AUTOMATIONDIRECT.com

LS ELECTRIC

EtherCAT®

PHOX Series DC Servo Drive
Quick Start Guide

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AutomationDirect Foreword

This QuickStart Guide is designed to get a PHOX servo system installed and running quickly. This AutomationDirect Guide is a supplement to the LS Electric PHOX User Manual. This Guide does not replace the manufacturer's User Manual. For advanced features or options required by your application, you may still need to refer to the User Manual. Download and reference both this QuickStart Guide and the PHOX User Manual when commissioning a PHOX servo system.

This quickstart guide will get your PHOX drive configured and commissioned using Drive CM.

- *For further EtherCAT commissioning help, see AutomationDirect's LS Electric Interactive PLC Guide available at https://cdn.automationdirect.com/static/helpfiles/ls_plc/Content/Home.htm*

A note on Part Numbers: LS Electric servo parts sold by AutomationDirect have part numbers that end with "-AD". This suffix signifies special packaging and labeling for AutomationDirect. All the LS servo products with the "-AD" function and behave exactly the same as the standard LS Electric parts. Please note that when reading the LS electric User Manual or using the Drive CM software, the "-AD" will NOT appear in any part numbers. For example, AutomationDirect part PHOX-06-080NS-AD is just PHOX-06-080NS in the LS Electric documentation.

NOTE: EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Table of Contents

PHOX Series Servo System Overview

Warnings and Cautions

WARNING:

- ***Install both the servo drive and the servo motor before performing any wiring.***
- ***Before wiring or inspecting, turn off the power, wait 15 minutes, make sure the charge lamp is off, and check the voltage.***
- ***Ensure this product is correctly grounded. All grounding and circuit protection methods must comply with all local standards/regulations and the national electrical standard (refer to NFPA 70: National Electrical Code, 202 Ed.)***
- ***Do not change the motor or drive wiring while power is on.***
- ***Only qualified and trained technicians may perform wiring on this product.***
- ***Do not operate the servo system with wet hands.***
- ***Do not open the servo drive cover during operation.***
- ***Do not operate the servo system with the servo drive cover removed.***
- ***Do not touch the heat sink of the servo drive when it is connected to power and operating This component gets very hot and will scald.***

FAILURE TO COMPLY WITH THESE WARNINGS CAN RESULT IN INJURY OR DEATH.

CAUTION:

- ***The installation location must be free of vapor and corrosive or flammable gas.***
- ***When wiring, do not connect the three-phase power supply to the motor UVW connectors. Incorrect wiring may cause damage to the servo drive.***
- ***Do not disassemble the servo drive.***
- ***Verify the emergency stop can be activated before the servo drive is connected to power and put into operation.***

NOT FOLLOWING ANY OF THE ABOVE CAUTIONS CAN RESULT IN DAMAGE TO EQUIPMENT.

For additional warnings and precautions, please see pages ***iii*** through ***vii*** of the PHOX User Manual.

Installation

Ambient Installation Conditions

The PHOX Servo and compatible motors should be installed under the environmental conditions detailed below. Exceeding these conditions risks damage to the equipment.

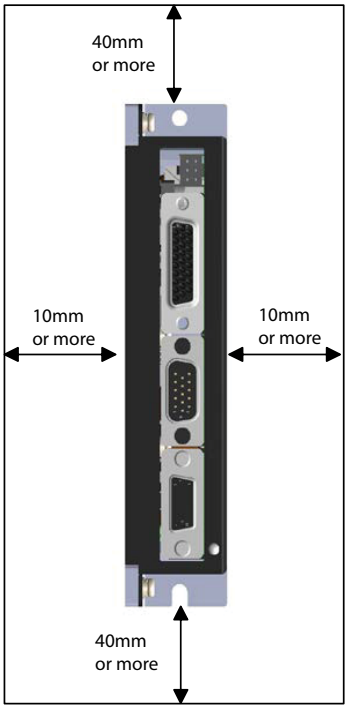
	Condition	Requirement	Notes
Servo Drive	Operating Temperature	0–50°C [32–122 °F]	Install a cooling fan on the control panel for ventilation and to maintain the temperature within the required range.
	Operating Humidity	90% relative humidity or below	Moisture developed inside the drive due to ice formation or condensation during a prolonged period of inactivity may damage the drive. If the drive has been inactive for a prolonged period remove all moisture before operating the drive.
	External Vibration	Vibration acceleration 49 m/s^2 (5.0G) or lower	Excessive vibration can cause malfunctions and reduces the lifespan of the drive.
	Ambient Conditions	• Do not expose the drive to direct sunlight. • Do not expose the drive to corrosive or combustible gases. • Do not expose the drive to oil or dust. • Ensure that the drive receives sufficient ventilation even if installed in a confined place.	

	Condition	Requirement	Notes
Motor	Operating Temperature	0–40°C [32–104 °F]	If motor temperature exceeds 40°C [104 °F], use forced air cooling to keep the motor temperature within spec.
	Operating Humidity	80% relative humidity or below	Do not operate the motors in an environment with steam.
	External Vibration	Vibration acceleration 19.6 m/s^2 (2.0 G) or lower on X and Y axes	Excessive vibrations reduce the lifespan of the motor bearings.

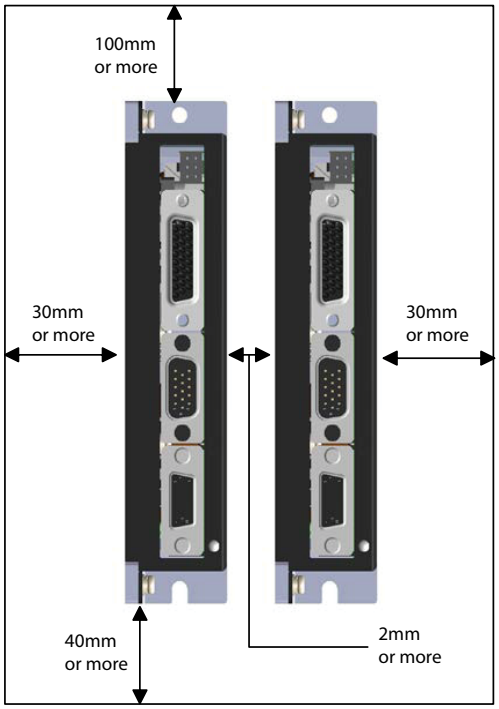
Installation Direction and Space

Comply with the spacing standard below when installing drives with the control panel:

Single Drive



Multiple Drives



Quick Start Instructions

To verify your servo components and motor/drive wiring as quickly as possible, please follow the steps below. These basic instructions will quickly get the motor spinning (verifying that parts and power wiring are correct).

This section bypasses detailed configuration and is only meant to test the hardware and wiring (spin the motor). Later parts of this quick start guide contain detailed information on how to properly set up your system and configure the drive for your specific application.

What you'll need:

- *Servo Drive*
- *Servo Motor*
- *Motor Power Cable*
- *Encoder Power Cable*
- *Brake Power Cable (for brake-equipped motors)*
- *STO cable (APCS-PHOX-STOxxA-AD)*
- *Drive CM software installed on a Windows PC*
- *A USB A to USB mini-B cable (such as SV2-PGM-USB15)*

Step 1: Before Powering on the Drive

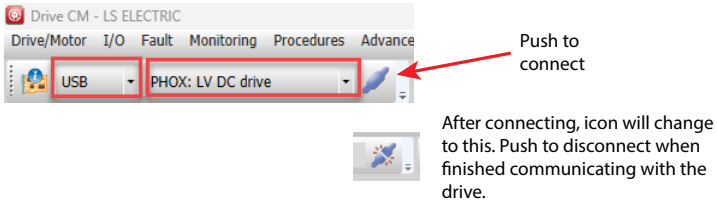
	Substep	Task
Step 1	A	Ensure Input Power wiring is connected to HV+/HV- and AUX+/AUX- and the frame is grounded. HV is drive power and AUX is optional control power. Refer to "Main Power Connection Wiring" on page 17.
	B	Ensure 12 or 24 VDC power is available for DI signals and 24VDC is available for DO signals. At the very least, make sure the E-Stop and STO circuits are connected. Refer to the I/O wiring detals on pages 17-19.
	C	Ensure the Motor Encoder cable is connected. Do not simply plug the connector into the motor. Use the captive screws to ensure the connector is secure. Intermittent encoder connection can wreak havoc with the system. Use Encoder A on the drive for most applications. Encoder B can be used if Full Closed Loop or Sine/Cosine or a resolver is used.
	D	Ensure the Motor Brake cable is connected (if using a brake motor). If practical, wire the brake directly to 24VDC during initial system testing. This eliminates any question of brake wiring functioning properly. Brake testing can be verified after initial drive testing. The PHOX drive has a 4-pin connector for direct brake control on the drive. Rating is 24VDC at 1A. See pages 15 and 19 for details.
	E	Leave the motor power cable disconnected until initial drive setup and testing are complete to prevent unwanted motion. Later, the motor will be wired and tested. Do not connect a load to the motor shaft until testing is completed.

Step 2: Power up the Drive

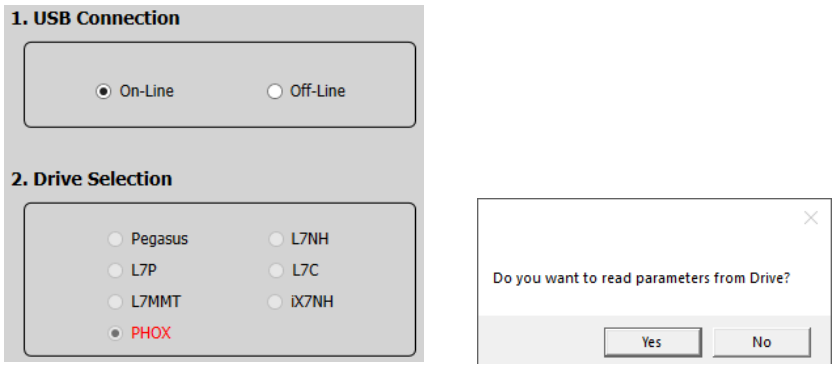
	Substep	Task
Step 2	A	Turn on 24VDC power to the Drive I/O terminal and brake (if using a brake motor).
	B	Turn on power: 24-80VDC on HV+, HV- (motor power), and AUX+, AUX- (optional control power, if used).
	C	The drive status LED will indicate the drive's status. See below for red/green LED status codes.

Color	State	Meaning
Green	Flickering (50ms pulses)	Drive is booting
	Blinking (200ms pulses)	Booting finished, drive is in ready state
	ON	Servo ON
	Double-flash	STO state
Red	Flickering (50ms pulses)	Firmware is downloading
	Blinking (200ms pulses)	Servo alarm
	Double-flash	Software error

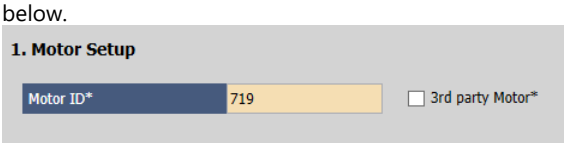
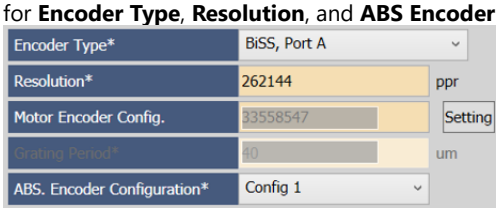
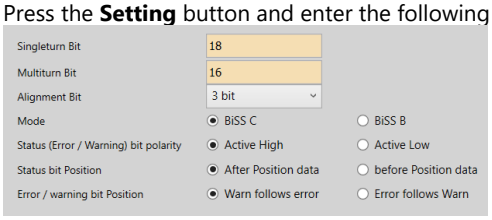
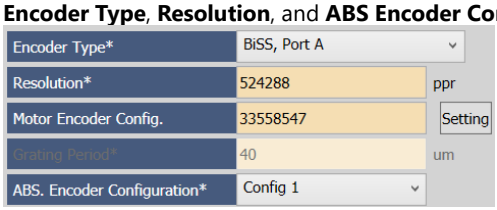
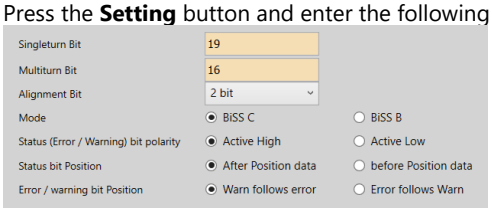
Step 3: Connect the PC to the Drive

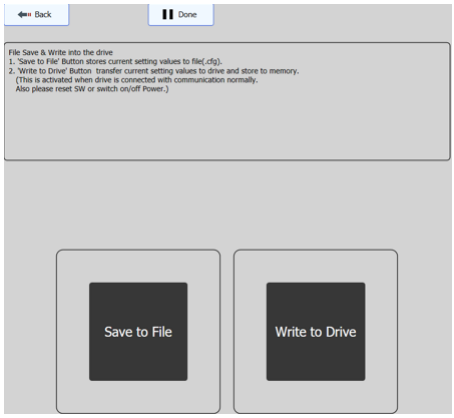
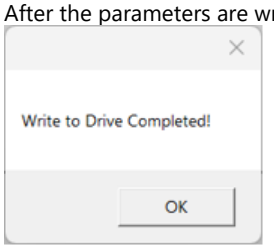
	Substep	Task
Step 3	A	Using a standard USB A to USB mini-B cable (such as SV2-PGM-USB15, MOSAIC-CSU, etc.), connect the PC to the Drive.
	B	Start Drive CM software.
	C	Select **PHOX: LV DC** and press the **Connect** button. The software should begin to communicate with the drive. A green flashing square should appear in the bottom left corner of the screen indicating comms traffic.  **Note:** In the Drive Information window, the drive names will display slightly differently than expected. • PHOX-03-080NS-AD will display as PHOX-03A-S • PHOX-06-080NS-AD will display as PHOX-06A-S

Step 4: Setup Wizard

	Substep	Task
Step 4	A	In the Quick Setup window (left side of screen), click **Setup Wizard**.
	B	In the USB Connection window, choose **On-Line** and click **Yes** to read parameters from the drive.  If the **On-Line** radio button is not available and grayed out, click on **Setup Wizard** again. This should restart the Setup Wizard and enable the button. Press **Next** to go to **Motor Selection**.
	C	For this initial setup and system testing, most of the Setup Wizard settings will use the default selection. But unlike other LS Electric servos, the PHOX drive allows many different types of encoders and motors. So, the motor and encoder setup must be manually entered. Select **Manual Setting** for motor selection. 

Step 4

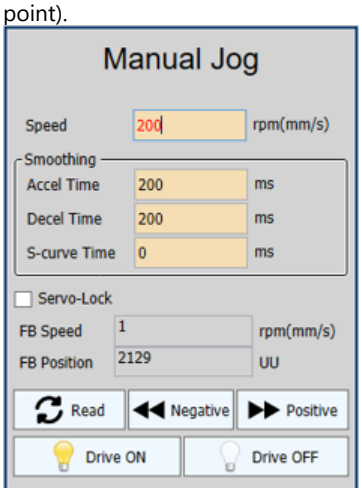
Substep	Task
D	Input the motor ID attached to the drive. This is located on the motor nameplate or refer to the table below.  **Phox Motor** / **ID** APMC-FAL01AM8N-8-AD APMC-FAL01AM8N2-8-AD — 705 APMC-FBL01AMK-8-AD APMC-FBL01AMK2-8-AD — 717 APMC-FBL02AMK-8-AD APMC-FBL02AMK2-8-AD — 718 APMC-FBL03AMK-8-AD APMC-FBL03AMK2-8-AD — 719 *NOTE: The number will appear red when first typed in. Press Enter to apply the new value. The number will then turn black to signify it has been applied.* Click **Next**.
E	Because the PHOX can accept over 10 types of encoder formats, and has two separate encoder inputs, the encoder setting can have many options. This QuickStart Guide only addresses the APMC motors from LS Electric designed for the PHOX drive. If you have a 3rd party motor, please refer to the PHOX User Manual for configuration details. • If you have an FAL motor (APMC-FAL01AM8N-8-AD or APMC-FAL01AM8N2-8-AD), fill in these values for **Encoder Type**, **Resolution**, and **ABS Encoder Configuration**.  Press the **Setting** button and enter the following parameters.  • If you have an FBL motor (APMC-FBLxxAMK-8-AD or APMC-FBLxxAMK2-8-AD), fill in these values for **Encoder Type**, **Resolution**, and **ABS Encoder Configuration**.  Press the **Setting** button and enter the following parameters.  **Important**: Press **Enter** after typing in numbers. The entry will turn from red to black to indicate acceptance. Click **OK**, then click **Next**.

	Substep	Task
Step 4	F	*NOTE: After the hardware and wiring are verified in the next steps, you can use one of the complete walkthroughs of the Setup Wizard found later in this Guide. Each Control Mode has a complete set of step-by-step instructions found later in these sections:* **-Index Position Mode:** *Indexing Position Mode using the Setup Wizard for Simple Motion* **-Pulse Input Position Mode:** *Pulse Input Position Mode Using the Setup Wizard for Simple Motion Commissioning Velocity* **-Velocity Mode:** *Velocity Mode (Speed Command) using the Setup Wizard for Simple Motion Commissioning* **-Torque Mode:** *Torque Mode Using the Setup Wizard for Simple Motion Commissioning* For now, the rest of the Setup Wizard settings can be left at their defaults for this "Spin the motor" exercise. Click **Next** several times to step through the rest of the Setup Wizard until the **Save to File / Write to Drive** window appears.
	G	Select **Write to Drive**.  After the parameters are written to the drive, click **OK**. 
	H	Click on **Software Reset** to reboot the drive and allow the changes to take affect. 

Step 5: Clear Faults

	Substep	Task
Step 5	A	Restart the drive and establish communications again.
	B	Go to "Fault\Servo Alarm History" and press the **Read** button. Correct any errors that are causing alarms to display on this page. Correction actions and information can be found in the User Manual or by selecting "Fault\Alarm List."
	C	After fixing any issues, click on **Reset Servo Alarm** and verify the alarms have been corrected. 

Step 6: Jog the Motor

	Substep	Task
Step 6	A	Remove power from the drive.
	B	Ensure that there is nothing attached to the motor shaft. Initial motion testing should always be done with the motor uncoupled.
	C	Connect the motor power cable and re-apply power to the drive.
	D	Reconnect the software to the drive (see Step 3C).
	E	Click on the **Jog** icon 
	F	Enter a nominal speed, acceleration, and deceleration (a value of 200 for each setting is a good starting point).  If a value is red, that means the value in the drive is different than the value in the software. Click in that field and press **Enter** to send the updated value to the drive.
	G	Press **Drive ON** to enable the drive from the software. The drive's LED should be solid green. **Note:** The **Servo On** (SV_ON) digital input must physically be **OFF** for the software Drive ON/Drive OFF buttons to function properly. The drive evaluates the physical digital input and the software buttons as an OR function for drive enable.
	H	Press **Negative** or **Positive** to jog the motor. Once the motor jogs, you have verified the power wiring, servo drive, motor, and motor cables are connected properly.

Complete guided walkthroughs for each control mode (Index, Pulse Input, Velocity, and Torque) can be found later in this guide.

First Time Inspection

Ensure your servo motor and drive match capacity.

PHOX Servo Drive

Part Number Explanation

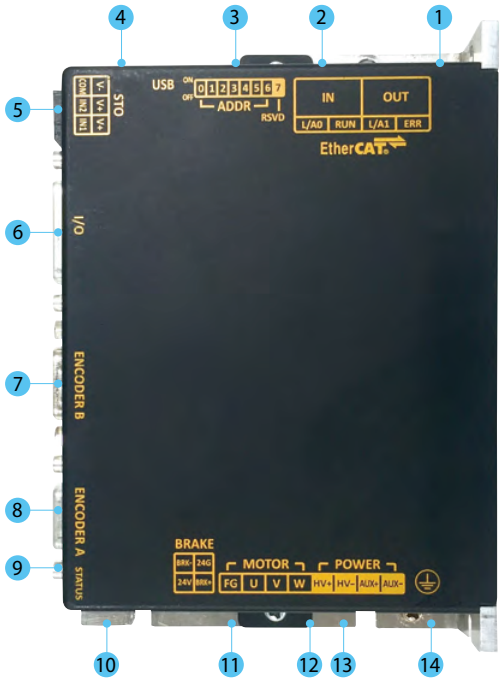
The two-digit number in the middle of the drive part number determines the current output of the drive. Note that the "-AD" simply represents special packaging for AutomationDirect. These are standard LS Electric parts. For example:

- *PHOX-03-080NS-AD*
- *PHOX-06-080NS-AD*

The value 03 represents a 3 amp output drive. The value 06 represents a 6 amp output drive.

Drive Model Explanation	Drive	Input Voltage	Current Rating	Compatible Motors	
				Non-braking	Braking
	PHOX-03-080NS-AD	24-80 VDC	3A	APMC-FAL01AM8N-8-AD APMC-FBL01AMK-8-AD	APMC-FAL01AM8N2-8-AD APMC-FBL01AMK2-8-AD
	PHOX-06-080NS-AD		6A	APMC-FBL02AMK-8-AD APMC-FBL03AMK-8-AD	APMC-FBL02AMK2-8-AD APMC-FBL03AMK2-8-AD

Servo Drive Components	Location	Description	Location	Description
	1	EtherCAT Out	8	Encoder A connector
	2	EtherCAT In	9	Status LED
	3	Switch for node address setting	10	Brake Connector
	4	Mini B USB	11	Motor Power Connector
	5	STO Connector	12	Master Power Connector (HV+, HV-)
	6	I/O Connector	13	Optional Power Connector (AUX+, AUX-)
	7	Encoder B connector	14	Ground



APMC Servo Motor

Part Number Explanation

The motor part number is defined by several of the digits in the middle. Note that the "-AD" simply represents special packaging for AutomationDirect. These are standard LS Electric Parts.

APM(C)-F**xxyy**zzz**(2)**-8-AD

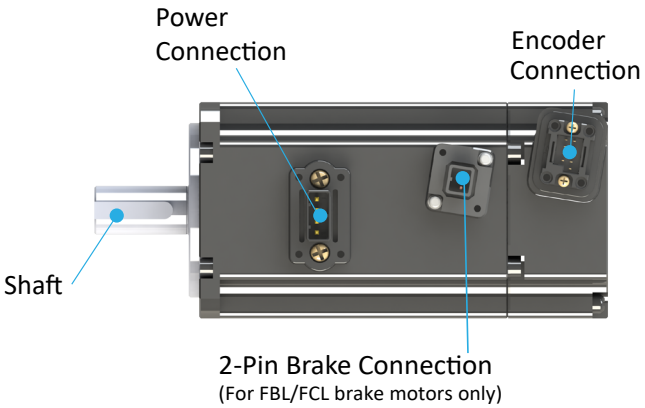
- *XX = the frame size:*
  - *AL = 40mm square (46mm bolt circle)*
  - *BL = 60mm square (70mm bolt circle)*
- *YY = power in hundreds of watts*
- *A = Rated speed 3000rpm*
- *M = 19-bit ppr multi-turn absolute (16-bit register for number of turns)*
- *M8 = 18-bit ppr multi-turn absolute (16-bit register for number of turns)*
- *(K) = represents keyed shaft*
- *(N) = represents round smooth shaft.*
- *(2) = If present at the end of the part number, represents a motor with built-in brake. No (2) = no brake.*
- *-8 = 8V/krpm of back EMF and is only applicable to low voltage DC powered servo motors.*

For example:

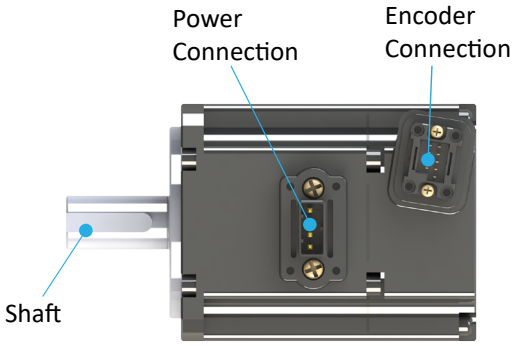
APMC-FAL01AM8N-8-AD

This represents a 48 VDC motor, 40mm square, 1 Amp power, 3000rpm rated speed, 18-bit encoder, smooth shaft with no key way, with no brake, specially packaged for AutomationDirect.

