANIN1). However, the value of ANIN1 remains ±10V; the upper value cannot be greater than 10V and the lower value cannot be less than -10V. For example, if ANIN1OFFSET = 5000, an analog input signal range of ±10V equates to a command range of -5000 mV to +10000 mV. Motor movement is in response to a range of -5V to 10V on the input. ANIN1OFFSET units are defined in volts.
Deadband	The deadband range of analog input 1. Refer to VarCom ANIN1DB. The FLEXI PRO allows the setting of a deadband range for which no analog command is generated. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. If ANIN1DB = 0.6, for example, the actual deadband range is -600 mV to +600 mV, and no motor movement occurs when the analog input voltage is within this range. ANIN1DB units are defined in volts.
Filter	A low-pass filter applied to the analog input. Refer to VarCom ANIN1LPFHZ. The FLEXI PRO provides a first-order filter on the front end of the analog input. This is useful for filtering out high frequency noise from the analog input, or for limiting the rate of change of that signal. The ANIN1LPFHZ value represents the corner frequency of the filter. This filter is always present and is adjusted automatically as the analog input sampling rate changes for different operational modes. ANIN1LPFHZ is defined in hertz.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN1.

Velocity Scaling	Velocity scaling affects how the motor speed will vary as a result of any change in voltage at the analog velocity command. When the first analog input is used as the command for the velocity loop, it is important to set the scaling, that is, the ratio of the analog input voltage to the command that the drive interprets. For example, if ANIN1VSCALE = 500 and UNITSROTVEL=1 (rpm), the result will be a variation of 500 rpm in the motor velocity for every 1V change. Refer to VarCom ANINVSCALE.
Velocity Command	The resulting Velocity command. Refer to VarCom VCMD.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.4 Serial Current Mode

In the Motion screen select Operation Mode **2 – Serial Current** to display the schematic and variables that affect the Serial Current command.

In Serial Current mode (OPMODE 2), only the FLEXI PRO's current loop is active, and the drive responds to instructions received via the USB or RS232 ports.

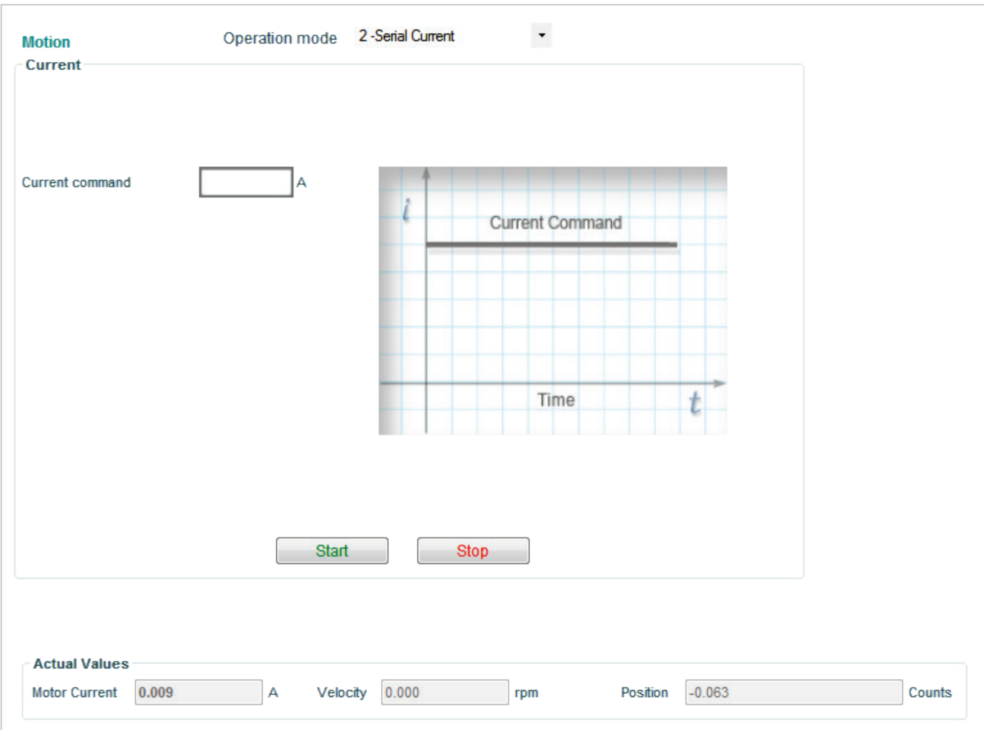


Figure 6-5. FLEXI SUITE – Motion Screen – Serial Current Mode

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

Current Command	Sets the value of the current. Refer to VarCom T.
Start	Sends the Current command to the motor.
Stop	Stops the Current command.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.5 Serial Velocity Mode

In the Motion screen, select Operation Mode **0 – Serial Velocity** to display the schematic and variables that affect the Serial Velocity command.

In serial velocity mode (OPMODE 0), the FLEXI PRO's current and velocity loops are active, and the drive responds to instructions received via the USB or RS232 ports. The commanded velocity is subject to programmable acceleration and deceleration limits.

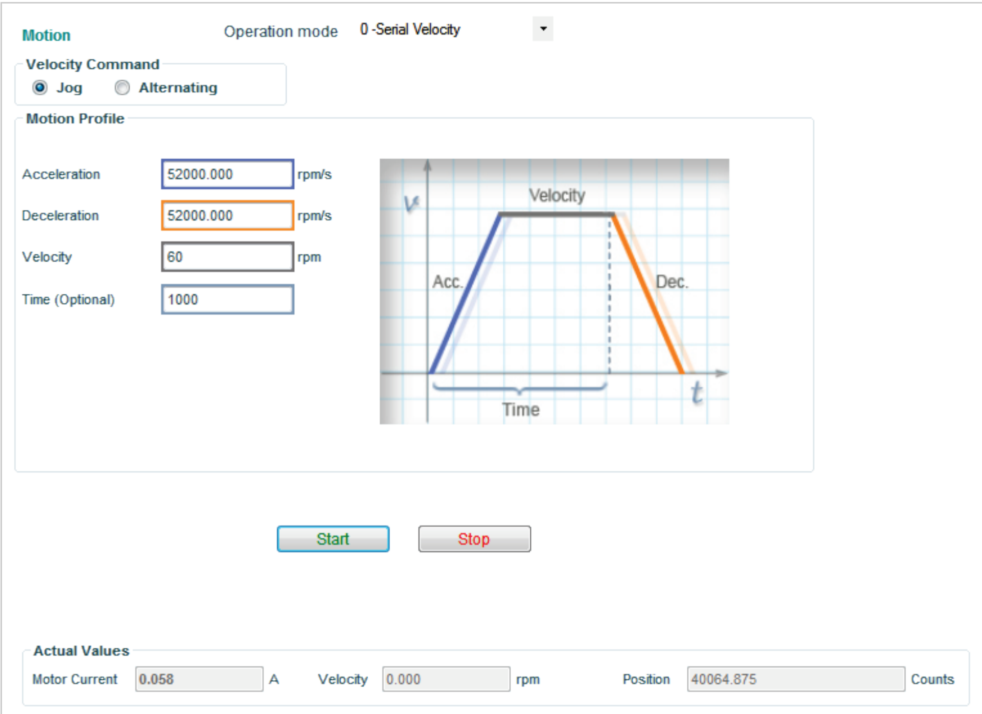


Figure 6-6. FLEXI SUITE – Motion Screen – Serial Velocity Mode

Velocity Command	**Jog** – Moves the motor at a constant velocity. Refer to VarCom J. **Alternating** – Moves the motor at two alternating velocities by issuing two independent velocity command values, with each running for a specified time. Refer to VarCom STEP.
Acceleration	Acceleration value. Refer to VarCom ACC.
Deceleration	Deceleration value. Refer to VarCom DEC.
Velocity/1/2	If **Jog** is selected, the velocity of the motion. If **Alternating** is selected, the command requires values for two velocity variables.

Time/1/2	If **Jog** is selected, the duration of the motion. If **Alternating** is selected, the command requires values for two time variables. Defined in milliseconds.
Start	Sends the Velocity command to the motor.
Stop	Stops the Velocity command
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.6 Gear Mode

In the Motion screen, select Operation Mode **4 – Position Gear** to display the schematic and variables that affect the Gear command.

In Gear mode, the FLEXI PRO's current, velocity and position loops are active, and the drive responds to incremental position pulses received from the controller or PLC.

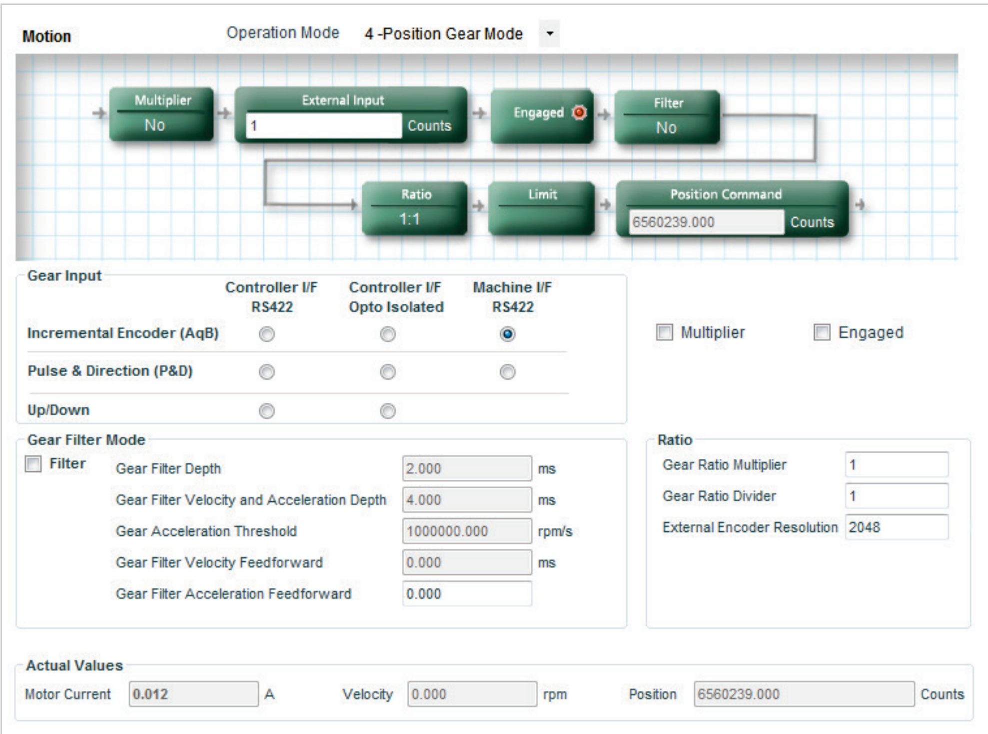


Figure 6-7. FLEXI SUITE – Motion Screen – Position Gear Mode

The FLEXI PRO supports a several types of Gear modes. The variable GEARMODE instructs the FLEXI PRO which particular gear mode to activate.

6.6.1 Gearbox

Regardless of the GEARMODE used, 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 (or actual motor position, PFB). 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:

$$\frac{GEARIN}{GEAROUT} \times \frac{1}{XENCRES}$$

The direction of rotation is determined by the sign of the variable GEARIN.

The gearing function can be engaged or disengaged, using the variable GEAR.

In addition to tuning the current, velocity and position loops, the following drive variables must be set.

External Encoder Resolution	Resolution of the external pulse source. Refer to VarCom XENCRES and to the sections below.
Gear In	Numerator of the gearbox equation. Refer to VarCom GEARIN.
Gear Out	Denominator of the gearbox equation. Refer to VarCom GEAROUT.
Acceleration Limit	Refer to VarCom ACC.
Deceleration Limit	Refer to VarCom DEC.

6.6.2 Pulse and Direction Mode

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

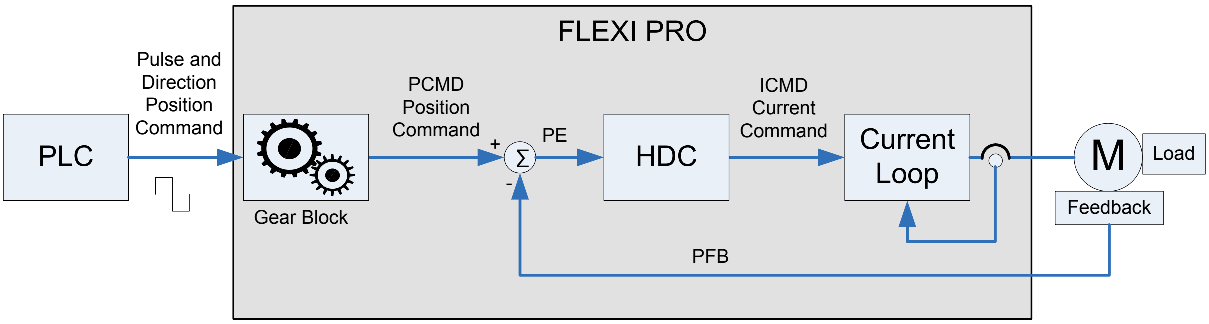


Figure 6-8. Pulse and Direction Position Control

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 actual motor position (PFB) to determine the position error (PE). The drive corrects the position error by incrementing the motor to the commanded position.

Gearing sets up a relationship between the number of input pulses (HWPEXT counts) and the position increments of the motor shaft (or actual motor position, PFB). 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.

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. For more information on homing, refer to *Homing*.

Pulse and Direction Commands Using a Differential Signal

For differential signaling, the pulse and direction signals can be connected to either the Controller I/F (C2) connector or to the Machine I/F connector (C3).

If using the FLEXI PRO Controller I/F connector:

- The Pulse signals are received from the controller or PLC on pins 28 and 11.
- The Directions signals are received from the controller or PLC on pins 9 and 27.

If using the FLEXI PRO Machine I/F connector:

- The Pulse signals are received from the controller or PLC on pins 1 and 11
- The Direction signals are received from the controller or PLC on pins 2 and 12

The variable GEARMODE indicates to the drive where the signals are connected.

- GEARMODE 1 if connected through the Controller I/F connector (C2)
- GEARMODE 4 if connected through the Machine I/F connector (C3).

Pulse and Direction Commands Using a Single-Ended Signal

The FLEXI PRO 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 FLEXI PRO Controller I/F connector (C2).

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

Refer to Figure 6-9 below. The diagram shows how to connect the PLC to the FLEXI PRO Controller I/F (C2) connector.

- Connect the cable shield on the PLC side to any available shield connector.
- Connect the cable shield on the FLEXI PRO side to the shell of the 36-pin connector.

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

Refer also to Table 2-9. I/O Specifications.

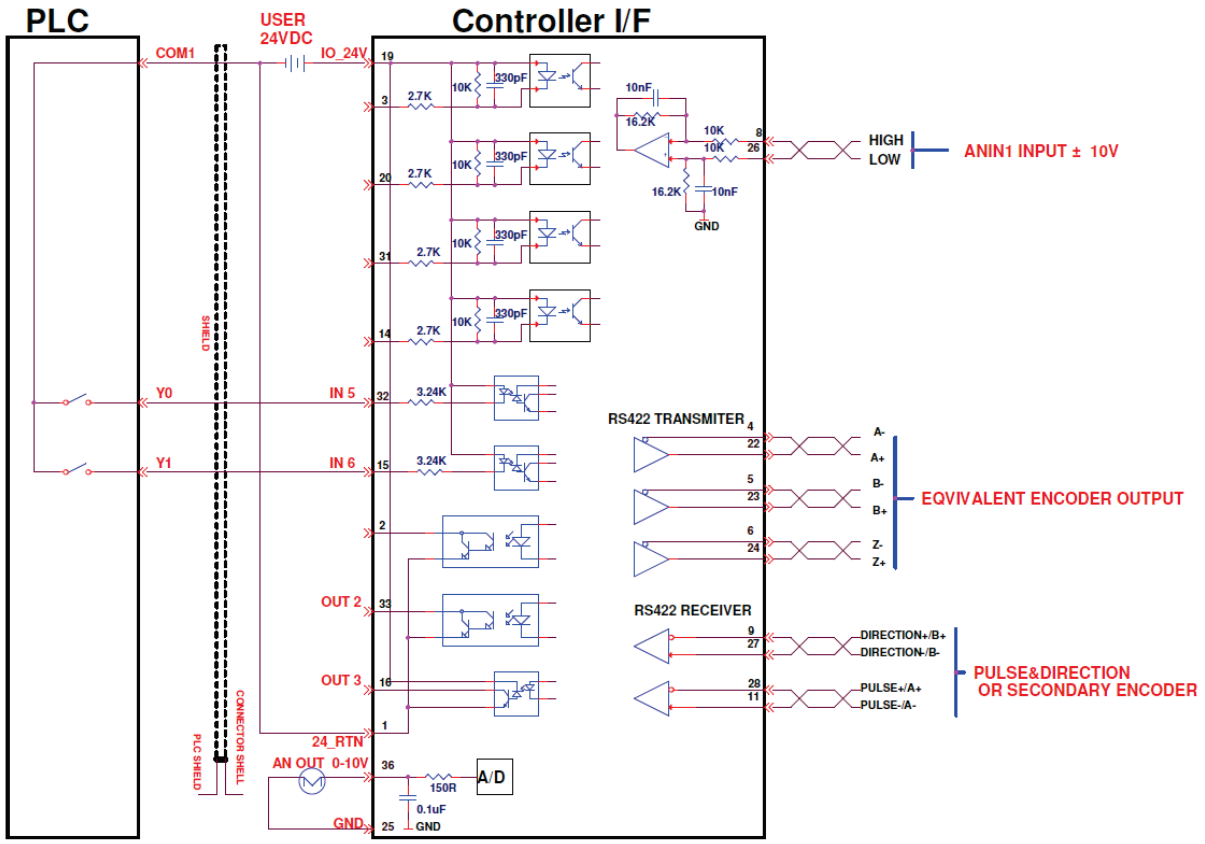


Figure 6-9. Wiring for Pulse and Direction Using Single-Ended Signal

Pulse and Direction Operation

For Pulse and Direction operation, the settings in the FLEXI SUITE Motion screen are similar to those shown in the following figure. Actual values may differ. Refer to this figure when performing the following steps.

Using FLEXI SUITE, the Pulse signal can be defined on digital input 5 (INMODE 5 17) and the Direction signal can be defined on digital input 6 (INMODE 6 18).

Selecting the option **Pulse & Direction (P&D)** and either **Controller I/F Opto-Isolated** or **Machine I/F Opto-Isolated** in the Motion–Position Gear Mode screen automatically sets the definitions for digital inputs 5 and 6.

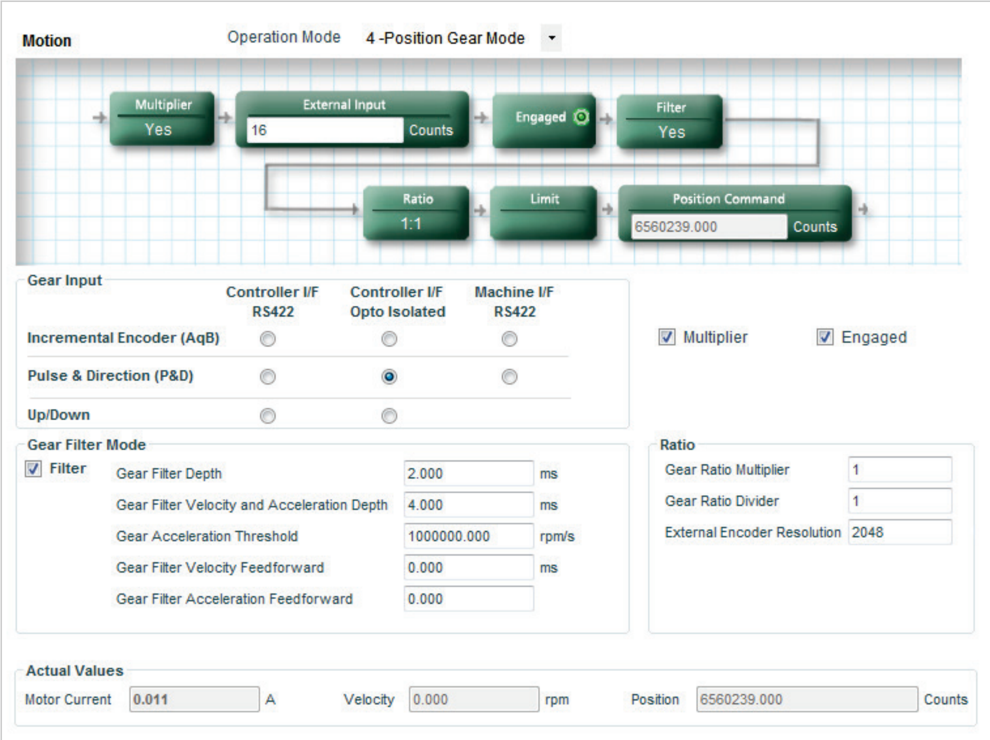


Figure 6-10. Motion Screen Settings for Pulse and Direction Commands Using a Single-Ended Signal

Step 1 – Setup and Tuning

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

Step 2 – Select Pulse and Direction

1. In FLEXI SUITE, go to Tuning > **Motion** screen.
2. Select Operation Mode **4-Position Gear Mode**.
3. In the Gear Input pane:
   - **If using Differential Signal:**
     Select the option **Controller I/F RS422** and Pulse & Direction (P&D).
   - **If using Single-Ended Signal:**
     Select the option **Controller I/F Opto-Isolated** and Pulse & Direction (P&D). Alternately, select **Machine I/F Opto-Isolated** and Pulse & Direction (P&D). Either of these options automatically sets the definitions for digital inputs 5 and 6.

Step 3 (for Single-Ended Signal only) – Confirm Digital Inputs 5 and 6 Settings

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**.

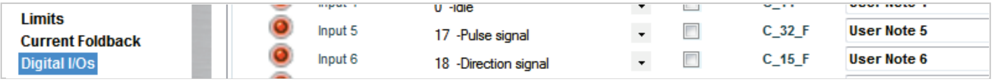


Figure 6-11. Digital Inputs for Pulse and Signal Directions

Step 4 – Set Pulse and Direction Parameters

1. In the **Motion** screen, select **Multiplier**.

   It is strongly recommended that you enable **Multiplier**. This internal FLEXI PRO feature is functional in pulse and direction operation, and typically improves the Pulse and Direction reading.

2. Make sure the Gear mode is **Engaged**.

3. In the Ratio pane, set the **External Encoder Resolution** and **Ratios**.

   The relationship between the number of incoming pulses and the motor shaft movement is determined by the External Encoder Resolution, and the Gear Ratio Multiplier and Divider (GEARI/GEARO).

   For example: A PLC controller is programmed to provide 1024 line pulses as an input command to a FLEXI PRO 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

Advanced Settings

If you experience noise, you may want to improve HDC tuning.
For more information, refer to *Tuning: HD Control.*

Alternately, enable the **Gear Filter Mode**, and modify the parameter settings. These settings have the effect of reducing the proportional gain of control.

It is recommended that you contact Technical Support for help in achieving optimized settings.

Use the following table to record the values recommended by Technical Support, and save for future reference.

Parameter	**Recommended Setting**
Gear Filter Depth	
Gear Filter Velocity and Acceleration Depth	
Gear Filter Acceleration Feedforward	

6.6.3 Master/Slave – Encoder Follower

In Master/Slave 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, or the equivalent encoder output of another servo drive.

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.

The quadrature signals can be connected to either the Controller I/F connector or to the Machine I/F connector. The GEARMODE variable indicates to the drive where the signals are connected to.

Note: The Controller I/F connector cannot supply voltage to the handwheel or the machine master encoder. Only the Machine I/F connector can supply this voltage (pins 4 and 14 on connector C3).

- Set GEARMODE to 0 to indicate to the drive that the signals are received on the Pulse and Direction inputs on the Controller I/F connector (C2) at pins 28 and 11 (Quadrature A), and pins 9 and 27 (Quadrature B).
- Set GEARMODE to 3 to indicate to the drive that the signals are received on the Secondary Encoder inputs on the Machine I/F connector (C3) at pins 1 and 11 (Quadrature A) and pins 2 an 12 (Quadrature B).

6.6.4 Up/Down Counting

In an up/down counting system, pulses on one signal increment the motor position while pulses on the other signal decrement the motor position. The signals must be connected to the Controller I/F connector.

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.

- Set GEARMODE to 2 to indicate to the drive that the signals received on the Pulse and Direction inputs on the Controller I/F connector (C2) at pins 28 and 11 (Up) and pins 9 and 27 (Down).

6.7 Serial Position Mode

The FLEXI PRO has a dedicated mode of operation (OPMODE 8) 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 Motion screen, select Operation Mode 8 **– Position** to display the schematic and variables that affect the Position mode motion setup.

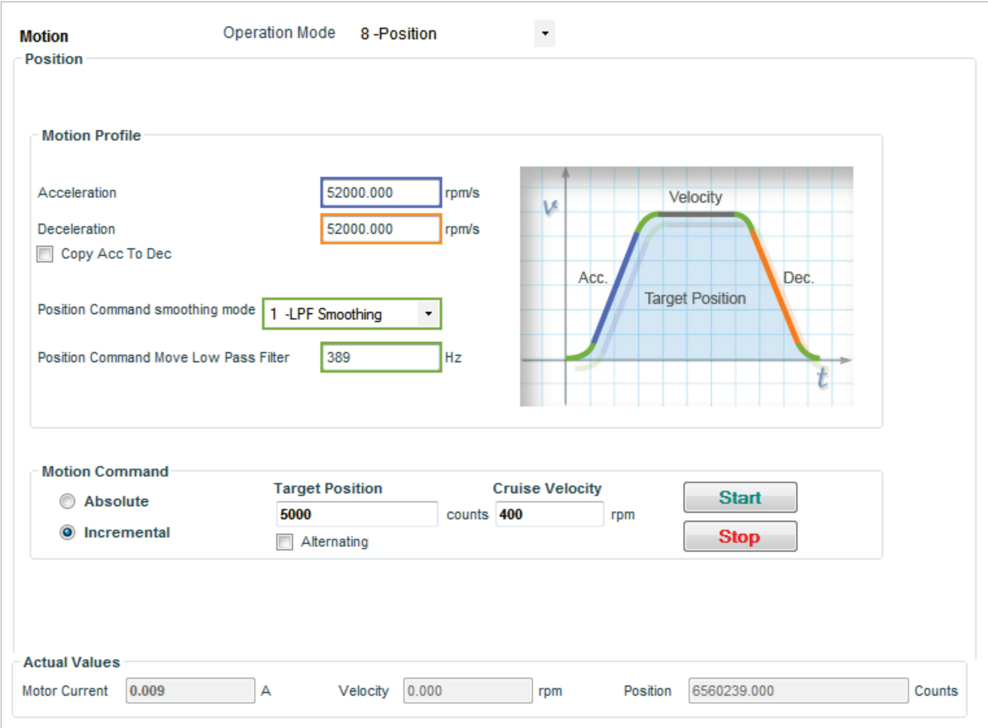


Figure 6-12. FLEXI SUITE – Motion Screen – Serial Position Mode

Acceleration	Acceleration value. Refer to VarCom ACC.
Deceleration	Deceleration value. Refer to VarCom DEC.
Copy Acceleration to Deceleration	Copies the acceleration value to the deceleration value field.
Position Command Smoothing Mode	Point-to-point move smoothing mode: **0** – No smoothing. **1** – LPF smoothing. **2** – S-Curve smoothing. Refer to VarCom MOVESMOOTHMODE.
Position Command Move Low Pass Filter	For LPF smoothing. The low pass filter for the point-to-point move. Refer to VarCom MOVESMOOTHLPFHZ.
Position Command Averaging Number	For S-Curve smoothing. The averaging number for the point-to-point move. Refer to VarCom MOVESMOOTHAVG.
Absolute Motion Command	An **Absolute** command moves the motor the specified number of counts from the encoder 0 position. Executes an absolute position movement according to the acceleration/deceleration settings. Refer to VarCom MOVEABS
Incremental Motion Command	An **Incremental** command moves the motor the specified number of counts from its current location. Executes an incremental position movement according to the acceleration/deceleration settings. Refer to VarCom MOVEINC

Target Position	The destination of the movement command.
Cruise Velocity	The velocity of the movement command.
Alternating	Automatically reverses the direction of motion each time **Start** is pressed.
Start	Sends the movement command to the motor.
Stop	Stops the movement.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.7.1 Motion Profile Information

The motion profile is determined by the acceleration, deceleration and profile definitions.

To set the acceleration and deceleration, use the variables ACC and DEC, respectively.

The variable PCMD is used to read the position command.

The variable PFB is used to read the actual motor position.

Refer to VarCom ACC, DEC, PCMD, PFB.

6.7.2 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, defined internally to the drive, is the current value of variable PFB.

Movement can be in either direction, depending on the sign of the position value. For example, if the target position is 1 revolution, the motor will turn one revolution from the starting point.

Refer to VarCom MOVEINC.

6.7.3 Absolute Motion

Absolute motion is always relative to an absolute reference point.

The reference point, defined internally to the drive, is the point at which the value of variable PFB is 0.

Refer to VarCom MOVEABS.

6.7.4 Position Error

The position error (also called following error) is the absolute value calculated as the difference between PCMD and PFB.

To read the position error, use the variable PE.

To set the maximum allowed position error, user the variable PEMAX. When the position error exceeds the PEMAX value, the drive will be disabled with fault **j1**.

Refer to VarCom PE and to the section *J1*.

6.7.5 In-Position Indication

The (read-only) variable INPOS is 1 when the motor is in position, and 0 when the motor is not in position.

The motor is in position when the value of PE is less than the value of the user-defined position error window, variable PEINPOS.

Whenever PE is less than PEINPOS, INPOS is set to 1, regardless of the state of the motion profile.

6.7.6 End of Motion

The motor is considered settled when the position error variable PE has remained below the position error threshold variable PEINPOS for a time defined by variable PEINPOSTIME.

The (read-only) variable STOPPED indicates the end of motion. While the position profile is being executed STOPPED is set to 0. At the end of the profile, STOPPED is set to 1. When the motor has settled, STOPPED is set to 2.

6.7.7 Position Offset

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

To set the current position to zero, do the following:

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 a whole number (integer) only, even though the actual position, PFB, is displayed as a real number, with fractions of a count (which is a result of internal interpolation being executed on the encoder signal).

6.8 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.

One of the steps in the Motor Setup Wizard allows you to test and reverse the direction of motion.

Alternately, use the VarCom variables DIR and MPHASE:

- Change the value of DIR to 1 if it is set to 0, or change it to 0 if it is set to 1.
- Change the value of MPHASE by 180.

Caution. Both values must be changed at the same time, before the drive is enabled, otherwise the motor might run away.

6.9 Disable Mode

The disabling of the drive may be due to an explicit command from the motion controller, or the drive's own response to a fault.

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.

The Disable mode function consists of two mechanisms:

- **Active disable**, by controlled deceleration and disable.
- **Dynamic brake**, by controlled motor short circuit.

The Disable Mode screen allows you to select the methods and parameters to be used for stopping the motor when the drive becomes disabled.