FAL/FBL Braking Motors



FAL/FBL Motors



NOTE: FAL series motors do not have a keyed shaft.

Basic Inspection

Perform periodic inspections to maintain your equipment, as well as inspections before operation of the servo and motor.

Inspection	*Task*
General Inspection	Periodically check to confirm the screws are securely tightened. This includes the screws in the servo drive, the connection screws between the motor shaft and the machine, and the connection screws between the terminal block and machine.
	Prevent oil, water, metallic particles, and other foreign matter from entering the control box or ventilation equipment. Protect the servo drive from any drill cuttings.
	If the control box is installed in a location where dust or harmful gas are present, ensure the dust or harmful gas cannot enter the control box.
	Make sure to wire encoders and other devices in the proper sequence to avoid sudden unintended acceleration or damage to the motor.
Inspection before operation (power OFF)	To avoid electric shock, connect the ground terminal of the servo drive to the ground terminal of the control box. If wiring must be added or modified, wait at least 10 minutes after disconnecting the servo drive from the power supply or discharge the electricity with a discharge device.
	Isolate the wires at the wiring terminal.
	Make sure the wiring is correct to avoid damage or any abnormal operation.
	Check for and remove any electrically conductive objects, including metal sheet and screws, or flammable objects inside or near the servo drive.
	Make sure the emergency stop switch is OFF.
	To ensure the electromagnetic brake works, make sure the stop and circuit breaker functions are working properly.
	Reduce the electromagnetic interference if there is electromagnetic interference with the peripheral devices.
	Make sure the external voltage level of the servo drive is correct.
Inspection before operation (power ON)	The encoder cable should be protected from excessive stress – make sure the cable is not worn or stretched.
	Contact AutomationDirect if the servo motor vibrates or makes unusual noise during operation.
	Make sure the parameter settings are correct. Different machines have different characteristics. Adjust the parameters according to the characteristics of each machine.
	Reset the parameters when the servo drive is in the Servo OFF status to avoid possible malfunction.
	If there is no contact noise or other abnormal noise when the relay is operating, contact AutomationDirect.

System Wiring

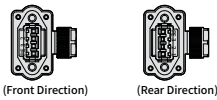
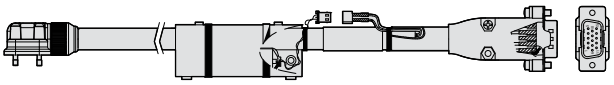
Pre-made Motor Cables

Motor connections utilize premade cables available in normal flex or robotic flex specifications. Cables are available for any PHOX drive and motor size 100, 200, and 300W, and are not model dependent (brake cables are only applicable for brake motors). They are available in lengths of 3m, 5m, 10m, and 20m (9.8 ft, 16.4 ft, 32.8 ft, and 65.6 ft).

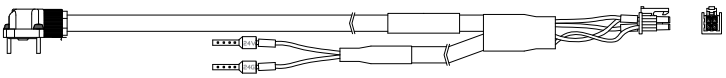
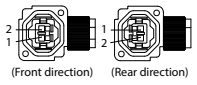
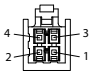
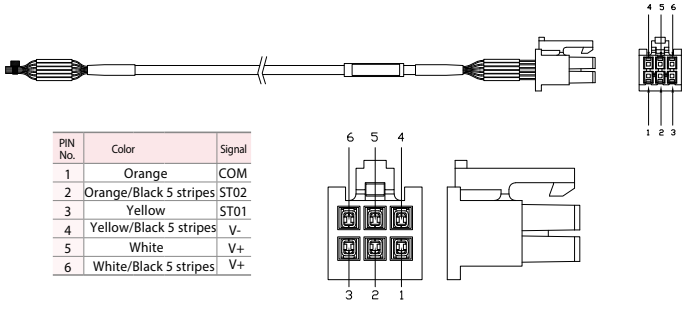
For cable model details and specifications, please see www.automationdirect.com.

For assistance in specifying a servo system, go to www.automationdirect.com/selectors for utilities that will help pick the correct motor, drive, cables, IO components, and accessories.

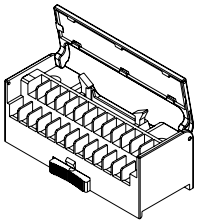
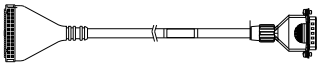
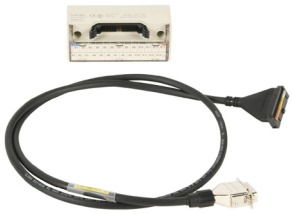
<table>
<tr><th>Cable Type</th><th>Illustration</th></tr>
<tr><td>Motor Power Cables (low voltage FAL, FBL motors)</td><td>



(Front Direction) (Rear Direction)
<table>
<tr><th>PIN No.</th><th>Signal</th></tr>
<tr><td>1</td><td>U</td></tr>
<tr><td>2</td><td>V</td></tr>
<tr><td>3</td><td>W</td></tr>
<tr><td>PE</td><td>Ground</td></tr>
</table>
</td></tr>
<tr><td>Motor Encoder Cable (low voltage FAL, FBL motors)</td><td>


(Front Direction) (Rear Direction)
<table>
<tr><th>PIN No.</th><th>Encoder Signal</th></tr>
<tr><td>1</td><td>BATTERY (VDD_B)</td></tr>
<tr><td>2</td><td>BATTERY 0V (GND_B)</td></tr>
</table>
(Battery Connector)
<table>
<tr><th>PIN No.</th><th>Encoder Signal</th></tr>
<tr><td>1</td><td>MA</td></tr>
<tr><td>2</td><td>SLO</td></tr>
<tr><td>3</td><td>GND_B</td></tr>
<tr><td>4</td><td>0V</td></tr>
<tr><td>5</td><td>SHIELD</td></tr>
<tr><td>6</td><td>$\overline{MA}$</td></tr>
<tr><td>7</td><td>$\overline{SLO}$</td></tr>
<tr><td>8</td><td>VDD_B</td></tr>
<tr><td>9</td><td>+5V</td></tr>
</table>
(Motor Connector)

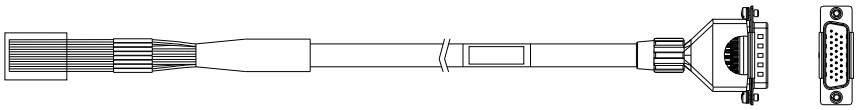
<table>
<tr><th>PIN No.</th><th>Encoder Signal</th><th>PIN No.</th><th>Encoder Signal</th></tr>
<tr><td>1</td><td>-</td><td>9</td><td>-</td></tr>
<tr><td>2</td><td>-</td><td>10</td><td>-</td></tr>
<tr><td>3</td><td>0V</td><td>11</td><td>$\overline{MA}$</td></tr>
<tr><td>4</td><td>-</td><td>12</td><td>MA</td></tr>
<tr><td>5</td><td>5V</td><td>13</td><td>-</td></tr>
<tr><td>6</td><td>-</td><td>14</td><td>-</td></tr>
<tr><td>7</td><td>$\overline{SLO}$</td><td>15</td><td>-</td></tr>
<tr><td>8</td><td>SLO</td><td>Plate</td><td>SHIELD</td></tr>
</table>
(Driver Connector)
</td></tr>
<tr><td>Motor Brake Cable (low voltage FAL, FBL motors used with PHOX drives)</td><td>


(Front direction) (Rear direction)
<table>
<tr><th>PIN No.</th><th>Color</th><th>Signal</th></tr>
<tr><td>1</td><td>White</td><td>BRK+</td></tr>
<tr><td>2</td><td>Black</td><td>BRK-</td></tr>
</table>
Motor Connector

<table>
<tr><th>PIN No.</th><th>Color</th><th>Signal</th></tr>
<tr><td>1</td><td>Red</td><td>24V</td></tr>
<tr><td>2</td><td>White</td><td>BRK+</td></tr>
<tr><td>3</td><td>Black</td><td>BRK-</td></tr>
<tr><td>4</td><td>Blue</td><td>24G</td></tr>
</table>
Drive Connector
</td></tr>
<tr><td>STO Cable (PHOX drives)</td><td>


<table>
<tr><th>PIN No.</th><th>Color</th><th>Signal</th></tr>
<tr><td>1</td><td>Orange</td><td>COM</td></tr>
<tr><td>2</td><td>Orange/Black 5 stripes</td><td>ST02</td></tr>
<tr><td>3</td><td>Yellow</td><td>ST01</td></tr>
<tr><td>4</td><td>Yellow/Black 5 stripes</td><td>V-</td></tr>
<tr><td>5</td><td>White</td><td>V+</td></tr>
<tr><td>6</td><td>White/Black 5 stripes</td><td>V+</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th colspan="2">Cable Type</th><th>Illustration</th></tr>
<tr><td colspan="2" rowspan="2">Drive I/O Cables</td><td>Choose either Terminal Block + CN1 cable or a CN1 cable with labeled flying leads.</td></tr>
<tr><td>




APCS-PHOX-IOT-AD, APCS-PHOX-IOT01-AD, APCS-PHOX-IOT015-AD, APCS-PHOX-IOT02-AD

You can download a printable terminal label (“I/O Breakout Template”) at
https://www.automationdirect.com/pn/APCS-PHOX-IOT-AD
See terminal assignments table on the following page.



APCS-PHOX-IO01A-AD, APCS-PHOX-IO02A-AD, APCS-PHOX-IO03A-AD
(see pinout on next page)
</td></tr>
<tr><td rowspan="5">Connectors</td><td>PHOX-CON-A</td><td>  </td><td rowspan="5">Connectors A, B, and C ship with every drive. So do 10 “E” crimp pins. You can make your own STO and Brake cables, but we recommend purchasing LE Electric pre-made cables.

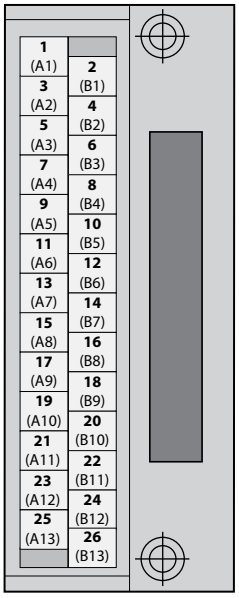
Connector E allows easy wiring of Encoder Port B to an external encoder using ZL-HD15M-CBL-DB15F (with ZIPlink ZL-RTB-DB15 breakout module) or ZL-HD15M-CBL-2P HD15 (with flying leads).</td></tr>
<tr><td>PHOX-CON-B</td><td></td></tr>
<tr><td>PHOX-CON-C</td><td></td></tr>
<tr><td>PHOX-CON-D</td><td>  </td></tr>
<tr><td>PHOX-CON-E</td><td>  </td></tr>
</table>

I/O Terminal Assignments and Wire Colors

CAUTION: Terminal assignments are different for every LS drive series. Use this terminal assignment chart with PHOX series drives ONLY. Using terminal charts from other LS series drives will result in incorrect wiring that will damage your equipment.

Terminal	Drive I/O Pin/Wire #	PHOX Series Description	Cable Color
A1	1	PF+	Orange/Black Stripe
B1	2	PF-	Orange/Red Stripe
A2	3	PR+	Orange/Black Stripe
B2	4	PR-	Orange/Red Stripe
A3	5	AGND	Orange/Black Stripe
B3	6	AI+	Orange/Red Stripe
A4	7	AI-	Orange/Black Stripe
B4	8	AMON1	Orange/Red Stripe
A5	9	AMON2	Orange/Black Stripe
B5	10	DICOM Input Power	Orange/Red Stripe
A6	11	DI1	Yellow/Black Stripe
B6	12	DI2	Yellow/Red Stripe
A7	13	DI3	Yellow/Black Stripe
B7	14	DI4	Yellow/Red Stripe
A8	15	DO1	Yellow/Black Stripe
B8	16	DO2	Yellow/Red Stripe
A9	17	DO3	Yellow/Black Stripe
B9	18	DO4	Yellow/Red Stripe
A10	19	AO	Yellow/Black Stripe
B10	20	/AO	Yellow/Red Stripe
A11	21	BO	White/Black Stripe
B11	22	/BO	White/Red Stripe
A12	23	ZO	White/Black Stripe
B12	24	/ZO	White/Red Stripe
A13	25	DOCOM Common GND	White/Black Stripe
B13	26	AGND	White/Red Stripe

APCS-PHOX-IOTxx-AD



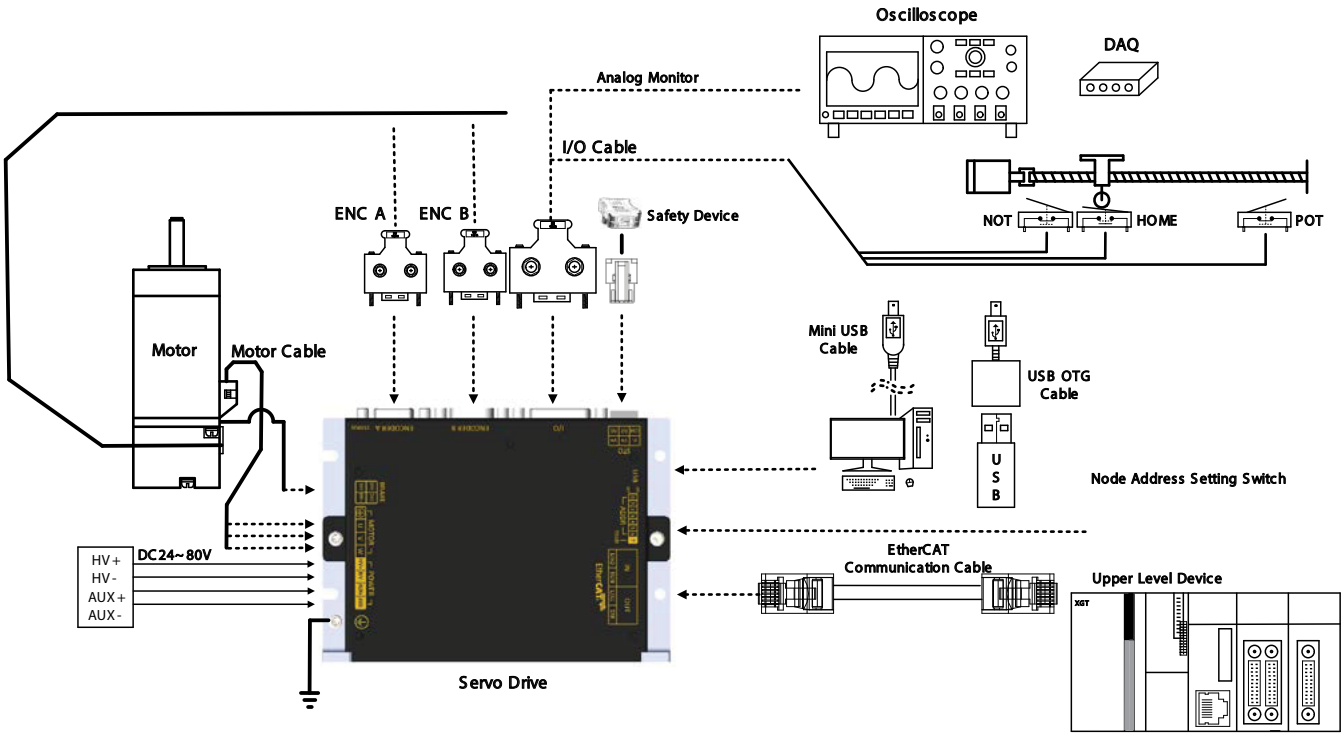
You can download a printable terminal label ("I/O Breakout Template") at https://www.automationdirect.com/pn/APCS-PHOX-IOT01-AD

Names and Functions of Brake Connector

Name	Description	Pin #
24V	Brake 24V Input	1
BRK+	Brake 24V Output	2
BRK-	Brake (1A)	3
24G	24V Return	4

General Wiring Overview

Example System Configuration



NOTE: PE between the servo motor and the servo drive, and between the servo drive and the host device must be connected.

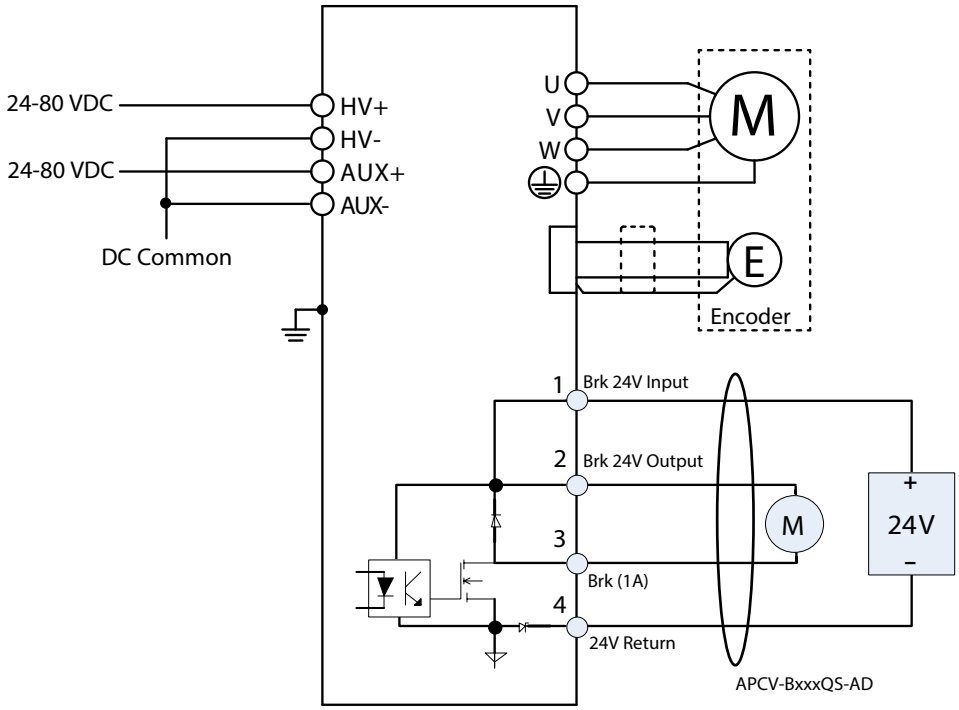
Example Encoder Configuration

To connect to external linear scale or encoder for full-closed loop and motor feedback to Encoder B you can use the following for easy connection to any third part encoder.

- *PHOX-CON-E*
- *ZL-HD15M-CBL-DB15F (with ZIPlink ZL-RTB-DB15 breakout module)*
- *or ZL-HD15M-CBL-2P HD15 to flying lead cable.*

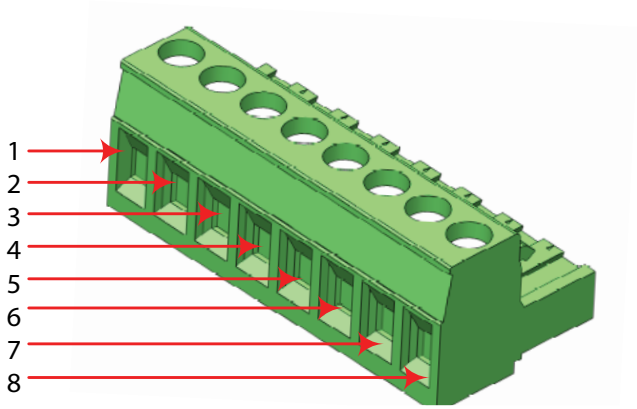
Main Power Connection Wiring

The PHOX drive can accept 24-80 VDC input. The PHOX motor/drive combination supplies 300% rated maximum/intermittent motor torque. Speed torque curves are established using nominal 48VDC input power.



NOTE 1: HV+ and AUX+ should be supplied by separate wires with separate disconnect relays.

Power Connector Signal Names



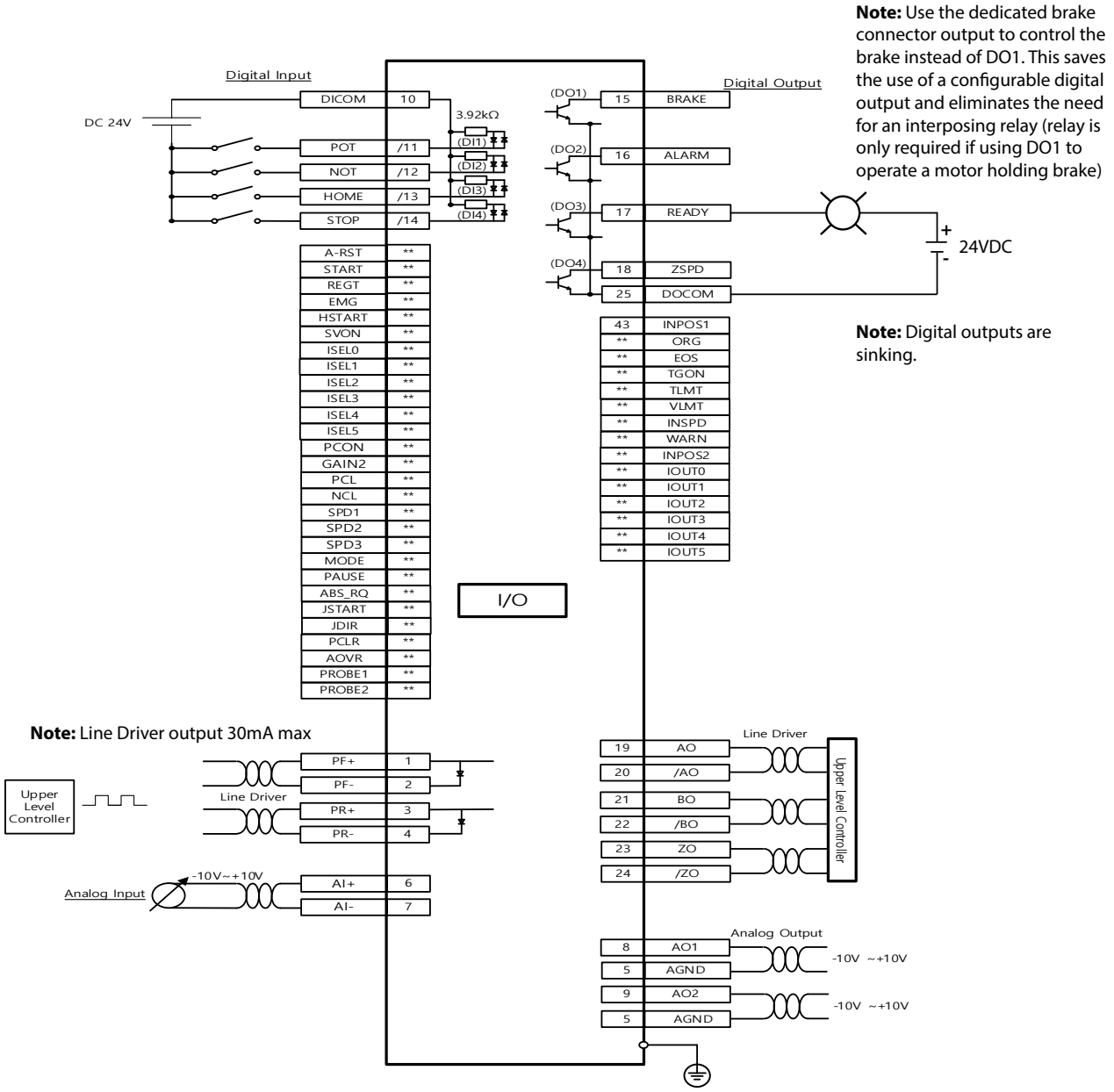
Signal Name	*Pin #*	*Description*
FG	1	Frame ground, for motor power cable. Connect the machine ground point to the ground screw located on the drive frame/heatsink.
U	2	These are the motor U, V, and W outputs.
V	3	
W	4	
HV+	5	These are the main power inputs.
HV-	6	
AUX+	7	These are the optional auxiliary power inputs. When the main power is disconnected, maintain communication and check the drive status using the auxiliary power.
AUX-	8	

NOTE: Strip all Power Connector wiring 7-10mm. Refer to section 2.3.2 of the User Manual.

I/O Connection Wiring Diagram with Default Functions

I/O Connection wiring diagram is shown below. For a printable terminal label, go to:
https://www.automationdirect.com/pn/APCS-PHOX-IOT01-AD

See "Terminal Assignments and Wire Colors" on page 15 for terminal assignments.

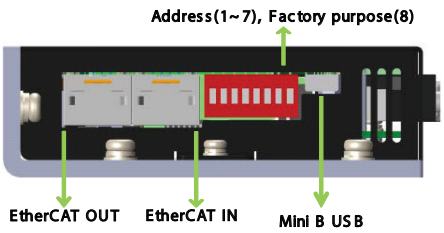


Input signals DI1 - DI4 and output signals DO1 - DO4 are factory default signals.

NOTE: Input signals DI1-DI4 and output signals DO1-DO4 are factory default signals and can be reconfigured.

NOTE: APCS-PHOX-IOTxx-AD provides shielding between the servo and the terminal blocks. User provided shielding should be installed for high speed and analog signals (ground the shield on the PLC side).

Drive Node Address Setting and EtherCAT Basics



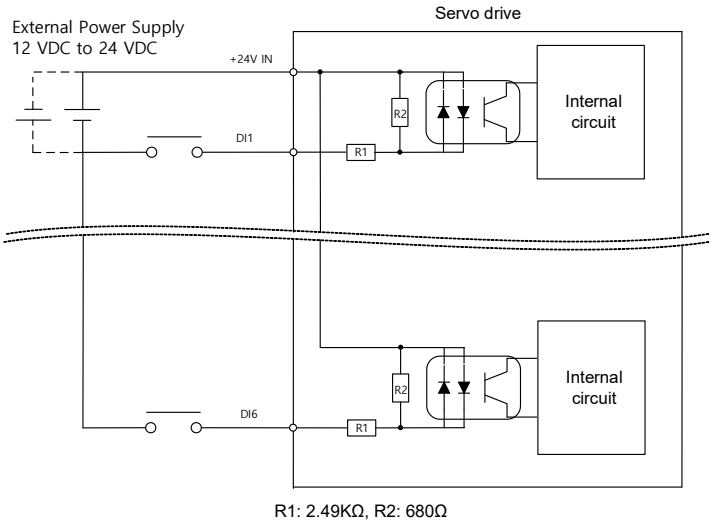
The PHOX drive can be used in an EtherCat network. The node address of the drive is determined by the 7 dip switches on the side of the drive. Switches 0–7 allow for node addresses up to 127. Dip switch 8 is for factory use, do not turn on. Node setting changes are applied on power up. The PHOX Node address must be unique on the network.

See chapters 3 and 4 in the PHOX user manual for further details. See chapter 13 for manufacturer recommended test procedures for starting up the drive.

I/O Wiring Details Digital Inputs/Outputs

Digital Inputs

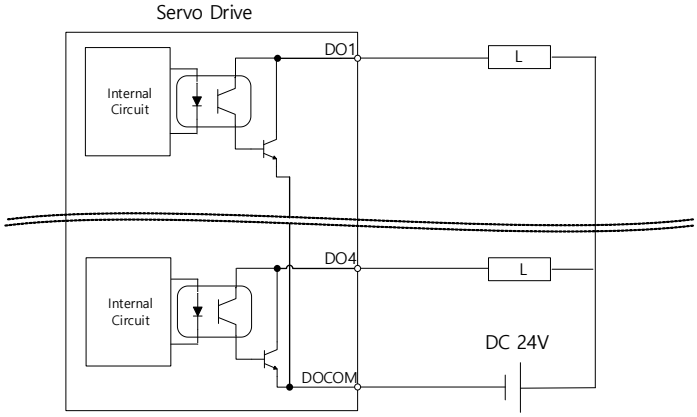
1) You can set the input contact to contact A (normally open) or contact B (normally closed).
2) You can assign each input contact to one of 33 functions.
3) For more information on signal assignment and change of the input contact, refer to the User Manual, section 5.1 “Setting for Input/Output Signals.” The Drive CM software makes setting the I/O signals very quick and easy.
4) The rated voltage is 12VDC to 24VDC. See section 2.4 “Wiring for Input/Output Signals” for more details.



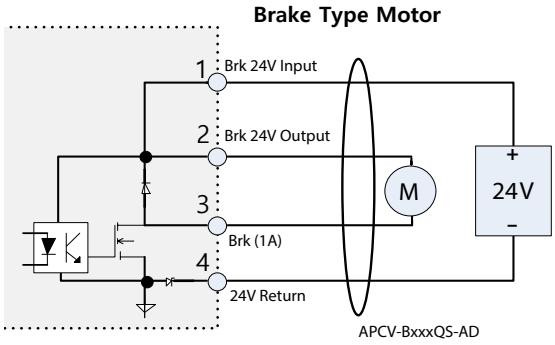
R1: 2.49KΩ, R2: 680Ω

Digital Outputs

1) You can set the output to contact A (normally open) or Contact B (normally closed).
2) You can assign each output contact to one of 19 output functions.
3) For more information on signal assignment and change of the output contact, refer to the User Manual, section 5.1 “Setting for Input/Output Signals.” The Drive CM software makes setting the I/O signals very quick and easy.
4) Excessive voltage or overcurrent may damage the device because it uses an internal transistor switch. Be cautious. Do not directly power large inductive loads, use an interposing relay.
5) The rated voltage and current are 24VDC ± 10% and 120mA. See section 2.4 “Wiring for Input/ Output Signals” for more details.



6) When using an electronic brake the PHOX drive offers a dedicated output for direct brake control. Refer to the wiring diagram below for configuration.
The Brake Connector Output is enabled via 0x2037 Motor Brake Fitted.
Related Parameters for this output AND Digital Output defined as Brake:
   a) 0x2407 Brake Output Speed (rpm)
   b) 0x2408 Brake Output Time (ms)
   c) 0x2011 PWM Off Time (ms)



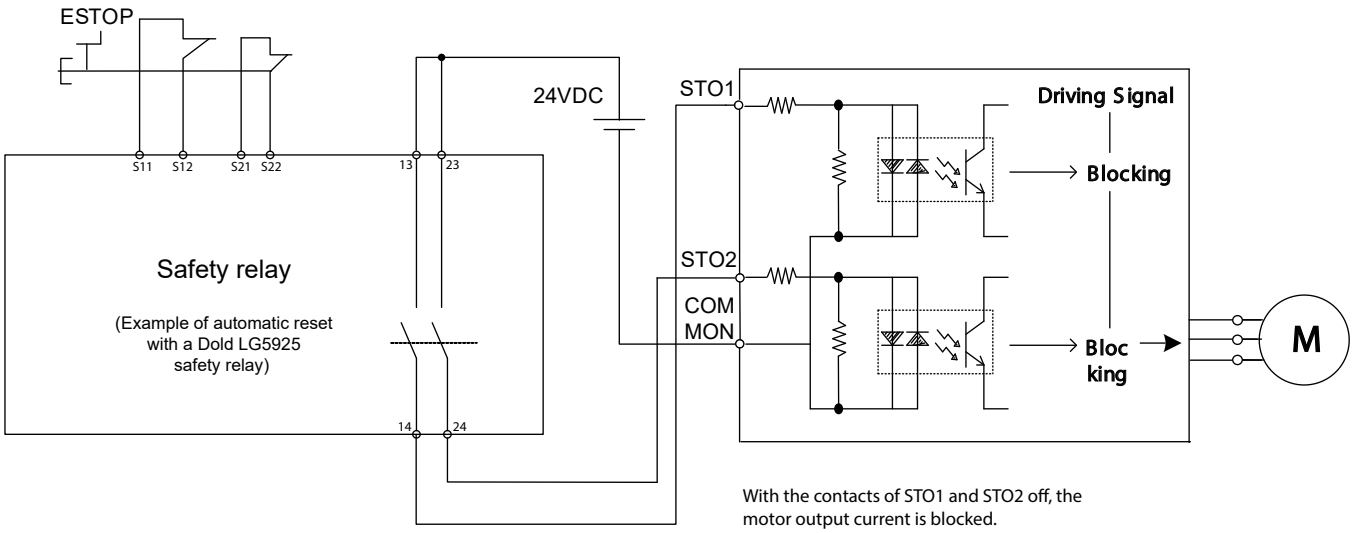
Input	*State*	*Function*
Brake	HI	Deactivates the brake depending on brake TR ON (Unlock)
	LO	Operates the brake depending on brake TR OFF (Lock)

NOTE: Use separate power sources for drive control and for the 24VDC motor brake.

STO Wiring

At the time of publication, the PHOX servo drive does not have 3rd party certification for Safe Torque Off (STO).

Until the PHOX drive STO receives certification, AutomationDirect recommends having the machine's safety circuit drop the motor power supply (not control power) when E-stop conditions are met. See section 6.2 of the PHOX user manual for details on connecting the STO circuit.

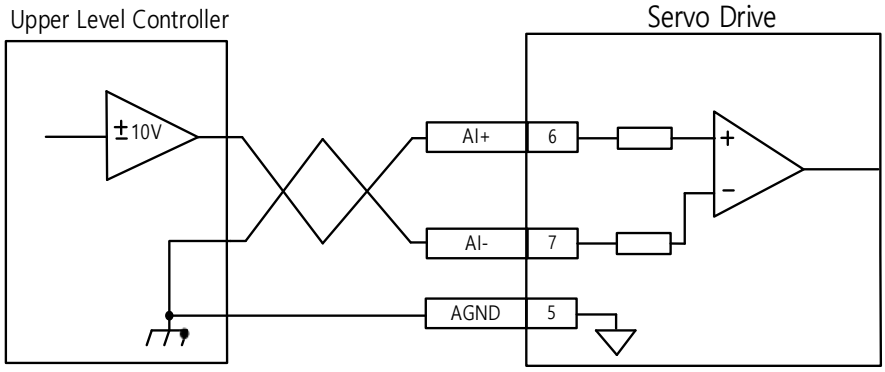


NOTE: Each PHOX drive ships with an STO connector and crimp pins to construct an STO cable. AutomationDirect recommends using pre-made STO cables (APCS-PHOX-STOxxA-AD) to facilitate STO wiring.

I/O Wiring and Option Details for the Analog Input

1) For information on how to operate the analog input signal, refer to the User Manual, section 2.4.3 of the PHOX user manual.
2) The range of the analog input signal is -10V to 10V.
3) The impedance for the analog input signal is approximately 3.74KΩ.

NOTE: APCS-PHOX-IOTxxx-AD provides shielding between the servo and the terminal blocks. User provided shielding should be installed for analog signals (ground the shield on the PLC side).



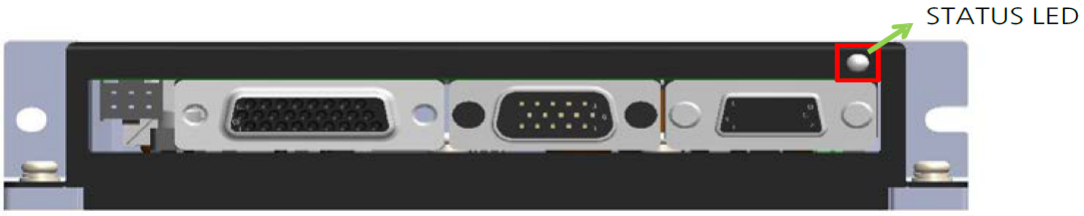
Depending on the parameter setting, the function changes as follows:

- *Speed override: Can be used in index operation mode while the indexing operation is performed.*
- *Speed command: Can be used in speed operation mode while the indexing operation is performed.*
- *Torque command: Can be used in torque operation mode while the indexing operation is performed.*
- *Torque limit: Can be used in index operation mode and EtherCAT operation mode while the indexing operation is performed.*

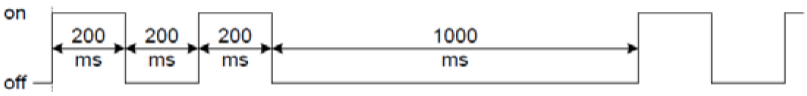
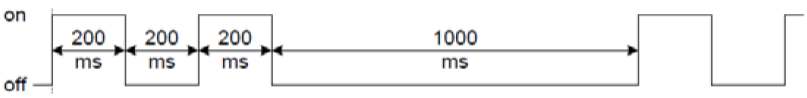
Using an FA-DCDC-1 DC-to-DC converter and the ECX2300-10K potentiometer from AutomationDirect is a good option for providing a -10V to +10V supply and control signal.

Status LED Display

The status LEDs on the front of the drive indicate the states and errors of the drive, as shown in the following figure. The status LED uses two colors (green and red) to indicate a total of 7 states.



The green LED shows the servo operation status and the red LED shows hte servo error status. Refer to the table below for details on the LED display.

LED Color	*LED Status*	*Description*
Green	Flickering	 Drive is booting.
	Blinking	 Booting was finished properly and the drive is in the ready state.
	ON	Servo is on (SVON)
	Double Flash	 STO state.
Red	Blinking	 Servo alarm is generated.
	Flickering	 Firmware is being downloaded.
	Double Flash	 Software error has occured. Please contact service center.

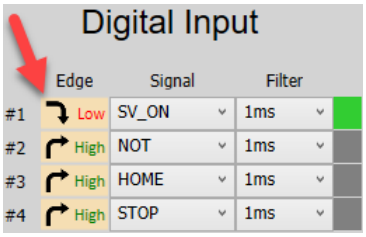
Drive CM Software

AutomationDirect Foreword

The LS Electric Drive CM software does not include "Are you sure?" types of warnings. When you make a change in the SW it takes place immediately in the drive, even settings that initiate motion.

Example 1:

When you go to the JOG screen and press "Enable", the drive Enables immediately.



Example 2:

When you change a Digital Input from active low to active high, the definition changes immediately by pushing the "Edge" button. In the picture to the right, Input #1 is configured for Servo On. If the input is physically low and you press the Edge button, the input's definition is changed to active low and the servo will immediately be enabled.

There is nothing wrong with this approach, but it may be more direct than most software packages that are in use today.

Getting Started

Drive CM software provides the fastest and easiest way to set up the LS Electric PHOX drive. The following steps show how to get started with the software and a few key features.

Before starting, you will need:

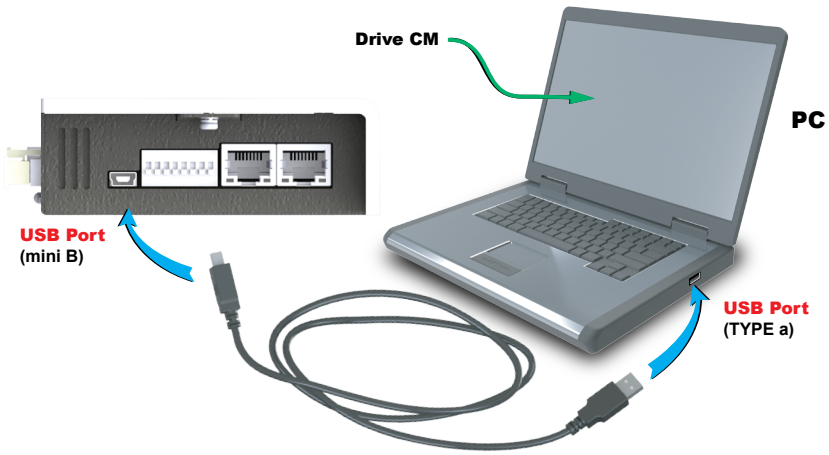
- *PC with Windows 8 or later*
- *PC USB port*
- *USB Type A to USB mini-B cable (SV2-PGM-USB15 is a good choice due to the dual ferrite filters and opto-isolator included with the cable. This USB cable is helpful when dealing with PC to Drive connectivity issues due to EMI)*

Step 1

Download and install Drive CM Software from the AutomationDirect software download page at https://www.automationdirect.com/support/software-downloads?itemcode=Drive%20CM%20Configuration.

Step 2

Connect the servo drive USB port to the PC USB port using a standard USB-A to USB-mini-B cable. Some cables available from AutomationDirect include:

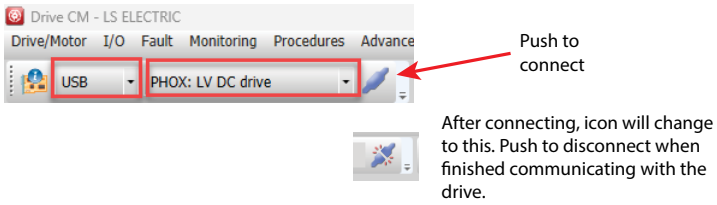


USB-A to USB-mini-B Cables
SV2-PGM-USB15
SV2-PGM-USB30
MOSAIC-CSU

Step 3

Open Drive CM Software and Connect to the drive.

1) Select the USB connection type and PHOX drive.
2) Then press the Cable icon to connect and establish communications with the drive.



NOTE: The icon does not show the current connection state, it shows what will happen if you push the button.

The comms status is displayed at the bottom left corner of the software screen. A green blinking square indicates active communication.

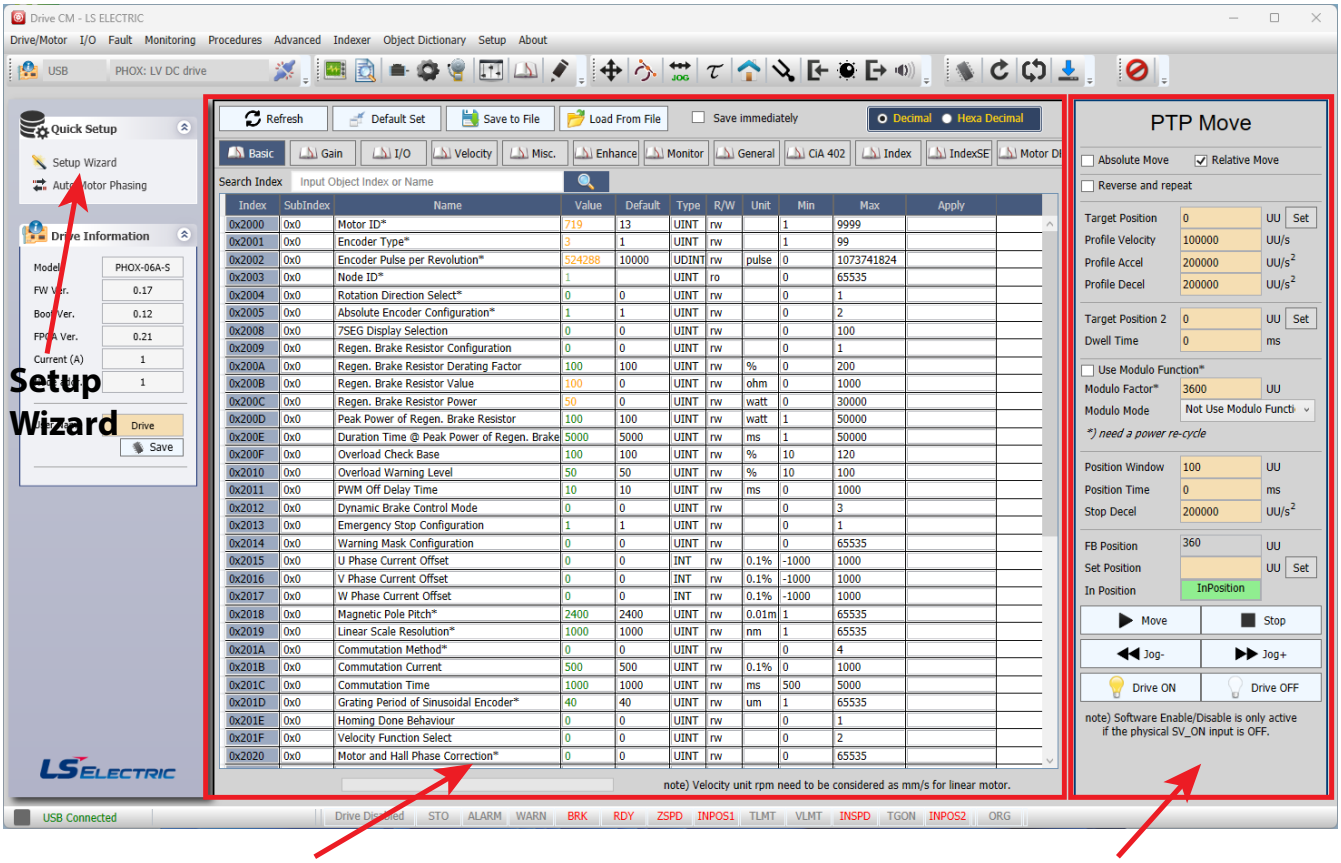
*NOTE: Some configuration screens (PTP Move, Manual Jog, etc.) have software **Drive ON**/ **Drive OFF** buttons to enable and disable the drive. The **Servo On** (SV_ON) digital input must physically be OFF for the software Drive ON/Drive OFF buttons to function properly. The drive evaluates the physical digital input and the software buttons as an OR function for drive enable.*

Using the Drive CM Software

There are two main working areas in Drive CM. The Main Window (larger, left) is mostly used for setup and configuration. The Auxiliary Window (smaller, right) has more dynamic operations available. Both areas can be viewed simultaneously for maximum usefulness. The left area is also used to run the Setup Wizard. The Setup Wizard will walk you step-by-step through setting up the basic parameters of the system.

NOTE: If you exit the "Setup Wizard" before completing the process, you will have to restart the wizard from the beginning. The "Setup Wizard" will not update the drive's parameters or the parameters in the object dictionary until they are written to the drive.

NOTE: In the "About" drop down menu you can find the Drive CM software user manual for specifics on each function in the software.



Toolbars

The two main toolbars at the top of the screen control what is displayed in the Main and Auxiliary windows.