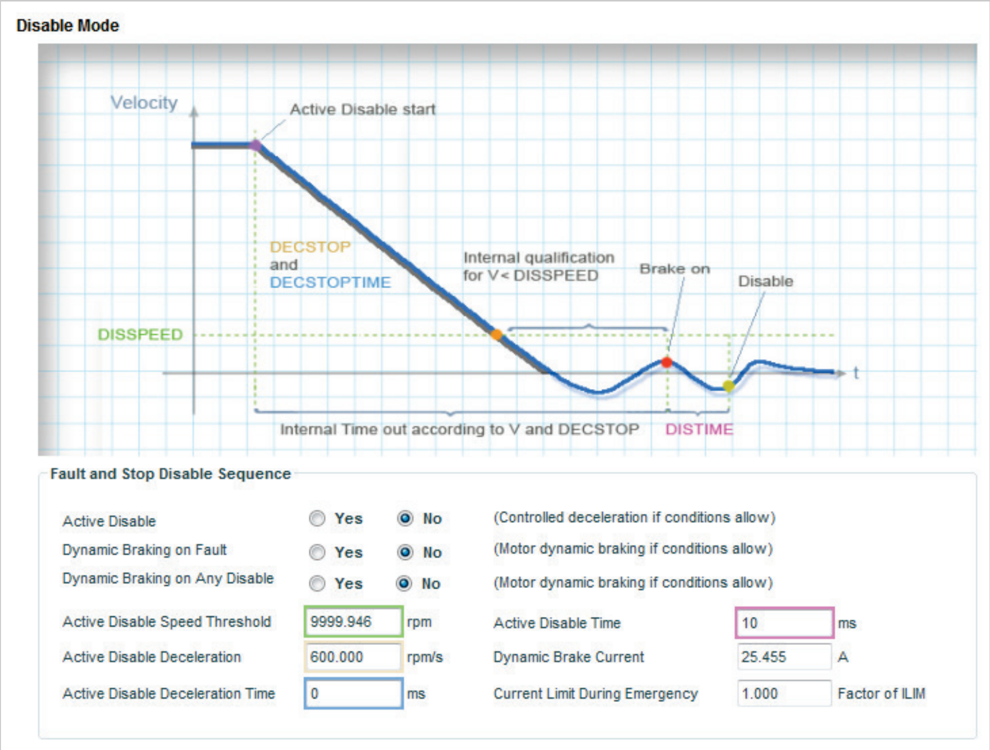


Figure 6-13. FLEXI SUITE – Disable Stop

Active Disable	If **Yes**, a controlled deceleration will be executed if conditions allow. Refer to VarCom DISMODE.
Dynamic Braking on Fault	If **Yes**, dynamic braking will be executed by means of a controlled motor short-circuit, if conditions allow. Refer to VarCom DISMODE.
Dynamic Braking on Any Disable	If **Yes**, dynamic braking will be executed by means of a controlled motor short-circuit, if conditions allow. Refer to VarCom DISMODE.
Active Disable Speed Threshold	The speed threshold for the Active Disable function. Refer to VarCom DISSPEED.

Active Disable Time	The time to wait after motor speed goes below the threshold (DISSPEED) until the drive is disabled by the Active Disable function. Refer to VarCom DISTIME.
Active Disable Deceleration	The deceleration speed value for the Active Disable function. Refer to VarCom DECSTOP
Active Disable Deceleration Time	The deceleration time for the Active Disable function. This value is ignored if it exceeds the deceleration speed value. Refer to VarCom DECSTOPTIME.
Dynamic Brake Current	The maximum current allowed during the dynamic braking process. Refer to VarCom ISTOP.
Current Limit During Emergency	The current limit used during the Active Disable process. Defined as a value from 0 to 1, as a factor of the application current limit. Refer to VarCom ILIM and ESTOPILIM.

6.9.1 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 works only when the drive is in a velocity mode (OPMODE 0 or OPMODE 1).

Figure 6-14 shows 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.

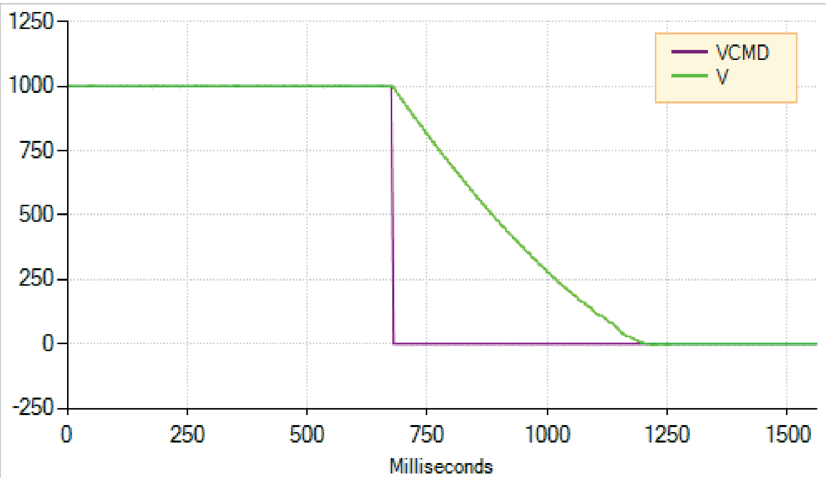


Figure 6-14. Disabling Without Active Disable

Figure 6-15 illustrates what happens when Active Disable is engaged. As soon as the drive receives the disable command, the velocity command is ramped down to zero, and only then is the drive disabled.

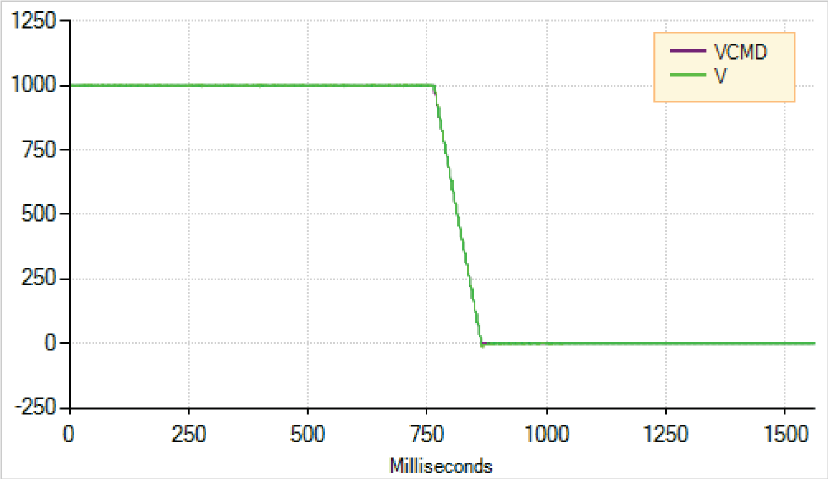


Figure 6-15. Disabling With Active Disable

Three additional variables that influence the behavior of Active Disable.

- 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 100 consecutive drive background cycles. Each background cycle is approximately 1 ms.
- 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 100 consecutive background cycles.
- DECSTOP defines the deceleration rate of the ramp down.

Figure 6-16 shows 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 100 consecutive background cycle, 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.

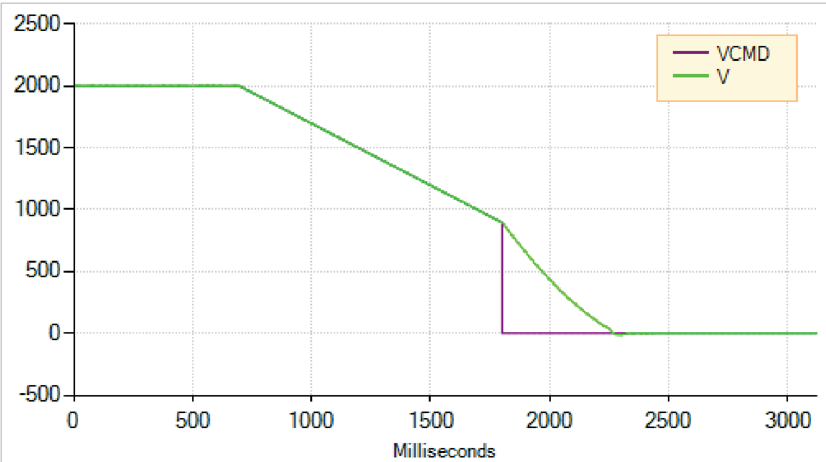


Figure 6-16. Effect of DISSPEED and DISTIME on Active Disable

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 6-17 shows 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.

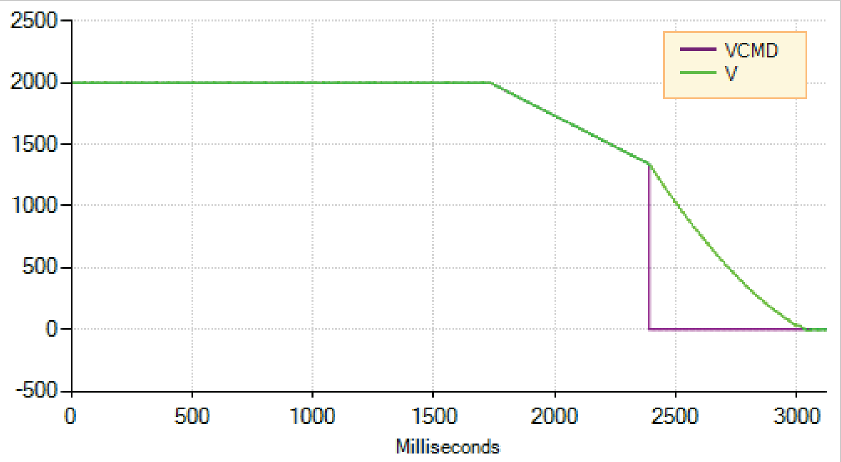


Figure 6-17. Effect of Second Disable Command on Active Disable

The diagram in the FLEXI SUITE Disable Mode screen illustrates the behavior of Active Disable.

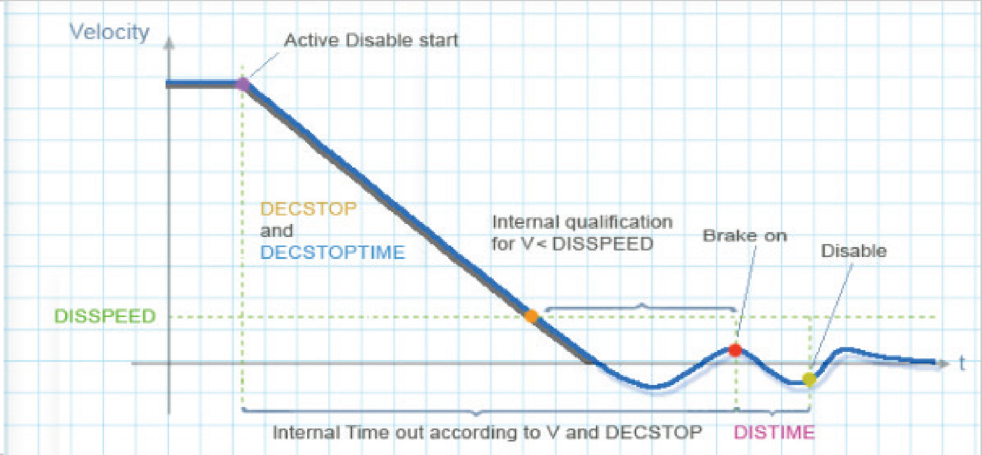


Figure 6-18. Disable Stop

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. Refer to the section *Motor Brake Control*.
- 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.

6.9.2 Dynamic Brake

Dynamic braking is a mechanism by which the drive is holding the motor during Disable mode, where 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 6-19 illustrates motor coasting, that is, no Dynamic Braking (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.

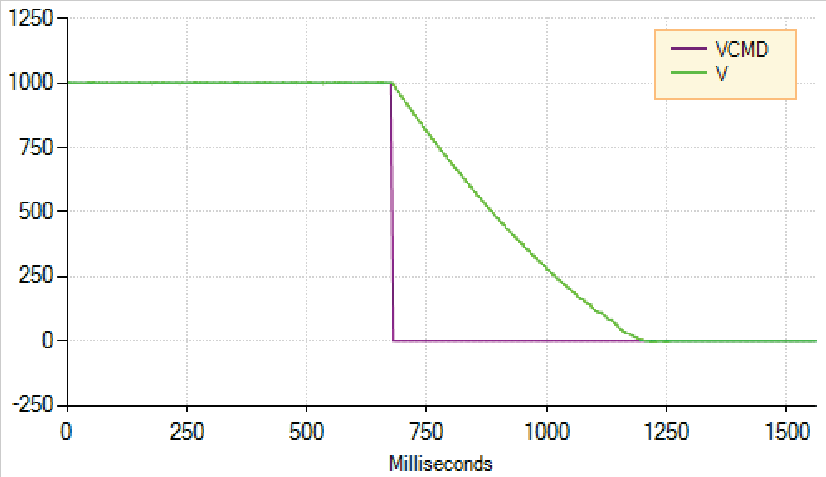


Figure 6-19. Motor Coasting, Without Dynamic Braking

Figure 6-20 shows what happens when Dynamic Braking is engaged. 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.

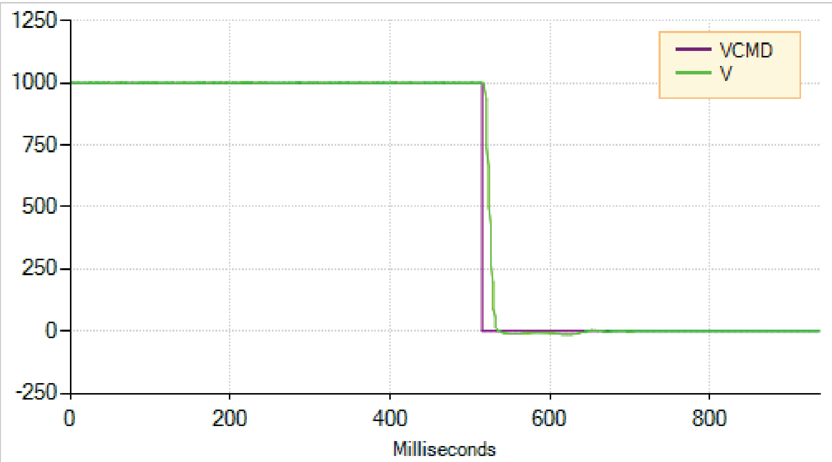


Figure 6-20. Dynamic Braking

Figure 6-21 shows Dynamic Braking with a very low value of ISTOP. In this instance, it takes longer to bring the motor to a stop.

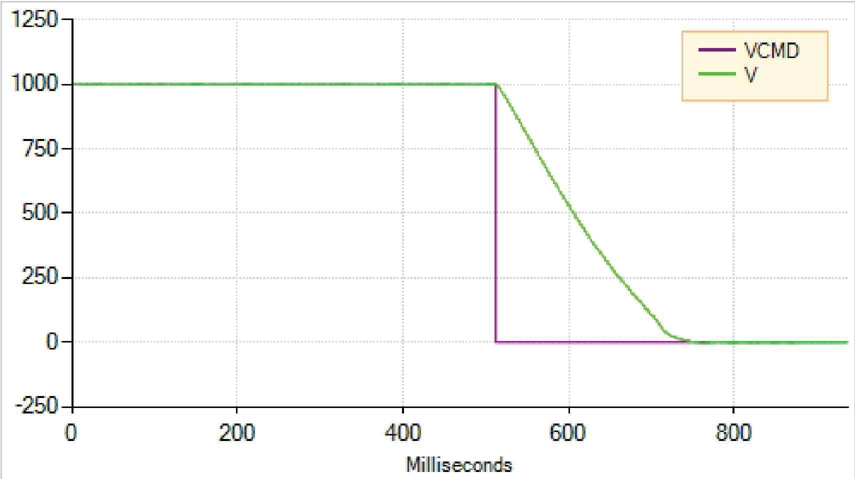


Figure 6-21. Dynamic Braking with Low ISTOP Value

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

6.10 Motor Brake Control

FLEXI PRO 120/240 VAC models do not have sufficient amperage to activate a motor brake. However, the FLEXI PRO can control a motor brake via a relay connected to digital output pins on either the Controller I/F connector or Machine I/F or connector. Refer to the section *Brake (Optional)* and to the FLEXI SUITE procedure below.

FLEXI PRO 400/480 VAC models have a dedicated connector (P4) for direct motor brake control. Refer to the section *Brake* .

When using the P4 connection, use the Terminal screen and VarCom instructions.

FLEXI PRO 400/480 VAC models can also be connected to a motor brake via a relay, and configured in FLEXI SUITE in the same manner as 120/240 VAC models, as described in the procedure below.

By default, the following conditions are in effect:

Output is **off**	Voltage to the brake is 0V	Brake coil is disengaged	Motor brake holds the motor shaft
Output is **on**	Voltage to the brake 24V	Brake coil is engaged	Motor brake releases the motor shaft

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

The FLEXI PRO disable time is programmable. 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.

To configure the digital output, perform the following procedure in FLEXI SUITE.

1. Define the output.

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

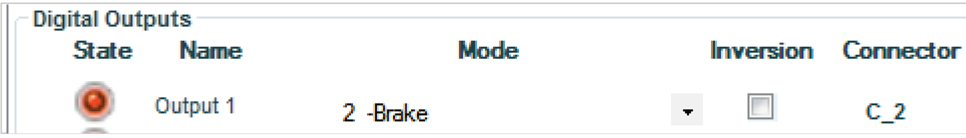


Figure 6-22. Digital Output Settings for Motor Brake Control

By default:

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

2. Go to the **Disable Mode** 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.

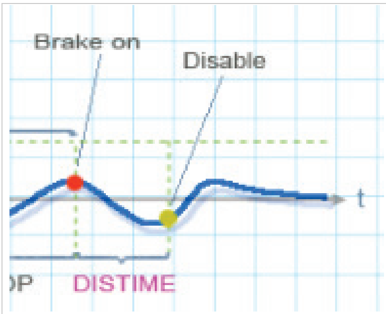


Figure 6-23. Active Disable Time (DISTIME)

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

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

6.11 Motor Phasing

Certain factors that affect the direction of motion, such as motor phase direction, A/B swap, index polarity, and Halls wiring, may be unknown or incorrectly set when the FLEXI PRO is connected to the motor for the first time. In addition, motor or feedback parameters, such as the number of poles or encoder resolution, may be incorrectly defined.

To overcome these problems, the Motor Phasing procedure, MOTORSETUP, enables a fast initial connection of the FLEXI PRO to the motor.

The procedure involves moving the motor in forced commutation, which does not require feedback. The rotary motor will move forward/backward about two mechanical revolutions, during which it gathers data regarding the state of Hall switches, index position and polarity, order of phases, and feedback resolution per electrical revolution.

Based on the collected data, the drive updates the variables MFBDIR, MPHASE, MPOLES, MENCRES and MENCZPOS, thereby allowing the user to begin working with the selected motor and wiring.

If the procedure fails (that is, the motor cannot be successfully commissioned by changing the drive parameters), the original values of MFBDIR, MPHASE, MPOLES, MENCZPOS and MENCRES will be restored.

Notes:

- Not all parameters are updated by the procedure. It depends on 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.
- At the end of the procedure, motion of more than two revolutions might occur.

This procedure is also started and stopped by using the **Verify** and **Stop** buttons in the Motor screen. Refer to the section *Motor Selection*.

To execute the Motor Phasing procedure, do the following:

1. Disable the drive.
2. Clear any faults in the drive.
3. Enter the command **MOTORSETUP**.
4. Enable the drive.

   The procedure will begin and perform several steps.

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

To cancel the 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.

6.12 Motor Temperature Sensor

The FLEXI PRO supports both thermostat (on/off) and thermistor (temperature sensitive resistance) motor temperature sensors.

When the drive detects a motor over-temperature condition, the motor over-temperature fault is latched, and the 7-segment display flashes **H**.

Several variables define how the drive interfaces and responds to the sensor.

- THERM indicates whether a motor over-temperature fault exists.
- THERMODE defines how the drive responds to a motor over-temperature fault. If the motor does not have a temperature sensor, or if the sensor is not wired, set THERMODE to 3, so that the drive will ignore this fault.
- THERMTYPE indicates whether the sensor is type PTC (positive temperature coefficient) or NTC (negative temperature coefficient). When using a

thermostat (on/off motor temperature sensor), set THERMTYPE to 0 to define type PTC.

- THERMREADOUT reads the resistance of the temperature sensor.

The motor over-temperature fault detection and clear mechanism is subject to a hysteresis mechanism. The fault will trip when the resistance passes a certain value, and can be cleared only when the resistance drops below a different value.

The variables THERMTRIPLEVEL and THERMCLEARLEVEL set the trip level and the clear fault level:

- For a PTC thermistor, the motor over-temperature fault will trip when the resistance is equal to or greater than the THERMTRIPLEVEL. The fault can be cleared when the resistance is equal to or less than the THERMCLEARLEVEL.
- For an NTC thermistor, the motor over-temperature fault will trip when the resistance is equal to or less than the THERMTRIPLEVEL. The fault can be cleared when the resistance is equal to or greater than the THERMCLEARLEVEL.
- If the motor temperature sensor is a thermostat, the resistance is zero in normal state and infinite in fault state.

6.13 Current Control Loop Tuning

The basic current control loop tuning is derived from the motor properties and the bus voltage.

The **Current Loop** screen allows you to set additional current loop gains whose use might improve performance.

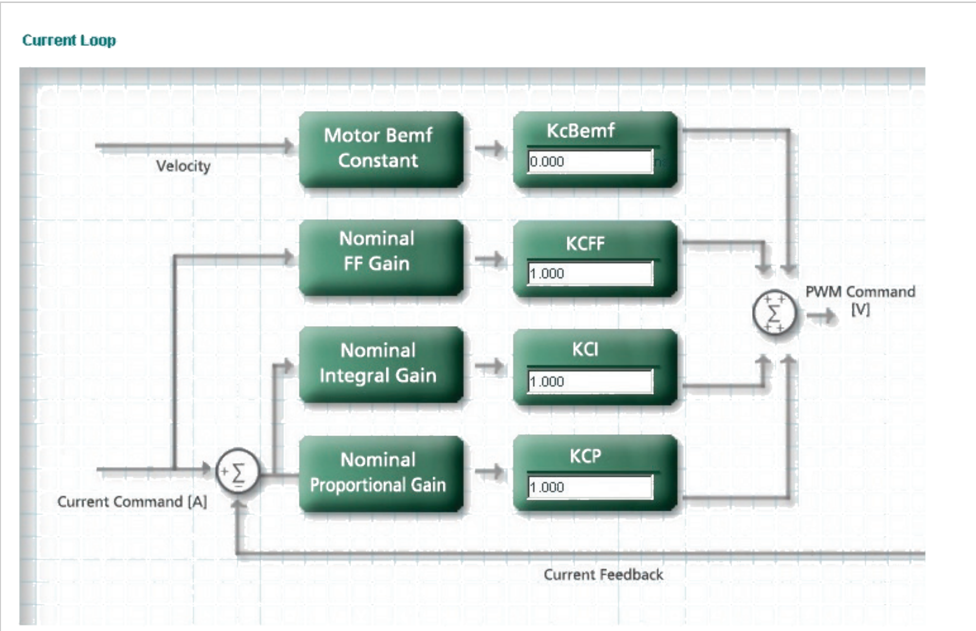


Figure 6-24. FLEXI SUITE – Current Loop Screen

Note: Current loop autotuning is best done with the motor disconnected from any gear and load.

⚠ **Caution**. Current loop tuning causes motion of a few revolutions (for rotary motors) and a few motor pitches (for linear motors). It should not be used for linear motors or rotary motor with movement limitation.

6.14 Velocity Control Loop Tuning

The **Velocity Loop** screen provides four options for velocity tuning. Select the controller method from the list at the top of the screen:

0 – PI controller

1 – PDFF controller

2 – Standard pole placement controller

5 – HD velocity control with integrator

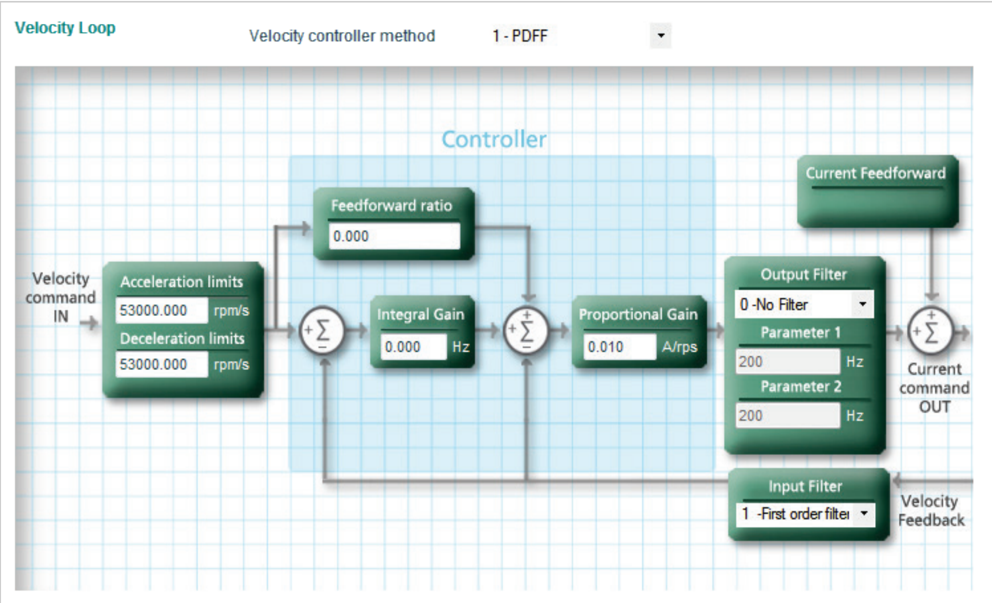


Figure 6-25. FLEXI SUITE – Velocity Loop Screen

The light blue background in the schematic shows the actual velocity loop. The other elements show pre- and post-processing options.

A filter can be applied to the output of the velocity loop. You can choose various options of low-pass, band-pass, high-pass, notch and user-defined filters.

6.14.1 Proportional and Integral (PI) Controller

The following figure shows a PI controller.

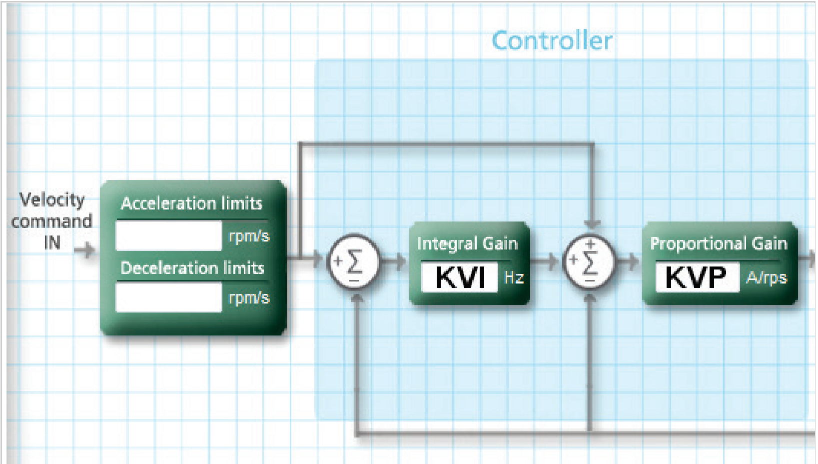


Figure 6-26. Velocity Control – PI Controller

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.

Refer to VarCom VELCONTROLMODE 0.

6.14.2 Pseudo Derivative Feedback and Feedforward (PDFF) Controller

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.

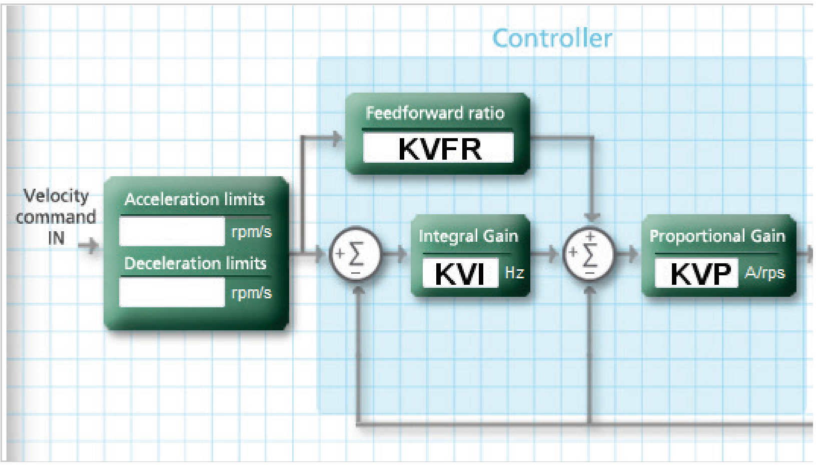


Figure 6-27. Velocity Control – PDFF Controller

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.

Refer to VarCom VELCONTROLMODE 1.

6.14.3 Standard Pole Placement (PP) Controller

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

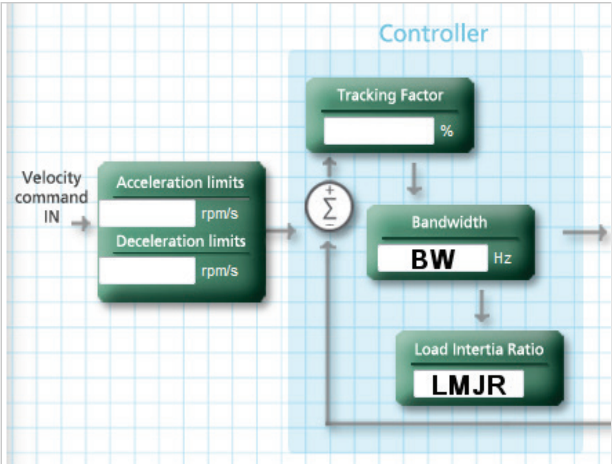


Figure 6-28. Velocity Control – Standard PP Controller

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.

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 FLEXI SUITE, go to the **Terminal** screen or a Terminal tab, and execute the steps using standard ASCII protocol.

Alternately, use the FLEXI SUITE **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.)

Refer to VarCom VELCONTROLMODE 2.

6.14.4 HD Velocity Control with Integrator

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

You can then proceed to use the HD velocity controller.

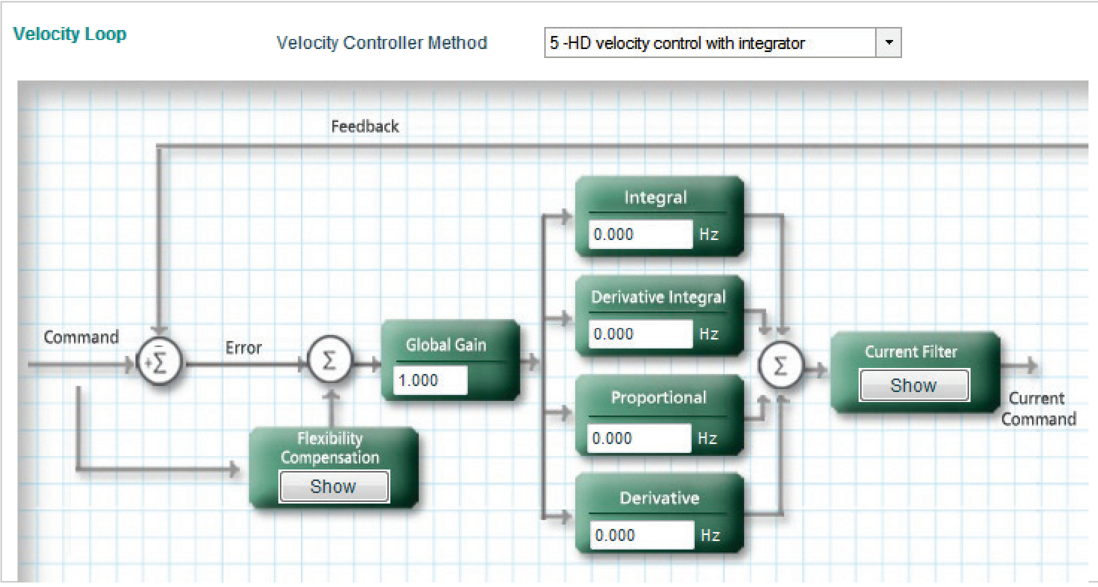


Figure 6-29. Velocity Control - HD with Integrator

Refer to VarCom VELCONTROLMODE 5.

6.15 Position Control Loop Tuning

Two position control loop options are available, Linear and HD Control. In the **Position Loop** screen, select the controller method from the list at the top of the screen.