Toolbar	*Controls*
	Main Window
	Auxiliary Window

NOTE: PHOX-03-080NS-AD will display as PHOX-03A-S, and PHOX-06-080NS-AD will display as PHOX-06A-S.

Toolbar Functions

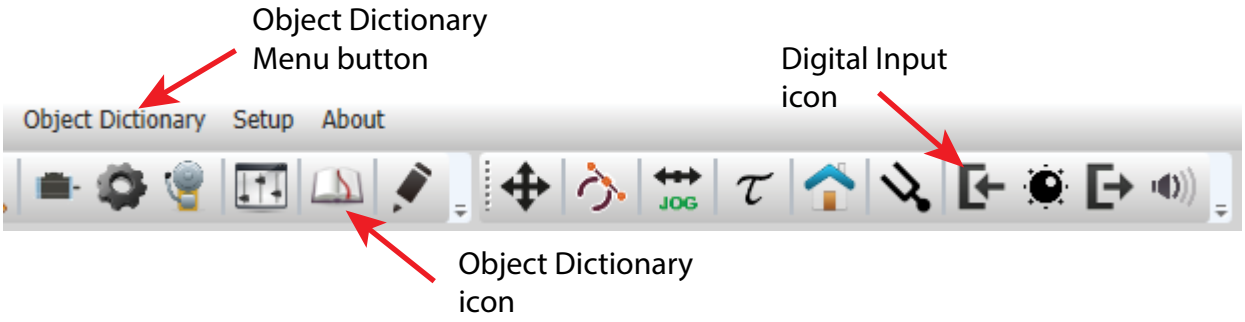
Icon	Function	Displays In
	Trace/Trigger Monitor (Scope)	Main Window
	Cyclic Monitor (System Data View)	
	Motor Encoder Setup (no configuration needed for auto-identifiable FBL/FCL motors)	
	General Configuration Setup	
	Fault Configuration	
	Controls Loop (Manual Tuning)	
	Object Dictionary (Parameters)	
	Index Edit (configure point-to-point moves/indexes)	
	Indexer Test	Aux Window
	PTP Move	
	Jog Manual	
	Torque Control	
	Homing	
	Tuning	
	Digital Input	
	Analog Input	
	Digital Output	
	Analog Monitor	
	Save to Drive Memory	n/a (Command only)
	Reset Servo Alarm	
	Software Reset for Drive CPU power cycle	
	Firmware Update	
	Emergency STOP	

I/O Configuration

Digital Inputs

Use the following parameters to configure Digital Input functionality or use the Digital Input window in Drive CM directly to make changes. The software provides a very easy way to change the DI functions using the digital input icon (quickest and easiest method for configuration). Alternatively, you can open the parameter object dictionary using the Object Dictionary menu button or the Object Dictionary icon.

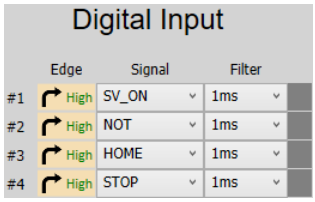
NOTE: When making these changes while the software is connected to the drive the change will take effect immediately, there is no "Are you sure?" warning. Example: Changing an SVON digital input from NO to NC by pressing the "Edge" button will cause the drive to change state immediately.
This feature of immediate changes from NO <-> NC can be used for "forcing" a digital input for testing and troubleshooting your application.



Digital Input Default Functions

These functions are located under the **I/O** tab.

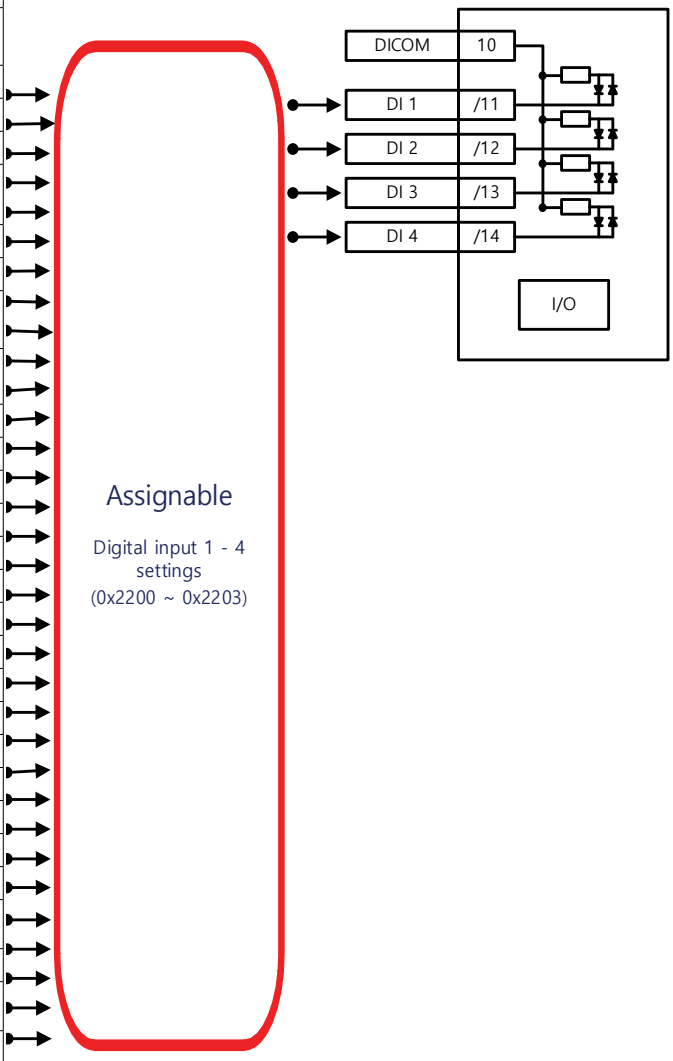
Input	Parameter Object	Default Function
DI1	0x2200	POT (0x01)
DI2	0x2201	NOT (0x02)
DI3	0x2202	HOME (0x03)
DI4	0x2203	STOP (0x04)



Digital Input Codes

See sections 2.4.1 and 5.1.1 in the User Manual for more information about DI codes. Drive CM is the easiest way to edit the DI codes - including changing the NO and NC settings. Either enter values directly into Parameters 0x2200–0x2203 (Object Dictionary's I/O tab) or use the pulldown lists after selecting the Digital Input icon.

Parameter Setting		Code	Function
NC	NO		
0x8000	0x0000	Not assigned	Input not used
0x8001	0x0001	POT	Prohibit forward rotation (CCW limit)
0x8002	0x0002	NOT	Prohibit reverse rotation (CW limit)
0x8003	0x0003	HOME	Origin sensor
0x8004	0x0004	STOP	Stop servo
0x8005	0x0005	PCON	Operate P control
0x8006	0x0006	GAIN2	Switch between Gain1 and Gain2
0x8007	0x0007	P_CL	Forward torque limit
0x8008	0x0008	N_CL	Reverse torque limit
0x8009	0x8009	PROBE1	Probe signal stores position value (1)
0x800A	0x000A	PROBE2	Probe signal stores position value (2)
0x800B	0x000B	EMG	Emergency stop
0x800C	0x000C	A_RST	Reset alarm
0x800D	0x000D	NA	NA
0x800E	0x000E	NA	NA
0x800F	0x000F	SV_ON	Servo ON
0x8010	0x0010	START	Operation start
0x8011	0x0011	PAUSE	Pause
0x8012	0x0012	REGT	Post-sensor operation
0x8013	0x0013	HSTART	Origin operation start
0x8014	0x0014	ISEL0	Position selection 0
0x8015	0x0015	ISEL1	Position selection 1
0x8016	0x0016	ISEL2	Position selection 2
0x8017	0x0017	ISEL3	Position selection 3
0x8018	0x0018	ISEL4	Position selection 4
0x8019	0x0019	ISEL5	Position selection 5
0x801A	0x001A	ABSRQ	Request for absolute position data
0x801B	0x001B	JSTART	Jog operation
0x801C	0x001C	JDIR	Select jog rotation direction
0x801D	0x001D	PCLR	Clear input pulse
0x801E	0x001E	AOVR	Select speed override
0x801F	0x001F	INHIB	Command pulse inhibit
0x8020	0x0020	SPD1	Multi-speed 1
0x8021	0x0021	SPD2	Multi-speed 2
0x8022	0x0022	SPD3	Multi-speed 3
0x8023	0x0023	MODE	Change operation mode

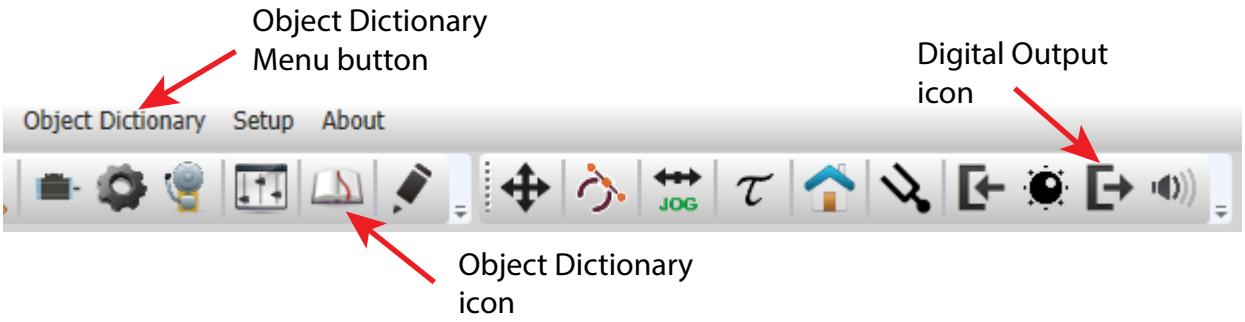


Digital Outputs

Use the following parameters to configure Digital Output functionality or use the Digital Output window in Drive CM directly to make changes. All four digital outputs are configurable.

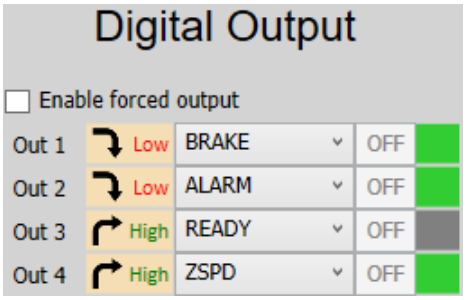
The software provides a very easy way to change the DO functions using the digital output icon (the quickest and easiest method of configuration). Here you can also force the outputs individually by checking the "Enable forced output" check box. Alternatively, you can open the parameter object dictionary using the Object Dictionary menu button or the Object Dictionary icon.

NOTE: When making these changes while the software is connected to the drive the change will take effect immediately, there is no "Are you sure?" warning. Example: Changing the BRAKE output from active low to active high (see the red "Low" and green "High" text in the in the Digital Output image below) will immediately change the physical state of the output.



Digital Output Functions

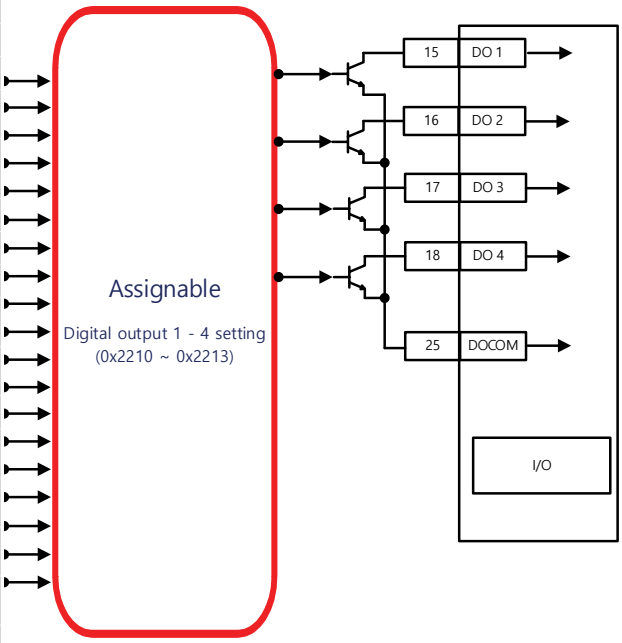
Input	Parameter Object	Default Function
DO1	0x2210	BRAKE (0x01)
DO2	0x2211	ALARM (0x02)
DO3	0x2212	READY (0x03)
DO4	0x2213	ZSPD (0x04)



Digital Output Codes

See section 2.5.1 and 5.1.2 in the user manual for more information about DO codes. Drive CM is the easiest way to edit the DO Codes, including changing the NO and NC settings. Either enter values directly into Parameters 0x2210–0x2213 (Object Dictionary's I/O tab) or use the pulldown lists after selecting the Digital Output icon.

Parameter Setting		*Code*	*Function*
NC	*NO*		
0x8000	0x00	Not assigned	Input not used
0x8001	0x01	BRAKE	Brake- (ON when SVON is off)
0x8002	0x02	ALARM	Servo alarm
0x8003	0x03	RDY	Servo ready
0x8004	0x04	ZSPD	Zero speed reached
0x8005	0x05	INPOS1	"Complete position reach 1"
0x8006	0x06	TLMT	Limit Torque is enabled
0x8007	0x07	VLMT	Speed Limit is enabled
0x8008	0x08	INSPD	Velocity is reached
0x8009	0x09	WARN	Servo warning
0x800A	0x0A	TGON	"Output rotation detection"
0x800B	0x0B	INPOS2	"Complete position reach 2"
0x0C–0x0F		Not assigned	Input not used
0x8010	0x10	ORG	Homing operation complete
0x8011	0x11	EOS	Origin coordinate complete
0x8012	0x12	IOUT0	Drive coordinate output 0
0x8013	0x13	IOUT1	Drive coordinate output 1
0x8014	0x14	IOUT2	Drive coordinate output 2
0x8015	0x15	IOUT3	Drive coordinate output 3
0x8016	0x16	IOUT4	Drive coordinate output 4
0x8017	0x17	IOUT5	Drive coordinate output 5

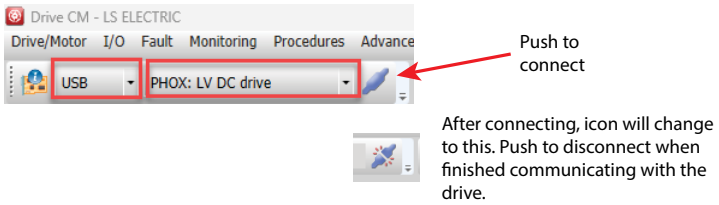
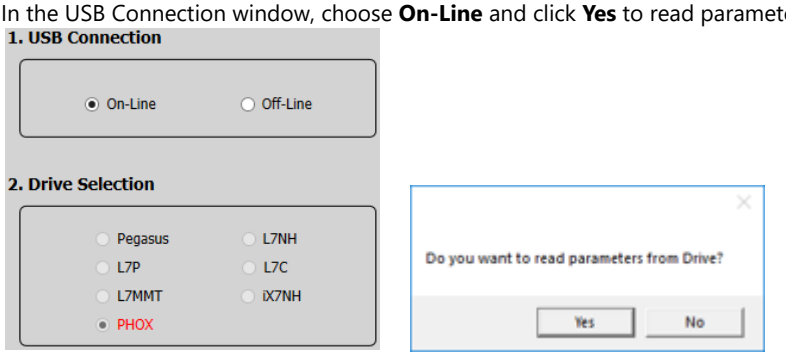


Index Position Mode

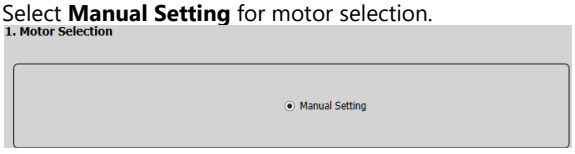
Indexing Position Mode using the Setup Wizard for Simple Motion Commissioning

Below is a simple walk through of minimal settings to establish an index application. Other object configuration settings may be required for your specific needs. See the User Manual for details

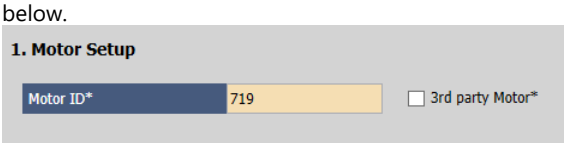
Step 1: Drive Selection

	Substep	Task
Index Mode Step 1	A	Using a standard USB A to USB mini-B cable (such as SV2-PGM-USB15, MOSAIC-CSU, etc.), connect the PC to the Drive.
	B	Start Drive CM software.
	C	Select **PHOX: LV DC Drive** and press the **Connect** button. The software should begin to communicate with the drive. A green flashing square should appear in the bottom left corner of the screen indicating comms traffic. 
	D	Click on **Setup Wizard**.
	E	In the USB Connection window, choose **On-Line** and click **Yes** to read parameters from the drive.  If the **On-Line** radio button is not available and greyed out, click on **Setup Wizard** again. This should restart the Setup Wizard and enable the button. Click **On-Line** and **Yes** to read drive parameters.
	F	Click **Next**.

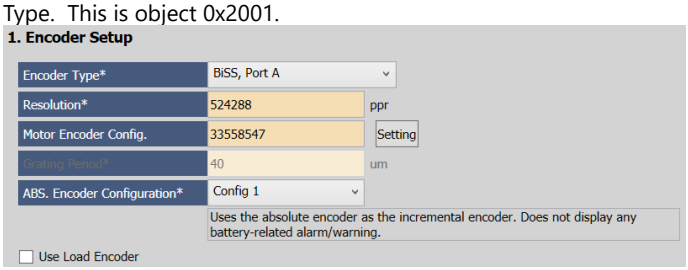
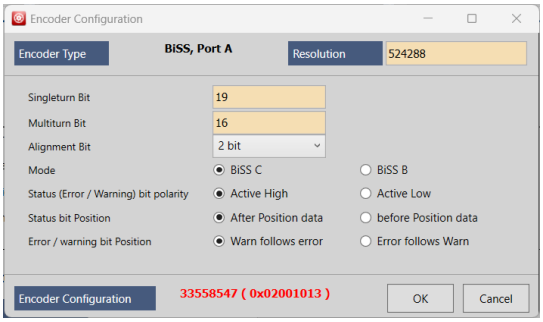
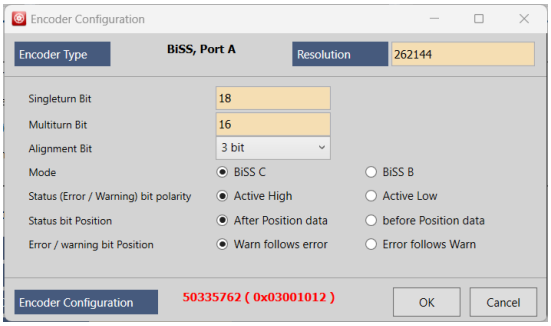
Step 2: Motor/Encoder Selection

	Substep	Task
Index Mode Step 2	A	Select **Manual Setting** for motor selection. 
	B	Click **Next**.

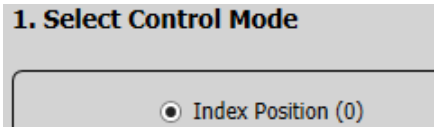
Step 3: Motor Setup

	Substep	Task
Index Mode Step 3	A	Input the motor ID attached to the drive. This is located on the motor nameplate or refer to the table below.  **Phox Motor** / **ID** APMC-FAL01AM8N-8-AD, APMC-FAL01AM8N2-8-AD: 705 APMC-FBL01AMK-8-AD, APMC-FBL01AMK2-8-AD: 717 APMC-FBL02AMK-8-AD, APMC-FBL02AMK2-8-AD: 718 APMC-FBL03AMK-8-AD, APMC-FBL03AMK2-8-AD: 719 *NOTE: The number will appear red when first typed in. Press Enter to apply the new value. The number will then turn black to signify it has been applied.*
	B	Click **Next**.

Step 4: Encoder Setup

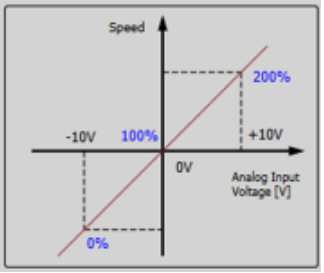
	Substep	Task
Index Mode Step 4	A	If using a standard LS Electric low voltage motor (APMC-xxxxxx-8-AD, choose **BiSS, Port A** for Encoder Type. This is object 0x2001. 
	B	If using a 40mm 100W FAL motor (APMC-FAL01AM8Nx-8-AD) choose a Resolution (0x2002) of 262144. This is the 18-bit encoder. If using a 60mm FBL motor (APMC-FBLxxxxxx-8-AD) choose a Resolution (0x2002) of 524288. This is the 19-bit encoder.
	C	Open the **Motor Encoder Configuration** by clicking on the **Setting** button. For a detailed explanation on this window, please reference "Encoder Configuration Explanation" on page 74.
	D	For a 19-bit encoder configuration, choose the following settings: • Singleturn bit=19 • Multiturn bit=16 • Alignment bit=2 bits This will put a value of 33558547 (0x02001013) into object 0x202A (Motor Encoder Configuration).  For these motors (60mm FBL): • APMC-FBL01AMK-8-AD • APMC-FBL01AMK2-8-AD • APMC-FBL02AMK-8-AD • APMC-FBL02AMK2-8-AD • APMC-FBL03AMK-8-AD • APMC-FBL03AMK2-8-AD
	E	For an 18-bit encoder configuration, choose the following settings. • Singleturn bit=18 • Multiturn bit=16 • Alignment bit=3 bits This will put a value of 50335762 (0x03001012) into object 0x202A (Motor Encoder Configuration).  For these motors (40mm FAL): • APMC-FAL01AM8N-8-AD • APMC-FAL01AM8N2-8-AD
	F	Select the behavior for the absolute encoder configuration (object 0x2005). If not using the battery backup for absolute mode, then choose configuration 1. • Config 0: Uses the absolute encoder as the absolute encoder. Uses the multi-turn data. • Config 1: Uses the absolute encoder as the incremental encoder. Does not display any battery-related alarm/warning. • Config 2: Uses the absolute encoder as the absolute encoder. Uses single-turn data only. **Note:** Load Encoder is for the secondary encoder input (Encoder B).
	G	Click **Next**.

Step 5: Control Mode Selection

Index Mode Step 5	*Substep*	*Task*
	A	On the **Select Control Mode** screen, select **Index Position** for Control Mode (Object 0x3000). 
	B	Click **Next**.