6.15.1 Linear Position Controller

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

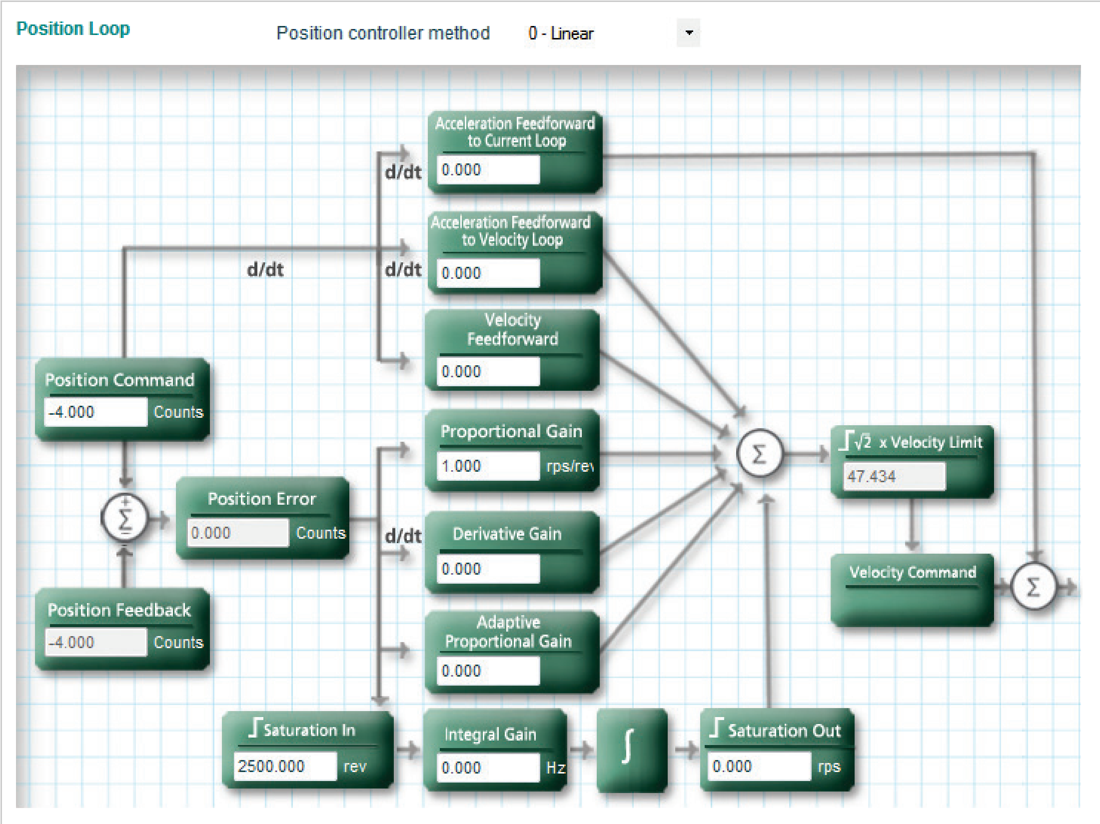


Figure 6-30. FLEXI SUITE – Position Loop – Linear Screen

6.15.2 HD (Nonlinear Position) Controller

The HD (nonlinear position) control algorithm is designed to minimize position error during motion and to minimize settling time at the end of motion.

The HD controller parameters should be initially set using the Autotuning Wizard. The parameters are shown in the Position Loop HD Controller screen, and can be modified as required by the application.

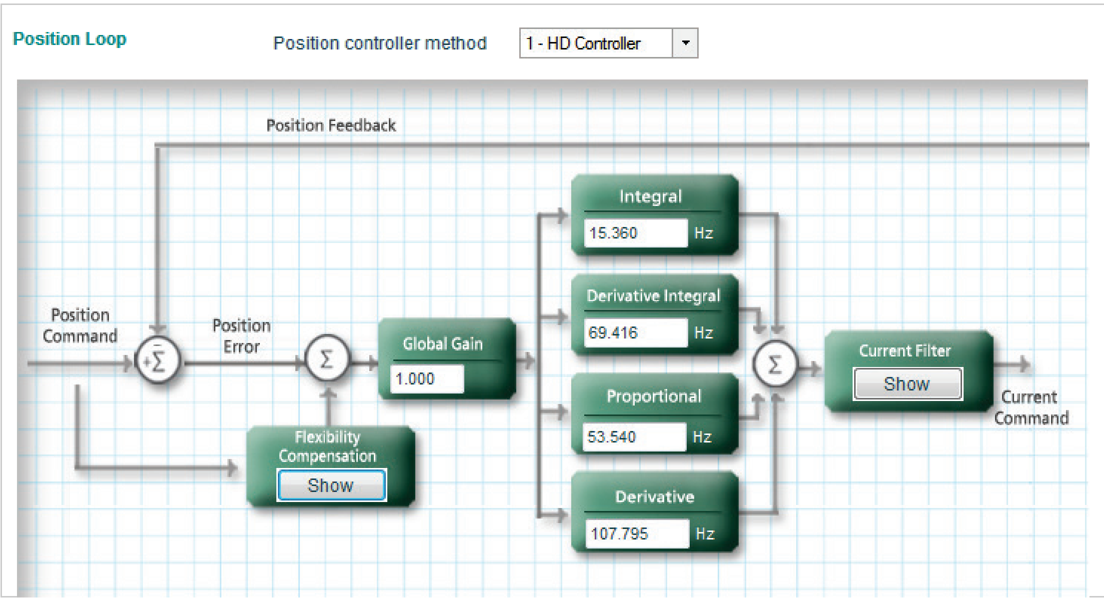


Figure 6-31. FLEXI SUITE – Position Loop – HD Controller Screen

The HD controller has four main parallel feedback functions, each of which has a nonlinear characteristic. These four functions change dynamically during movement in order to apply the optimal feedback gain while maintaining the stability of the system.

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.

6.16 Data Recording

FLEXI SUITE provides extensive recording and data graphing capabilities. Recording is done by the drive in real-time, and sent to the host computer for display.

Recording can be set up to be triggered when a specified event or condition occurs. In addition, FLEXI SUITE enables continuous data recording or a one-time recording. FLEXI SUITE also allows execution of a motion command during recording. This is useful, and even necessary, as a tuning tool.

Note: When FLEXI SUITE is communicating with the drive through a CAN port, recording operations are significantly slower than when a serial connection is used.

The FLEXI SUITE **Scope** screen is a dashboard for data recording and graphing.

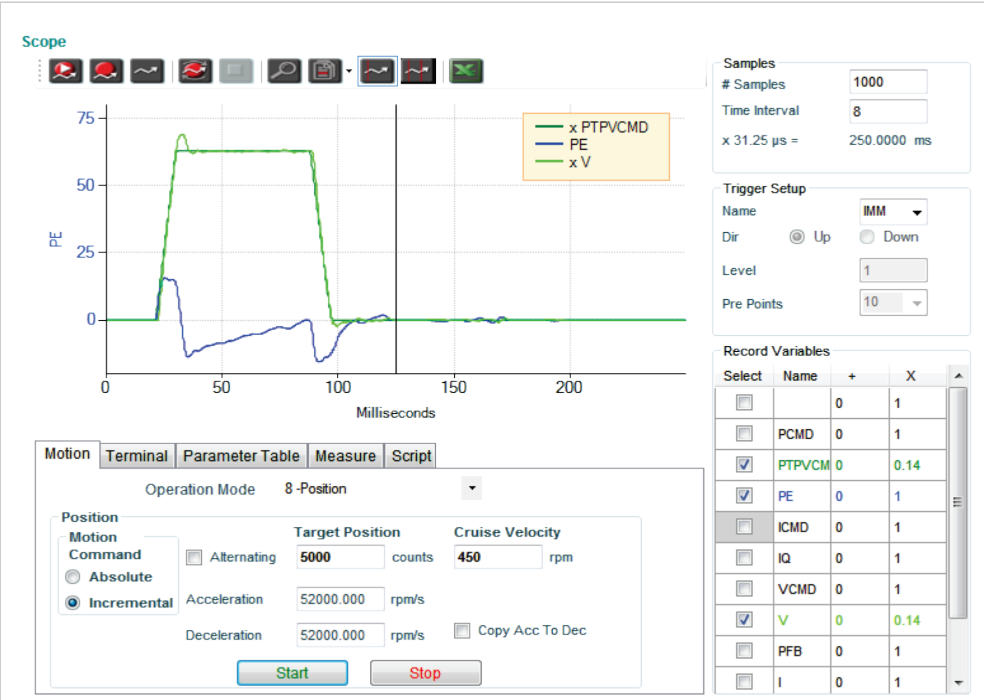


Figure 6-32. FLEXI SUITE – Scope Screen

6.16.1 Recording Setup

The **Recorder Setup** panel, on the right side of the Scope screen, allows you to define the variables and conditions for the data recording.

Samples

# Samples	The total number of points to be recorded. Up to 2000 data points for up to six 32-bit (non-position) variables, or three 64-bit (position) variables, can be recorded simultaneously. Continuously reads and records data from the drive, and displays on screen. Does not have a trigger. Does not have a defined number of sampling points.
Time Interval	The rate at which data is recorded. The interval value is specified in multiples of the drive's basic sampling rate, which is 31.25 µs. For example, an interval of 5 means data is recorded once every 5 samples, that is, every 156.25 µs (5x31.25=156.25).

Record Variables

Name	Name of a variable that can be recorded. Refer to VarCom RECLIST. To add a variable to the list, type the name of the variable in the blank cell in the first row, and press Enter. To define the variables that will actually be recorded, select or clear the checkboxes. Up to six 32-bit (non-position) variables, or three 64-bit (position) variables, can be recorded simultaneously.
+	**Offset** – An offset value on the X-axis that serves to separate overlapping traces on the chart, or to move traces closer together for easier viewing and comparison. Whenever an offset is in effect, a plus sign **+** is displayed next to the variable name in the legend.
X	**Multiply** – Enlarges a trace that may be too small to view properly because the chart is scaled to the largest value of another variable. Whenever an enlarged trace is in effect, an asterisk * is displayed next to the variable name in the legend.

To clear all settings in the Record Variables pane, right-click on any variable cell, and select the option **Reset Variable List.**

When using Terminal, the syntax for the comparable VarCom 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 (").

Trigger Setup

Name	Name of a variable that will trigger the recording. Refer to VarCom RECTRIGLIST. The following variables can also trigger the recording: **IMM** – Starts the recording immediately **CMD** – Starts the recording as soon as the next command is sent to the drive
Direction	Defines whether the trigger occurs when value of the variable goes above the threshold (**Up**) or below the threshold (**Down**).
Level	The threshold value for the trigger.
Pre Points	The number of points to be recorded prior to the trigger point.

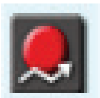
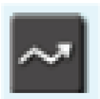
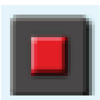
When using Terminal, the syntax for the comparable VarCom instruction is:

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).

6.16.2 Scope Toolbar

	**Move Record and Plot**	Executes the command defined in the Motion screen, triggers (and stops) the recording, plots the response and stops the motion.
	**Record and Plot**	Triggers the recording and plots the response. Does not start or stop the drive.
	**Plot**	Reads the data last recorded (in the drive), and displays a trace on screen.
	**Continuous Record and Plot**	Continuously records and displays a trace of the currently defined record data. Does not have a trigger. Does not have a defined number of sampling points. The number of data points and variables that can be recorded depends on several factors. Refer to the section *Samples*. **Note:** Do not attempt to use this function when FLEXI SUITE is communicating with the drive via a CAN port.
	**Stop Recording**	Stops a recording. Aborts the command.

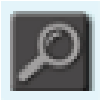
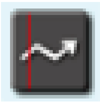
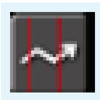
	**Toggle Cursor to Zoom**	Toggles Zoom In and Zoom Out view of graph. When Zoom In is selected, a minus sign appears on the button. Using the left mouse button, click-and-drag to select an area on the graph for magnification.
	**Toggle Zoom to Cursor**	Cancels the cursor zoom. Hides/displays cursor line/s. When cursor is displayed, use left mouse button to select and position the cursor on the graph. Variable values at the cursor point are displayed in a floating box. Use the **Measure** tab to view additional variable values at the point marked by the cursor.
	**Select Cursor**	Displays a second cursor line. Click on the graph to position the second cursor.
	**View in Excel**	Copies recorded data to a temporary CSV file and opens Microsoft Excel to display it.
	**Chart Options**	Refer to the section *Chart Options*.

Chart Options

The options in the Chart Options menu can also be accessed by right-clicking anywhere on the chart.

Some of the chart options, together with additional trace options, are accessed by right-clicking on any of the cells in the Record Variables pane.

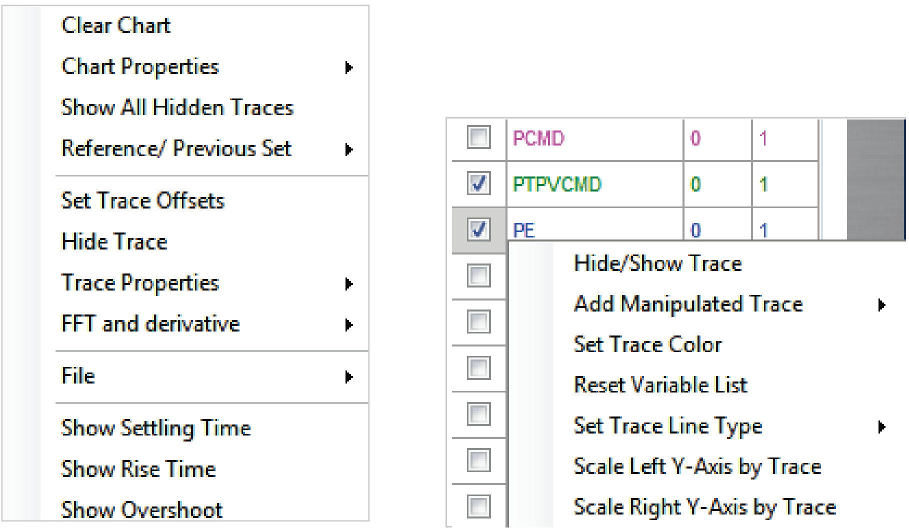


Figure 6-33. FLEXI SUITE – Chart Options menu / Trace Options menu

Clear Chart

Clears the displayed chart.

Chart Properties

Set Background Color	Opens the Colors dialog box, and allows you to modify the background color of the chart.
Grid	Toggles the grid display on and off. Also allows you to modify the grid: **X Axis** – Toggles the X-axis grid line on/off. **Y Axis** – Toggles the Y-axis grid line on/off. **Dot | Line** – Uses either dotted lines or solid lines for the grid.
Show Legend	Toggles the legend display on and off.
Legend Position	Top right or bottom left
Freeze Scale	Sets the Y-axis to a fixed scale. Normally the Y-axis is scaled dynamically as the amplitude of the signals changes. When Scale is frozen, the letter **F** is displayed next to the Chart Options button on the toolbar. When Scale is frozen, the letter **O** is also displayed if part of the trace is out of view.
Reset All Trace Offsets	Resets the value of all offset (+) values in the Record Variables list to 1. Whenever an offset is in effect, a plus sign **+** is displayed next to the variable name in the legend.
Grid Color by Trace	If two grids are used (right and left axis), different colors can be defined to improve the readability of the chart.
Hide Right Y Scale	Hides the Y-axis scale on the right side of the chart, if displayed.
Copy Image to Clipboard	Copies the chart to a graphic image, which can be pasted into other application.

Show All (Hidden) Traces

Displays all traces on the chart that were hidden by the **Hide Trace** option.

The Show/Hide status of a trace can be toggled by right-clicking on the variable in the Record Variables pane.

Reference/Previous Set

Show Reference Set	Displays the trace previously saved as a reference.
Show Previous Set	Displays the previously displayed trace in addition to the currently displayed trace.
Save as Reference Set	Saves the trace currently displayed on screen as a reference.
Keep Previous as Background	Displays the previously recorded trace as a background.
Keep Reference as Background	Keeps the reference trace displayed on screen as a background.
Shift Set Position	Allows you to move a set of traces along the X-axis, to separate overlapping traces on the chart, or to align the trigger points on different traces.

Set Trace Offsets

This option is used to separate overlapping traces, and improve the readability of the chart.

Right-click on a specific trace, and enter offset values.

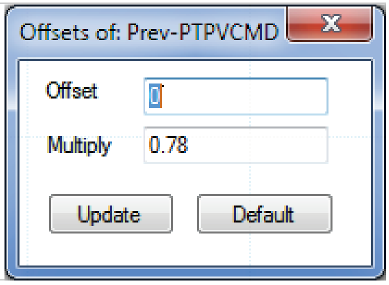


Figure 6-34. Set Trace Offsets Dialog Box

Hide Trace

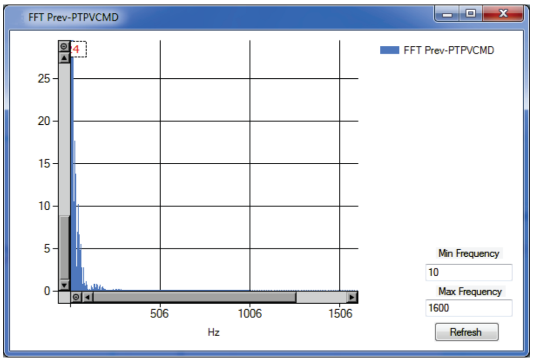
Right-click on a specific trace, and select **Hide Trace** to hide just one trace.

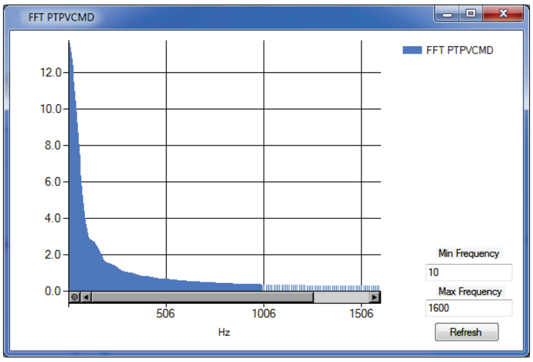
Trace Properties

Set Trace Color	In Chart Options/Trace Options. Allows you to define the color of the trace.
Set Trace Line Type	In Chart Options/Trace Options. Allows you to define how the trace line is displayed: **Line**, **Spline** or **Points**.
Scale Left Y-Axis by Trace	In Chart Options/Trace Options. Displays a Y-axis on the left side of the chart, scaled to the values of the selected variable.
Scale Right Y-Axis by Trace	In Chart Options/Trace Options. Displays a Y-axis on the right side of the chart, scaled to the values of the selected variable.
Scale All	In Chart Options only. Adjusts and displays all traces on a scale of 0—100%, for better viewing.
As Percentage of MICONT	In Chart Options/Trace Options. Displays current as a percentage of motor continuous current, rather than amperage.

FFT and Derivative

These options define how a fast Fourier transform (FFT) algorithm is performed on the selected trace.

Add Derivative Trace	In Chart Options/Trace Options. Calculates and displays the derivative of the function.
FFT Trace	In Chart Options/Trace Options. The FFT is performed on the selected trace, and displays a graph that represents the frequency domain. 

FFT Between Cursors	In Chart Options only. The FFT is performed on the selected trace between the two cursors, and ignores the data outside the cursors. 

File

Save As	Exports a recording to a CSV file, so that it can be viewed and analyzed in Microsoft Excel.
Load From	Loads recorded data that was saved in a CSV file.

Show Settling Time

Settling time is the time elapsed from the application of a step command (e.g., PTPVCMD) to the time at which the output has entered and remained within a specified error window (e.g., PE less than a specified value).

Settling time is indicated by two vertical red lines in the chart.

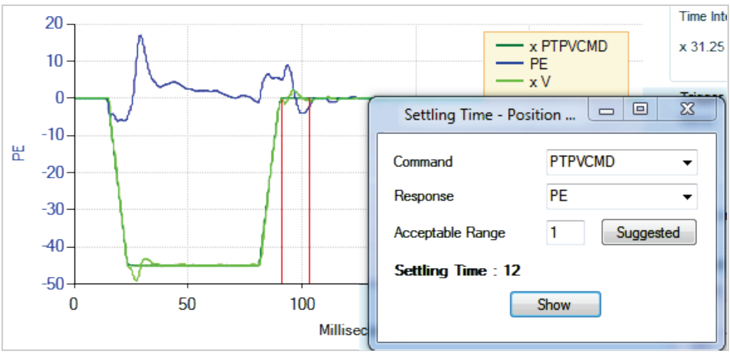


Figure 6-35. Show Settling Time

Show Rise Time

Rise time is the time required for a signal to change from a specified low value to a specified high value. Typically, these values are 10% and 90% of the step command (e.g., PTPVCMD as input, and V as OUTPUT).

Rise time is indicated by two vertical black lines in the chart.

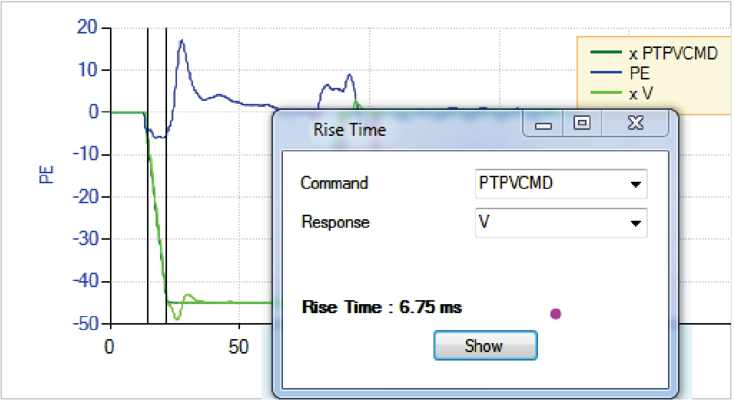


Figure 6-36. Show Rise Time

Show Overshoot

Overshoot is when a signal exceeds its target, as for example, the maximum value of V when it exceeds PTPVCMD.

Rise time is indicated by a single vertical black line in the chart.

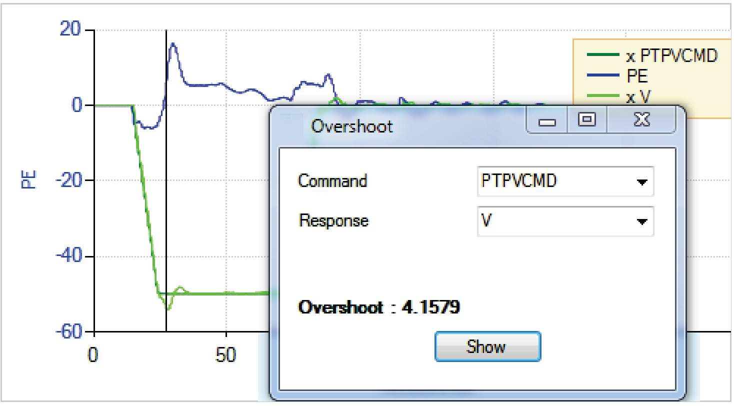


Figure 6-37. Show Overshoot

6.16.3 [Motion|Terminal|Parameter Table|Measure] Panel

Motion Tab

Refer to the section *Operation Modes*.

Terminal Tab

Refer to the section *Terminal*.

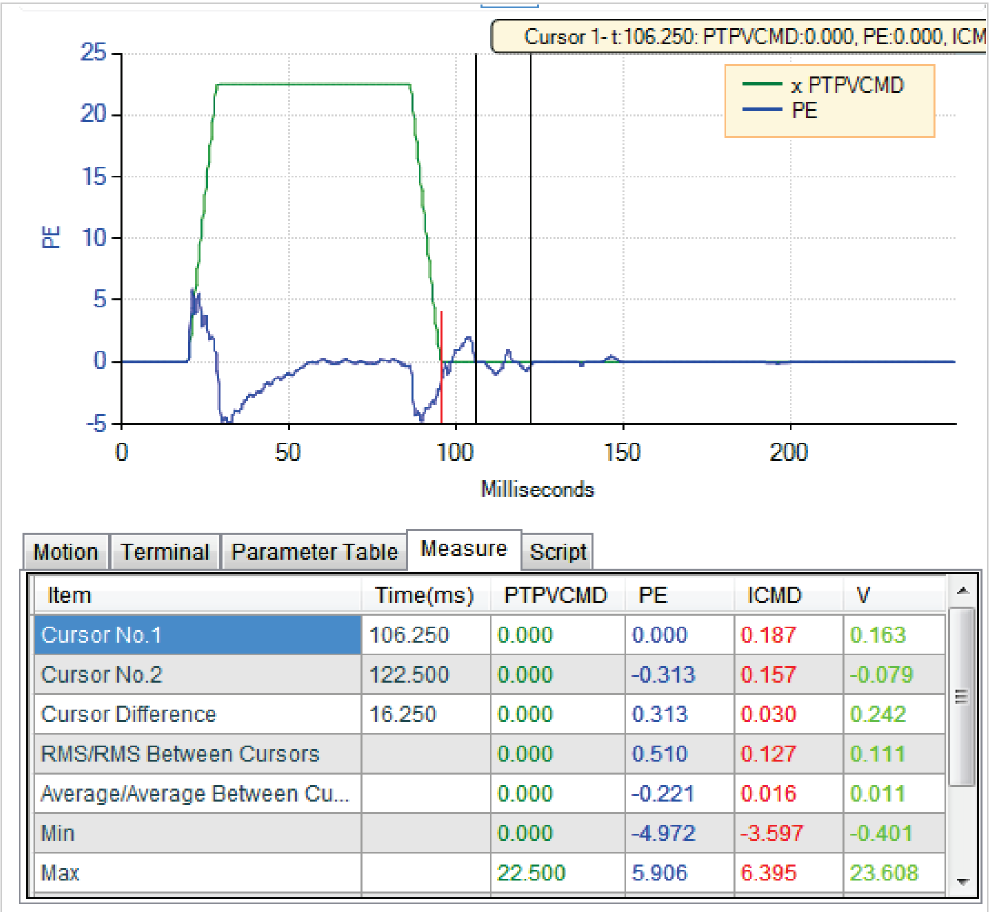
Parameter Table Tab

The **Parameter Table** displays and allows you to modify a set of variables related to the mode of operation in effect. The mode is shown in the Motion tab.

Measure Tab

The Measure tab presents several measurements from the data currently displayed in the chart.

The values displayed change as you drag the cursors to different locations on the chart.



Item	Time(ms)	PTPVCMD	PE	ICMD	V
Cursor No.1	106.250	0.000	0.000	0.187	0.163
Cursor No.2	122.500	0.000	-0.313	0.157	-0.079
Cursor Difference	16.250	0.000	0.313	0.030	0.242
RMS/RMS Between Cursors		0.000	0.510	0.127	0.111
Average/Average Between Cu...		0.000	-0.221	0.016	0.011
Min		0.000	-4.972	-3.597	-0.401
Max		22.500	5.906	6.395	23.608

Figure 6-38. FLEXI SUITE – Scope Measurement Tab

Cursor No.1	X-axis = time (in ms); value of trace at the point crossed by cursor.
Cursor No.2	X-axis = time (in ms); value of trace at the point crossed by cursor.
Cursor Difference	Time difference between the two cursors. (Cursor 2 – Cursor 1)
RMS/RMS Between Cursors	The root mean square for the entire recording; or the root mean square for the recording between the two cursors.
Average/ Average Between Cursors	The average value for the entire recording; or the average value for the recording between the two cursors.
Min	Lowest recorded value in the trace.
Max	Highest recorded value in the trace.
Pk-Pk	The total span, between the highest and lowest recorded values in the trace.
STD	The standard deviation of the trace.

Script Tab

Refer to the section *Script Tab*.

6.16.4 Recording Data Using VarCom Instructions (Terminal)

To record data in the FLEXI PRO, perform the following steps:

1. Use the command RECORD to define the variables to be recorded, the recording interval, and the number of points to record.
2. Use the command RECTRIG to define the variable and conditions that triggers the recording.
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.

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.

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)
- GET retrieves the recorded data

7 Troubleshooting

7.1 Reports

Before contacting Technical Support, create a report of application settings by means of the Report Generator. 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 is available in two locations:

- Autotuning Wizard (Step 4)
- Backup and Restore screen

When activated, opens a dialog box that allows you to enter application and user information, and define a destination for the report.

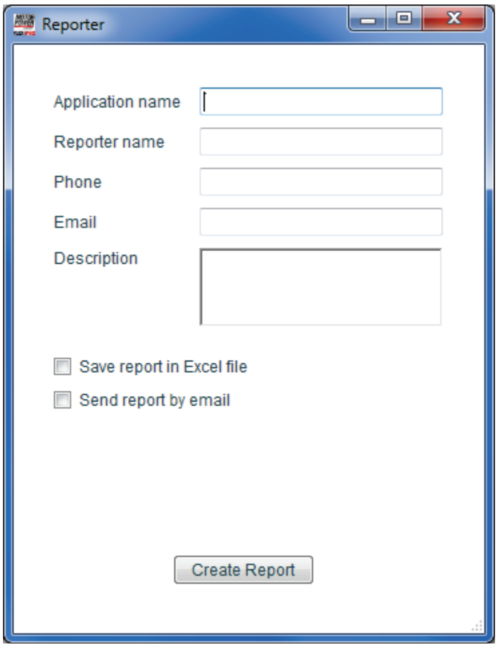


Figure 7-1. Report Generator

Save report in Excel file	Saves the report to the host computer. The Excel file is saved to the default path: \Users\owner\Documents\FLEXI SUITE
Send report by email	Creates a set of csv and txt files within a zip file, and attaches it to an email that is automatically addressed to Technical Support. You can change the address and send to a different recipient. The zip file is also saved to the default path: Users\owner\Documents\FLEXI SUITE\Reports\History

7.2 Faults and Warnings

If the FLEXI PRO is connected to a host computer via the USB or RS232 ports, 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 line (REMOTE).
  - In some systems, a specific drive input is defined as Alarm Clear. In this case, toggling this input will clear the fault.

  If the fault condition no longer exists, the drive is re-enabled.
- 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.

7.3 Fault and Warning Indicators

The FLEXI SUITE **status bar** continuously shows the status of the drive.

Figure 7-2. FLEXI SUITE Status Bar

Faults	This segment of the status bar is **green** as long as no faults exist; it is **red** whenever a fault exists. Click **Faults** to open the Enable & Faults screen.
Warnings	This segment of the status bar is **green** as long as no warnings exist; it is **yellow** whenever a warning exists. Click **Warnings** to open the Enable & Faults screen.
Messages	Notifications from FLEXI SUITE about conditions that require attention. Click **Messages** to see the full text.

The FLEXI SUITE **Enable & Faults** screen has a **Faults** panel. This panel has two tabs:

- **Faults & Warnings**: Shows a list of faults that are preventing the drive from being enabled. Alternately, the variable FLT returns a list of faults latched by the drive. Faults remain latched until cleared by CLEARFAULTS or EN, provided that the fault condition has been removed.
- **Fault History**: Shows a list of faults that have occurred since the fault buffer was last cleared. Alternately, the variable FLTHIST returns this list; FLTHISTCLR clears the fault history buffer.

Each tab presents the following information:

Icon	A graphic image that indicates the type of fault: Warning, Fault, Fatal Fault.
Display	In **Faults & Warnings** tab only. A graphic replica of the code that appears on the drive's 7-segment display.
Time	In **Fault History** tab only. The internal runtime at which the fault occurred.
Fault Name	The system name of the fault.
Description	Describes the status or fault indicated by the code.
Action Required	Describes the recommended steps for correcting the fault.

7.4 Drive Status 7-Segment Display

The 7-segment display provides various indications of drive status, such as operation modes, drive enable status, and fault conditions.