Step 6: Reference Input Settings

Index Mode Step 6

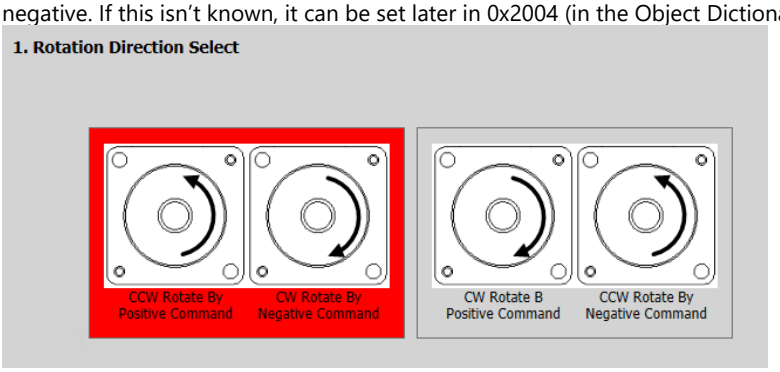
Substep	Task
A	Select Linear or Rotary axis. **Linear Axis** is selected for this example. (Object 0x3001). **1. Index Configuration** Coordinate Select* — Rotary Axis Start Index Number — OFF, Not Used Index Buffer Mode — Single buffer set IOUT Configuration — 0
B	Set **Start Index Number** (Object 0x3008). This allows you to select index numbers 0-63 for which index number will be called when the START signal is applied. Setting this parameter to a value of 64 allows you to use the digital inputs for index selection using a binary pattern (ISEL0~ISEL5). Option 64 is selected for this example. There are only 4 digital inputs so not all 6 index selection bits can be selected. All index selections are available (0-63). Configuring different ISELx assignments to inputs will allow you to choose any of the 0-63 indexes. *NOTE: The Start Index Number (0x3008) MUST be set to 64 (OFF, Not Used) if you want to test different indexes using DriveCM.*
C	Set **Index Buffer Mode** (Object 0x3009) allows you to trigger the START signal once or twice. In this example, **Single buffer set** is selected. [AutomationDirect advises using **Single buffer set**]
D	Set **IOUT Configuration** (Object 0x300A). For a full description of each of these bit selections please see object 0x3004 details in the PHOX user manual. IOUT Configuration — 0
E	To slightly adjust or override command speed, select the **Analog Velocity Override Function** (only available in **Index Mode**). This will allow the -10V to +10V analog velocity input scale to override the commanded velocity 0% to 200%. See Section 4.4 in the User Manual for more details. If using the Analog Input as a velocity override be sure to change 0x222B=3. **2. Analog Velocity Override** Use Analog Velocity Override Function 
F	Click **Next**.

Bit	Function	Value
0	IOUT Config.	0 : Completed Index No. output 1 : Processing Index No. output
1	Index Start	0 : Index Start signal recognizes only positive edges 1 : Index Start signal recognizes positive/negative edges
2	Jog Select	0 : Use JSTART / JDIR 1 : Use PJOG / NJOG
3	Velocity Override	0 : Applied to each index section. 1 : Applied to real time.
4	Registration Move Config.	0 : Absolute/relative operation depending on registration type 1 : Absolute/relative operation depending on 0x300B
5	Use Software Position Limit in Velocity	0 : Used 1 : Not Used
6	ORG Output	0 : ORG is maintained even when SVOFF. 1 : ORG OFF when SV OFF after completion of origin operation.

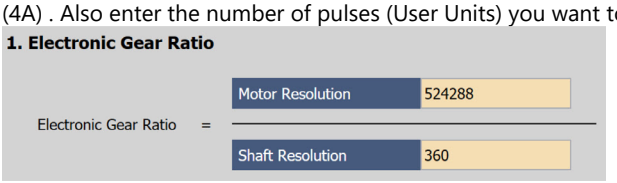
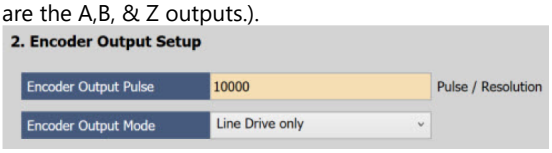
NOTE: This example shows a Linear Axis setup. If you have a Rotary Application, the following settings are critical:

1. *Coordinate Select in step 6A above (0x3001) = Rotary Axis*
2. *E-Gear Numerator (0x6091:1) = 262144 (2^{18} bit encoders); 524288 (2^{19} bit encoders)*
3. *E-Gear Denominator (0x6091:2) = desired User Units per motor rotation*
4. *Modulo Factor (0x240C) = "Rollover" for the machine. Use Units equal to one machine revolution (i.e. if using a 10:1 gearbox, the Module would be 10x the E-Gear Denominator)*

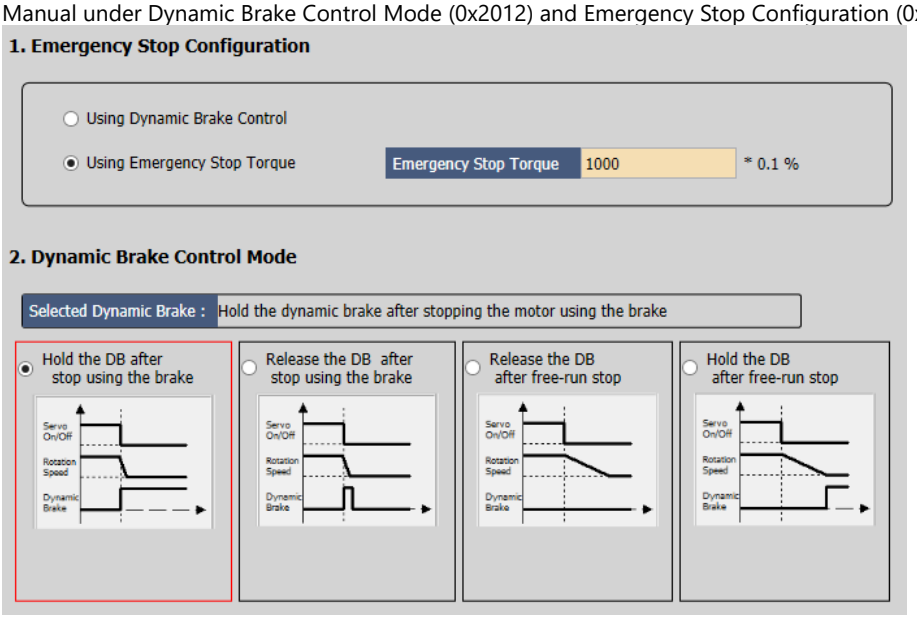
Step 7: Set Rotation Direction

	Substep	Task
Index Mode Step 7	A	Click **Next** to set the **Rotation Direction**. This sets which motor direction is considered positive or negative. If this isn't known, it can be set later in 0x2004 (in the Object Dictionary \ Basic tab). 
	B	Click **Next**.

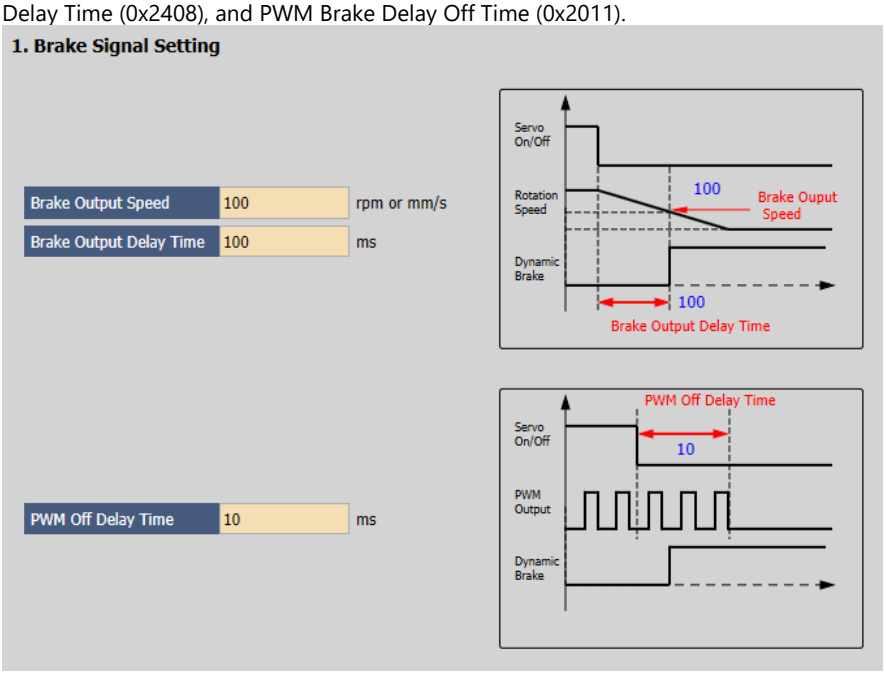
Step 8: Set Electronic Gear Ratio

	Substep	Task
Index Mode Step 8	A	On the Electronic Gear Ratio screen, enter the resolution of the motor's encoder (18-bit=262144, 19-bit=524288 ppr)(Object 6091:1). This value should be the same number entered in "Encoder Setup" step (4A) . Also enter the number of pulses (User Units) you want to equal one shaft rotation (Object 6091:2). 
	B	If no gear ratios are changed (all numerators and denominators have default values=1), then a position command of 262144 (18-bit) or 524288 (19-bit) user units (UU) will result in one motor shaft revolution. This is because the LS Electric APM and APMC motors that are compatible with the PHOX drive and sold by Automation Direct have 18-bit or 19-bit bit serial encoders (18 bits=262144, 19 bits=524288 pulses/rev). To convert this into an easier number to use for positioning adjust the Electronic Gear ratios in step C.
	C	If desired, set the Electronic Gear ratio so that one motor revolution = 360 user units (360 user units/rev will be used later in the Index example). Example for a 19-bit encoder: To do this, set the Electronic Gear numerator to the 19-bit encoder value (encoder pulses per motor rev) and set the denominator to your desired User Units/rev. • Set Motor Resolution 0x6091:01 = 524288 (encoder pulses per motor rev) • Set Shaft Revolution 0x6091:01 = 360 (user units per motor rev) Now all Index positions, speeds, accelerations, and decelerations will be referenced in degrees. $\text{Actual Move Distance} = 720 \text{ user units} \times \frac{524288 \text{ encoder pulses}}{\text{motor rev}} \times \frac{1 \text{ motor rev}}{360 \text{ user units}} = 2 \times 524288 \text{ encoder pulses}$ (which is 2 motor revs) **NOTE:** You will probably want more resolution than 360 user units per motor rev. The basic rule of thumb is: • Set Motor Resolution = 524288 for a 19-bit encoder • Set Shaft Revolution = your desired pulses per motor rev.
	D	[This step is performed on the same screen with Electronic Gear Ratio] Configure the Encoder Output signal if desired. If the definition isn't known, the Encoder Output can be configured later with Encoder Output Pulse (0x3006). Encoder Output Mode (0x3007) cannot be changed. The encoder output on the PHOX drive only supports Line Driver type. Pins 19–24 on the I/O connector are the A,B, & Z outputs.). 
	E	Click **Next**.

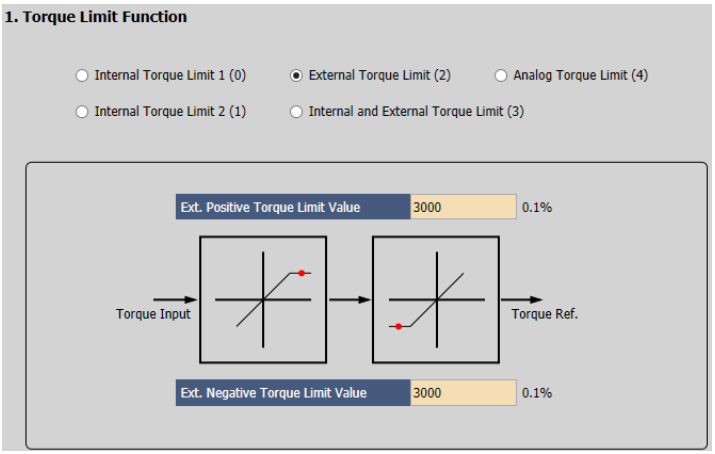
Step 9: Set Emergency Stop and Dynamic Brake Control

	Substep	Task
Index Mode Step 9	A	For initial setup and testing, choose the defaults for these settings on the **Emergency Stop Configuration** and **Dynamic Brake Control Mode** screen. More information can be found in the User Manual under Dynamic Brake Control Mode (0x2012) and Emergency Stop Configuration (0x2013). 
	B	Click **Next**.

Step 10: Set Brake Signal Setting

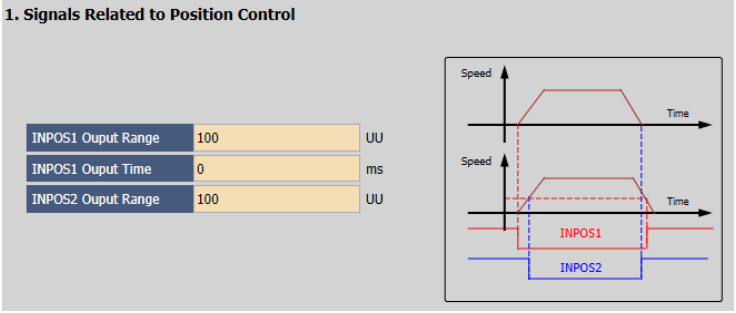
	Substep	Task
Index Mode Step 10	A	For initial setup and testing, choose the defaults for these settings on the **Brake Signal Setting** screen. More information can be found in the User Manual under Brake Output Speed (0x2407), Brake Output Delay Time (0x2408), and PWM Brake Delay Off Time (0x2011). 
	B	Click **Next**.

Step 11: Set the Torque Limit Function

Index Mode Step 11	*Substep*	*Task*
	A	Set the **Torque Limit Function**.  Select a method for limiting the torque (0x2110) applied to the load while the motor is trying to attain commanded speed and final position. For initial testing and setup, a value less than max torque is recommended. The above example sets the torque limits to 50% of system **rated** torque. Rated torque is the motor's nameplate torque. These values can be increased after initial commissioning by adjusting 0x60E0 and 0x60E1 in the **Object Dictionary \ CIA 402** tab. Default values are 3000 (300%).
	B	Click **Next**.

Option	*Description*
Internal Torque Limit 1 (0)	• Uses the value of 0x60E0 as the Fwd direction torque limit • Uses the value of 0x60E1 as the Rev direction torque limit
Internal Torque Limit 2 (1)	Uses a constant 300% of rated motor torque as the Fwd and Rev torque limits
External Torque Limit (2)	• Uses the value of 0x2111 as the Fwd direction torque limit • Uses the value of 0x2112 as the Rev direction torque limit
Internal and External Torque Limit (3)	• Uses the value of 0x60E0 when Digital Input P_CL is on and the value of 0x2111 when Digital Input P_CL is off for the Fwd direction torque limit • Uses the value of 0x60E1 when Digital Input N_CL is on and the value of 0x2112 when Digital Input N_CL is off for the Rev direction torque limit
Analog Torque Limit (4)	Uses the analog value that is supplied to pin 6 and 7 of CN1 when the analog input is not used for velocity commands. Set 0x222B=1

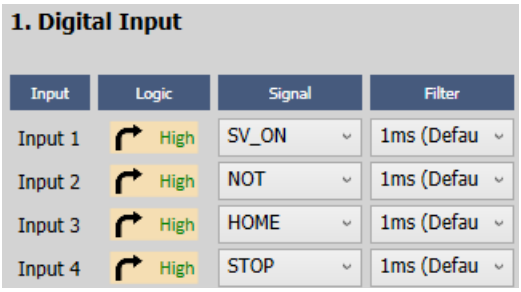
Step 12: Set Signals Related to Position Control

Index Mode Step 12	*Substep*	*Task*
	A	Configure the "In Position" signals on the **Signals Related to Position Control** screen if you will use Digital Outputs INPOS1 and INPOS2. 
	B	Click **Next**.

Step 13: Set the I/O Signal Setting

Index Mode Step 13

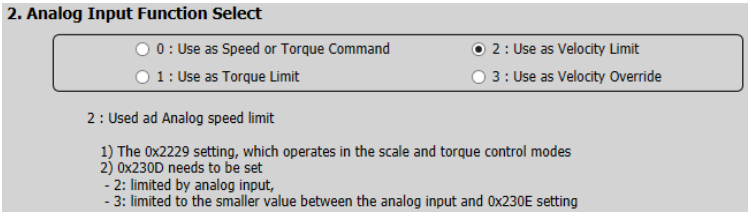
Substep	Task
A	Configure Inputs 1 through 4 as shown below on the **Digital Input** screen. Configure additional inputs as needed for your application. The filter column allows for filtering out EMI and false triggering. 1 millisecond is the default and multiple processor cycles can be added to the filter time. 1 cycle = 125 microseconds.



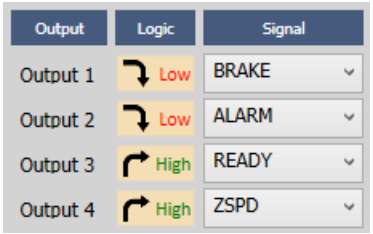
Below is a binary map example of how the Index Select digital inputs can select indexes using ISEL0 through ISEL3.

Index No.	*ISEL Input Signal*			
	ISEL3	*ISEL2*	*ISEL1*	*ISEL0*
0	X	X	X	X
1	X	X	X	O
2	X	X	O	X
3	X	X	O	O
4	X	O	X	X

B	To use an analog function with the one analog input on the drive, choose an option for the application. Certain analog input functions will only work with certain control modes. See the following parameters for more information. 0x222B, 0x2229, 0x230D, 0x221C, and 0x2110.

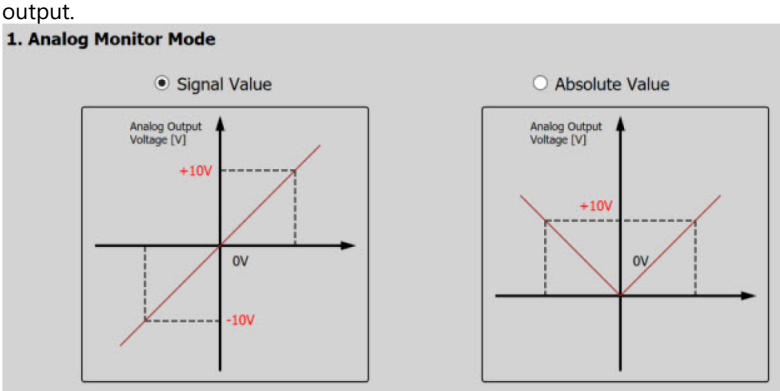
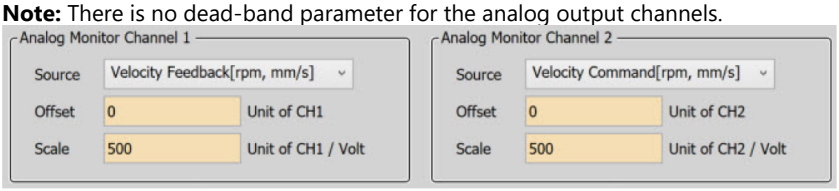


C	Click **Next** to Go to **Digital Output** in the Setup Wizard.
D	Configure Outputs 1 through 4 as shown below. If other DO functions are needed for the application then adjust as needed. The IOUT outputs will signal the Index that is currently in operation (in binary code).

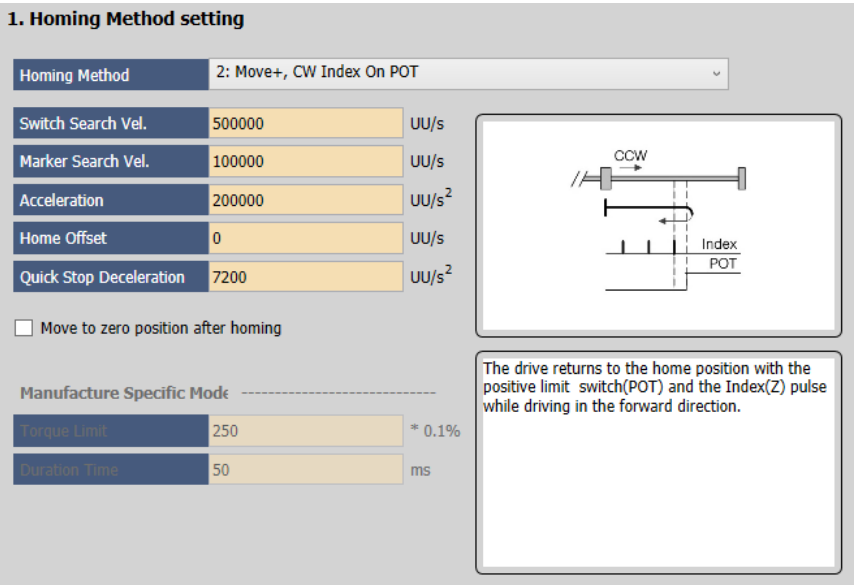


E	Click **Next**.

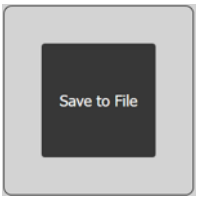
Step 14: Set the Analog Monitor Mode

	Substep	Task
Index Mode Step 14	A	Objects 0x2220–0x2226 are used to configure Ch1 and Ch2 of the analog output monitoring terminals. There are 22 different drive status variables you can monitor using the analog output pins. See section 2.4.4 in the User Manual for more details. Decide below whether to have the voltage output -10V to +10V or have both positive and negative variable information represented in an absolute (positive only) voltage output. 
	B	Choose what variable (source) you want to monitor. The offset is just the shift, positive (up) or negative (down), from 0 units desired. Next set the scale. This is how many units of the selected variable is represented per 1 volt out of Ch1 or Ch2. Example below would represent 500rpms of the motor for every 1 volt. **Note:** There is no dead-band parameter for the analog output channels. 
	C	Click **Next**.

Step 15: Set Homing Method Setting

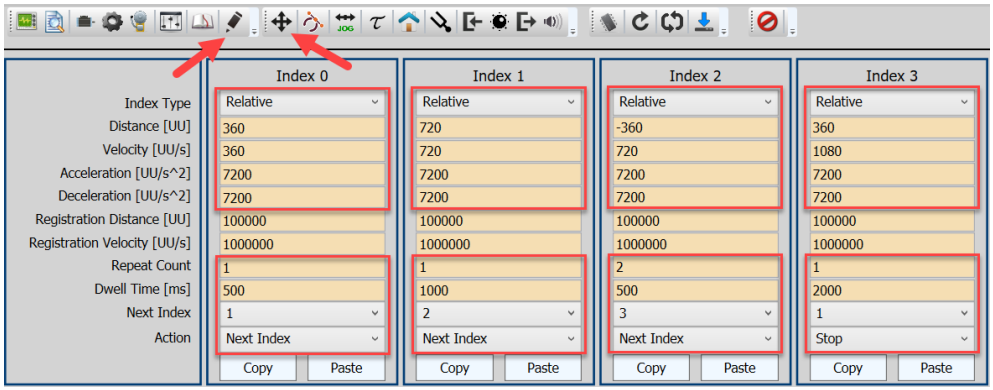
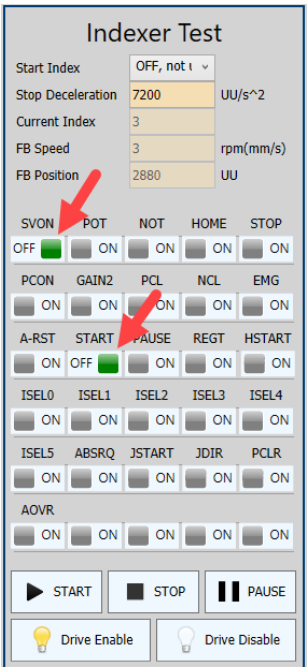
	Substep	Task
Index Mode Step 15	A	On the **Homing Method Setting** screen, select the Homing method appropriate for your application. For initial setup and testing, choose the defaults for these settings. Refer to Chapter 4.6 Homing in the User Manual for more details. 
	B	Click **Next**.