In general, the display uses the following conventions:

- **Decimal point** – Indicates the drive's Enable/Disable status; if displayed, the drive is enabled.
- **Steadily lit digit** – Indicates the operation mode (OPMODE) currently in effect.
- **Steadily lit letter** – Indicates a warning.
- **Flashing** – Indicates a fault.
- **Sequential display of letters and digits** – Indicates a fault, with some exceptions:
  - **A t 1** displayed in sequence indicates motor phasing (MOTORSETUP) is in progress.
  - **L1, L2, L3, L4 –** displayed in sequence indicate the state of software and hardware limit switches.
  - A digit flashing at half-second intervals during encoder initialization, indicates the operation mode (OPMODE) currently in effect.

In the event of concurrent faults, only one fault code is displayed on the 7-segment display. The display shows the code of the fault with the highest priority.

7.5 7-Segment Code Descriptions

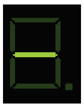
The 7-segment code descriptions are presented here in alphanumerical order, in the following format:

picture of code	code in text	How displayed (e.g., flashing)
	Definition	Short name. Used in FLEXI SUITE.
	Type	Specifies the type of status or fault indicated by the code: **Mode**, **Warning**, **Fault** or **Fatal fault**.
	Active disable	Indicates whether the Active Disable function (part of Disable mode) can be triggered by the fault.
	Description	Describes the status or fault indicated by the code.
	Action required	Describes the recommended steps for correcting the fault.

≡

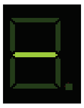
	≡	Flashing
	Definition	Watchdog Fault
	Type	Fault
	Active disable	No
	Description	Generally occurs due to an unforeseen circumstance. The drive is inoperable until power is cycled
	Action required	Contact technical support

-



	-	Flash
	Definition	Watchdog Fault
	Type	Fault
	Active disable	No
	Description	Generally occurs due to an unforeseen circumstance. The drive is inoperable until power is cycled.
	Action required	Contact technical support

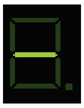
-1



-1 Displayed in sequence

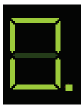
Definition	Not Configured
Type	Fault
Active disable	Not applicable
Description	Drive configuration required. CONFIG is required after the value of any of the following parameters is modified: DIR, ENCOUTMODE, ENCOUTRES, FEEDBACKTYPE, KCBEMF, KCD, KCDQCOMP, KCFF, KCI, KCIV, KCP, MENCRES, MENCTYPE, MFBDIR, MFBINT, MFBMODE, MICONT, MIPEAK, MJ, MKF, MKT, ML, MLGAINC, MLGAINP, MOTORCOMMTYPE, MOTORTYPE, MPITCH, MPOLES, MR, MRESPOLES, MSININT, MSPEED, PWMFRQ, PWMSATRATIO, VBUS, VLIM CONFIG is also required after any of the following parameters is sent to the drive, even if its value has not been changed: FEEDBACKTYPE, KCD, MJ, PWMFRQ, VLIM
Action required	Set drive parameters and/or and execute CONFIG.

-5



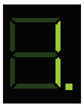
-5	Displayed in sequence
Definition	Motor Setup Failed
Type	Fault
Active disable	No
Description	Motor Setup procedure failed. MOTORSETUPST will show the cause. This fault disables the drive.
Action required	Check phase and motor wiring. Make sure the correct feedback type is selected. Check MOTORSETUPST for hints.

0



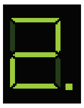
0	Lit steadily
Definition	Serial Velocity Mode
Type	Mode
Active disable	Not applicable
Description	Not applicable
Action required	Not applicable

1



1	Lit steadily
Definition	Analog Velocity Mode
Type	Mode
Active disable	Not applicable
Description	Not applicable
Action required	Not applicable

2



2	Lit steadily
Definition	Serial Current Mode
Type	Mode
Active disable	Not applicable
Description	Not applicable
Action required	Not applicable

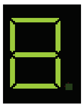
3

3	Lit steadily
Definition	Analog Current Mode
Type	Mode
Active disable	Not applicable
Description	Not applicable
Action required	Not applicable

4

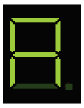
4	Lit steadily
Definition	Gearing Mode
Type	Mode
Active disable	Not applicable
Description	Not applicable
Action required	Not applicable

8



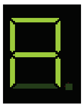
8	Lit steadily
Definition	Profile Position Mode
Type	Mode
Active disable	Not applicable
Description	Not applicable
Action required	Not applicable

A4



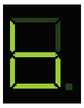
A4	Displayed in sequence
Definition	CAN Supply Fault
Type	Fault
Active disable	Yes
Description	A problem with the internal voltage supply for the CANbus. This fault disables the drive.
Action required	The drive probably needs repair. Contact technical support

At1



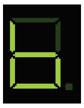
At1	Displayed in sequence
Definition	Motor Setup in Progress
Type	Mode
Active disable	Not applicable
Description	The Motor Phasing procedure is in progress. If the procedure fails, the display will show "-5".
Action required	Not applicable

b



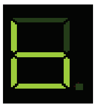
b	Steady
Definition	Tamagawa Battery Low-Voltage
Type	Warning
Active disable	Not applicable
Description	Battery voltage is nearing fault level.
Action required	Prepare to replace battery soon.

b



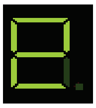
b	Flashing
Definition	Drive Locked
Type	Fatal fault
Active disable	Not applicable
Description	Security code and key do not match. Drive cannot be enabled.
Action required	Contact technical support

b1



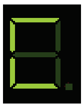
b1	Displayed in sequence
Definition	PLL (Phase-Locked Loop) Synchronization Failed
Type	Fault
Active disable	No
Description	Controller synchronization signal is missing or not stable. The fault is detected only when synchronization is enabled by SYNCSOURCE command. This fault disables the drive.
Action required	Check for controller synchronization signal. Check the cable connection and wiring.

e



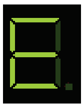
e	Flashing
Definition	Parameter's Memory Checksum Failure
Type	Fault
Active disable	Not applicable
Description	The non-volatile memory used to store drive parameters is empty or the data is corrupted.
Action required	Reconfigure the drive, or download the parameter set, and save the parameters.

C1



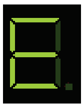
C	Displayed in sequence
Definition	CAN Heartbeat Lost
Type	Fault
Active disable	Yes
Description	Drive detected disconnection between CAN master and drive. This fault disables the drive.
Action required	Reconnect master and slave, and power cycle the drive.

E



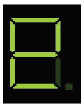
E	Lit steadily
Definition	Ember Mode
Type	Mode
Active disable	Not applicable
Description	Firmware is being updated in the drive.
Action required	Not applicable

E



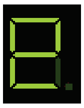
E	Flashing
Definition	Failure Writing to Flash Memory
Type	Fatal fault
Active disable	Not applicable
Description	An internal problem accessing the flash memory. Drive cannot be enabled.
Action required	Contact technical support.

e101



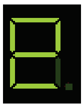
e101	Displayed in sequence
Definition	FPGA Config Fail
Type	Fatal fault
Active disable	Not applicable
Description	The code for the FPGA did not load. Drive cannot be enabled.
Action required	Contact technical support.

e105



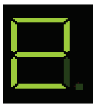
e105	Displayed in sequence
Definition	Self Test Fail
Type	Fatal fault
Active disable	Not applicable
Description	The power-up self test failed. Drive cannot be enabled.
Action required	Contact technical support.

e106



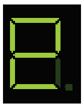
e106	Displayed in sequence
Definition	Control EEPROM Fault
Type	Fatal fault
Active disable	Not applicable
Description	A problem accessing the EEPROM on the control board. Drive cannot be enabled.
Action required	Contact technical support.

e107



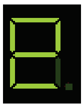
e107	Displayed in sequence
Definition	Power EEPROM Fault
Type	Fatal fault
Active disable	Not applicable
Description	A problem accessing the EEPROM on the power board. Drive cannot be enabled.
Action required	Contact technical support.

e108



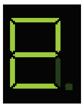
e108	Displayed in sequence
Definition	Vbus Measure Circuit Fail
Type	Fault
Active disable	Yes
Description	A failure occurred in the circuit that measures bus voltage. This fault disables the drive.
Action required	Reset faults. If the fault persists, the drive probably needs repair. Contact technical support.

e109



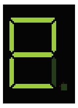
e109	Displayed in sequence
Definition	Current-Sensors Offset Out-of-Range
Type	Fault
Active disable	No
Description	The calculated offsets for the current sensors are out of range. This fault disables the drive.
Action required	Reset faults. If the fault persists, the drive probably. needs repair. Contact technical support.

e120



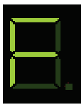
e120	Displayed in sequence
Definition	FPGA Version Mismatch
Type	Fault
Active disable	Yes
Description	FPGA version does not match the firmware version. This fault disables the drive.
Action required	Update either FPGA version or drive version.

e121



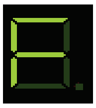
e121	Displayed in sequence
Definition	Internal Error
Type	Fault
Active disable	No
Description	Internal error due to an endless while loop or a numerical issue. This fault disables the drive.
Action required	Contact technical support.

F



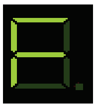
F	Lit steadily
Definition	Foldback Warning
Type	Warning
Active disable	Not Applicable
Description	Drive fold current dropped below the drive fold current warning threshold (MIFOLDWTHRESH). Or, motor fold current dropped below the motor fold current warning threshold (IFOLDWTHRESH).
Action required	Check the drive-motor sizing. This warning can occur if the drive is under-sized (under-powered) for the application.

F1



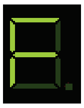
F1	Displayed in sequence
Definition	Drive Foldback
Type	Fault
Active disable	Yes
Description	Drive average current exceeds rated drive continuous current. It occurs after the Foldback warning has occurred.
Action required	Check motor-drive sizing. This warning can occur if the drive is under-sized (under-powered) for the application. Check that the commutation angle is correct (i.e., commutation is balanced).

F2



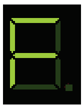
F2	Displayed in sequence
Definition	Motor Foldback
Type	Fault
Active disable	Yes
Description	Motor average current exceeds rated motor continuous current. It occurs after the Foldback warning has occurred.
Action required	Check the drive-motor sizing. This warning can occur if the motor is under-sized (under-powered) for the application.

F3



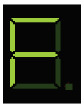
F3	Displayed in sequence
Definition	Stall Fault
Type	Fault
Active disable	No
Description	A stall **condition** occurs when [I > MICONT] and [I > 0.9×ILIM] and [V < STALLVEL]. A stall **fault** occurs whenever a stall condition persists for a duration greater than STALLTIME. This fault disables the drive.
Action required	Remove the stall condition, and take care to prevent stall conditions.

Fb1



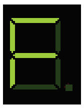
Fb1	Displayed in sequence
Definition	Fieldbus - Target position exceeds velocity limit
Type	Fault
Active disable	Yes
Description	A target position command from controller was rejected because it would cause motor to exceed the velocity limit. This fault disables the drive.
Action required	Enable the drive and send valid position commands.

Fb2



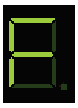
Fb2	Displayed in sequence
Definition	Fieldbus - Target position exceeds acceleration/ deceleration limits
Type	Fault
Active disable	Yes
Description	A target position command from controller was rejected because it would cause the motor to exceed the acceleration/ deceleration limit. This fault disables the drive.
Action required	Enable the drive and send valid position commands.

Fb3



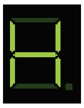
Fb3	Displayed in sequence
Definition	EtherCAT - Cable disconnected
Type	Fault
Active disable	Yes
Description	The connection between controller and drive was removed. This fault disables the drive.
Action required	Reestablish the connection between controller and drive.

Fb4



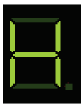
Fb4	Displayed in sequence
Definition	Fieldbus Target Command Lost
Type	Fault
Active disable	Yes
Description	The fieldbus controller has not sent a target command in 3 consecutive instances. This fault disables the drive.
Action required	Clear the fault and allow the controller to send new commands.

H



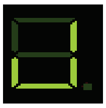
H	Steady
Definition	Motor Over-Temperature
Type	Warning
Active disable	
Description	Motor is overheated.
Action required	

H



H	Flashing
Definition	Motor Over-Temperature
Type	Fault
Active disable	Yes
Description	Either the motor has overheated, or the drive is not set up correctly for the motor temperature sensor. This fault disables the drive.
Action required	Check that the drive is configured properly (using THERMODE, THERMTYPE, THERMTHRESH and THERMTIME), and that the motor temperature sensor is properly connected to the drive if needed. If the drive is configured and wired properly, check whether the motor is under-sized for the application.

J



J	Flashing
Definition	Velocity Over-Speed Exceeded
Type	Fault
Active disable	Yes
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.

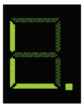
J1

J1	Displayed in sequence
Definition	Exceeded Maximum Position Error
Type	Fault
Active disable	Yes
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

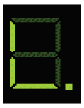
J2	Displayed in sequence
Definition	Exceeded Maximum Velocity Error
Type	Fault
Active disable	Yes
Description	The position error (PE) has exceeded the position error limit (PEMAX). This fault disables the drive.
Action required	Change drive tuning to improve position tracking, or increase PEMAX to allow a greater position error.

L1



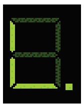
L1	Displayed in sequence
Definition	Hardware positive limit switch is open
Type	Warning
Active disable	
Description	Positive hardware limit switch is activated.
Action required	

L2



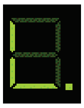
L2	Displayed in sequence
Definition	Hardware negative limit switch is open
Type	Warning
Active disable	
Description	Negative hardware limit switch is activated.
Action required	

L3



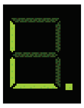
L3	Displayed in sequence
Definition	Hardware positive and negative limit switches are open
Type	Warning
Active disable	
Description	Positive and negative hardware limit switches are both activated.
Action required	

L4



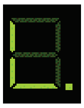
L4	Displayed in sequence
Definition	Software positive limit switch is tripped
Type	Warning
Active disable	
Description	Positive software limit switch is activated. PFB > POSLIMPOS and POSLIMMODE = 1
Action required	

L5



L5	Displayed in sequence
Definition	Software negative limit switch is tripped
Type	Warning
Active disable	
Description	Negative software limit switch is activated. PFB < POSLIMNEG and POSLIMMODE = 1
Action required	

L6

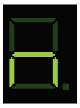


L6	Displayed in sequence
Definition	Software limit switches are tripped
Type	Warning
Active disable	
Description	Positive and negative software limit switches are activated. PFB > POSLIMPOS and PFB < POSLIMNEG and POSLIMMODE = 1
Action required	

n

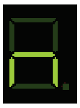
n	Steady
Definition	STO Warning
Type	Warning
Active disable	No
Description	The STO signal is not connected when drive disabled.
Action required	Check that the STO connector (P1) is wired correctly.

n



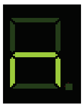
n	Flashing
Definition	STO Fault
Type	Fault
Active disable	No
Description	The STO signal is not connected when drive enabled. This fault disables the drive.
Action required	Check that the STO connector (P1) is wired correctly.

n1



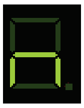
n1	Displayed in sequence
Definition	Regen Over-Current
Type	Fault
Active disable	Yes
Description	The preset current limit for regen current has been exceeded. This fault disables the drive.
Action required	Increase the value of the regen resistor.

n3



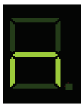
n3	Displayed in sequence
Definition	Emergency Stop Issued
Type	Fault
Active disable	Yes
Description	Input defined as Emergency Stop indicator has been activated. This fault disables the drive.
Action required	Turn off the input.

n41



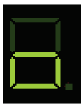
n41	Displayed in sequence
Definition	Power Brake Open Load
Type	Fault
Active disable	No
Description	Open load on the power brake output. Drive cannot be enabled.
Action required	Make sure the power brake load cables are connected properly and are not damaged.

n42



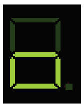
n42	Displayed in sequence
Definition	Power Brake Short
Type	Fault
Active disable	No
Description	Short circuit on the power brake output. This fault disables the drive.
Action required	Replace the power brake (the motor).

o



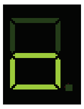
o	Flashing
Definition	Over-Voltage
Type	Fault
Active disable	No
Description	The bus voltage exceeded the maximum value. This fault disables the drive.
Action required	Check whether a regen resistor is required for the application.

o15



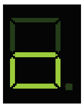
o15	Displayed in sequence
Definition	Plus 15V Out of Range
Type	Fault
Active disable	Yes
Description	The internal +15 V supply is out of range. This fault disables the drive.
Action required	The drive probably needs repair. Contact technical support.

0-15



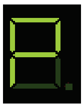
o-15	Displayed in sequence
Definition	Minus 15V Out of Range
Type	Fault
Active disable	Yes
Description	The internal -15 V supply is out of range. This fault disables the drive.
Action required	The drive probably needs repair. Contact technical support.

o5



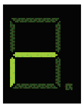
o5	Displayed in sequence
Definition	5V Out of Range
Type	Fault
Active disable	Yes
Description	5V is low or powering off. This fault disables the drive.
Action required	May occur during power off. If occurs otherwise, contact technical support.

P



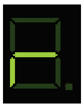
P	Flashing
Definition	Over-Current
Type	Fault
Active disable	No
Description	Over-current at the drive output has been detected. The drive allows this fault to occur up to 3 times in succession. After 3 faults, the drive forces a delay of 1 minute before it can be reenabled. This fault disables the drive.
Action required	Check for a short circuit on the motor connection. Check for excessive overshoot in the current loop.

r



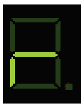
r	Steady
Definition	Offset and/or Gain Adjustment Values Detected After SININIT
Type	Warning
Active disable	Not applicable
Description	Significant offset and/or gain adjustment values were detected after SININIT. The values that trigger this warning are half the value of those used to declare a fault. 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.

r10



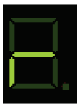
r10	Displayed in sequence
Definition	Sine Feedback Communication Fail
Type	Fault
Active disable	No
Description	Communication problem between the drive and the EnDat encoder. This fault disables the drive.
Action required	Check that the data and clock signals to the EnDat encoder are connected properly. The cable must be shielded.

r14



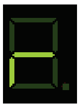
r14	Displayed in sequence
Definition	Sine Encoder Quadrature Fault
Type	Fault
Active disable	No
Description	Mismatch between calculated and actual encoder quadrature information. This fault disables the drive.
Action required	Check the feedback device wiring. Make sure the correct encoder type (MENCTYPE) is selected.

r15



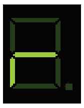
r15	Displayed in sequence
Definition	Sin/Cos Calibration Invalid
Type	Fault
Active disable	No
Description	The sine/cosine calibration parameters are out of range. This fault is related to resolver and sine encoder feedback. This fault disables the drive.
Action required	Re-execute the sine/cosine calibration process.

r16



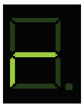
r16	Displayed in sequence
Definition	Feedback 5V Over-Current
Type	Fault
Active disable	No
Description	The current supplied by the drive on the 5V primary encoder supply has exceeded the preset current limit. The drive allows this fault to occur up to 3 times in succession. After 3 faults, the drive forces a delay of 1 minute before it can be reenabled. This fault disables the drive.
Action required	The FLEXI PRO can source a maximum current of 250 mA to the primary encoder. Check for a short-circuit at the encoder. Check if the encoder is drawing more than the current limit

r17



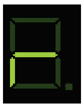
r17	Displayed in sequence
Definition	Secondary Feedback Index Break
Type	Fault
Active disable	Yes
Description	Secondary encoder index line not connected. This fault disables the drive.
Action required	Check whether the drive is configured for working with the index signal on the secondary encoder, and check if the index signal is connected.

r18



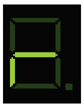
r18	Displayed in sequence
Definition	Secondary Feedback A/B Line Break
Type	Fault
Active disable	Yes
Description	One of the secondary feedback signals is not connected. This fault disables the drive.
Action required	Check that all signals from the secondary encoder are properly connected to the drive.

r19



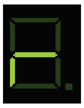
r19	Displayed in sequence
Definition	Secondary Feedback 5V Over-Current
Type	Fault
Active disable	Yes
Description	The preset current limit for current supplied by the drive on the 5 V secondary encoder supply has been exceeded. This fault disables the drive.
Action required	The FLEXI PRO can source a maximum current of 250 mA to the secondary encoder. Check for a short-circuit at the encoder. Check if the encoder is drawing more than the current limit.

r20



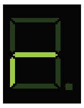
r20	Displayed in sequence
Definition	Feedback Communication Error
Type	Fault
Active disable	No
Description	Communication with the feedback device did not initialize correctly. This fault disables the drive.
Action required	Check that the feedback device is wired correctly. Check that the correct encoder type (MENCTYPE) is selected.

r21



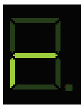
r21	Displayed in sequence
Definition	Nikon Encoder Operational Fault
Type	Fault
Active disable	No
Description	Communication with the Nikon feedback device did not initialize correctly. This fault disables the drive.
Action required	Check that the feedback device is wired correctly. Check that the correct encoder type (MENCTYPE) is selected.

r23



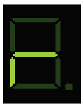
r23	Displayed in sequence
Definition	Phase Find Failed
Type	Fault
Active disable	No
Description	Commutation initialization has failed. This fault occurs in systems that do not have commutation information (e.g., Hall signals) in the motor feedback device. This fault disables the drive.
Action required	Check whether the motor feedback type and the phase-finding parameters are set correctly for the application.

r24



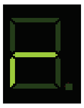
r24	Displayed in sequence
Definition	Tamagawa Init Failed
Type	Fault
Active disable	No
Description	The initialization process with the Tamagawa feedback device has failed. This fault disables the drive.
Action required	Check that the wiring to the encoder is correct.

r25



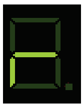
r25	Displayed in sequence
Definition	Pulse & Direction Input Line Break
Type	Fault
Active disable	Yes
Description	One of the Pulse & Direction signals is not connected. This fault disables the drive.
Action required	Check that all signals to the P&D inputs are properly connected to the drive.

r26



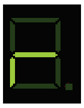
r26	Displayed in sequence
Definition	Tamagawa Abs Operational Fault
Type	Fault
Active disable	No
Description	Several faults are indicated by the feedback device and include one or more of the following: battery low/error, over-speed, counting error, multiturn error. This fault disables the drive.
Action required	Check the battery voltage and feedback wiring. Make sure the motor did not move at a high velocity during encoder initialization.

r27



r27	Displayed in sequence
Definition	Motor Phases Disconnected
Type	Fault
Active disable	Yes
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.

r28



r28	Displayed in sequence
Definition	Resolver Initialization Failed
Type	Fault
Active disable	No
Description	The drive could not detect the proper gain setting or sampling point for the sine/cosine signals. This fault disables the drive.
Action required	Check resolver wiring and gain value.

r29

r29	Displayed in sequence
Definition	Absolute Encoder Battery Low-Voltage
Type	Fault
Active disable	No
Description	An error bit indicating a battery problem was detected in data from the drive. This fault disables the drive.
Action required	Replace battery, then reset drive. If battery is replaced while drive is on, position information is retained.

r34

r34	Displayed in sequence
Definition	PFB Off Checksum Invalid
Type	Fault
Active disable	No
Description	The calculated checksum of the PFB backup data does not match the expected checksum. This fault disables the drive.
Action required	If required by the application, home the machine.

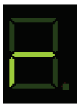
r35

r35	Displayed in sequence
Definition	PFB Off Data Mismatch
Type	Fault
Active disable	No
Description	Multiturn data of the PFB cannot be restored due to axis movement. This fault disables the drive.
Action required	If required by the application, home the machine.

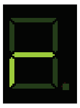
r36

r31	Displayed in sequence
Definition	No PFB Off Data
Type	Fault
Active disable	No
Description	PFB backup memory is empty. This fault disables the drive.
Action required	If required by the application, home the machine.

r37

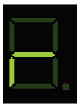


r37	Displayed in sequence
Definition	Encoder Phase Error
Type	Fault
Active disable	No
Description	In normal incremental encoder operation, quadrature inputs A and B are 90 degrees out of phase. The phase error occurs when edge transition is detected simultaneously on the A and B signals. This fault disables the drive.
Action required	Set MENCAQBFILT to 0 to remove the filter on A and B signals. If problem persists, it may be due to a faulty encoder.



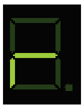
r38	Displayed in sequence
Definition	Differential Halls Line Break
Type	Fault
Active disable	No
Description	Line break in differential Hall sensors.
Action required	Make sure HALLSTYPE matches the Hall sensors in use (single-ended or differential). Check whether all signals from the differential Hall sensors are properly connected to the drive

r4



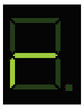
r4	Displayed in sequence
Definition	A/B Line Break
Type	Fault
Active disable	No
Description	One of the primary feedback signals is not connected. This fault occurs in incremental encoder, resolver and sine encoder feedback types. This fault disables the drive.
Action required	Check whether all signals from the primary feedback device are properly connected to the drive.

r5



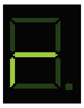
r5	Displayed in sequence
Definition	Index Line Break
Type	Fault
Active disable	Yes
Description	Encoder index line is not connected. This fault disables the drive.
Action required	Check that the drive is configured for working with the index signal (using MENCTYPE), and check if the index signal is connected.

r6



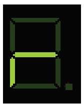
r6	Displayed in sequence
Definition	Illegal Halls
Type	Fault
Active disable	Yes
Description	The drive has detected either 000 or 111 state on the Hall feedback signals. This fault disables the drive.
Action required	Check that the Hall signals are all properly connected. While turning the motor, read the Halls state (using HALLS) to see which signal is not connected. If the feedback type is Tamagawa, check that the feedback wiring is correct

r8



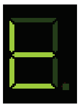
r8	Displayed in sequence
Definition	A/B Out of Range
Type	Fault
Active disable	No
Description	Feedback analog signal is out of range. This fault is related to resolver and sine encoder feedback. The drive checks that the amplitudes of the sine and cosine signals are correct, based on the calculation $\sin^2 + \cos^2 = 1$ This fault disables the drive.
Action required	Check the amplitudes of the sine and cosine signals.

r9



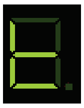
r9	Displayed in sequence
Definition	Encoder Simulation Freq Too High
Type	Fault
Active disable	Yes
Description	The computed equivalent encoder output frequency exceeds the upper limit for this signal, which is 4 MHz. This fault disables the drive.
Action required	Check the parameters used for setting up the equivalent encoder output. If using a sine encoder, check the ENCOUTRES parameter settings.

t



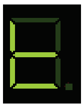
t	Lit steadily
Definition	Over-Temperature
Type	Warning
Active disable	Not Applicable
Description	The temperature on the power board and/or on the control board has exceeded the preset limit.
Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact technical support.

t1



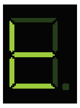
t1	Displayed in sequence
Definition	Power Stage Over-Temperature
Type	Fault
Active disable	Yes
Description	The temperature on the power board has exceeded the preset limit. This fault disables the drive.
Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact technical support.

t2



t2	Displayed in sequence
Definition	Integrated Power Module Over-Temperature
Type	Fault
Active disable	Yes
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



t3	Displayed in sequence
Definition	Control Board Over-Temperature
Type	Fault
Active disable	Yes
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

u	Lit steadily
Definition	Under-Voltage
Type	Warning
Active disable	Not Applicable
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.

u

u	Flashing
Definition	Under-Voltage
Type	Fault
Active disable	Yes
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.

8 Firmware Upgrade

The FLEXI PRO firmware can be upgraded using the FLEXI SUITE software.

8.1 Preparation

Important: Before upgrading the firmware, do the following:

- Backup the drive parameters since parameter settings may be lost during the upgrade. After the upgrade is completed, the parameters can be reloaded/restored.

  To backup parameters from FLEXI SUITE, go the **Backup & Restore** screen, and click the **Backup** button. Refer to *Managing Parameters.*
- Read the release note or other documentation supplied with the new firmware.

8.2 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 FLEXI PRO has two Ember modes, Software and Hardware.

Normally, you can and should communicate with the drive in Software Ember mode 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 press the Hardware Ember switch. This switch is located on the top of the drive next to the daisy chain connector (C8). Refer to Figure 8-1.

Pressing the switch sets the drive to serial communication Boot-Up Mode. All segments on the front panel 7-segment LED display light up, and (if it exists) 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.

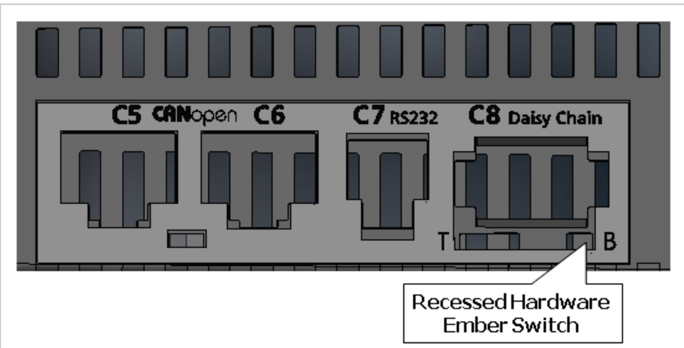


Figure 8-1. Location of Hardware Ember Switch

8.3 Upgrade Procedure

1. From the FLEXI SUITE **Drive Info** screen, click **Download Firmware**.

The **Firmware Upgrade** dialog box opens, and allows you to download the firmware file to the drive over a USB or RS232 serial communications link.

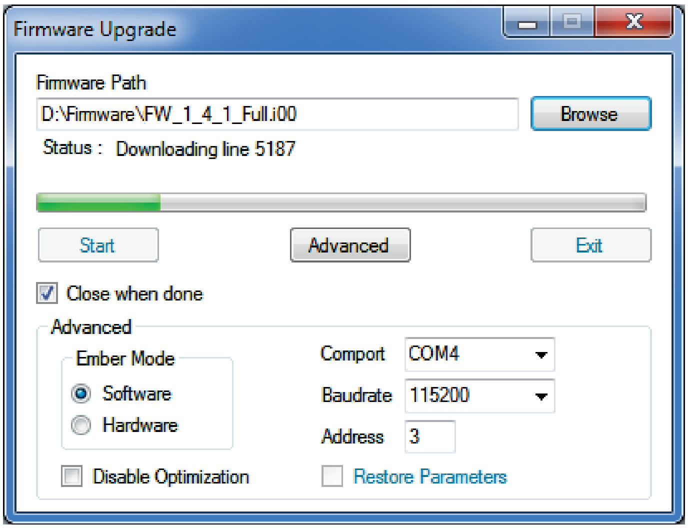


Figure 8-2. Firmware Upgrade Interface

2. Browse to and select the firmware file, and press **Start**.

Alternately, click **Advanced** to expand the dialog box and modify settings. Then press **Start** to begin the firmware upgrade process.

Firmware Path	The path and name of the file containing the firmware upgrade. The file name indicates the firmware version; for example: 1_4_1_Full.i00 represents firmware version 1.4.1. The default path is \My Documents\ FLEXI SUITE.
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. Refer to the section *Ember Mode.*
Com Port	The COM port of the host computer to which the FLEXI PRO is connected. Make sure this COM port is not being used by any other application.
Baud Rate	The rate must be set to 115200.

Address	■ When only one drive is connected to the host computer, a drive address is not needed. Ignite attempts to communicate with the drive that was communicating with the host before Ignite was launched. Thus, if the drive responds to serial communication, Ignite will begin the firmware download. ■ When multiple drives are connected to the host in a daisy-chain, a drive address must be specified. When a drive address is specified, Ignite 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.
Disable Optimization	The firmware upgrade 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 upgrade.
Restore Parameters	The firmware upgrade procedure stores all user parameters to memory before downloading the firmware and restores the parameters after the upgrade. This option can be disabled. This option is not available if host and drive are not communicating.
Close When Done	When selected, the Firmware Upgrade dialog box closes automatically once the procedure is completed.

During the firmware upgrade process, the 7-segment LED display shows a steadily-lit **E**.

When the process is complete, click the **Exit** button.

Ignite automatically restarts the FLEXI PRO when the firmware download process is complete.

8.4 Resuming Operation

1. Go to the FLEXI SUITE **Drive Info** screen in FLEXI SUITE, and check the drive firmware version to verify that the new firmware has been loaded.
2. If the drive parameters were not restored by the Ignite program, go the FLEXI SUITE **Backup & Restore** screen, and click the **Restore** button.
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 SAVE command over the serial port, or click the Save button on the FLEXI SUITE toolbar.

8.5 Command Line Activation

FLEXI PRO supports the use of command line options, making it possible to download firmware automatically to a number of drives.

The required commands and command syntax are shown below. The order of the commands is irrelevant.

Command Line Format

```
comport=COM29

emberMode=software {hardware}

firmware="c:\Temp\test\Resident.i00"

ember="c:\Temp\test\ember.a00"

comtype=serial {CanOpen}

serialbauderate=115200

driveID=2
```

comport	Communication port
emberMode	Software (or hardware) ember mode
firmware	The path of the firmware file (*.00i)
ember	The path of the ember file (*.00a)
comtype	Serial (or CANopen) communication
serialbauderate	Serial baud rate
driveID	Drive ID

Sample Command

```
start /wait FLEXI SUITE.exe comport=COM29 emberMode=software
firmware="c:\Temp\test\Resident.i00" ember="c:\Temp\test\ember.a00"
comtype=serial serialbauderate=115200 driveID=2

echo  %errorlevel%
```

9 Scripting

9.1 FLEXI SUITE Scripts

FLEXI SUITE includes a simple scripting language that allows the FLEXI PRO to perform logical and control tasks that can run independently and simultaneously.

A script may contain any number of commands. A command may be either a drive command (i.e., a VarCom instruction; refer to the *VarCom Reference Guide*) or a script command, as described in this chapter.

Any number of script files can be stored on the host computer and opened in FLEXI SUITE. Scripts are stored as text files, which can also be edited in Notepad or any other text editor.

Multiple scripts can be executed concurrently. Each script is executed in its own thread, so that other program functions, such as Terminal, Scope and Watch, can be simultaneously active for any number of scripts.

9.2 Syntax and Special Characters

#	Defines the start of a script command.
$	Prefix for all variable names. A variable name begins with the character $ followed by any combination of letters and digits.
+ - * /	**Operators** – add, subtract, multiply, divide.
< > ==	**Condition operators** – less than, greater than, equal to, not equal to.
=	Assigns a value to a variable; for example: #Var $Pos = 3 $Pos = $Pos + 1
;	Marks the beginning of a comment. Can be inserted anywhere in the line. All text after the ; until the end of the line is ignored. Comment text is displayed in green.
{ }	Brackets delineate a string of two or more arguments (tokens), which are thus sent to the drive as a single entity. The script engine can handle only 3 variables.
@	Replaces name of a variable with an address from a map file (FLEXI PRO.map)

9.3 Variables

A variable is defined by an **assignment statement**:

<VarName> = <Value> <Operator> <Value>

Where *<Value>* is a variable name, drive command, or decimal number.

Variable values can be the output of drive command or the result of a calculation. These values can be compared in a **condition statement**:

`<Condition> = <Value> <Condition Operator> <Value>`

Where *<Condition>* is **if** or **while**

9.4 Commands

The following commands are recognized by the FLEXI SUITE script engine.

9.4.1 Program Flow

Label

Syntax	`#Label <LabelName>`
Variables	*<LabelName>* = the label name
Operation	Sets a label to be referred to by #If and #Goto commands.

Goto

Syntax	`#Goto <LabelName>`
Variables	*<LabelName>* = the name of the label for the #Goto
Operation	Jumps to the label name

If

Syntax	`#If <Condition> <Label_Name>`
Variables	*<Condition>* = can be < > == != *<LabelName>* = the name of the label for the #Goto
Operation	Evaluates a condition; if true, jumps to the label name.

While

Syntax	`#While <Condition>`
	…
	`#End_While`

Variables	*<Condition>* = can be < > == !=
Operation	Repeats all commands between #While and #End_While, as long as the condition is true. The #While block may include any script commands, including any number of nested #While blocks.

Delay

Syntax	`#Delay $<VarName>`
Variables	$*<VarName>* = a number or a variable
Operation	Pauses execution of the script for the specified number of milliseconds.

9.4.2 Data

Var

Syntax	`#Var $<VarName>` `#Var $<VarName> = <Value>`
Variables	$<*VarName*> = variable name <*Value*> = number or drive parameter name
Operation	Declares the variable. Declares the variable and sets its initial value.

Print

Syntax	`#Print <Var_1> [<Var_2>]`
Variables	<*Var_1*> <*Var_2*> = can be a script variable, drive command or text string
Operation	Prints the value of the variable/s to the Output panel.

Print Parameters

Syntax	`#PrintParameters <CommandName_prefix>`
Variables	<*CommandName_prefix*> = first few characters of a VarCom name
Operation	Outputs all VarCom commands that start with the specified prefix. Useful for saving a partial list of VarCom parameters. Example: `#PrintParameters kc*` Outputs all current loop parameters

ClearOutput

Syntax	`#ClearOutput`
Operation	Clears the contents of the Output panel

Message

Syntax	`#Message <VarName_1> [<VarName _2>]`
Variables	<*VarName _1*> <*VarName _2*> = can be a script variable, drive command or text string
Operation	Opens message box to display the value of the variables, and pauses execution of the script until user clicks OK.

Round

Syntax	`#Round $<VarName>`
Variables	$<*VarName*> = a script variable

Operation	Gets the variable and the number of digits after the point. For example: `#Round $var 0`

SysValue

Syntax	`# SysValue`
Variables	$<*VarName*> = a script variable

Operation	Gets FLEXI SUITE internal values.
	A script can get a value from any of the following:
	■ Any cell in the Measurement table in the Scope screen, such as Min, Max, Pk-Pk of each of the recorded variables.
	■ Any cell in the Motor parameter table in the motor screen.
	■ A value calculated from data in the Scope chart.
	Settling time (SLT)
	Overshoot (OS)
	Rise time (RT)
	
	Examples:
	`#SysValue $var MT 2 3`
	Gets value from Measurement table, column 2 row 3 and assigns to variable **var**.
	`#SysValue $st SLT PTPVCMD PE`
	Gets the settling time value and assigns to variable **st**.
	`#SysValue $var OV VCMD V`
	Gets overshoot and assigns to variable **var**.
	`#SysValue $var RT VCMD V`
	Gets rise time and assigns to variable **var**.

9.4.3 Operation

Plot

Syntax	`#Plot`
Operation	Plots a graph using recorded data from the drive. This is the same as pressing the **Plot** button on Scope screen toolbar.

SavePlotFile

Syntax	`#SavePlotFile [<Filename>]` `#SavePlotFile [$<Name>]`
Variables	<*Filename*> = name of a file; if not specified, a default name is used $<*VarName*> = a script variable; enables saving multiple files in the same script

Operation	Saves data from the currently displayed Scope screen to a CVS file.

DownloadFirmware

Syntax	`#DownloadFirmware`
Operation	Starts the firmware upgrade. The command can get the path of the firmware or use the default path, if one exists. When used with #Connect, firmware can downloaded to more than one drive from a single script.

BroadcastingOn \| BroadcastingOff

Syntax	`#BroadcastingOn | #BroadcastingOff`
Operation	Starts and ends the broadcasting session.

Connect

Syntax	`#Connect <ComPortNum> <DriveID>`
Variables	<*ComPortNum*> = ID number of communication port <*Drive ID*> = ID number of drive
Operation	Establishes communication, switches from offline to online, and connects FLEXI SUITE to the specified drive through a specified communication port. Example: `#Connect 33 1` Connects to drive ID 1 through port COM33

ScaleYTrace

Syntax	`#ScaleYTrace <Name>`
Variables	<*TraceName*> = name of a trace
Operation	Sets the units of axis Y in the scope chart to the units of the specified trace.

9.5 Sample Scripts

Example 1 – Record a Motion

```
k
opmode 0
VELCONTROLMODE 0
acc 5000
dec 5000
kvp 1
kvi 0
en
record 16 1000 "vcmd "v "iq
rectrig "imm
j 500
#Delay 200
```

```
j 0
#Delay 200
k
#Plot
```

Example 2 – Set Outputs According to Input

```
; Toggle_out.txt script
;
; First, the script checks state of digital input 7
; if digital input 7 equal to 1 then
; the script will toggle one by one
; digital outputs from output 4 to 6

; Digital outputs setup
#Print .........Digital_outputs_init
outmode 4 0
outmode 5 0
outmode 6 0
outinv 4 0
outinv 5 0
outinv 6 0

; Digital input setup
#Print .........Digital_input_7_init
inmode 7 0
ininv 7 0

; Initialize output number counter
#Var $out_n
$out_n=4

; Infinite loop
#While 1>0

#If {in 7} <1 end_loop

out $out_n 1
#Print outputs
#Delay 500
out $out_n 0

$out_n= $out_n + 1
#If $out_n> 6 reset_out_n

#Goto end_loop

#Label reset_out_n
$out_n = 4

#Label end_loop
#End_While
```

Example 3 – Set Speed According to Inputs

```
; Toggle_velocity.txt script
;
; The script checks state of digital inputs 7,8
; and sets drive speed accordingly
;  IN 7  | IN 8 | V
;   0    |   0  |  0
;   1    |   0  |  200
;   0    |   1  | -200
;   1    |   1  |  0

; Digital input setup
#Print .........Digital_Inputs_Setup
inmode 7 0
inmode 8 0
ininv 7 0
ininv 8 0

; Variable for digital input 7,8 state
#var $in_state
#var $in_7
#var $in_8

; Enter the drive to serial velocity loop
k
opmode 0
en

; Infinite loop
#While 1>0

; Read state of in 7 and in 8
$in_7 = {in 7}
$in_8 = {in 8}*2
$in_state =$in_7+$in_8

#If $in_state == 0 jog_zero
#If $in_state == 1 jog_positive
#If $in_state == 2 jog_negative

#Label jog_zero
#Print JOG_zero
j 0
#Goto end_loop

#Label jog_positive
#Print JOG_plus_200
j 200
#Goto end_loop

#Label jog_negative
#Print JOG_minus_200
j -200
```

```
#Label end_loop
#Delay 500
#End_While
```

Example 4 – Set Position Feedback to Zero (Forced Homing)

```
pfboffset 0          ;Clear position offset
#Print pfboffset     ;Print position offset
pfboffset = -pfb     ;Assign the inverse value of actual position
;                     (PFB) to the position offset
#Print pfboffset     ;Print the new value of position offset
```

10 Serial Communication

The serial communication link enables the FLEXI PRO digital drive and host (terminal, PC, or high-level controller) to communicate using ASCII-coded messages transmitted over an asynchronous, multi-drop line.

When the host and FLEXI PRO are communicating through serial communication, a set of commands and variables, called **VarCom**, are used to configure, control and monitor the drive.

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

This chapter describes the serial communication protocol used by FLEXI PRO and its host.

10.1 General Information

Specifications

Communications port	RS-232, USB
Baud rate	115200 bits per second (bps)
Start bits	1
Data bits	8
Stop bits	1
Parity	None
Hardware handshake	None
Software handshake	None
Character	ASCII code
Data error check	8-bit checksum

Control Code Definitions

Name	**Symbol**	**Hex**
Line feed	<LF>	0Ah
Carriage return	<CR>	0Dh
Space	<SP>	20h
Delay	<DLY>	Indicates delay due to internal drive processing of information

Communication Summary

Drive-to-Terminal Transmission	Terminal-to-Drive Transmission	Protocol Flags (Variables)
■ Character echoes ■ Prompts ■ Variable values ■ Error/fault messages	■ Commands ■ Variable values ■ Variable queries	ECHO MSGPROMPT CHECKSUM

10.2 Data Transmission Format

To enable proper serial communication between the FLEXI PRO and the host, they must both use the same data transmission format:

- Full-duplex
- 8 bits per character
- No parity
- 1 start bit
- 1 stop bit
- Baud rate: 115200 bps
- Hardware: RS-232 or USB serial port

10.3 Drive Addressing

The FLEXI PRO can be addressed and controlled on a single-line RS-232 (C7 connector), or on a daisy-chained RS-232 (C8 connector), or USB (C1 connector) line.

The FLEXI PRO has two 10-position rotary switches, which are used to set the drive address. Refer to the section *Drive Address*.

Single-Line Configuration

In a single-line RS-232 configuration, the drive is connected to the C7 connector, and assigned address 0 by setting both rotary switches to 0.

By default, the rotary switches are set to 0, and the drive assumes a single-line configuration.

Daisy-Chain (Multi-Drop) Configuration

In a daisy-chain RS-232 configuration, all drives must be daisy-chained through the C8 connector. Each drive must have a unique address to enable its identification on the network.

A daisy-chained drive can be assigned an address from 1 to 99 by setting the rotary switches on the drive. When configuring a daisy-chain, address 0 cannot be used.

You can communicate with any or all drives on the daisy-chain from any RS-232 or USB port on any of the daisy-chained drives.

- To communicate with an individual drive in a daisy-chain, enter the following at the prompt:

\x <CR>

Where **x** = 1 to 99, the address setting of the drive.

- To communicate simultaneously with all drives on the chain, enter the following at the prompt:

  *** <CR>**

  This is called global addressing. When using global addressing, no character echo to the terminal occurs.

10.4 Variables and Commands

Serial communication with the FLEXI PRO is by means of **VarCom,** a proprietary set of commands and variables used to configure, control and monitor the drive.

- Commands instruct the drive to perform an operation.
- Read-only variables are calculated and/or set by the drive, and are used to monitor the drive and its operational status.

  To read a variable, type the name followed by a <CR>. The drive returns the value of the variable.

- Read/Write variables are used to configure and monitor the drive.

  To set a variable, type the variable name (VarCom mnemonic), a space (or =), the value, followed by <CR> (the Enter key).

10.5 Data Control

The FLEXI PRO can process approximately 16 characters per millisecond (at 115200 baud rate).

The operating system recognizes backspaces and resets upon receipt of an ESC character.

The following VarCom variables allow you to configure communication responses between drive and host.

ECHO	Enables/disables the serial port character echo. If echo is enabled, characters received via the serial port are echoed back to the serial port and displayed on the computer monitor. ECHO 0 = Serial port echo disabled ECHO 1 = Serial port echo enabled ECHO allows the host to check the validity of the information received by the drive.
MSGPROMPT	Defines whether asynchronous messages and the prompt from the drive are sent to the serial port (and to the host computer) 0 = Messages and prompt disabled 1 = Messages and prompt enabled

CHECKSUM	Enables/disables checksum protection on the message. 0 = Message checksum disabled (default) 1 = Message checksum enabled The checksum is an 8-bit value, displayed within brackets <>. For example, 0x1F checksum is displayed as <1F> at the end of the message before the carriage return.

10.6 Message Format

The message format is the structure by which the FLEXI PRO processes ASCII coded messages. Messages from the host to the drive are used to send commands, to set variables, or to query the drive. Messages from the drive to the host contain the response to queries.

This message format has two main elements: **message uni**t and **message termination**, as shown in the following figure.

The checksum utility is optional.

Note: *Start* has no significance; it simply represents the drive waiting for the host to send a message.

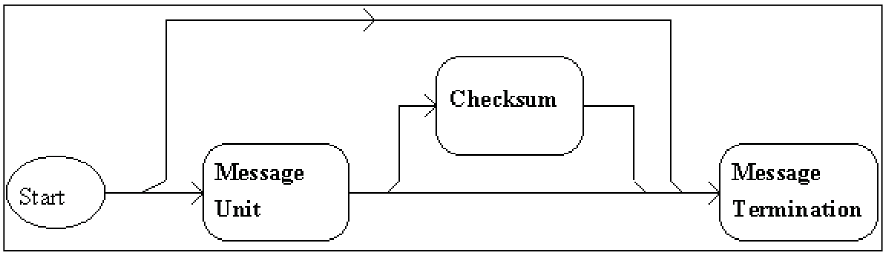


Figure 10-1. Message Format

Message Unit

A message unit is a block of information that is transmitted on the communications link. The basic message unit is shown in the following figure.

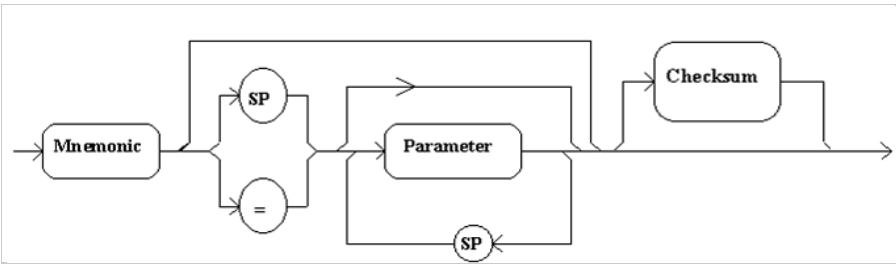


Figure 10-2. Message Unit

A message unit includes a header (VarCom mnemonic) with or without parameters. The header defines the context of the parameters that follow it. Messages sent from the host to the drives always have headers. Messages from the drive to the host do not generally include a header.

When used, parameters are separated from the mnemonic by either a space or an assignment operator. Parameters must be separated by spaces.

The FLEXI PRO can receive only a single message unit in a message format.

Message Termination

Message termination refers to the end of the message being sent.

Messages transmitted by the host are terminated by a carriage return (CR) – ASCII character 0DH.

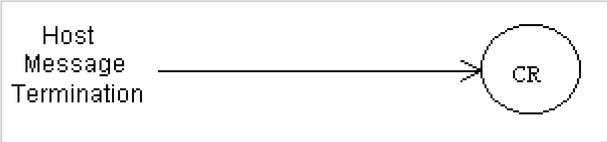


Figure 10-3. Host Message Termination Format

Messages transmitted by the drive are terminated by a carriage return/line feed (CR/LF) combination – ASCII characters 0DH/0AH.

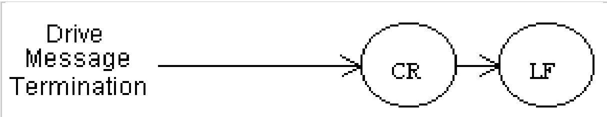


Figure 10-4. Drive Message Termination Format

The drive also accepts a message termination sent without any additional information.

Complete Message Format with Checksum

The CHECKSUM block is used only when CHECKSUM command is set.

The drive is configured to accept incoming messages with or without checksum, and to append checksum to outgoing message according to the CHECKSUM variable.

Checksum is represented by two ASCII digits within brackets <> preceding the <CR>.

The complete message format is shown in the following figure.

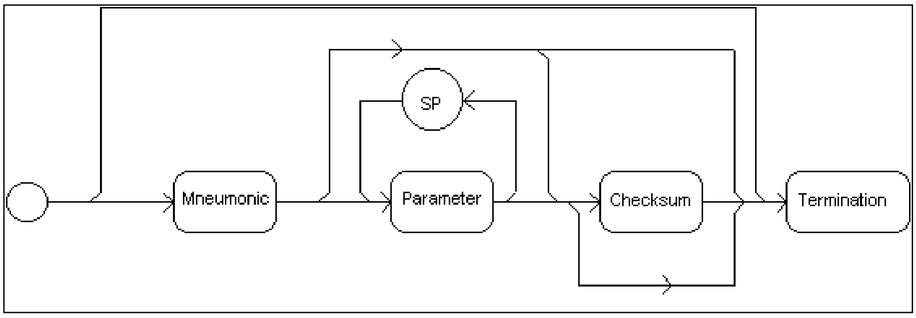


Figure 10-5. Complete Message Format

Units

Within a message or command, units are enclosed in brackets [ ]. For example:

- Message to drive: mpoles
- Message from drive: 4 [poles]

When a command from the host contains units, the drive ignores the unit information.

10.7 Asynchronous Error Messages

The asynchronous error message function is enabled by the variable MSGPROMPT.

- If this function is enabled, and an error or fault occurs, the drive transmits a brief error message to the host.
- If the function is disabled, the error message is transmitted after a <CR> message termination is detected by the drive. This occurs whenever the host sends a message to the drive.

The variable MSGPROMPT also controls the prompt sent by the drive at the end of a message.

- If echoing is enabled, the characters in the message are all echoed before the error message is transmitted. Even though an error has occurred and its message returned to the host, the drive still accepts new incoming messages and attempts to execute them.
- If echoing is disabled, the error message is transmitted after the <CR> message termination is detected by the drive.

The drive must detect a new error or fault before transmitting an error message.

10.8 Examples of FLEXI PRO Serial Protocol

The following examples demonstrate serial protocol between the FLEXI PRO and a host.

Issuing a Command or Variable

In Examples 1 through 5, FLEXI PRO parameters are defined as:

```
ADDR 0
CHECKSUM 0
ECHO 1
MSGPROMPT 1
```

Example 1 – Command

EN (drive enable)

Sequence #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
User Enters	**E**		**N**		**<CR>**						
Drive Returns		**E**		**N**		**<CR>**	**<LF>**	**<DLY>**	**-**	**-**	**>**

Displayed on terminal:

```
-->EN
-->
```

Example 2 – Command/Variable – Returns Multiple Lines of Values

This type of command typically has a longer delay due to the large amount of data that is output to the screen.

DUMP (return drive parameter values)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	**D**		**U**		**M**		**P**		**<CR>**	
Drive Returns		**D**		**U**		**M**		**P**		**<CR>**

Sequence #	11	12	13	14	15	16	17	18
User Enters								
Drive Returns	**<LF>**	**<DLY>**	**<VAR1>**	**<SP>**	**<VAL1>**	**<CR>**	**<LF>**	**<VAR2>**

Sequence #	19	20	21	22	23	24	25	26
User Enters								
Drive Returns	**<SP>**	**<VAL2>**	**<CR>**	**<LF>**	**<VAR*n*>**	**<SP>**	**<VAL*n*>**	**<LF>**

Sequence #	27	28	29	30
User Enters				
Drive Returns	**<CR>**	**-**	**-**	**>**

Displayed on terminal:

```
-->DUMP
-->var1 val1
-->var2 val2
-->varn valn
```

Example 3 – Command/Variable – Returns Multiple Values

J (jog)

Sequence #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
User Enters	**J**		**<CR>**							
Drive Returns		**J**		**<CR>**	**<LF>**	**<DLY>**	**<VAL1>**	**<SP>**	**<VAL2>**	**<CR>**

Sequence #	11	12	13	14
User Enters				
Drive Returns	**<LF>**	**-**	**-**	**>**

Displayed on terminal:

```
-->J
-->nnnnn nnnnn
-->
```

Example 4 – Reading a Variable Value

MPOLES (single pole motor with value 2)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	**M**		**P**		**O**		**L**		**E**	
Drive Returns		**M**		**P**		**O**		**L**		**E**

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters	**S**		**<CR>**							
Drive Returns		**S**		**<CR>**	**<LF>**	**<DLY>**	**2**	**<SP>**	**[**	**p**

Sequence #	21	22	23	24	25	26	27	28	29	30	31
User Enters											
Drive Returns	**o**	**l**	**e**	**s**	**]**	**<CR>**	**<LF>**	**<DLY>**	**-**	**-**	**>**

Displayed on terminal:

```
-->MPOLES
2 [poles]
-->
```

Example 5 – Defining a Variable Value

ACC (acceleration with value 50000)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	**A**		**C**		**C**		**=**		**5**	
Drive Returns		**A**		**C**		**C**		**=**		**5**

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters	**0**		**0**		**0**		**0**		**<CR>**	
Drive Returns		**0**		**0**		**0**		**0**		**<CR>**

Sequence #	21	22	23	24	25
User Enters					
Drive Returns	**<LF>**	**<DLY>**	**-**	**-**	**>**

Displayed on terminal:

```
-->ACC=50000
-->
```

Multi-Drop Mode

In Examples 6 and 7, FLEXI PRO parameter values are defined as:

```
ADDR 3

ECHO 1

MSGPROMPT 1
```

Example 6 – Addressing a Daisy-Chained Drive

The range of values for ADDR is 0 to 99. A value other than 0 puts the system in Multi-drop mode, which results in a different prompt.

Sequence #	1	2	3	4	5	6	7	8	9	10	11
User Enters	****		**3**		**<CR>**						
Drive Returns		****		**3**		**<CR>**	**<LF>**	**<DLY>**	**3**	**-**	**>**

Displayed on terminal:

```
-->\3
3->
```

Example 7 – Reading a Variable

IMAX (drive current limit)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	**I**		**M**		**A**		**X**		**<CR>**	
Drive Returns		**I**		**M**		**A**		**X**		**<CR>**

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters										
Drive Returns	**<LF>**	**1**	**5**	**.**	**6**	**9**	**7**	**<CR>**	**<LF>**	**<DLY>**

Sequence #	21	22	23
User Enters			
Drive Returns	**3**	**-**	**>**

Displayed on terminal:

```
-->IMAX
3->15.697
3->
```

Serial Checksum

Example 8 – Variable

In this example, FLEXI PRO parameters are defined as:

```
ADDR 0
CHECKSUM 1
ECHO 1
MSGPROMPT 1
```

ACC (acceleration) with value 25000

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	**A**		**C**		**C**		**=**		**2**	
Drive Returns		**A**		**C**		**C**		**=**		**2**

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters	**5**		**0**		**0**		**0**		**<**	
Drive Returns		**5**		**0**		**0**		**0**		**<**

Sequence #	21	22	23	24	25	26	27	28	29	30	31
User Enters	**F**		**B**		**>**		**<CR>**				
Drive Returns		**F**		**B**		**>**		**<CR>**	**-**	**-**	**>**

Character	Hex Value	ASCII Value
A	41	65
C	43	67
C	43	67
=	3D	61
2	32	50
5	35	53
0	30	48
0	30	48
0	30	48

```
Checksum=0xFF& (0x41+0x43+0x43+0x3d+0x32+0x35+0x30+0x30+0x30)
=0xFF & 0x01FB=0xFB
```

Note: Enter the last two characters of the HEX VALUE sum before the <CR>. Between brackets < >

Displayed on terminal:

```
//setting the checksum
-->CHECKSUM 1
//sending command to the drive with checksum appended
-->ACC=25000<FB>
//checking the actual value stored at the drive
-->ACC
//the reply is appended by checksum
25000.000[rpm/s]<7E>
-->
```

11 Accessories

11.1 Line Filters

The manufacturers and part numbers of line filters recommended for the FLEXI PRO are listed in the following tables.

Table 11-1. Recommended Line Filters

	FLEXI PRO-1D5-2A FLEXI PRO-003-2A	FLEXI PRO-4D5-2A FLEXI PRO-006-2A	FLEXI PRO-4D5-2A FLEXI PRO-006-2A
Mains	**1-Phase**	**1-Phase**	**3-Phase**
Manufacturer PN	High & Low 04SS4-2NC2-x-Q	LCR 0923.01021.00	LCR 096B.01001.00
Manufacturer PN	LCR 055M.80601.00	LCR 092.01023.00	Schaffner FN3258
Manufacturer PN	LCR 092.00423.00	LCR 055.81011.00	
Manufacturer PN	Schaffner FN2070	Schaffner FN2070	
	FLEXI PRO-008-2A FLEXI PRO-010-2A FLEXI PRO-013-2A	**FLEXI PRO-008-2A FLEXI PRO-010-2A FLEXI PRO-013-2A**	**FLEXI PRO-020-2A FLEXI PRO-024-2A**
Mains	**1-Phase**	**3-Phase**	**3-Phase**
Manufacturer PN	High & Low 20SS4-2KC3-Q	LCR 096B.02001.00	LCR 096.03501.00
Manufacturer PN	LCR 0923.02021.00	LCR 097.01601.00	LCR 096B.03001.00
Manufacturer PN	LCR 092.02023.00	Schaffner FN3258	Schaffner FN3258
Manufacturer PN	High & Low 20SS4-2JC3-Q		
	FLEXI PRO-003-4A FLEXI PRO-006-4A	**FLEXI PRO-012-4A**	**FLEXI PRO-020-4A FLEXI PRO-024-4A**
Mains	**3-Phase**	**3-Phase**	**3-Phase**
Manufacturer PN	LCR 096B.01001.00	LCR 096B.02001.00	LCR 096.03501.00
Manufacturer PN	CORCOM 25FCD10	CORCOM 25FCD10	LCR 096B.03001.00

11.2 Regeneration Resistors

Resistance values (Ohms, Ω) are defined by the FLEXI PRO servo drive. Required power is defined by the application. Therefore, each drive has several regen resistor options.

The manufacturers and part numbers of regen resistors recommended for the FLEXI PRO are listed in the following tables.

Table 11-2. Recommended Regen Resistors for FLEXI PRO 120/240 VAC

	FLEXI PRO-1D5-2A FLEXI PRO-003-2A	FLEXI PRO-4D5-2A FLEXI PRO-006-2A FLEXI PRO-008-2A FLEXI PRO-010-2A FLEXI PRO-013-2A	FLEXI PRO-020-2A FLEXI PRO-024-2A
Power (W)	**Resistance 100 Ω**	**Resistance 33 Ω**	**Resistance 15 Ω**
150	ISOTEK ULH150 N 100 K FL500	ISOTEK ULH150 N 33 K FL500	ISOTEK ULH150 N 15 K FL500
300	ISOTEK ULH300 N 100 K FL500	ISOTEK ULH300 N 33 K FL500	ISOTEK ULH150 N 15 K FL500
600	FRIZLEN FZECU400x65-100	FRIZLEN FZECU400x65-33	ISOTEK ULV600 N 15 K FL500
1000	X	ISOTEK ULV1000 N 33 K FL500	ISOTEK ULV1000 N 15 K FL500
2000	X	FRIZLEN FZZCU600x65-33	ISOTEK ULM2000 N 15 K
3000	X	FRIZLEN FGFKU3100602-33	FRIZLEN FGFKU3100602-15
4000	X	X	FRIZLEN FGFKU3100802-15

Table 11-3. Recommended Regen Resistors for FLEXI PRO 400/480 VAC

	FLEXI PRO-003-4A FLEXI PRO-006-4A	FLEXI PRO-012-4A
Power (W)	**Resistance 47 Ω**	**Resistance 33 Ω**
300	Use FLEXI PRO internal resistor (P3)	Use FLEXI PRO internal resistor (P3)
600	ISOTEK ULV600 N 47 K FL500	ISOTEK ULV600 N 33 K FL500
1000	ISOTEK ULV1000 N 47 K FL500	ISOTEK ULV1000 N 33 K FL500
2000	ISOTEK ULM2000 N 47 K	ISOTEK ULM2000 N 33 K
3000	FRIZLEN FGFKU3100602-47	FRIZLEN FGFKU3100602-33
4000	FRIZLEN FGFKU3100802-47	FRIZLEN FGFKU3100802-33

11.3 D9-RJ45 Adapter

Many PLC devices use D9 type interfaces for CAN connections.

To enable the connection of the FLEXI PRO RJ45 port to a D9 interface, Motor Power Company offers an adapter, as shown below.