Step 16: Save Your Configuration

Index Mode Step 16	*Substep*	*Task*
	A	Select **Save to File** to save the configuration file to your PC. 
	B	Select **Write to Drive** to download the configuration to the drive. The drive **MUST NOT** be enabled during download. The software will not acknowledge that certain parameters were not changed, so ensure that the drive is not enabled before pressing **Write to Drive**. This **Write to Drive** button also saves the settings to memory. 
	C	After download is complete either power cycle the drive (ensuring the LED display turns off) or click on the **Software Reset** icon in the upper toolbar. 

Step 17: Open Index Edit and Index Test Windows

Index Mode Step 17

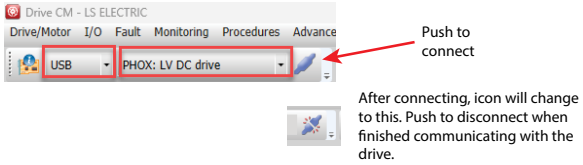
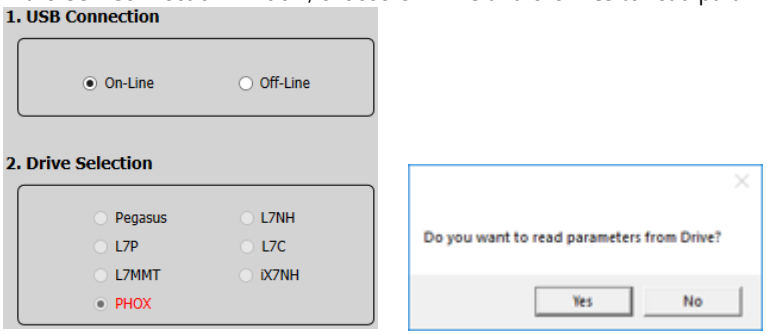
Substep	*Task*
A	Click the **Index Edit** button on the Drive CM toolbar. 
B	Configure Index 0, Index 1, Index 2, and Index 3 per the image below:  After each entry the text will turn red indicating it has not been downloaded to the drive. Press the **Enter** key after typing a new value to write this value to the drive. The value will turn black indicating it has been downloaded. This will only push the value to the drive's RAM (volatile memory). You must still press the **Save Index to EEPROM** button for the settings to survive a power cycle.
C	Click the **Indexer Test** button on the toolbar.  The Indexer Test window will open. 
D	Switch **SVON** to **ON**.
E	Switch **START** to **ON**. Sometimes the START button must be pressed twice to initiate an index.
F	Index 0 will begin executing (if not, select Start Index = "0" at the top of Indexer Test). As the drive cycles through the index moves you can monitor the current index number in the **Index Tester** window (Current Index) or by viewing the status of IOUT0 through IOUT2.
G	Index 2 will execute twice (because Repeat Count = 2) and after Index 3 is complete the Index sequence will stop (because Action = Stop). Index Position Mode Commissioning is now complete.

Pulse Input Position Mode

Pulse Input Position Mode Using the Setup Wizard for Simple Motion Commissioning

Below is a simple walkthrough of minimal settings to establish a pulse input controlled application. Other object configuration settings may be required for your specific needs. See the User Manual for details

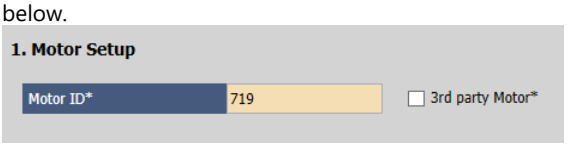
Step 1: Drive Selection

	Substep	Task
Pulse Mode Step 1	A	Using a standard USB A to USB mini-B cable (such as SV2-PGM-USB15, MOSAIC-CSU, etc.), connect the PC to the Drive.
	B	Start Drive CM software.
	C	Select **PHOX:LV DC Drive** and press the **Connect** button. The software should begin to communicate with the drive. A green flashing square should appear in the bottom left corner of the screen indicating comms traffic. 
	D	Click on **Setup Wizard**.
	E	In the USB Connection window, choose **On-Line** and click **Yes** to read parameters from the drive.  If the **On-Line** radio button is not available and greyed out, click on **Setup Wizard** again. This should restart the Setup Wizard and enable the button. Click **On-Line** and **Yes** to read drive parameters.
	F	Click **Next**.

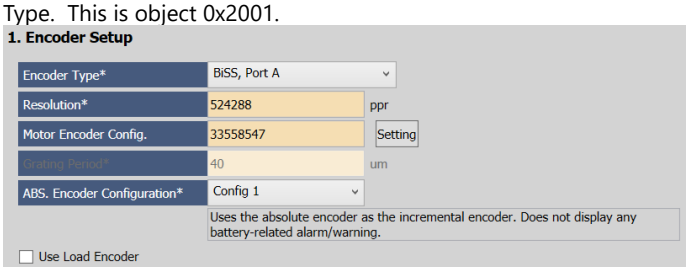
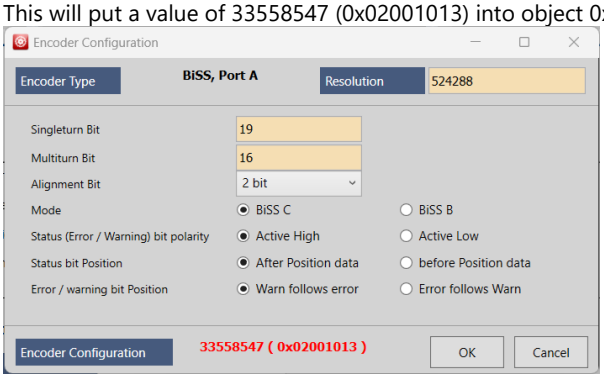
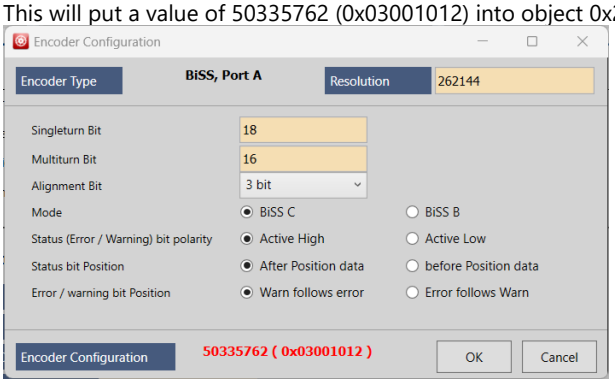
Step 2: Motor/Encoder Selection

	Substep	Task
Pulse Mode Step 2	A	Select **Manual Setting** for motor selection. 
	B	Click **Next**.

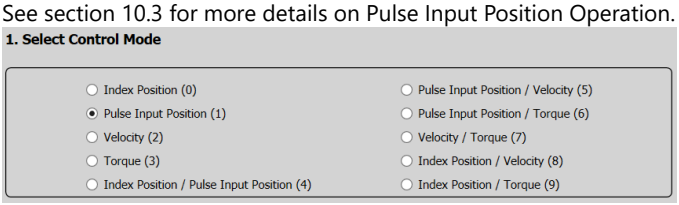
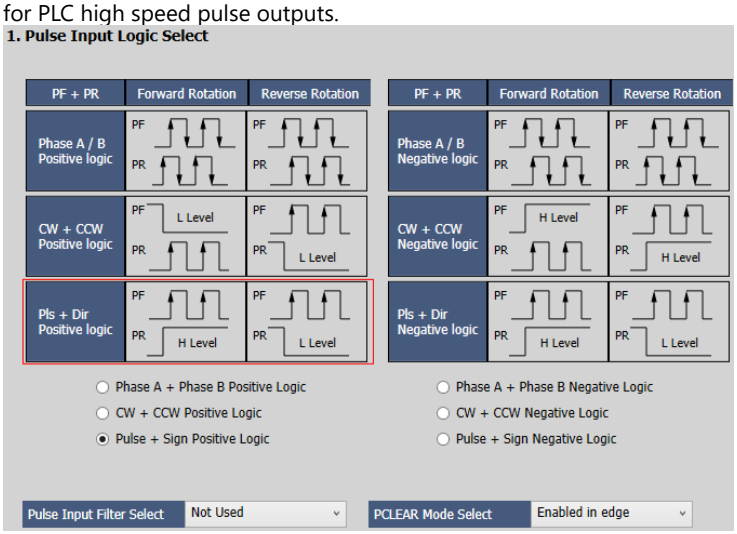
Step 3: Motor Setup

	Substep	Task
Index Mode Step 3	A	Input the motor ID attached to the drive. This is located on the motor nameplate or refer to the table below.  **Phox Motor** / **ID** APMC-FAL01AM8N-8-AD, APMC-FAL01AM8N2-8-AD: 705 APMC-FBL01AMK-8-AD, APMC-FBL01AMK2-8-AD: 717 APMC-FBL02AMK-8-AD, APMC-FBL02AMK2-8-AD: 718 APMC-FBL03AMK-8-AD, APMC-FBL03AMK2-8-AD: 719 *NOTE: The number will appear red when first typed in. Press Enter to apply the new value. The number will then turn black to signify it has been applied.*
	B	Click **Next**.

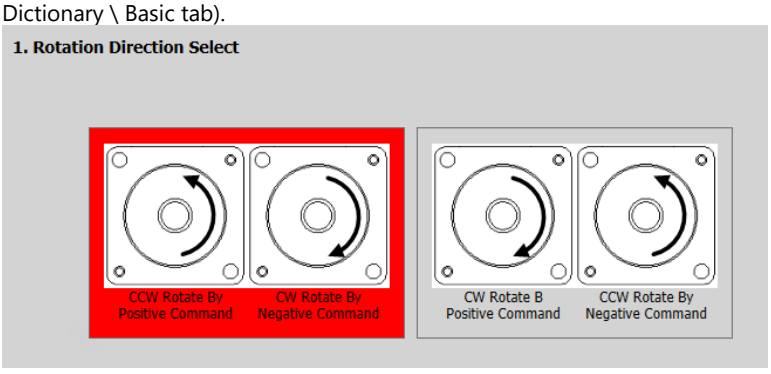
Step 4: Encoder Setup

	Substep	Task
Pulse Mode Step 4	A	If using a standard LS Electric low voltage motor (APMC-xxxxxx-8-AD, choose **BiSS, Port A** for Encoder Type. This is object 0x2001. 
	B	If using a 40mm 100W FAL motor (APMC-FAL01AM8Nx-8-AD) choose a Resolution (0x2002) of 262144. This is the 18-bit encoder. If using a 60mm FBL motor (APMC-FBLxxxxxx-8-AD) choose a Resolution (0x2002) of 524288. This is the 19-bit encoder.
	C	Open the **Motor Encoder Configuration** by clicking on the **Setting** button. For a detailed explanation of this window, please refer to "Encoder Configuration Explanation" on page 74.
	D	For a 19-bit encoder configuration, choose the following settings: • Singleturn bit=19 • Multiturn bit=16 • Alignment bit=2 bits This will put a value of 33558547 (0x02001013) into object 0x202A (Motor Encoder Configuration). 
	E	For an 18-bit encoder configuration, choose the following settings. • Singleturn bit=18 • Multiturn bit=16 • Alignment bit=3 bits This will put a value of 50335762 (0x03001012) into object 0x202A (Motor Encoder Configuration). 
	F	Select the behavior for the absolute encoder configuration (object 0x2005). If not using the battery backup for absolute mode, then choose configuration 1. • Config 0: Uses the absolute encoder as the absolute encoder. Uses the multi-turn data. • Config 1: Uses the absolute encoder as the incremental encoder. Does not display any battery-related alarm/warning. **Note:** Load Encoder is for the secondary encoder input (Encoder B).
	G	Click **Next**.

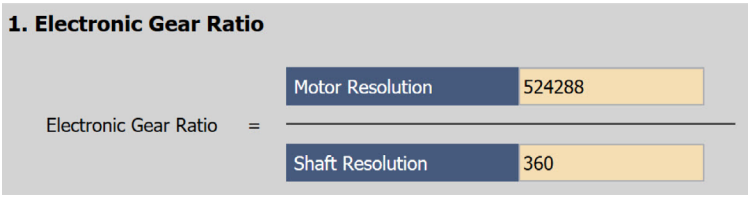
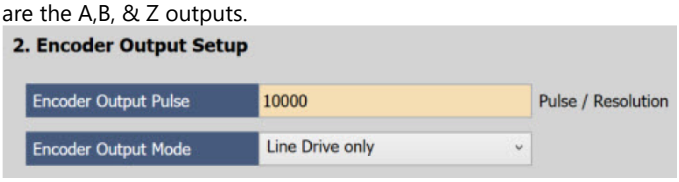
Step 5: Control Mode Selection

	Substep	Task
Pulse Mode Step 5	A	On the **Select Control Mode** screen, select **Pulse Input Position (1)** for Control Mode (Object 0x3000). See section 10.3 for more details on Pulse Input Position Operation.  Click **Next**.
	B	On the **Pulse Input Logic Select** screen, select the type of pulse train you want to use from the host controller or PLC. **Pulse + Sign Positive Logic** is selected in the image below. This is the typical setting for PLC high speed pulse outputs.  For the PHOX drive CN1 connector, the pulse inputs terminate as follows: • Pulse (or CW) signal will terminate to pin 1 PF+ and pin 2 PF- • Sign (or CCW) signal will terminate to pin 3 PR+ and pin 4 PR- See section 2.4.5 of the User Manual for more details (and how to connect Line Driver high speed pulses).
	C	For Pulse Input Filter Select (0x3004) and PCLEAR Mode Select (0x3005), use the default settings for initial setup/testing.
	D	Click **Next**.

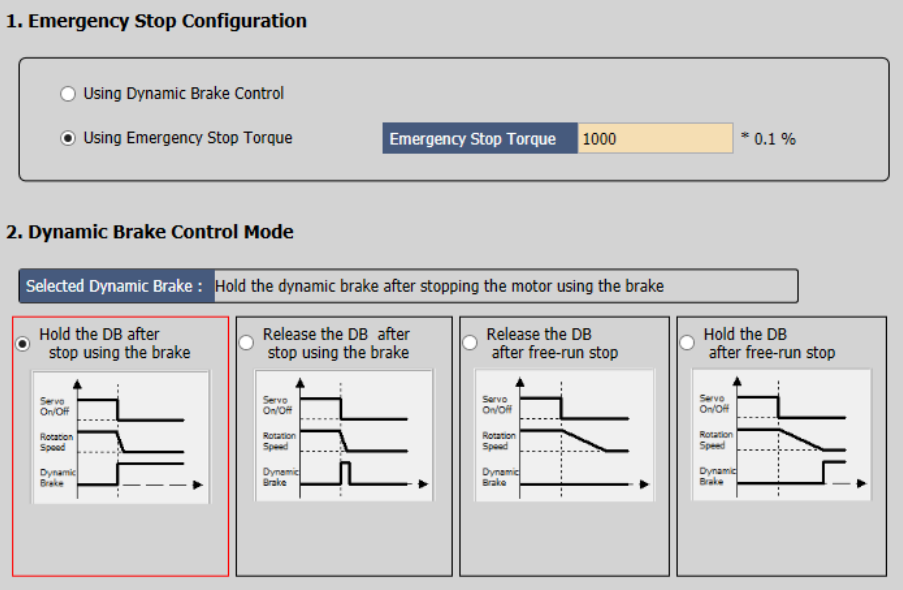
Step 6: Set Rotation Direction

	Substep	Task
Pulse Mode Step 6	A	Set rotation direction on the **Rotation Direction Select** screen. This sets which motor direction is considered positive or negative. If this isn't known, it can be set later in 0x2004 (in the Object Dictionary \ Basic tab). 
	B	Click **Next**.

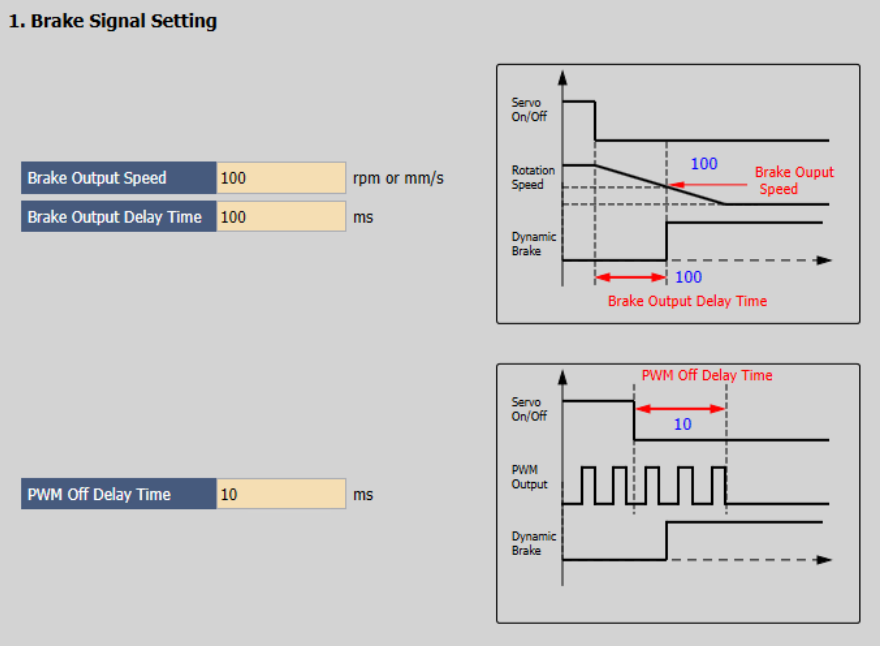
Step 7: Set Electronic Gear Ratio

	Substep	Task
Pulse Mode Step 7	A	On the Electronic Gear Ratio screen, enter the resolution of the motor's encoder (18-bit=262144 or 19-bit=524288 ppr)(Object 6091:1). This value should be the same number entered in "Encoder Setup" step (4A). Also enter the number of pulses (User Units) you want to equal one shaft rotation (Object 6091:2). 
	B	If no gear ratios are changed (all numerators and denominators have default values=1), then a position command of 262144 (for 18-bit) or 524288 (for 19-bit) user units (UU) will result in one motor shaft revolution. This is because the LS Electric APM and APMC motors that are compatible with the PHOX drive and sold by Automation Direct have 18-bit or 19-bit serial encoders (18-bit=262144, 19i-bit=524288 pulses/rev). To convert this into an easier number to use for positioning adjust the Electronic Gear ratios in step C.
	C	If desired, set the Electronic Gear ratio so that one motor revolution = 360 user units (360 user units/rev will be used later in the Index example). Example for a 19-bit encoder: To do this, set the Electronic Gear numerator to the 19-bit encoder value (encoder pulses per motor rev) and set the denominator to your desired User Units/rev. • Set Motor Resolution 0x6091:01 = 524288 (encoder pulses per motor rev) • Set Shaft Revolution 0x6091:01 = 360 (user units per motor rev) Now all Index positions, speeds, accelerations, and decelerations will be referenced in degrees. $\text{Actual Move Distance} = 720 \text{ user units} \times \frac{524288 \text{ encoder pulses}}{\text{motor rev}} \times \frac{1 \text{ motor rev}}{360 \text{ user units}} = 2 \times 524288 \text{ encoder pulses}$ (which is 2 motor revs) **NOTE:** You will probably want more resolution than 360 user units per motor rev. The basic rule of thumb is: • Set Motor Resolution = 524288 • Set Shaft Revolution = your desired pulses per motor rev.
	D	[This is located on the same screen with Electronic Gear Ratio] Configure the Encoder Output signal if desired. If the definition isn't known, the Encoder Output can be configured later with Encoder Output Pulse (0x3006). Encoder Output Mode (0x3007) cannot be changed. The encoder output on the PHOX drive only supports Line Driver type. Pins 19–24 on the I/O connector are the A,B, & Z outputs. 
	E	Click **Next**.

Step 8: Set Emergency Stop and Dynamic Brake Control

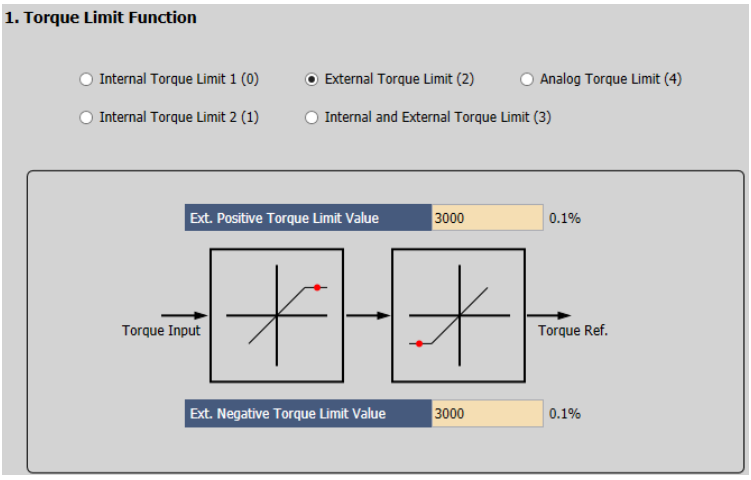
	Substep	Task
Pulse Mode Step 8	A	For initial setup and testing, choose the defaults for these settings on the **Emergency Stop Configuration** and **Dynamic Brake Control Mode** screen. More information can be found in the User Manual under Dynamic Brake Control Mode (0x2012) and Emergency Stop Configuration (0x2013). 
	B	Click **Next**.

Step 9: Set Brake Signal Setting

	Substep	Task
Pulse Mode Step 9	A	For initial setup and testing, choose the defaults for these settings on the **Brake Signal Setting** screen. More information can be found in the User Manual under Brake Output Speed (0x2407), Brake Output Delay Time (0x2408), and PWM Brake Delay Off Time (0x2011). 
	B	Click **Next**.

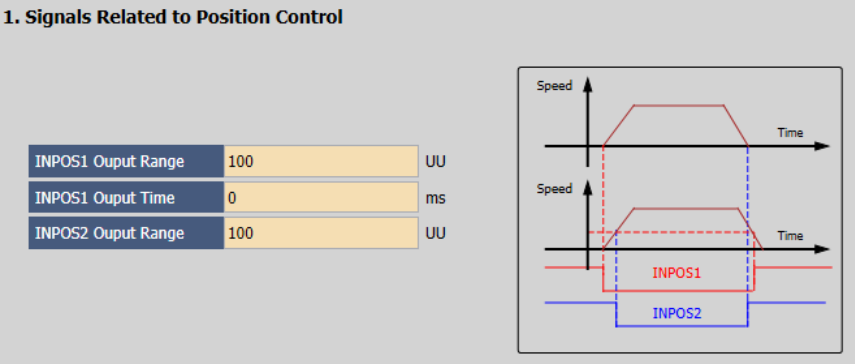
Step 10: Set Torque Limit Function

Pulse Mode Step 10

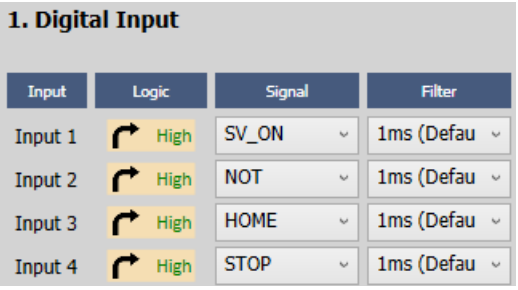
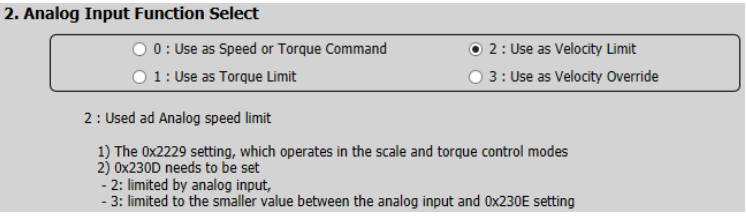
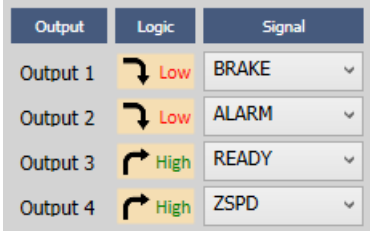
Substep	Task
A	Set the **Torque Limit Function**.  Select a method for limiting the torque (0x2110) applied to the load while the motor is trying to attain commanded speed and final position. For initial testing and setup, a value less than max torque is recommended. The above example sets the torque limits to 50% of system **rated** torque. These values can be increased after initial commissioning by adjusting 0x60E0 and 0x60E1 in the **Object Dictionary \ Index** tab. Default values are 3000 (300%).
B	Click **Next**.

Option	Description
Internal Torque Limit 1 (0)	• Uses the value of 0x60E0 as the Fwd direction torque limit • Uses the value of 0x60E1 as the Rev direction torque limit
Internal Torque Limit 2 (1)	Uses a constant 300% of rated motor torque as the Fwd and Rev torque limits
External Torque Limit (2)	• Uses the value of 0x2111 as the Fwd direction torque limit • Uses the value of 0x2112 as the Rev direction torque limit
Internal and External Torque Limit (3)	• Uses the value of 0x60E0 when Digital Input P_CL is on and the value of 0x2111 when Digital Input P_CL is off for the Fwd direction torque limit • Uses the value of 0x60E1 when Digital Input N_CL is on and the value of 0x2112 when Digital Input N_CL is off for the Rev direction torque limit
Analog Torque Limit (4)	Uses the analog value that is supplied to pin 6 and 7 of CN1 when the analog input is not used for velocity commands. Set 0x222B=1

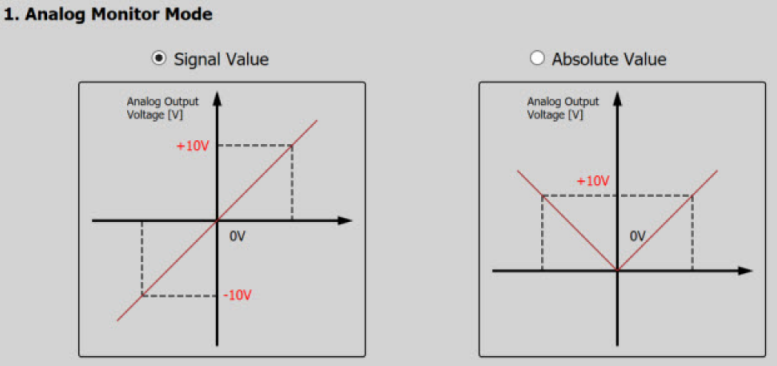
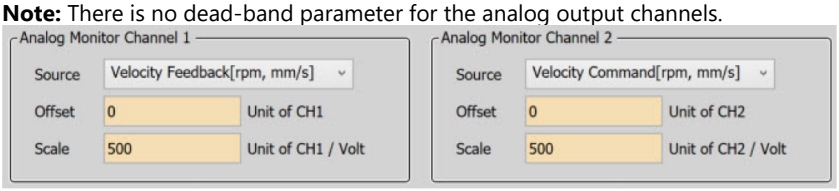
Step 11: Set Signals Related to Position Control

	Substep	Task
Pulse Mode Step 11	A	On the **Signals Related to Position Control** screen, configure the "In Position" signals if you will use Digital Outputs INPOS1 and INPOS2. 
	B	Click **Next**.

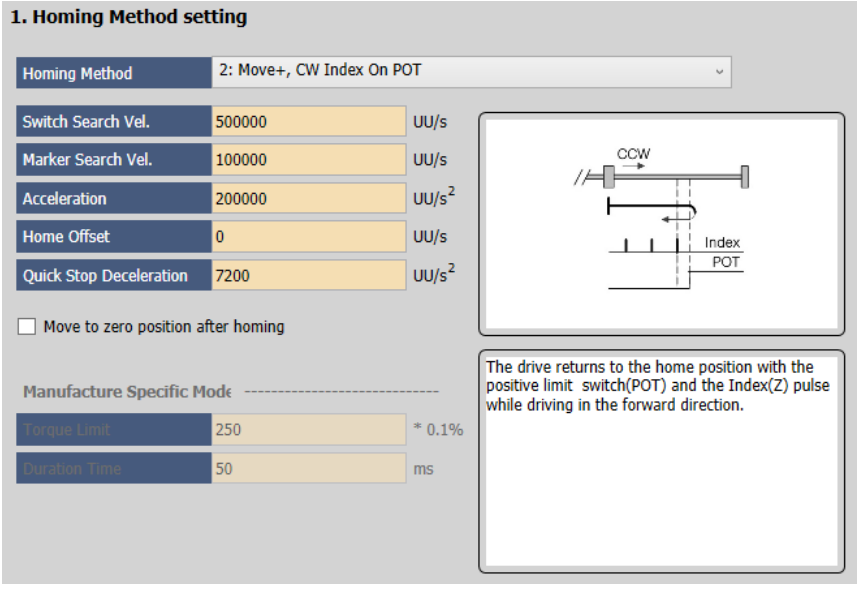
Step 12: Set the I/O Signal Setting

	Substep	Task
Pulse Mode Step 12	A	On the **Digital Input** screen, configure Inputs 1 through 4 as shown below. Configure additional inputs as needed for your application. The filter column allows for filtering out EMI and false triggering. 1 millisecond is the default and multiple processor cycles can be added to the filter time. 1 cycle = 125 microseconds. 
	B	To use an analog function with the one analog input on the drive, choose an option for the application. Certain analog input functions will only work with certain control modes. See the following parameters for more information. 0x222B, 0x2229, 0x230D, 0x221C, and 0x2110. 
	C	Click **Next** to go to **Digital Output** in the Setup Wizard.
	D	Configure Outputs 1 through 4 as shown below. If other DO functions are needed for the application then adjust as needed. 
	E	Click **Next**.

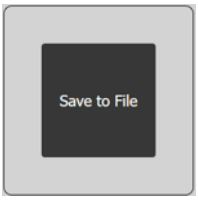
Step 13: Set the Analog Monitor Mode

	Substep	Task
Pulse Mode Step 13	A	Objects 0x2220–0x2226 are used to configure Ch1 and Ch2 of the analog output monitoring terminals. There are 25 different drive status variables you can monitor using the analog output pins. See section 2.4.4 in the User Manual for more details. Decide below whether to have the voltage output -10V to +10V or have both positive and negative variable information represented in an absolute (positive only) voltage output. 
	B	Choose what variable (source) you want to monitor. The offset is just the shift, positive (up) or negative (down), from 0 units desired. Next set the scale. This is how many units of the selected variable is represented per 1 volt out of Ch1 or Ch2. Example below would represent 500rpms of the motor for every 1 volt. **Note:** There is no dead-band parameter for the analog output channels. 
	C	Click **Next**.

Step 14: Set Homing Method Setting

	Substep	Task
Pulse Mode Step 14	A	On the **Homing Method Setting** screen, select the Homing method appropriate for your application. For initial setup and testing, choose the defaults for these settings. Refer to Chapter 4.6 Homing in the User Manual for more details. 
	B	Click **Next**.

Step 15: Save Your Configuration

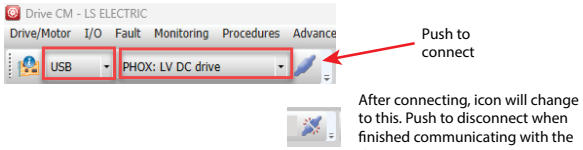
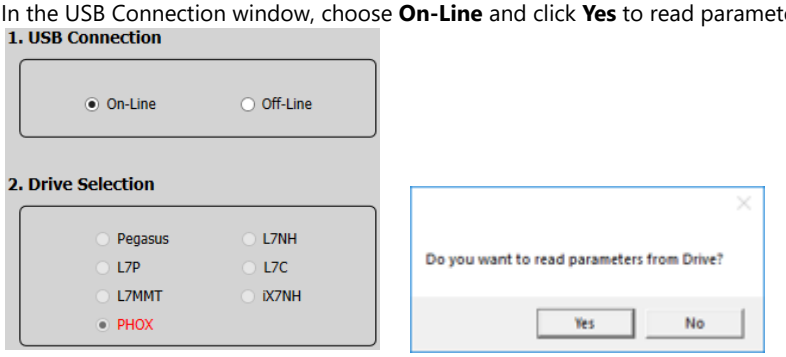
	Substep	Task
Pulse Mode Step 15	A	Select **Save to File** to save the configuration file to your PC. 
	B	Select **Write to Drive** to download the configuration to the drive. The drive **MUST NOT** be enabled during download. The software will not acknowledge that certain parameters were not changed, so ensure that the drive is not enabled before pressing **Write to Drive**. This **Write to Drive** button also saves the settings to memory. 
	C	After download is complete either power cycle the drive (ensuring the LED display turns off) or click on the **Software Reset** icon in the upper toolbar. 
	D	Pulse Input Position Mode Commissioning is now complete.

Velocity Mode

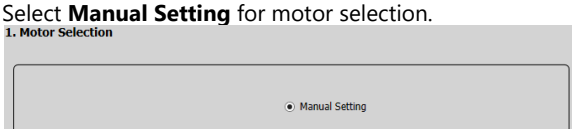
Velocity Mode (Speed Command) using the Setup Wizard for Simple Motion Commissioning

Below is a simple walk through to establish a speed application with a variable torque limit. Other object configuration settings may be required for your specific needs. See the user manual for details. The example below will allow the application to select between 8 preset speeds (saved in the drive) and/or the analog speed input. The changes are made by toggling 3 digital inputs: SPD1, SPD2, SPD3.

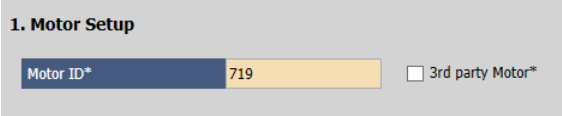
Step 1: Drive Selection

	Substep	Task
Velocity Mode Step 1	A	Using a standard USB A to USB mini-B cable (such as SV2-PGM-USB15, MOSAIC-CSU, etc.), connect the PC to the Drive.
	B	Start Drive CM software.
	C	Select **PHOX:LV DC Drive** and press the **Connect** button. The software should begin to communicate with the drive. A green flashing square should appear in the bottom left corner of the screen indicating comms traffic. 
	D	Click on **Setup Wizard**.
	E	In the USB Connection window, choose **On-Line** and click **Yes** to read parameters from the drive.  If the **On-Line** radio button is not available and greyed out, click on **Setup Wizard** again. This should restart the Setup Wizard and enable the button. Click **On-Line** and **Yes** to read drive parameters.
	F	Click **Next**.

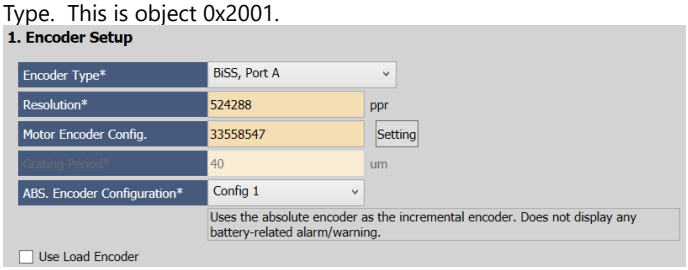
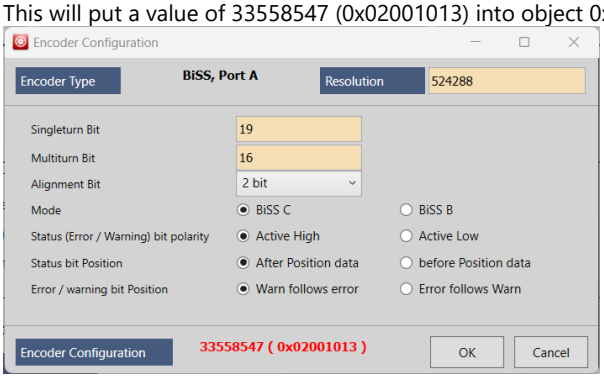
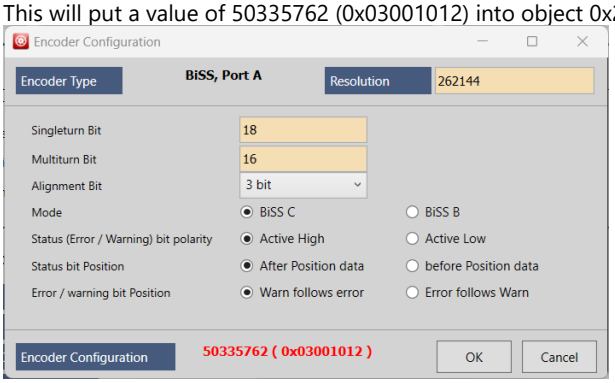
Step 2: Motor/Encoder Selection

	Substep	Task
Velocity Mode Step 2	A	Select **Manual Setting** for motor selection. 
	B	Click **Next**.

Step 3: Motor Setup

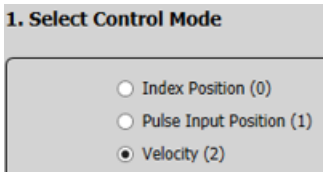
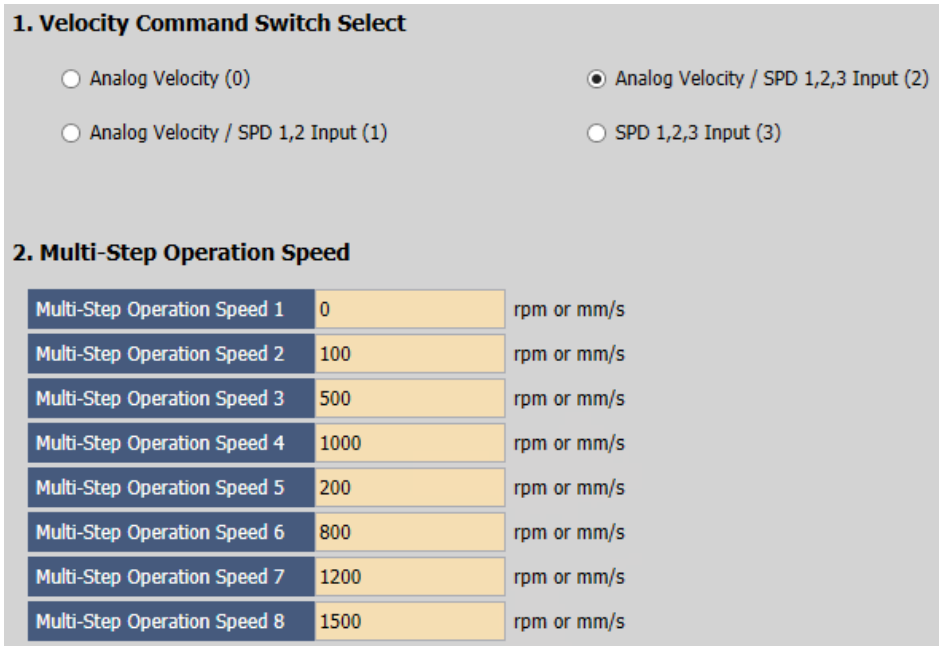
	Substep	Task
Velocity Mode Step 3	A	Input the motor ID attached to the drive. This is located on the motor nameplate or refer to the table below.  **Phox Motor** / **ID** APMC-FAL01AM8N-8-AD, APMC-FAL01AM8N2-8-AD: 705 APMC-FBL01AMK-8-AD, APMC-FBL01AMK2-8-AD: 717 APMC-FBL02AMK-8-AD, APMC-FBL02AMK2-8-AD: 718 APMC-FBL03AMK-8-AD, APMC-FBL03AMK2-8-AD: 719 *NOTE: The number will appear red when first typed in. Press Enter to apply the new value. The number will then turn black to signify it has been applied.*
	B	Click **Next**.

Step 4: Encoder Setup

	Substep	Task
Velocity Mode Step 4	A	If using a standard LS Electric low voltage motor (APMC-xxxxxx-8-AD, choose **BiSS, Port A** for Encoder Type. This is object 0x2001. 
	B	If using a 40mm 100W FAL motor (APMC-FAL01AM8Nx-8-AD) choose a Resolution (0x2002) of 262144. This is the 18-bit encoder. If using a 60mm FBL motor (APMC-FBLxxxxxx-8-AD) choose a Resolution (0x2002) of 524288. This is the 19-bit encoder.
	C	Open the **Motor Encoder Configuration** by clicking on the **Setting** button. For a detailed explanation of this window, please refer to "Encoder Configuration Explanation" on page 74
	D	For a 19-bit encoder configuration, choose the following settings: • Singleturn bit=19 • Multiturn bit=16 • Alignment bit=2 bits This will put a value of 33558547 (0x02001013) into object 0x202A (Motor Encoder Configuration). 
	E	For an 18-bit encoder configuration, choose the following settings. • Singleturn bit=18 • Multiturn bit=16 • Alignment bit=3 bits This will put a value of 50335762 (0x03001012) into object 0x202A (Motor Encoder Configuration). 
	F	Select the behavior for the absolute encoder configuration (object 0x2005). If not using the battery backup for absolute mode, then choose configuration 1. • Config 0: Uses the absolute encoder as the absolute encoder. Uses the multi-turn data. • Config 1: Uses the absolute encoder as the incremental encoder. Does not display any battery-related alarm/warning. **Note:** Load Encoder is for the secondary encoder input (Encoder B).
	G	Click **Next**.

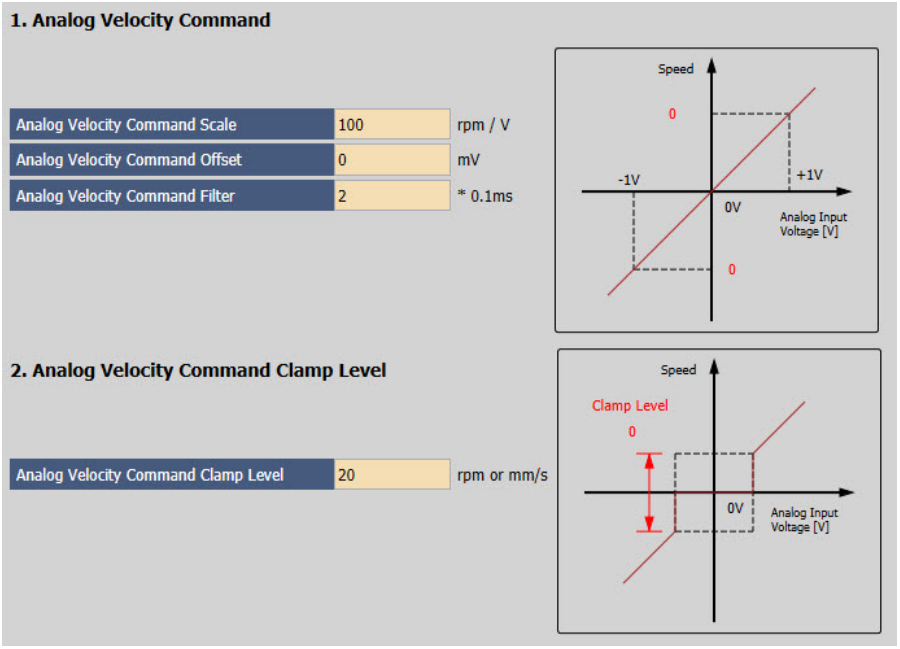
Step 5: Control Mode Selection

Velocity Mode Step 5

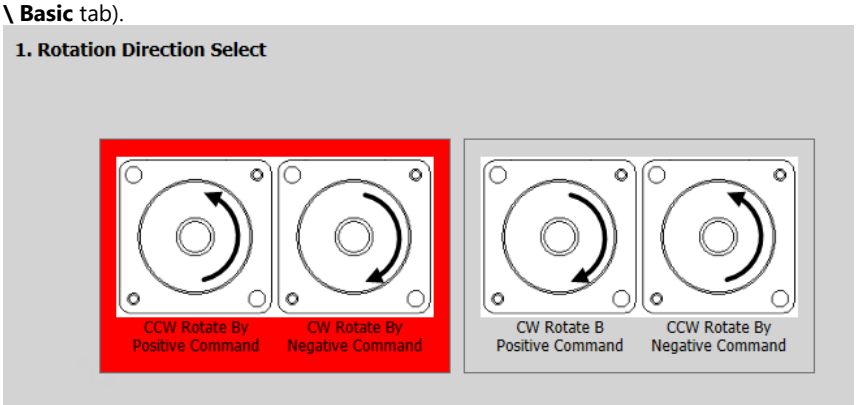
Substep	Task
A	On the **Select Control Mode** screen, select **Velocity (2)** for Control Mode (Object 0x3000).  Click **Next**.
B	On the **Velocity Command Switch Select** screen, select the desired velocity command. In the example below, **Analog Velocity/SPD1, SPD2, SPD3 Input (2)** (Object 0x231A) is selected. This will allow you to have seven predefined speeds selectable via DI and one analog input for variable speed control. 
C	Enter the desired values for the speed registers. Speed register 1 is recommended to be 0 so there is at least one consistent 0 speed command with holding torque. See the table below for the relationship between SPD1, SPD2, SPD3, Analog Input (AI+: pin 6 and AI-: pin 7), and the command velocity.
D	Click **Next**.

0x231A - Velocity Command Switch Select					
Setting Values	***Setting Details***	***SPD1***	***SPD2***	***SPD3***	***Speed Command***
0	Use analog velocity commands.	n/a	n/a	n/a	Analog Input
1	Use SPD1, SPD2 contact and analog velocity commands.	OFF	OFF	n/a	Speed 1 - 0x2312
		ON	OFF	n/a	Speed 2 - 0x2313
		OFF	ON	n/a	Speed 3 - 0x2314
		ON	ON	n/a	Analog input
2	Use SPD1, SPD2, and SPD3 contact and analog velocity commands.	OFF	OFF	OFF	0x2312
		ON	OFF	OFF	0x2313
		OFF	ON	OFF	0x2314
		ON	ON	OFF	0x2315
		OFF	OFF	ON	0x2316
		ON	OFF	ON	0x2317
		OFF	ON	ON	0x2318
		ON	ON	ON	Analog input
3	Use velocity commands for SPD1, SPD2, and SPD3 contact.	OFF	OFF	OFF	0x2312
		ON	OFF	OFF	0x2313
		OFF	ON	OFF	0x2314
		ON	ON	OFF	0x2315
		OFF	OFF	ON	0x2316
		ON	OFF	ON	0x2317
		OFF	ON	ON	0x2318
		ON	ON	ON	0x2319

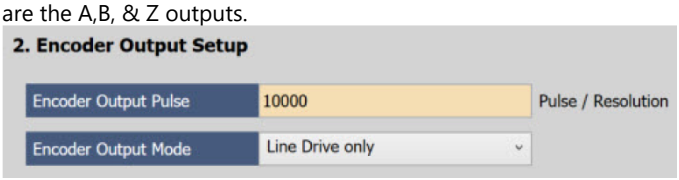
Step 6: Set Analog Velocity Command and Clamp Level

	Substep	Task
Velocity Mode Step 6	A	Set the **Analog Velocity Command Scale** (Object 0x2229). The analog signal is set for +/-10V = +/-1000rpm (100rpm/V x 10V). For initial testing and setup, leave these settings at default values. If your application needs different scaling, adjust these settings. For more information, see 0x2227–0x222B in the User Manual. If using the Analog Input as a velocity command be sure to change 0x222B=0. 
	C	Set the **Analog Velocity Command Clamp Level** (Object 0x222A). This is the same as a deadband. The value entered here will cause the shaft speed to remain at 0 RPMs until the analog speed command is above 20 RPMs.
	D	Click **Next**.