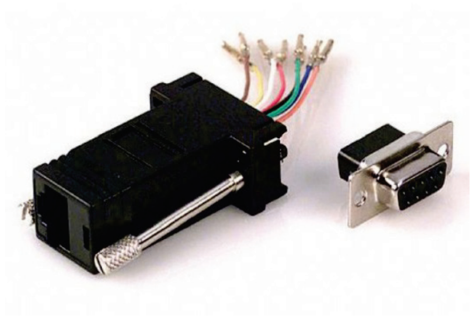


Figure 11-1. D9-RJ45 Adapter

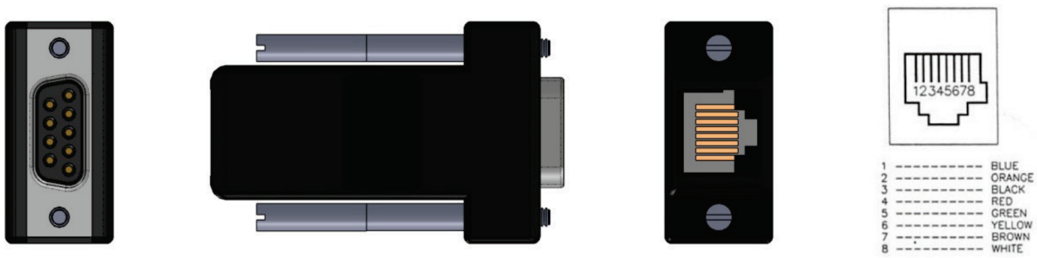


Figure 11-2. D9-RJ45 Adapter Interfaces

Table 11-4. D9-RJ45 Adapter Wiring

Function	FLEXI PRO RJ45 Pin	D9 Connector Pin
CAN High	1	7
CAN Low	2	2
Functional Ground	3	3
CAN Shield	6	5
Functional Ground	7	6

12 Tuning: HD Control

Note: The data shown in the software screens in this documentation may appear different than what you see on your screen; descriptive parameters names, in particular, may have changed.
The textual information and instructions, however, are in accordance with the latest version of the firmware and software.

12.1 HD Control Overview

HD Control (HDC) is an innovative, proprietary control algorithm. It achieves minimum position error and minimum settling time at levels far superior to other controllers.

The tuning performed by the Setup and Autotuning wizards in FLEXI SUITE software is usually sufficient. However, you may need to tune the control parameters manually to optimize them for particular applications. This application note explains how to perform the manual fine tuning.

Automatic and manual tuning use similar methods. During autotuning, the quality of the movement is measured and evaluated by the drive and FLEXI SUITE 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.

HDC is tuned like conventional PID. Each gain parameter is increased progressively until an oscillating behavior occurs, and then reduced back to a safe value (approximately 10-20% lower).

The following diagram shows the order and purpose of common tuning procedures for a FLEXI PRO drive system.

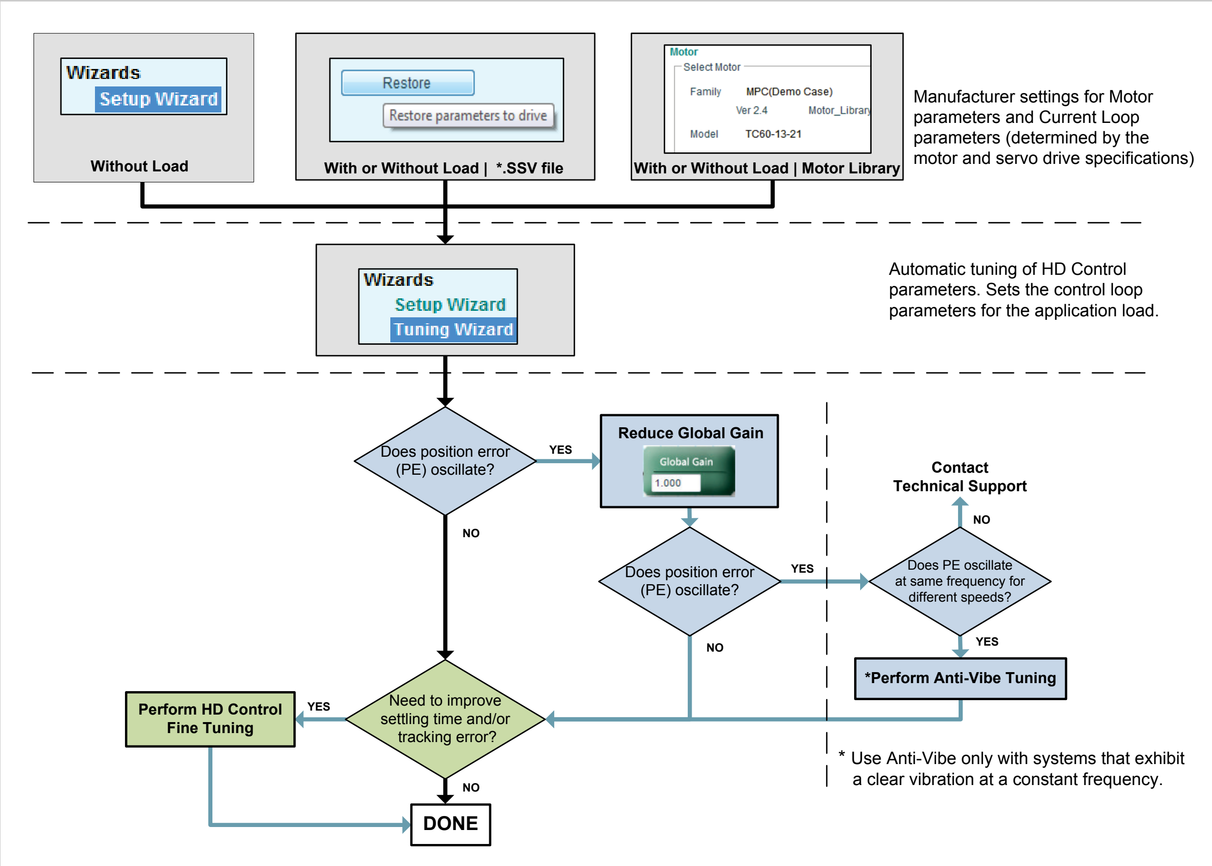


Figure 12-1. FLEXI PRO Tuning Procedures

The FLEXI PRO drive system is shown in the following diagram.

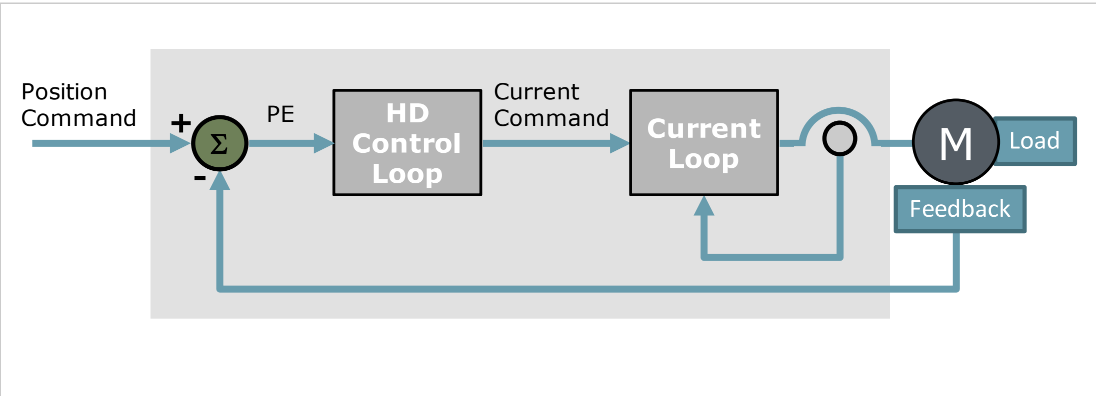


Figure 12-2. FLEXI PRO Drive System

The HD control loop is shown in the following diagram.

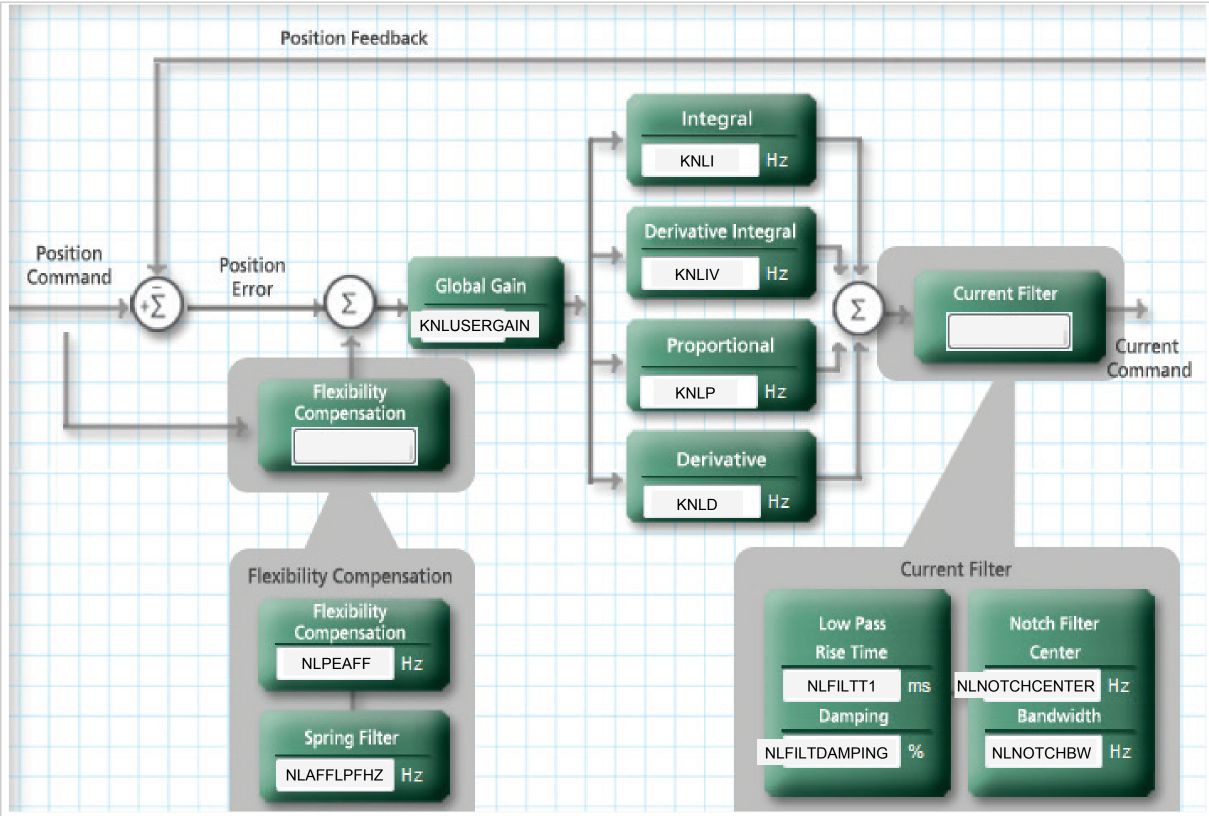


Figure 12-3. FLEXI PRO HD Control Loop

Refer to the next section for descriptions of the control parameters.

12.2 Parameters

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

Notes: **NL** in VarCom mnemonics indicates a nonlinear control parameter.

Parameter	VarCom	Default	Range	Unit
HD Global Gain	KNLUSERGAIN	1.000	0.001 – 3.000	–
HD Derivative Gain	**KNLD**	0	0 – 2000	Hz
HD Proportional Gain	**KNLP**	0	0 – 400	Hz
HD Integral Gain	**KNLI**	0	0 – 200	Hz
HD Derivative-Integral Gain	**KNLIV**	0	0 – 400	Hz
HD Current Filter – Notch Filter Center	**NLNOTCHCENTER**	100	100 – 10000	Hz
HD Current Filter – Notch Filter Bandwidth	**NLNOTCHBW**	0	0 – 500	Hz
HD Current Filter – Second Notch Filter Center	NLNOTCH2CENTER	100	100 – 10000	Hz
HD Current Filter – Second Notch Filter Bandwidth	NLNOTCH2BW	0	0 – 500	Hz
HD Current Filter – Low Pass Filter Rise Time	**NLFILTT1**	9	0 – 30	ms
HD Current Filter – Damping	**NLFILTDAMPING**	0	0 – 100	%
HD Flexibility Compensation	**NLPEAFF**	0	0 – 200000	Hz
HD Spring Filter	**NLAFFLPFHZ**	7000	10 – 7000	Hz
HD Maximum Adaptive Gain	NLMAXGAIN	1	1 – 5	–

Feedback Gain Parameters

HD control has four feedback gain parameters.

- **KNLD** (HD Derivative Gain) is the HDC equivalent of PID **D**.
- **KNLP** (HD Proportional Gain) is the HDC equivalent of PID **P**.
- **KNLI** (HD Integral Gain) is the HDC equivalent of PID **I**.
- **KNLIV** (HD Derivative Integral Gain) is an additional feedback parameter of the HD control algorithm. This parameter substantially reduces the tracking and steady state error and increases the control stiffness. It is tuned like the **P** of a conventional PID controller.

The feedback gain parameters are tuned in the following general order:

KNLD → KNLP → KNLIV → KNLI

Notch Filters

HD control has two notch filters that can be used to eliminate the high frequency vibrations that are sometimes observed.

- **NLNOTCHCENTER** (HD Notch Center) and **NLNOTCH2CENTER** (NL Second Notch Center)
- **NLNOTCHBW** (ND Notch Bandwidth) and **NLNOTCH2BW** (NL Notch Bandwidth)

Notch filters can be set from 100 to 8000 Hz; however, the typical range is 300 to 2000 Hz.

Typical instances of a vibrating system:

- Ballscrew linear slide with coupling
- Highly loaded motor, with resonance due to shaft flexibility
- Resonance of encoder or resolver

Tuning is done by checking the frequency of the oscillation, and setting the notch accordingly.

Typically, oscillations occur during the first tuning steps (feedback gain). The notch parameters can then be set and the tuning procedure can continue.

Low Pass Filter (Second Order) on Current Command Parameters

The output of the HD control loop is a current command. This current command is low pass filtered before it is transferred to the current controller.

- **NLFILTDAMPING** (HD Torque Filter 2), defined as a percentage, maintains the bandwidth of the filter up to the cutoff frequency. This parameter can be used independently of NLFILTT1, to allow some compensation of the plant limited bandwidth.
- **NLFILTT1** (HD Torque Filter 1), defined in milliseconds, defines the inverse of the cutoff frequency.

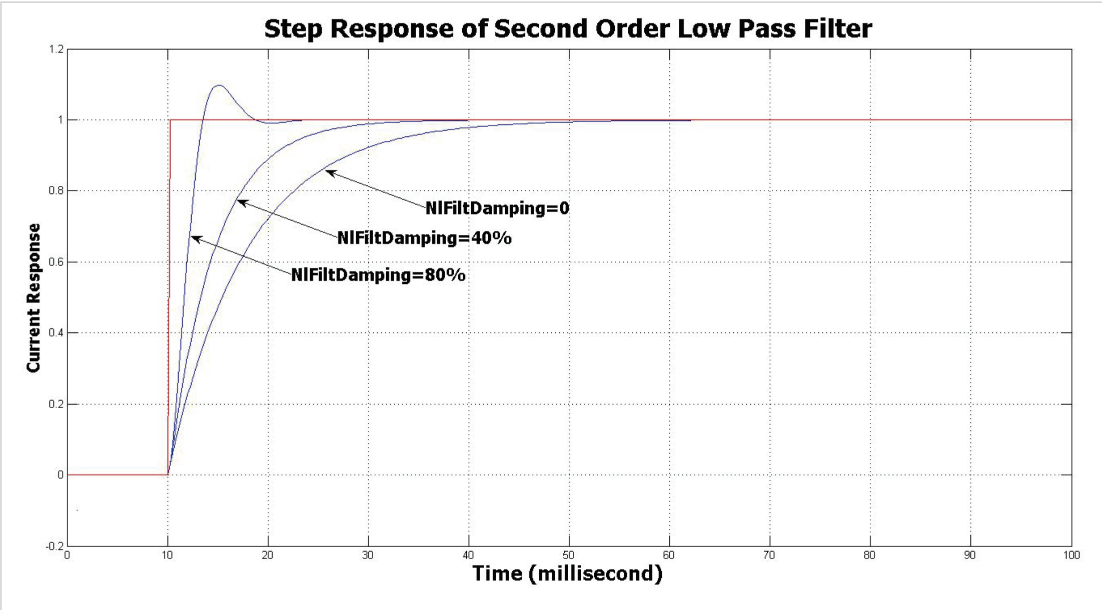


Figure 12-4. Step Response of Second Order Low Pass Filter

These parameters are normally set by the load estimation procedure. However, they can be tuned further after tuning KNLD. The goal is to use the minimum value of filter NLFILTT1 and the maximum value of NLFILTDAMPING, in order to achieve the minimum response time of the HDC loop.

Plant Flexibility Compensation Parameters

These parameters reduce the vibrations induced to the load by abrupt changes in acceleration (jerk), and reduce tracking error; they can also be used 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.

- **NLAFFLPHZ** (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 NLAFFLPHZ smoothes the calculated acceleration of the command position, and should be used whenever noisy operation is observed while applying the parameter NLPEAFF.

12.3 Preliminary Procedures

Note: These instructions assume you are familiar with FLEXI SUITE software and motion control theory.

1. Make sure the drive firmware version is 1.3.2 or later, and the FLEXI SUITE software version is 1.3.2.3 or later. If not, download and install these versions.

   If you are working with a later version, some software screens might appear different than those shown in this document.
2. Run the FLEXI SUITE **Motor Setup Wizard**, and make sure motor setup is successfully completed.
3. Run the FLEXI SUITE **Autotuning Wizard**, and make sure autotuning is successfully completed.
4. Using the following table, write down the values determined by the wizard. This will be a useful reference while you are performing manual tuning.

Parameter	VarCom	Range	Autotuning Value	Manual Value
Global Gain	KNLUSERGAIN	0.001 – 3.000		
HD Derivative Gain	**KNLD**	**0 – 200**		
HD Proportional Gain	**KNLP**	**0 – 400**		
HD Integral Gain	**KNLI**	**0 – 200**		
HD Derivative-Integral Gain	**KNLIV**	**0 – 400**		
HD Current Filter – Notch Filter Center	**NLNOTCHCENTER**	**100 – 8000**		
HD Current Filter – Notch Filter Bandwidth	**NLNOTCHBW**	**0 – 500**		
HD Current Filter – Second Notch Filter Center	NLNOTCH2CENTER	100 – 8000		
HD Current Filter – Second Notch Filter Bandwidth	NLNOTCH2BW	0 – 500		
HD Current Filter – Low Pass Filter Rise Time	**NLFILTT1**	**0 – 30**		
HD Current Filter – Damping	**NLFILTDAMPING**	**0 – 100**		
HD Flexibility Compensation	**NLPEAFF**	**0 – 2000**		
HD Spring Filter	**NLAFFLPFHZ**	**10 – 7000**		
HD Maximum Adaptive Gain	NLMAXGAIN	1 – 3		

5. Open the FLEXI SUITE **Scope** screen.
6. Select the **Motion** tab.
   - Make sure Operation Mode is **8-Position**.
   - Set the value of the **Target Position** to 2000 counts.
   - 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.

     In the example shown below, the maximum speed (**Cruise Velocity**) is set to 1000, and the **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.

Figure 12-5. Motion and Record Settings

7. In the **Recorder Setup** panel, select the following **Record Variables**:
   - **PTPVCMD** (Position command velocity)
   - **ICMD** (Current command)
   - **PE** (Position error). Also enter a trace scaling factor of **10** for the PE variable.
8. In the **Recorder Setup** panel, enter the sampling values and trigger variable:
   - Samples: **1000**
   - Time Interval: **16**
   - Trigger: **IMM**

9. Select the **Parameter Table** tab.

- Set the parameter **KNLUSERGAIN** (HD Global Gain) to 1.000.

By default, KNLUSERGAIN is set to 0.300 during autotuning. For manual tuning, you can usually begin by using a value of 1.000.

10. Make sure the drive is enabled, and then click the **Move Record and Plot** button in the Scope toolbar.

Verify that this gain is not too high.

11. If the gain is too high (as evidenced by vibrations and noise), decrease the value of **KNLUSERGAIN** (HD Global Gain) until a smooth movement is obtained.

The following screen image shows a typical motion obtained with default parameters set by the load estimation and KNLUSERGAIN set to 1.000.

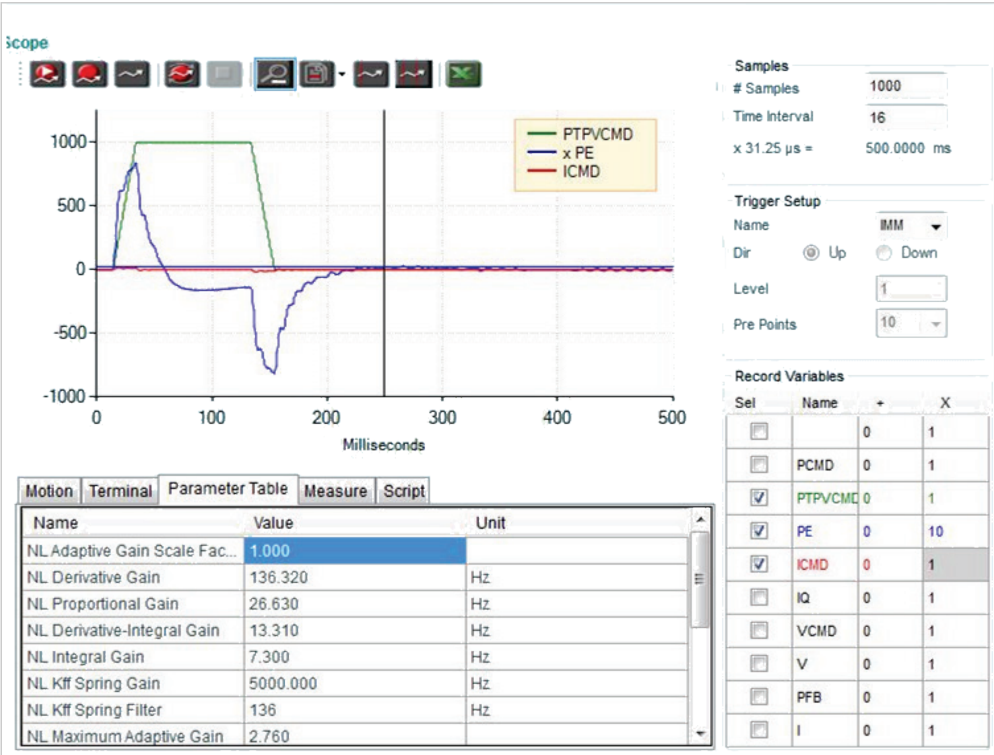


Figure 12-6. Example of Motion Obtained with Default Parameters

Note that the trace of the Position Error variable shown here is scaled by a factor of 10.

12.4 Tuning Procedures

Tuning Sequence

Parameters are tuned sequentially in the following order:

1. **KNLD**
2. Low Pass Filter (optional): **NLFILTDAMPING** and **NLFILTT1**
3. **KNLD** (optional)
4. **KNLP**
5. **KNLIV**
6. **KNLI**
7. Flexible System Compensation: **NLAFFPHZ** and **NLPEAFF**

Steps 2 and 3 are optional and may be skipped whenever the performance requirements are not critical.

At each step, check the parameter value by executing a back and forth movement and observing the recorded variables in the FLEXI SUITE Scope screen | Motion pane.

Step 1 – Tuning 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 ICMD acceptable level of ripple depends on the system, and mainly on the load:

- For light loads (< 2 × rotor inertia), 5% of rated current may be normal.
- For higher loads, the acceptable ripple may be 10%.

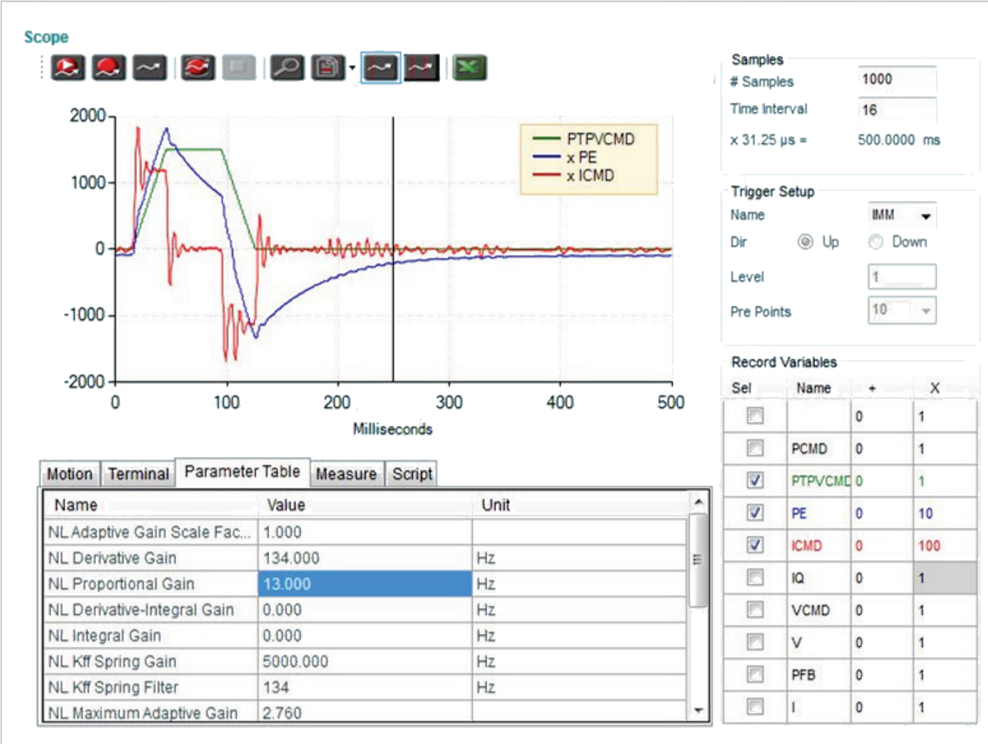


Figure 12-7. KNLD 134 Hz – Default (note that ICMD is multiplied by 100)

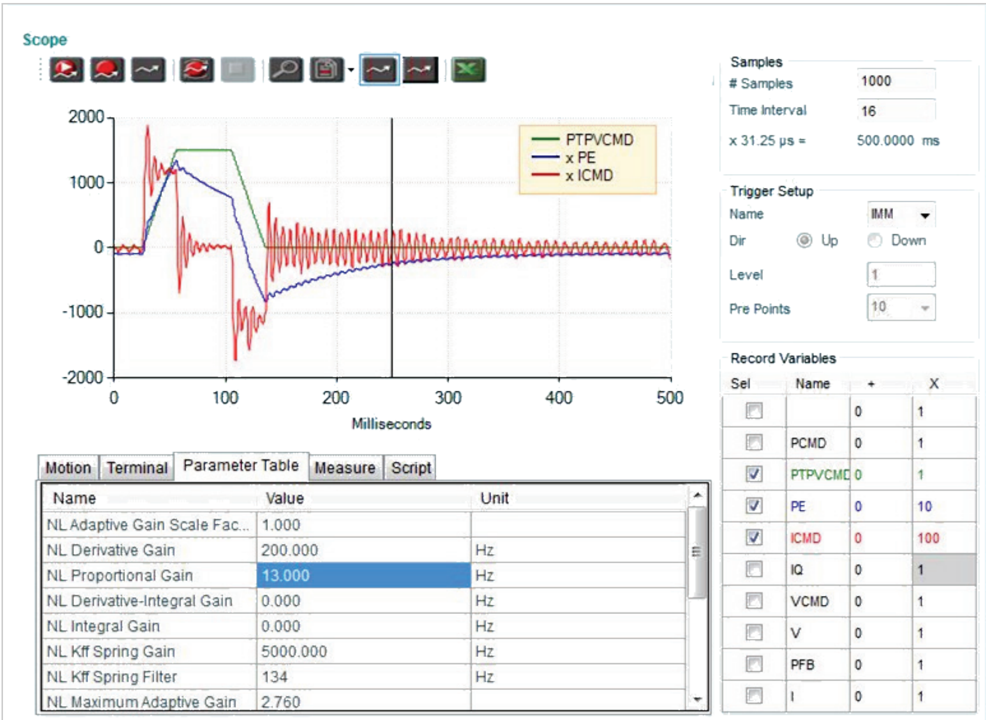


Figure 12-8. KNLD 200 Hz –KNLD too high

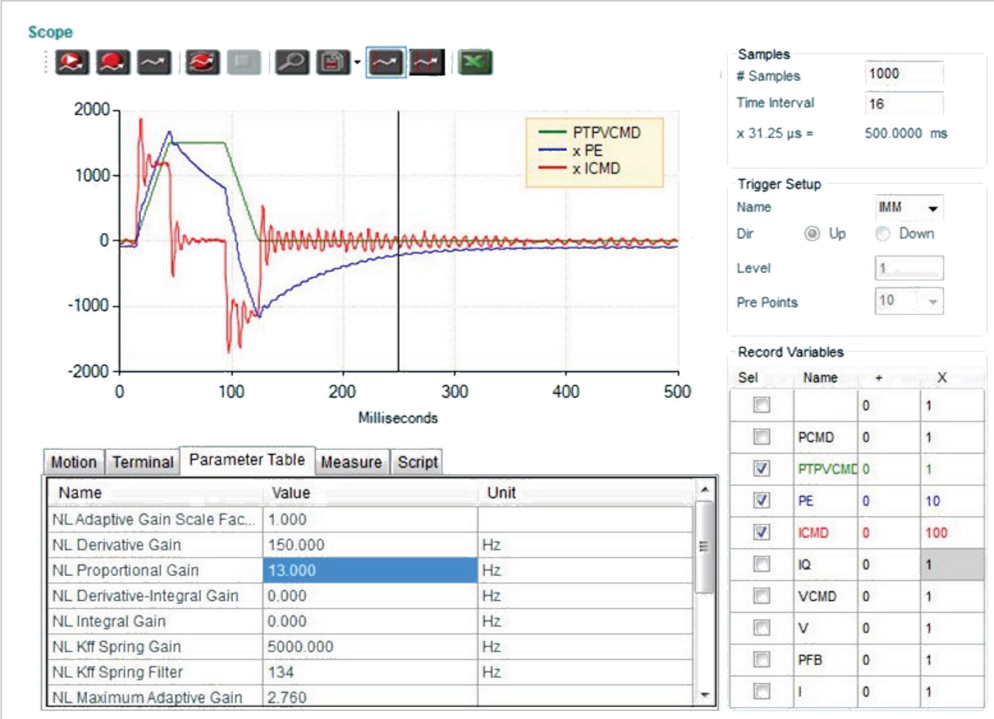


Figure 12-9. KNLD 150 Hz - Selected value

Step 2 – Tuning Low Pass Filter

1. Increase NLFILTDAMPING until noise and/or oscillations of ICMD are observed, then reduce by 10%.

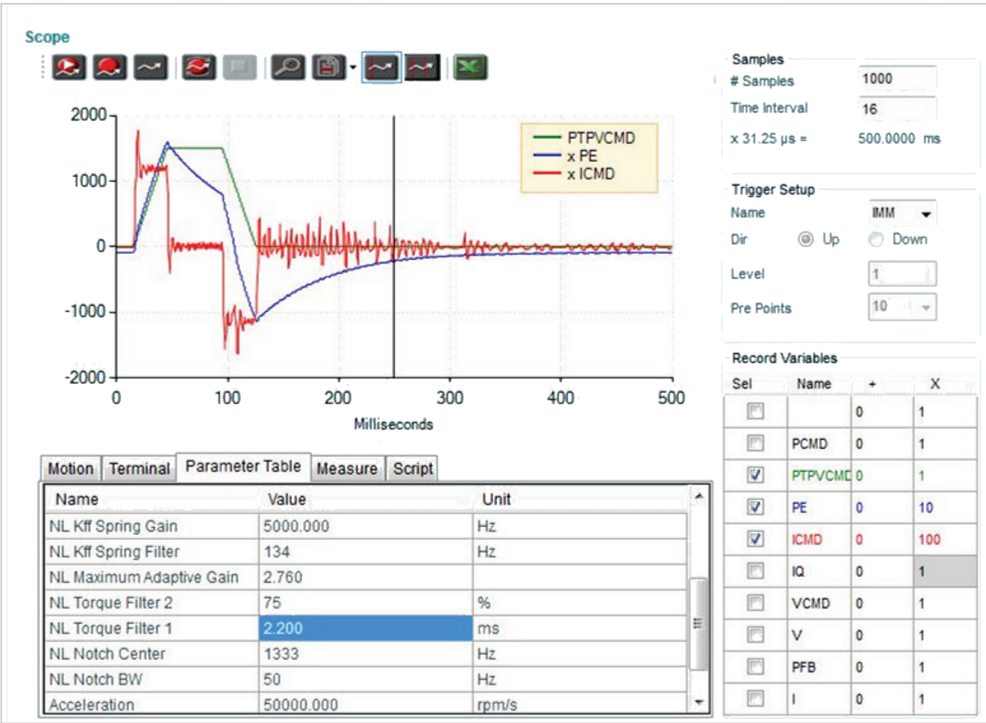


Figure 12-10.NLFILTDAMPING 75% - Selected value

2. Decrease NLFITT1 until noise and/or oscillations of ICMD are observed, then increase by 20% and at least 0.05 ms.

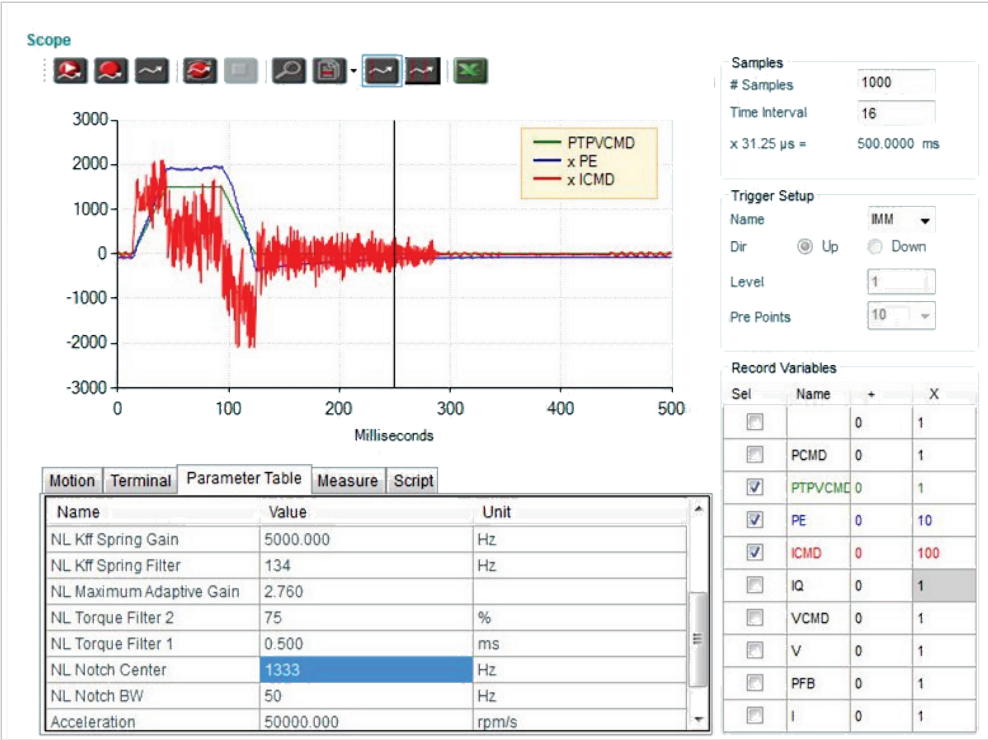


Figure 12-11.NLFILTT1 0.5 ms - Value too low

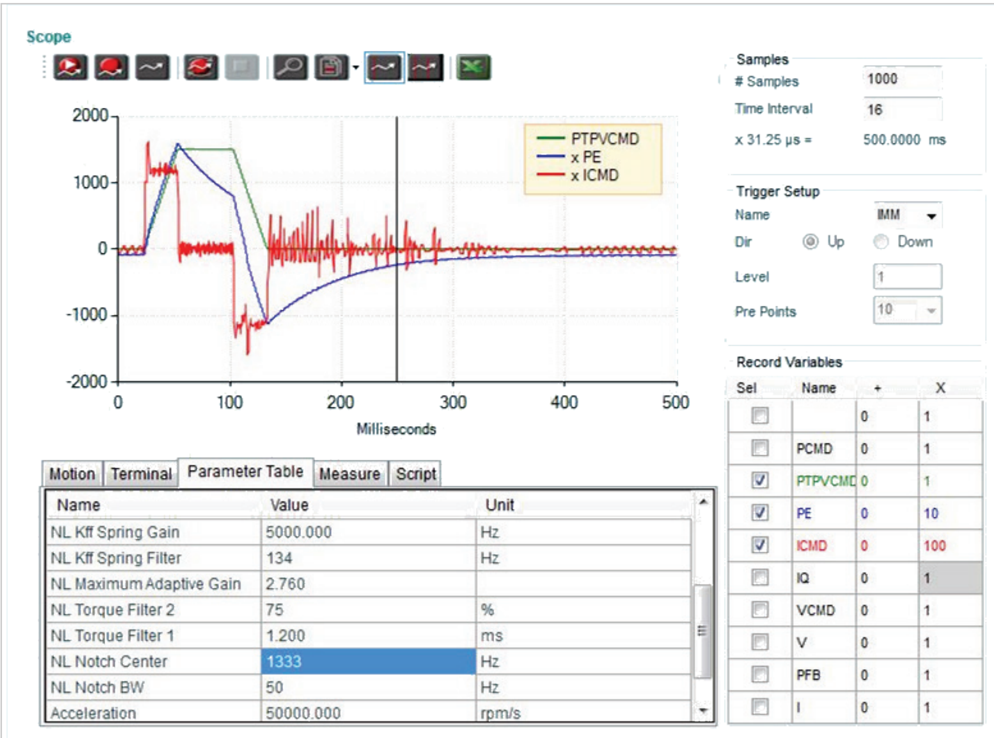


Figure 12-12.NLFILTT1 1.2 ms - Selected value

Step 3 – Re-tuning KNLD After Filter Change

If the low pass filter values (NLFILTT1 and/or NLFILTDAMPING) have been substantially changed, KNLD may be tuned again to a higher value.

Follow the procedures detailed in Step 1.

Step 4 – Tuning KNLP (Proportional Gain)

Increase KNLP until oscillations of the tracking error (PE) occur.

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).

Tuning is best when the graph shape is as square as possible; that is, 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).

The following screen images show the progressive changes in the position error graph.

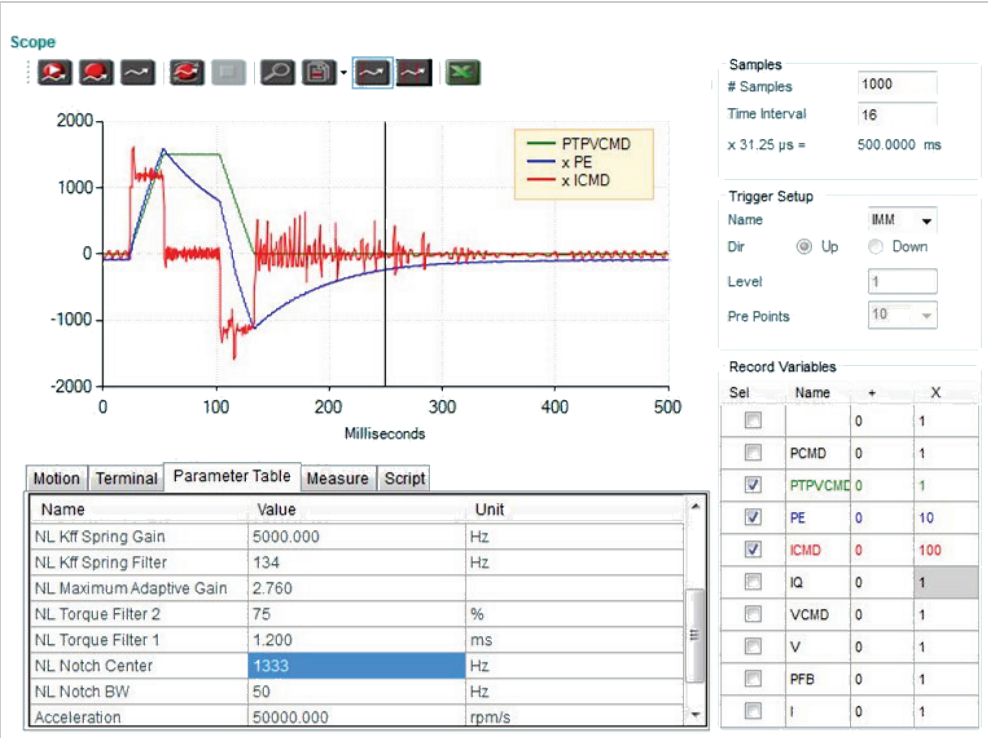


Figure 12-13.KNLP 13 Hz - Starting value

Figure 12-14.KNLP 25 Hz – Position error reduced

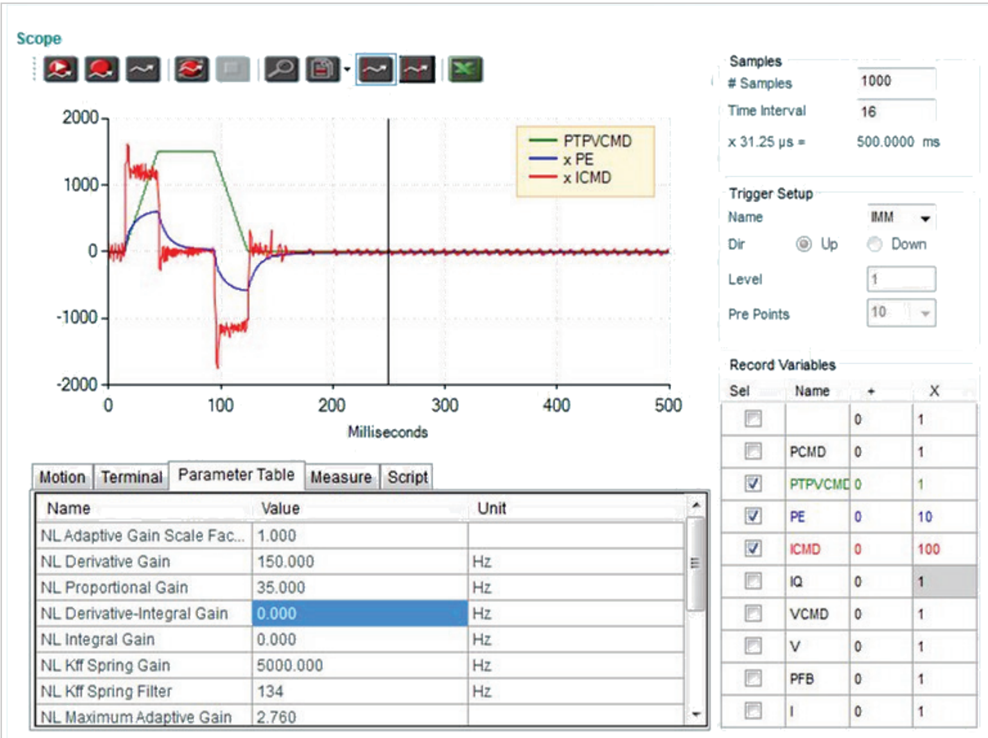


Figure 12-15.KNLP 35 Hz – Position error reduced more

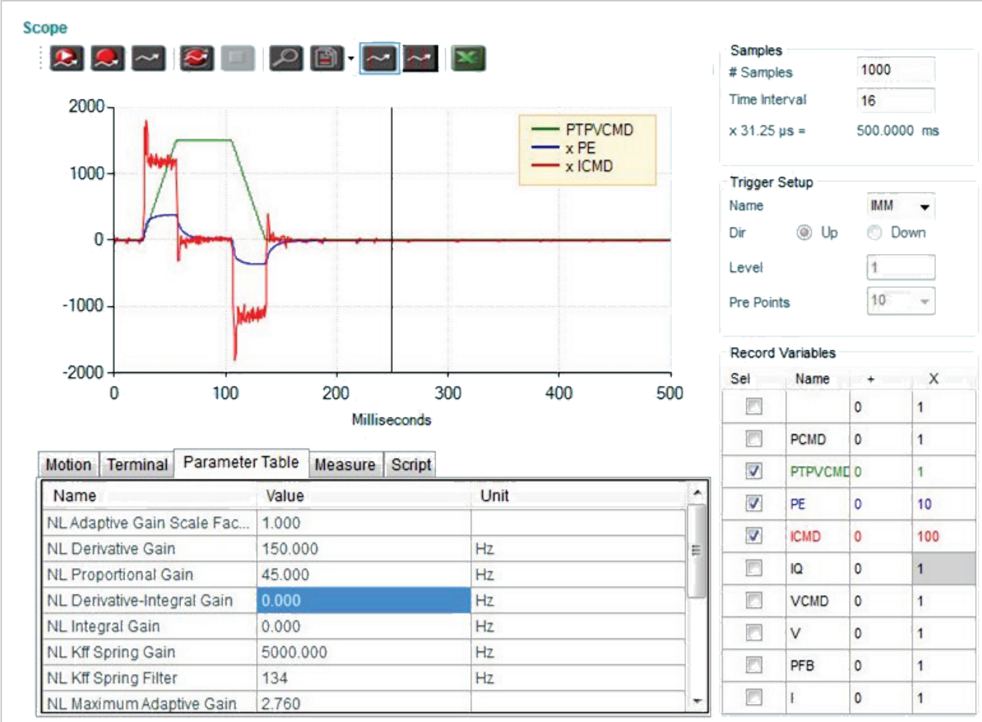


Figure 12-16.KNLP 45 Hz – Position error reduced more; plot of position error gets flatter during acceleration and deceleration

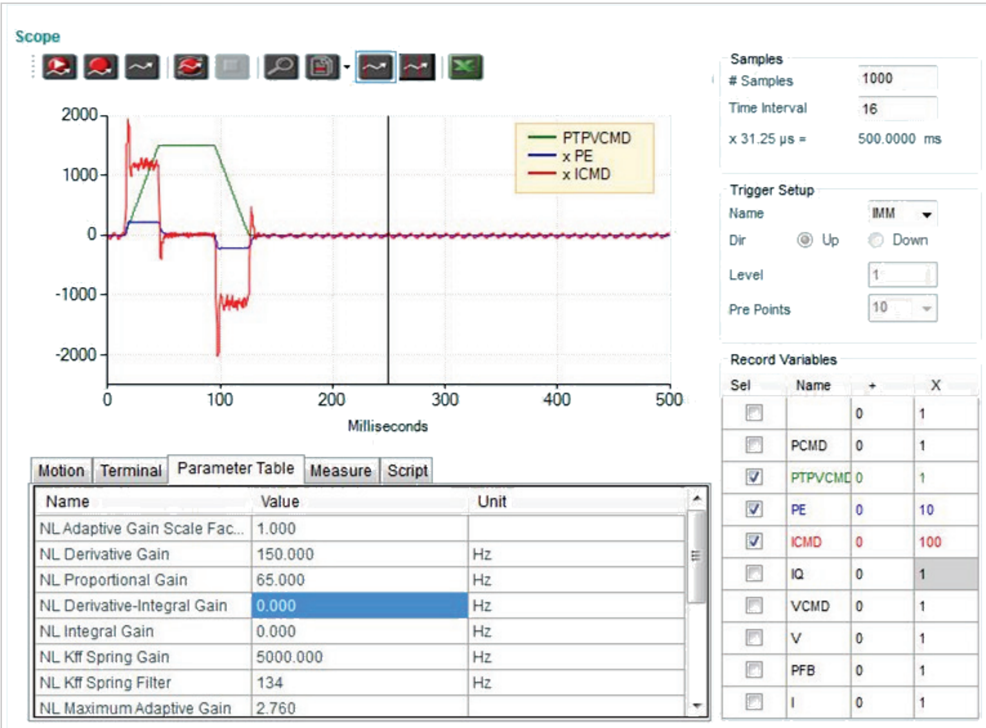


Figure 12-17.KNLP 65 Hz - Position error reduced even more; plot of position error gets even flatter during acceleration and deceleration

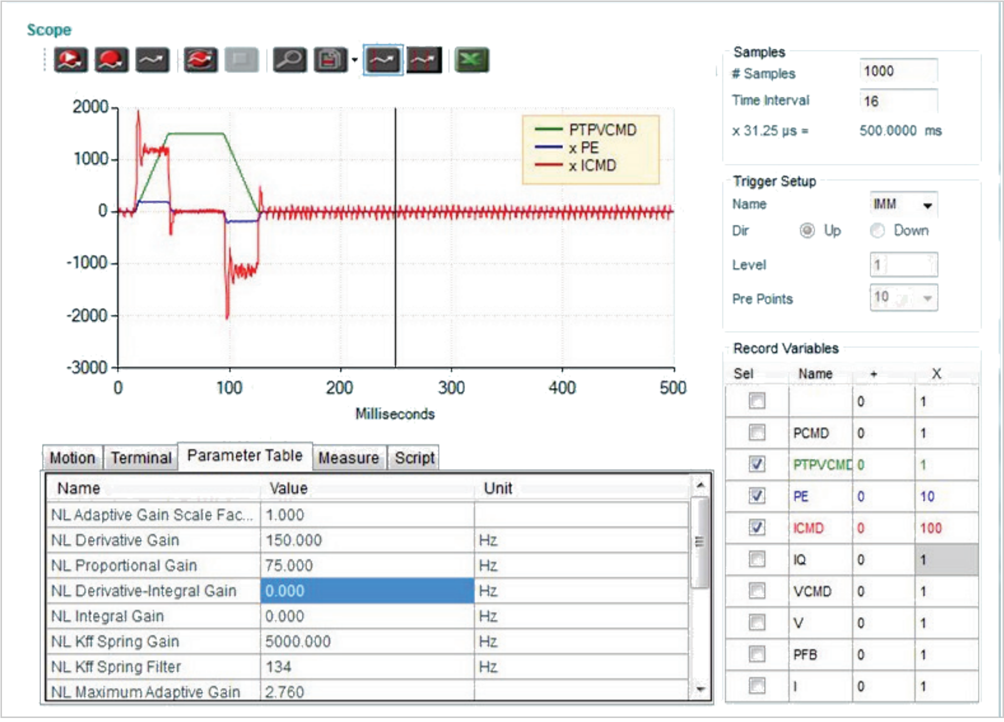


Figure 12-18.KNLP 75 Hz – Value too high; vibrations at stop

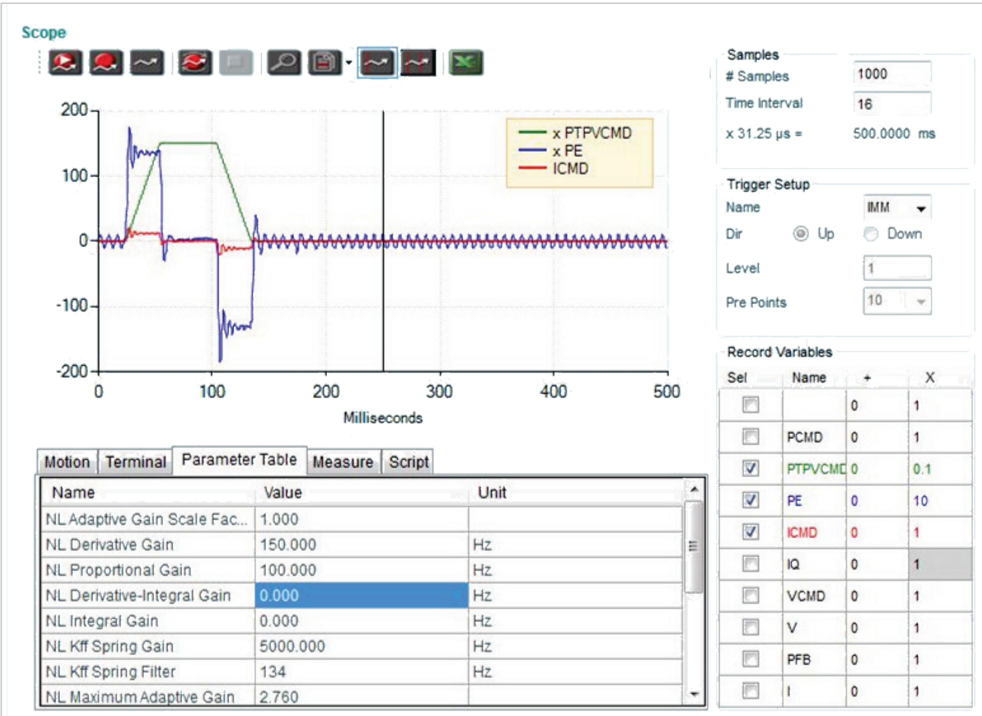


Figure 12-19.KNLP 100 Hz -Value too high; vibrations at stop, overshoot of position error

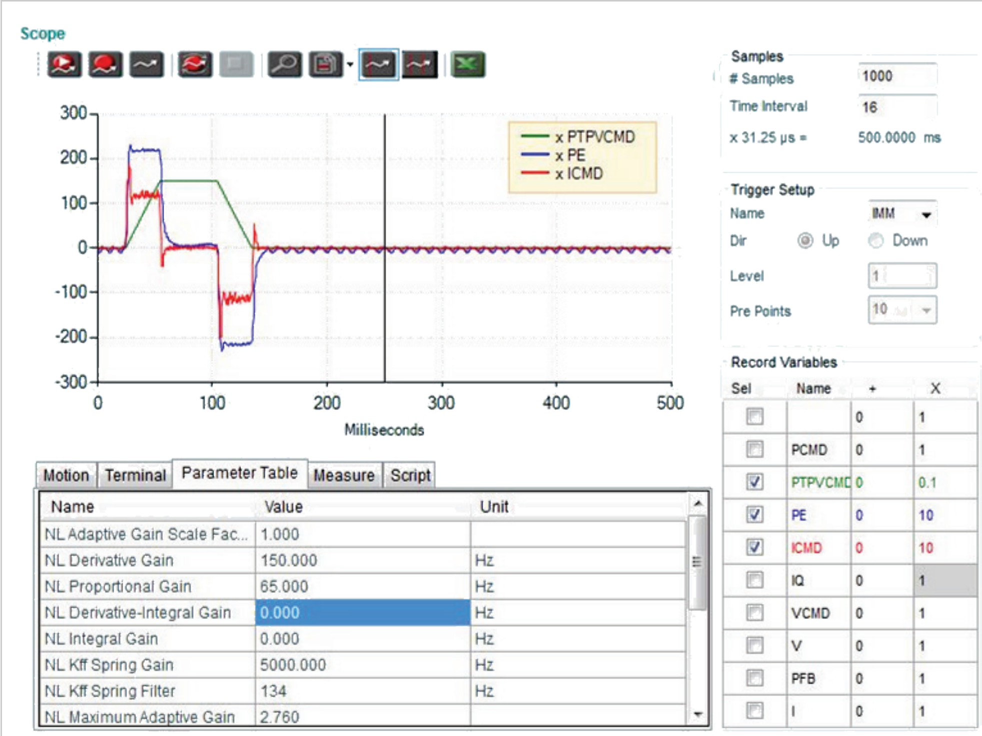


Figure 12-20.KNLP 65 Hz - Selected value (position error multiplied by 10)

- No overshoot of position error
- Current ripple OK
- Oscillation at steady state OK

Step 5 – Tuning KNLIV (Derivative-Integral Gain)

Increase KNLIV until oscillations of the tracking error (PE)

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

The typical range of values for KNLIV is: KNLP/2 < KNLIV < 2×KNLP

The following screen images show the progressive changes in the position error graph.

While KNLIV proportional gain gets higher, the position error decreases during each phase of the movement (acceleration, plateau, deceleration).

Tuning is best when the position error decreases as fast as possible after each movement phase transition (jerk), without oscillations during transition between phases.

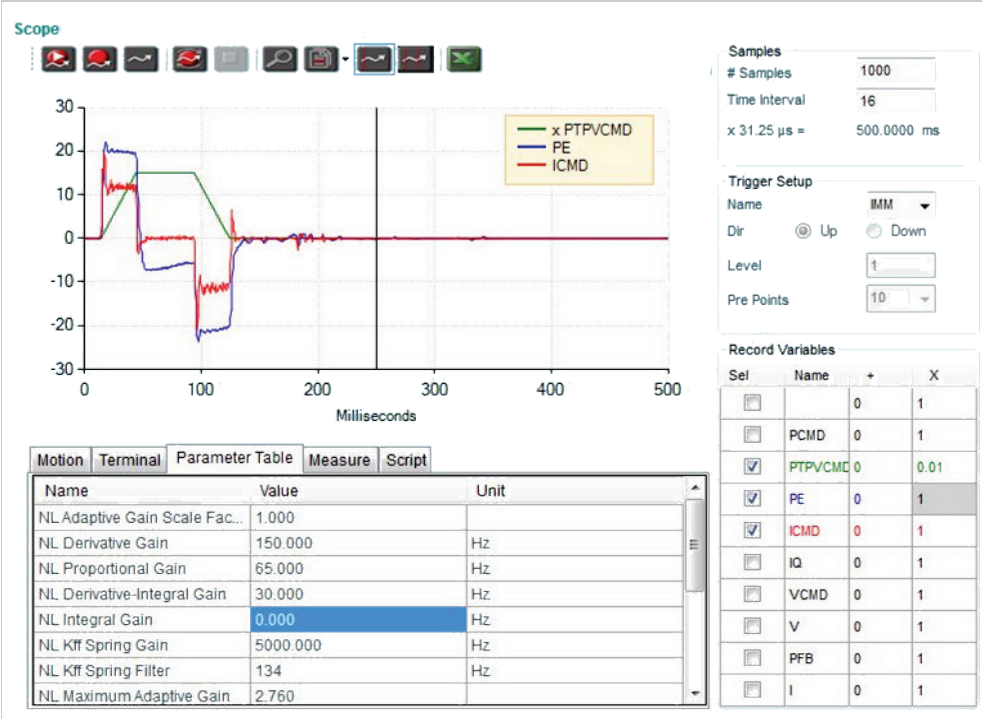


Figure 12-21.KNLIV 30 Hz - Position error decreases slightly during acceleration and deceleration phases

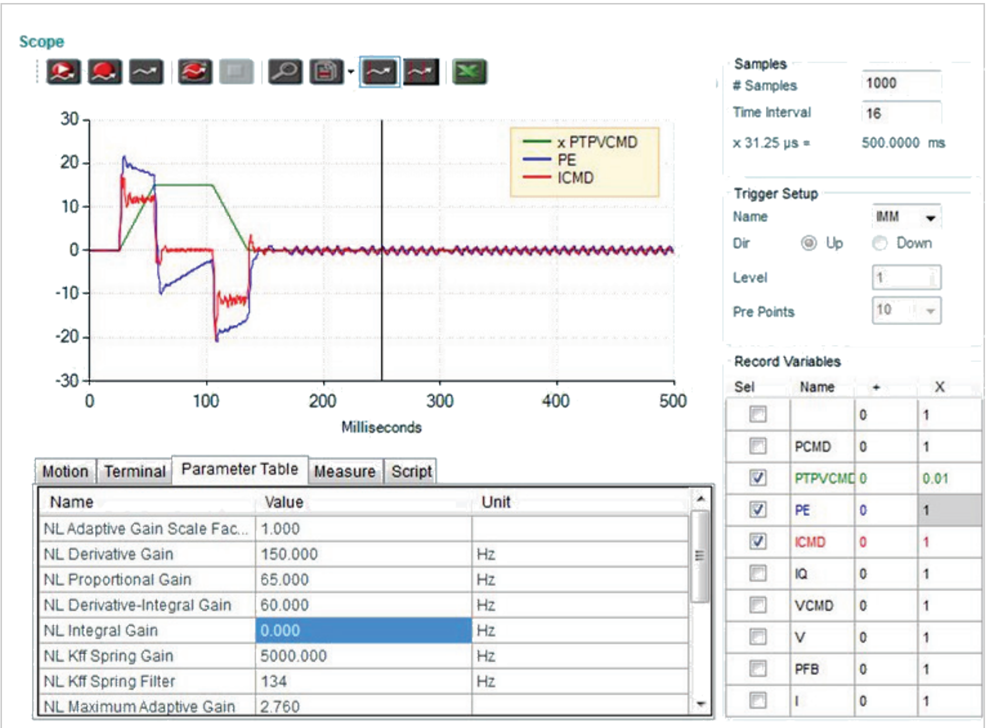


Figure 12-22.KNLIV 30 Hz - Position error is reduced

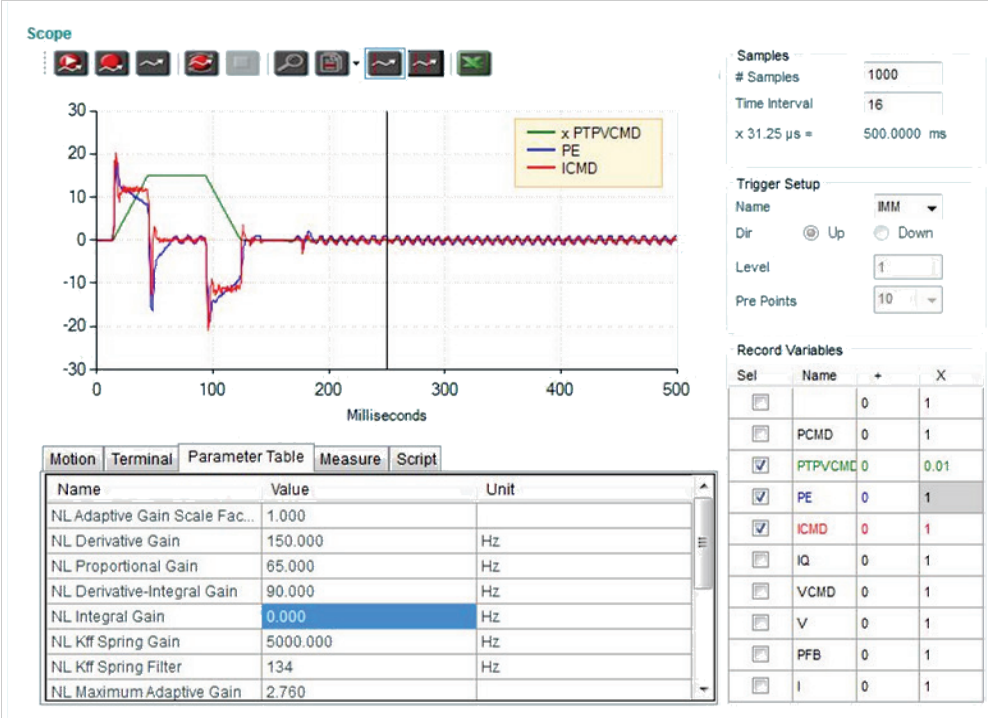


Figure 12-23.KNLIV 90 Hz - Position error is rapidly reduced to zero during plateau phase

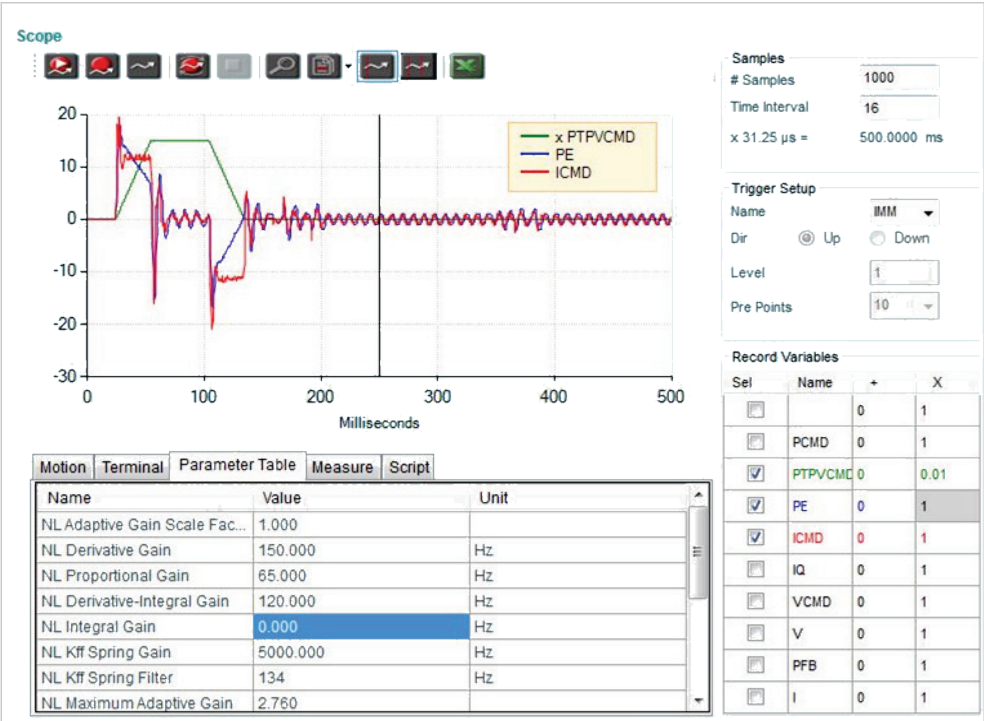


Figure 12-24.KNLIV 120 Hz - Value too high; vibrations at stop are too strong; overshoot of position error

Figure 12-25.KNLIV 90 Hz - Selected value

- Fast return to zero position error during movement phases
- No overshoot of position error
- Vibrations at stop are acceptable (±1 encoder count)

Step 6 – Tuning KNLI (Integral Gain)

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

KNLI should be tuned to the maximum value that does not create overshoot or oscillations.

Increase KNLI until oscillations of the position error (PE) occur.

Figure 12-26.KNLI 50 Hz – Value too high; position error oscillations at stop; overshoot of position error

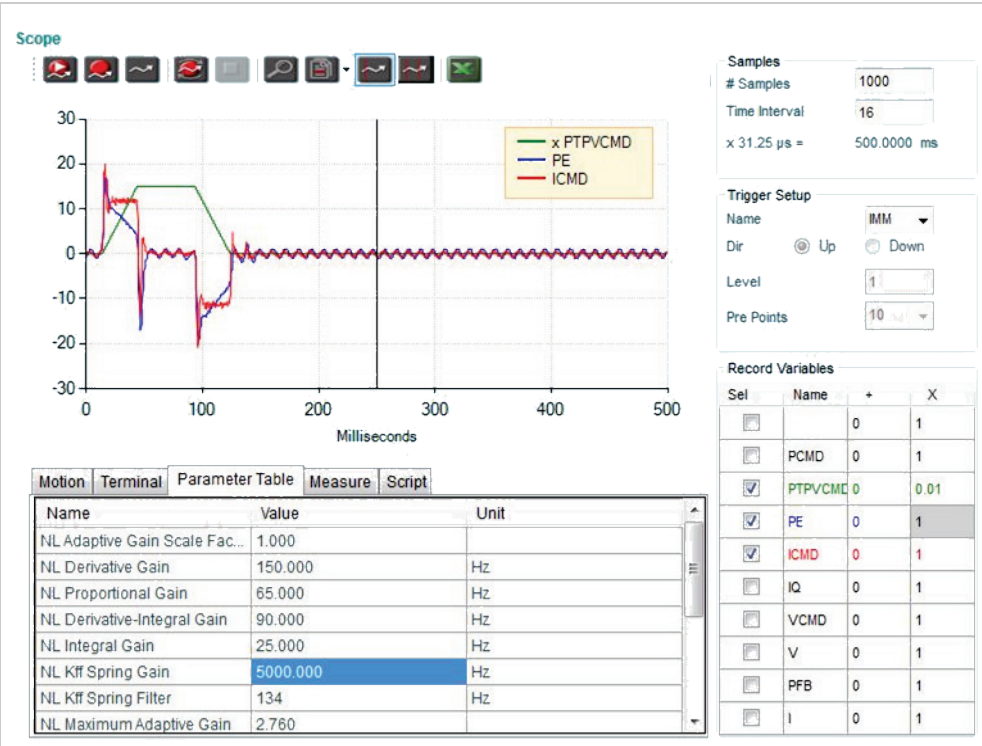


Figure 12-27.KNLI 25 Hz – Selected value

- Position error reduced slightly
- Oscillations at stop are acceptable (±1 encoder count)
- No overshoot of position error at end of deceleration phase (stopping point)

Step 7 – Tuning Flexible System Compensation

1. Set NLAFFPHZ to a value 3 × KNLD

NLAFFPHZ sets a low pass filter for the calculation of the profile acceleration. Setting it to 3×KNLD ensures that the bandwidth of this filter is sufficiently higher than the system response time.

2. Reduce NLPEAFF until the best result for the application is achieved. Criteria may be either settling time or tracking error.

The NLPEAFF value reflects the natural oscillation frequency of the coupling between the motor and the load. The more flexible the system, the lower this frequency.

Tuning NLPEAFF therefore starts with the highest value and then decreases.

Typically, the highest frequency is 400 Hz; therefore, for very heavily loaded and flexible systems, the typical range for NLPEAFF is 400 to 30 Hz.

The following screen images show the position error graph for decreasing values of NLPEAFF. In this example, values of NLPEAFF 220 Hz or 120 Hz may be selected, depending on whether the amplitude of the position error or the settling time is more important.

Figure 12-28.NLPEAFF 5000 Hz - No flexible system compensation

Figure 12-29.NLPEAFF 300 Hz - Peak position error reduced

Figure 12-30.NLPEAFF 220 Hz - Peak position error reduced more; improved settling time

Figure 12-31.NLPEAFF 120 Hz - Minimum position error, but some oscillations at stop

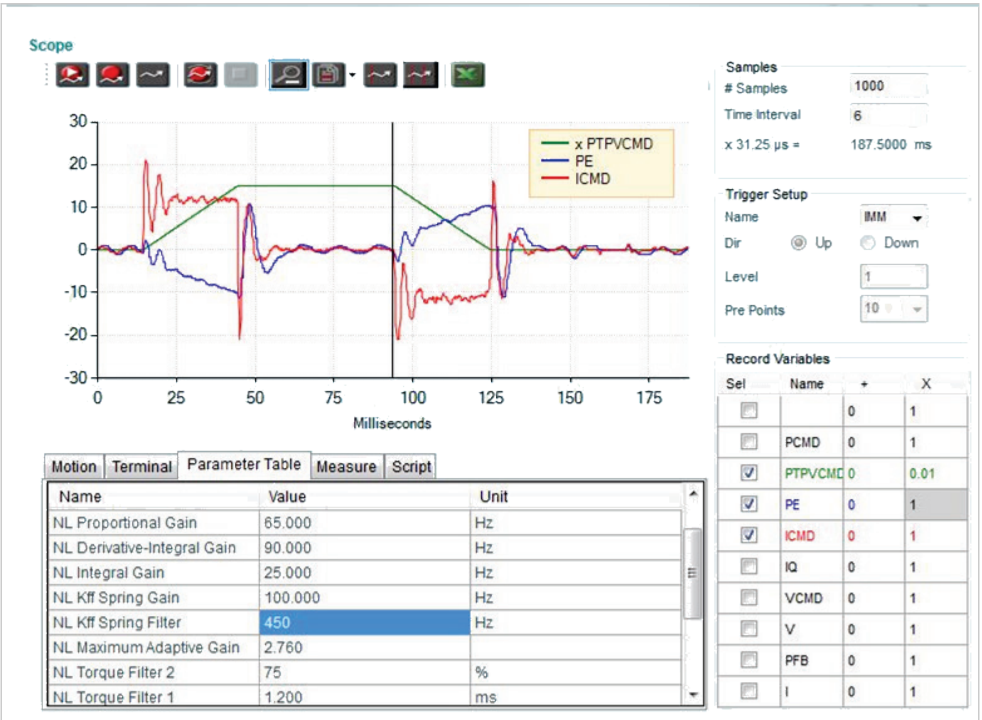


Figure 12-32.NLPEAFF 100 Hz - Position error too low; Negative position error in acceleration phase

13 Tuning: Anti-Vibration

Note: The data shown in the software screens in this documentation may appear different than what you see on your screen; descriptive parameters names, in particular, may have changed.
The textual information and instructions, however, are in accordance with the latest version of the firmware and software.

13.1 Anti-Vibration Overview

The **Anti-Vibe** feature of HD Control comprises two proprietary control algorithms, which provide a solution for systems that exhibit a clear vibration at a constant frequency. Anti-Vibe significantly reduces the time it takes for a heavy load or an end effector to reach its target position.

Anti-Vibe provides **active damping** of the load oscillations. **It functions in a closed loop mode**, detects oscillations as they occur, and dampens them immediately.

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.

Anti-Vibe reduces the following error and the settling time of the load. Although the following error seen at encoder level may be higher, the overall performance of the system, as evaluated at load position, is significantly improved.

Anti-Vibe can handle systems with an oscillation frequency of up to 100 Hz.

13.2 Parameters

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

Parameter	VarCom	Default	Range	Unit
HD Anti-Vibration Filter HD PE Filter	NLANTIVIBHZ NLANTIVIBHZ2	500	0 to 500	Hz
HD Anti Resonance Sharpness HD PE Sharpness	NLANTIVIBSHARP NLANTIVIBSHARP 2	0.5	0.01 to 10	–
HD Anti Vibration Gain HD PE Filter	NLANTIVIBGAIN NLANTIVIBGAIN 2	0	0 to 10000	

Possibly also:

HD Global Gain	KNLUSERGAIN	1.000	0.001 – 3.000	–

The following diagram shows the four phases of the Anti-Vibe process.

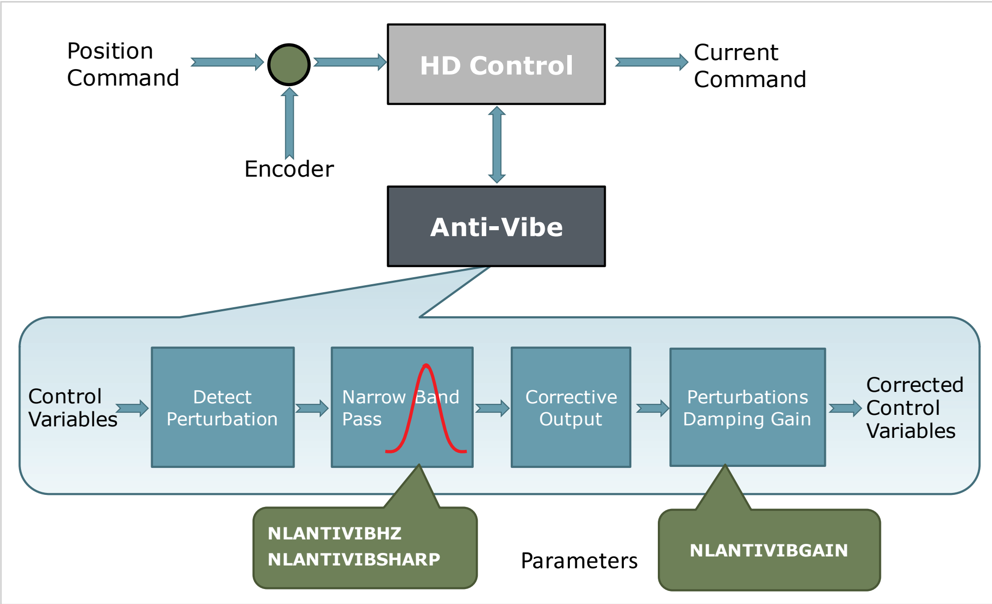


Figure 13-1. FLEXI PRO Anti-Vibe Process

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 NLANTIVIBHZ and NLANTIVIBSHARP.

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).

13.3 Preliminary Procedures

Note: These instructions assume you are familiar with FLEXI SUITE software and motion control theory.

1. Make sure the drive firmware version is 1.3.2 or later, and the FLEXI SUITE software version is 1.3.2.3 or later. If not, download and install these versions.

   If you are working with a later version, some software screens might appear different than those shown in this document.

2. Run the FLEXI SUITE **Motor Setup Wizard**, and make sure motor setup is successfully completed.

3. Run the FLEXI SUITE **Autotuning Wizard**, and make sure autotuning is successfully completed.

4. Using the table below, write down the values determined by the wizard. This will be a useful reference while you are performing the Anti-Vibe tuning.

Anti-Vibration 1

Parameter	VarCom	Range	Autotuning Value	Manual Value
HD Anti-Vibration Filter	**NLANTIVIBHZ**	**0 to 500**		
HD Anti-Resonance Sharpness	**NLANTIVIBSHARP**	**0.01 – 10**		
HD Anti-Vibration Gain	**NLANTIVIBGAIN**	**0 – 10000**		
HD Global Gain	KNLUSERGAIN	0.001 – 3.000		

Anti-Vibration 2

Parameter	VarCom	Range	Autotuning Value	Manual Value
HD PE Filter	**NLANTIVIBHZ2**	**0 to 500**		
HD PE Sharpness	**NLANTIVIBSHARP2**	**0.01 – 10**		
HD Anti-Vibration Gain	**NLANTIVIBGAIN2**	**0 – 10000**		
HD PE Filter	KNLUSERGAIN	0.001 – 3.000		

The following diagram shows the procedure for anti-vibration tuning utilizing the two sets of anti-vibration parameters.

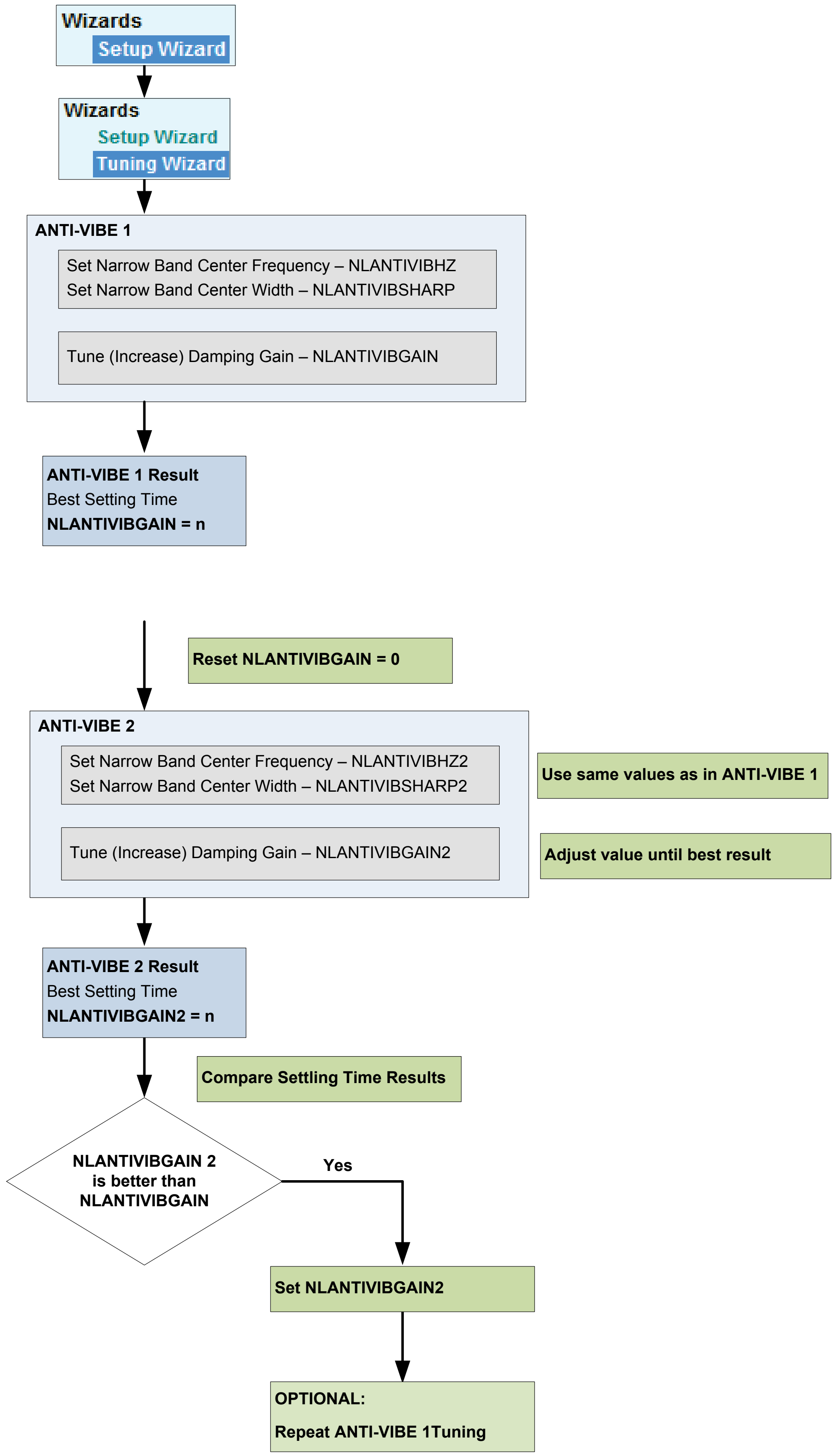


Figure 13-2. Anti-Vibe Tuning Procedure

13.4 Tuning Procedures

Tuning Sequence

Parameters are set and tuned in two steps:

1. Set the narrow band filter center frequency and width.
2. Tune the damping gain.

For every change you make in a parameter value, check it by executing a movement and observing the recorded variables in the FLEXI SUITE Scope screen.

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:

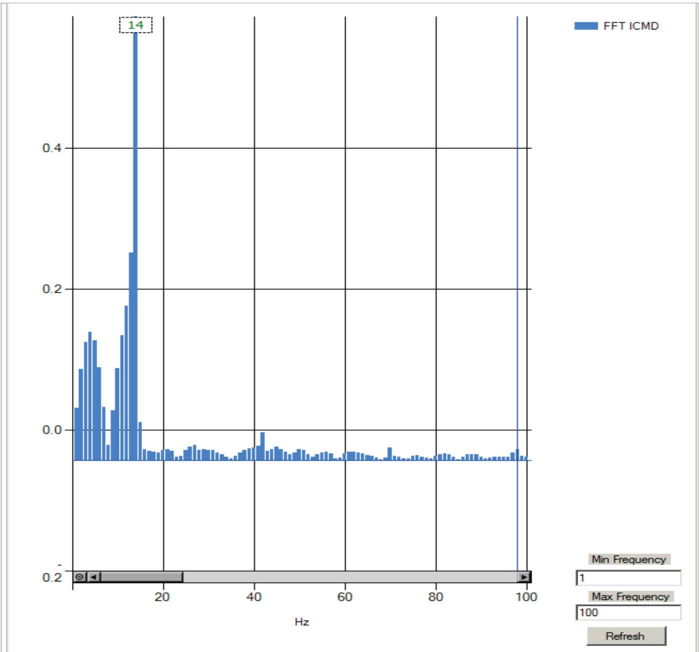


Figure 13-3. FFT Trace

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

2. Set the narrow band center width.

- Set the value of parameter NLANTIVIBSHARP 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 NLANTIVIBSHARP. Typical setting values range from 0.1 to 1.0.

The following diagram shows the narrow band filter frequency response.

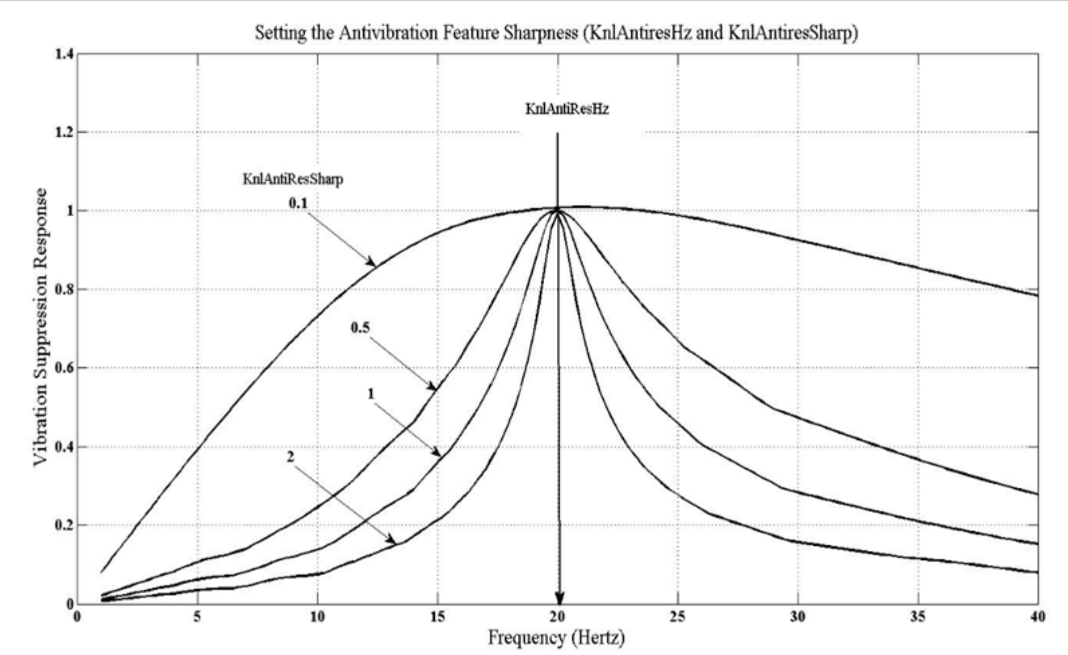


Figure 13-4. Frequency response as a function of NLANTIVIBSHARP for 20 Hz center frequency

Step 2 – Tuning the Damping Gain

Increase parameter NLANTIVIBGAIN 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: When performing this step, the position error plot is not a good indicator, as it may still be oscillating while the current, and thus the load, are smoothly settling down.

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

Tuning Example

Without Anti-Vibe, position error and current oscillate.

(Note that variable plots are scaled.)

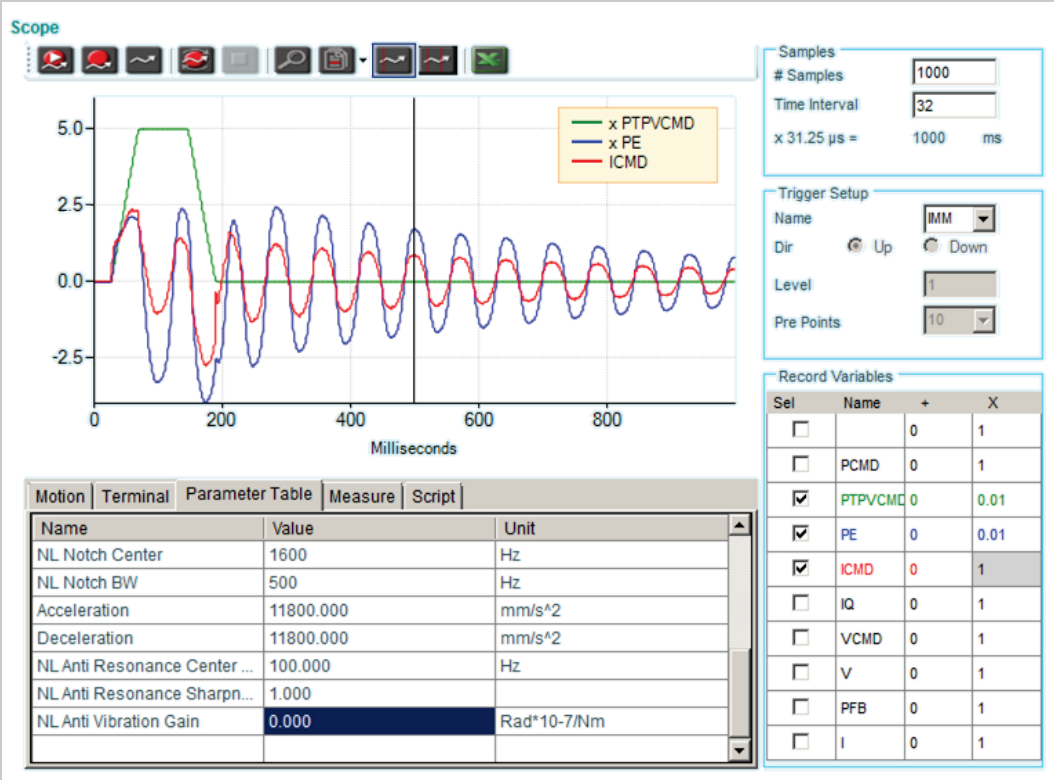


Figure 13-5. Without Anti-Vibe, oscillation of position error and current

Without Anti-Vibe, settling time is very long – 1622 ms

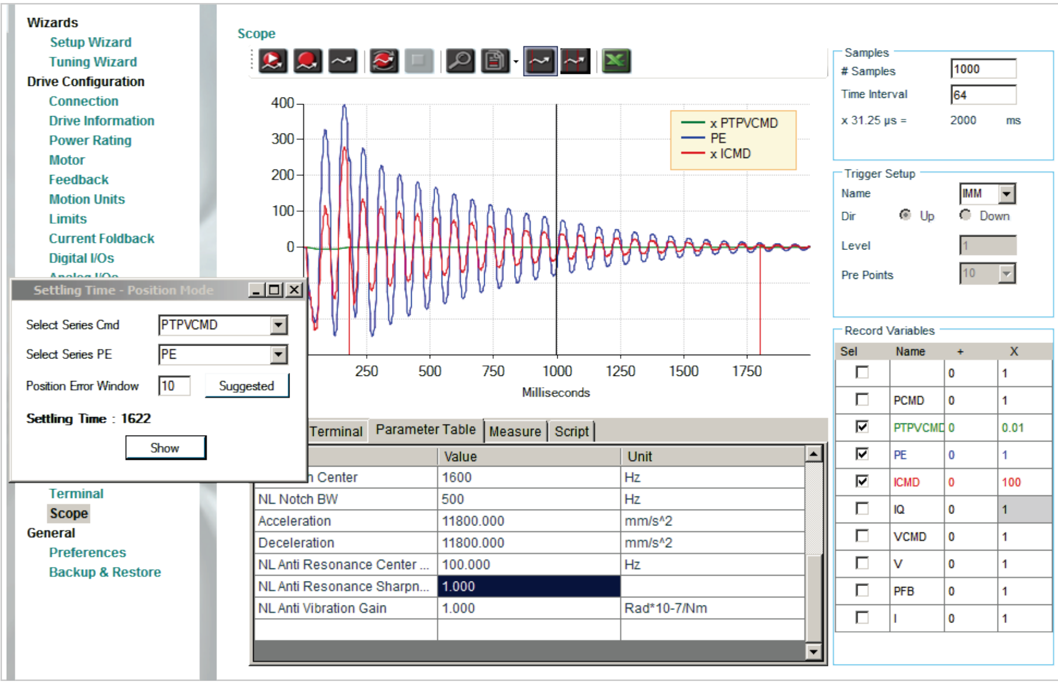


Figure 13-6. Without Anti-Vibe, long settling time

The FFT trace of ICMD shows resonance at 14 Hz

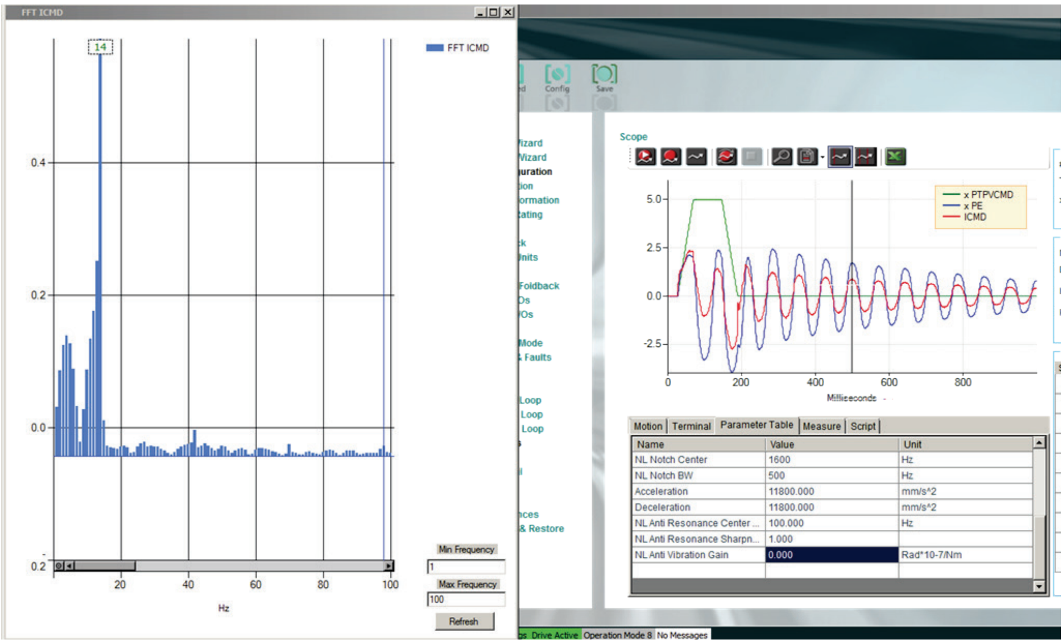


Figure 13-7. FFT Trace of ICMD Showing Resonance

With Anti-Vibe, settling time is reduced to 236 ms.

Parameters are set:

- NLANTIVIBHZ = 14 Hz, frequency of the measured resonance.
- NLANTIVIBSHARP = 0.4, width estimated according to the sharpness displayed in the FFT trace.
- NLANTIVIBGAIN = 75, determined by manually increasing the value from 0, until best settling time is achieved.

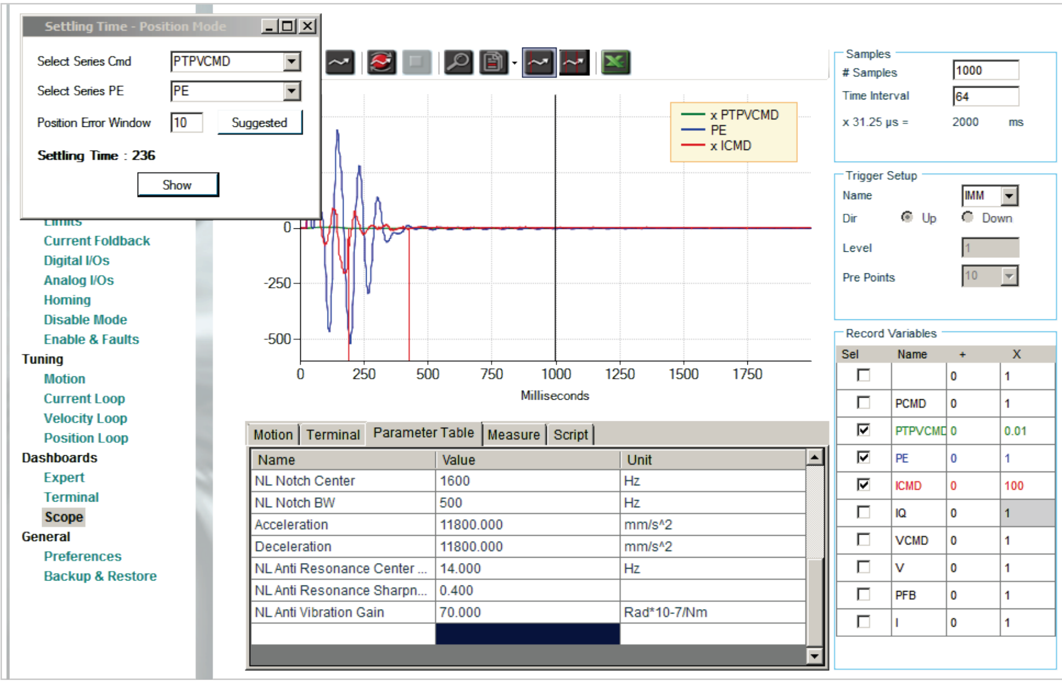


Figure 13-8. With Anti-Vibe, Improved Settling Time

FLEXI PRO Servo Drive

User Manual

Revision 5.1

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