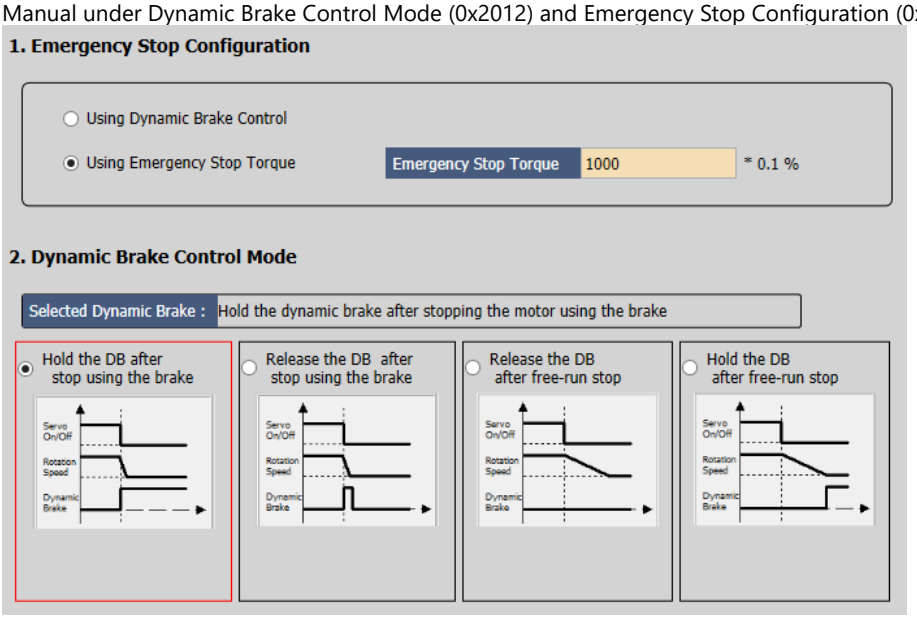
Step 7: Set Rotation Direction

	Substep	Task
Velocity Mode Step 7	A	Set rotation direction on the **Rotation Direction Select** screen. This sets which motor direction is considered positive or negative. If this isn't known, it can be set later in 0x2004 (in the **Object Dictionary \ Basic** tab). 
	B	Click **Next**.

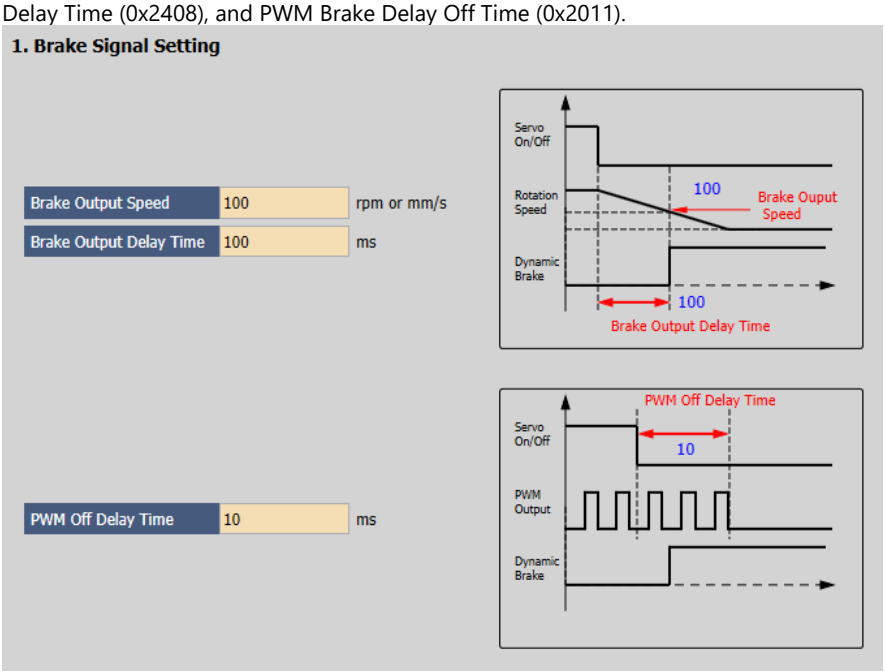
Step 8: Set Electronic Gear Ratio

	Substep	Task
Velocity Mode Step 8	A	Leave the Electronic Gear Ratio settings at default values. They have no affect on Velocity Mode.
	B	[This step is performed on the same screen as Electronic Gear Ratio]. Configure the Encoder Output signal if desired. If the definition isn't known, the Encoder Output can be configured later with Encoder Output Pulse (0x3006). Encoder Output Mode (0x3007) cannot be changed. The encoder output on the PHOX drive only supports Line Driver type. Pins 19–24 on the I/O connector are the A,B, & Z outputs. 
	C	Click **Next**.

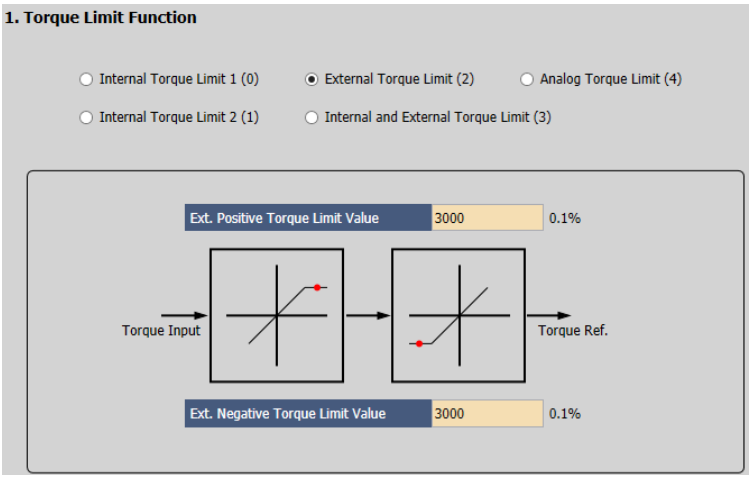
Step 9: Set Emergency Stop and Dynamic Brake Control

	Substep	Task
Velocity Mode Step 9	A	For initial setup and testing, choose the defaults for these settings on the **Emergency Stop Configuration** and **Dynamic Brake Control Mode** screen. More information can be found in the User Manual under Dynamic Brake Control Mode (0x2012) and Emergency Stop Configuration (0x2013). 
	B	Click **Next**.

Step 10: Set Brake Signal Setting

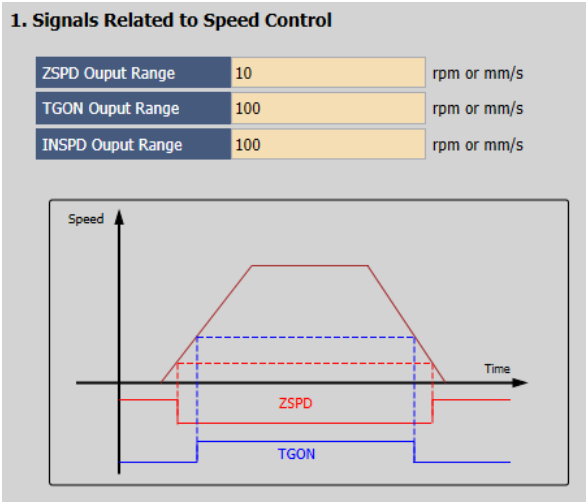
	Substep	Task
Velocity Mode Step 10	A	For initial setup and testing, choose the defaults for these settings on the **Brake Signal Setting** screen. More information can be found in the User Manual under Brake Output Speed (0x2407), Brake Output Delay Time (0x2408), and PWM Brake Delay Off Time (0x2011). 
	B	Click **Next**.

Step 11: Set Torque Limit Function

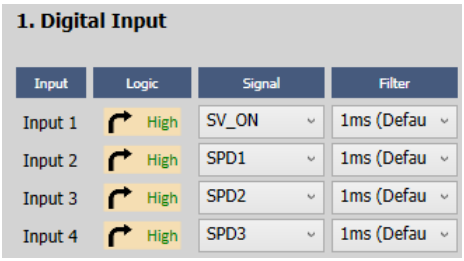
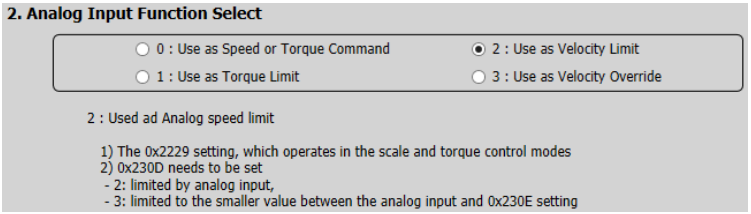
	Substep	Task
Velocity Mode Step 11	A	Set the **Torque Limit Function**.  Select a method for limiting the torque (0x2110) applied to the load while the motor is trying to attain commanded speed. For initial testing and setup, a value less than max torque is recommended. The above example sets the torque limits to 50% of system rated torque. These values can be increased after initial commissioning by adjusting 0x60E0 and 0x60E1 in the **Object Dictionary \ Index** tab. Default values are 3000 (300%).
	B	Click **Next**.

Option	*Description*
Internal Torque Limit 1 (0)	• Uses the value of 0x60E0 as the Fwd direction torque limit • Uses the value of 0x60E1 as the Rev direction torque limit
Internal Torque Limit 2 (1)	Uses a constant 300% of rated motor torque as the Fwd and Rev torque limits
External Torque Limit (2)	• Uses the value of 0x2111 as the Fwd direction torque limit • Uses the value of 0x2112 as the Rev direction torque limit
Internal and External Torque Limit (3)	• Uses the value of 0x60E0 when Digital Input P_CL is on and the value of 0x2111 when Digital Input P_CL is off for the Fwd direction torque limit • Uses the value of 0x60E1 when Digital Input N_CL is on and the value of 0x2112 when Digital Input N_CL is off for the Rev direction torque limit
Analog Torque Limit (4)	Uses the analog value that is supplied to pin (6 and 7) of CN1 when the analog input is not used for velocity commands. Set 0x222B=1.

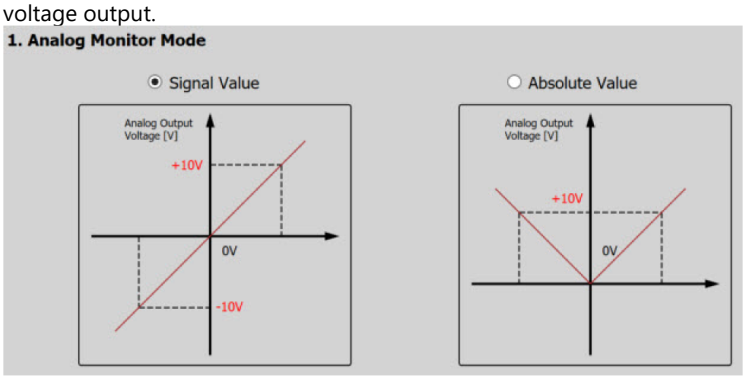
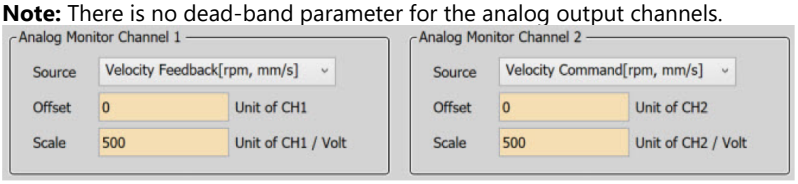
Step 12: Set Signals Related to Speed Control

	Substep	Task
Velocity Mode Step 12	A	On the **Signals Related to Speed Control** screen, configure the speed output ranges that will trigger the digital outputs ZSPD, TGON, and INSPD. For initial testing and setup, these can be left as default. For more information, see section 11.4.3 Signals Related with Speed Control in the User Manual. To adjust these values later, see ZSPD (0x2404), TGON (0x2405), and INSPD (0x2406) in the **Object Dictionary \ Misc.** tab. 
	B	Click **Next**.

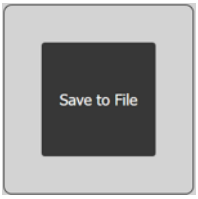
Step 13: Set the I/O Signal Setting

	Substep	Task
Velocity Mode Step 13	A	On the **Digital Input** screen, configure Inputs 1 through 4 as shown below. Configure additional inputs and outputs as needed for your application. The filter column allows for filtering out EMI and false triggering. 1 millisecond is the default and multiple processor cycles can be added to the filter time. 1 cycle =125 microseconds. 
	B	To use an analog function with the one analog input on the drive, choose an option for the application. Certain analog input functions will only work with certain control modes. See the following parameters for more information. 0x222B, 0x2229, 0x230D, 0x221C, and 0x2110. 
	C	Click **Next** to configure Digital Outputs. For initial setup and testing, these values can be left at defaults. For more information, see Sections 2.4.1 and 2.4.2 Names and Functions of Digital Input/Output Signals in the User Manual.
	D	Click **Next**.

Step 14: Set the Analog Monitor Mode

	Substep	Task
Velocity Mode Step 14	A	Objects 0x2220–0x2226 are used to configure Ch1 and Ch2 of the analog output monitoring terminals. There are 22 different drive status variables you can monitor using the analog output pins. See section 7.5 in the User Manual for more details. Decide below whether to have the voltage output -10V to +10V or have both positive and negative variable information represented in an absolute (positive only) voltage output. 
	B	Choose what variable (source) you want to monitor. The offset is just the shift, positive (up) or negative (down), from 0 units desired. Next set the scale. This is how many units of the selected variable is represented per 1 volt out of Ch1 or Ch2. Example below would represent 500rpms of the motor for every 1 volt. **Note:** There is no dead-band parameter for the analog output channels. 
	C	Click **Next**.

Step 15: Save Your Configuration

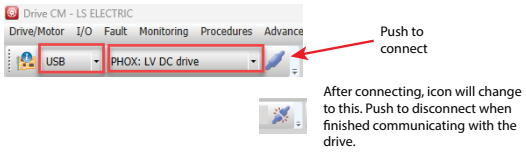
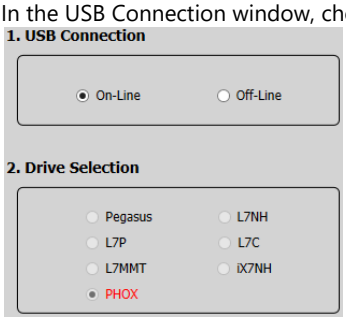
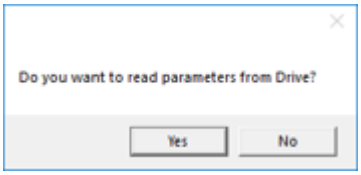
	Substep	Task
Velocity Mode Step 15	A	Select **Save to File** to save the configuration file to your PC. 
	B	Select **Write to Drive** to download the configuration to the drive. The drive **MUST NOT** be enabled during download. The software will not acknowledge that certain parameters were not changed, so ensure that the drive is not enabled before pressing **Write to Drive**. This **Write to Drive** button also saves the settings to memory. 
	C	After download is complete either power cycle the drive (ensuring the LED display turns off) or click on the **Software Reset** icon in the upper toolbar. 
	D	Velocity Mode Commissioning is now complete.

Torque Mode

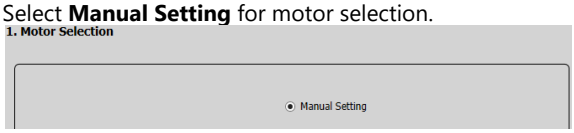
Torque Mode Using the Setup Wizard for Simple Motion Commissioning

Below is a simple walk through of minimal settings to establish a variable torque application with a variable speed limit. Other object configuration settings may be required for your specific needs. See the User Manual for details. Section 13.5.4 Torque Operation in the LS Electric PHOX user manual has a test procedure for more information. You can also reference section 10.5 Torque Operation in the user manual for more information.

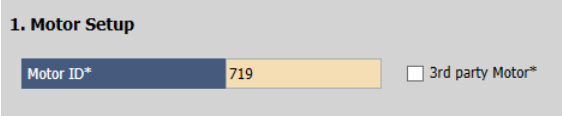
Step 1: Drive Selection

	Substep	Task
Torque Mode Step 1	A	Using a standard USB A to USB mini-B cable (such as SV2-PGM-USB15, MOSAIC-CSU, etc.), connect the PC to the Drive.
	B	Start Drive CM software.
	C	Select **PHOX:LV DC Drive** and press the **Connect** button. The software should begin to communicate with the drive. A green flashing square should appear in the bottom left corner of the screen indicating comms traffic. 
	D	Click on **Setup Wizard**.
	E	In the USB Connection window, choose **On-Line** and click **Yes** to read parameters from the drive.   If the **On-Line** radio button is not available and greyed out, click on **Setup Wizard** again. This should restart the Setup Wizard and enable the button. Click **On-Line** and **Yes** to read drive parameters.
	F	Click **Next**.

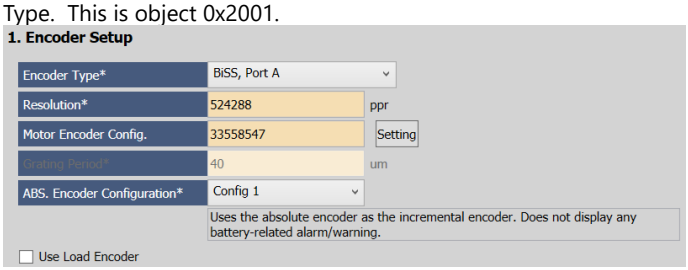
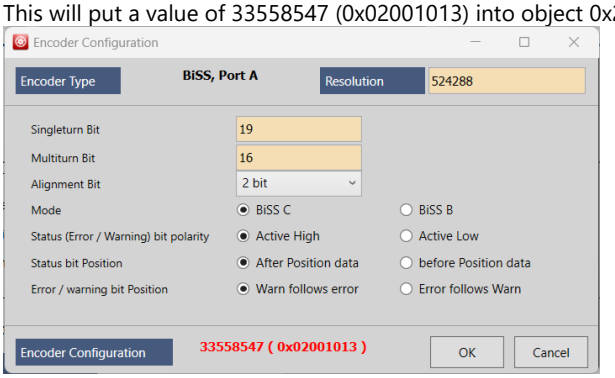
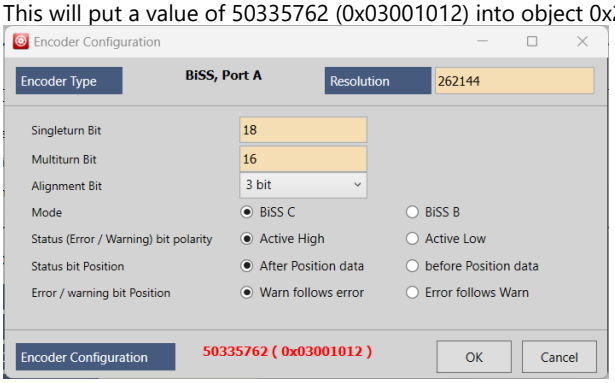
Step 2: Motor/Encoder Selection

	Substep	Task
Torque Mode Step 2	A	Select **Manual Setting** for motor selection. 
	B	Click **Next**.

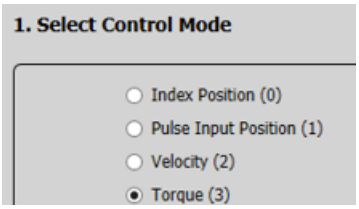
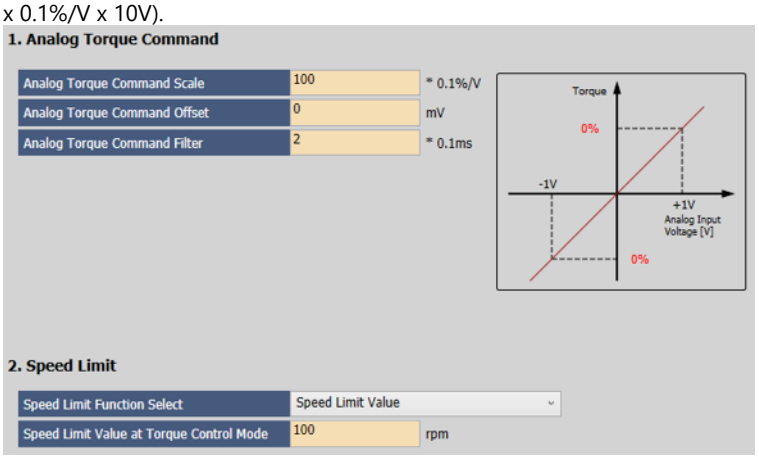
Step 3: Motor Setup

	Substep	Task
Torque Mode Step 3	A	Input the motor ID attached to the drive. This is located on the motor nameplate or refer to the table below.  **Phox Motor** / **ID** APMC-FAL01AM8N-8-AD, APMC-FAL01AM8N2-8-AD — 705 APMC-FBL01AMK-8-AD, APMC-FBL01AMK2-8-AD — 717 APMC-FBL02AMK-8-AD, APMC-FBL02AMK2-8-AD — 718 APMC-FBL03AMK-8-AD, APMC-FBL03AMK2-8-AD — 719 *NOTE: The number will appear red when first typed in. Press Enter to apply the new value. The number will then turn black to signify it has been applied.*
	B	Click **Next**.

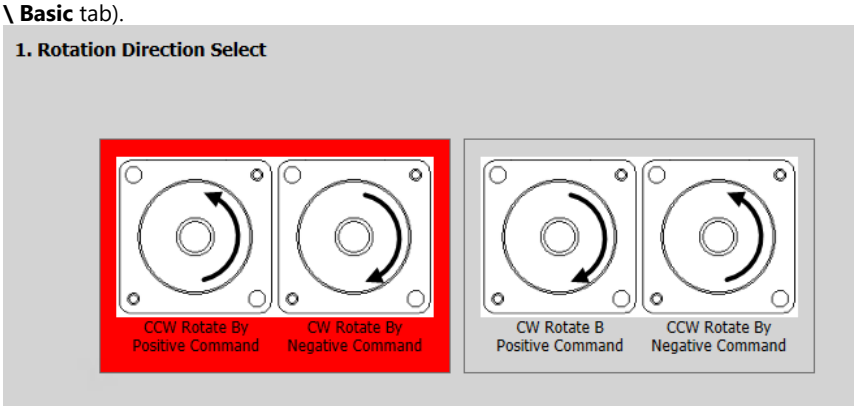
Step 4: Encoder Setup

	Substep	Task
Torque Mode Step 4	A	If using a standard LS Electric low voltage motor (APMC-xxxxxx-8-AD, choose **BiSS, Port A** for Encoder Type. This is object 0x2001. 
	B	If using a 40mm 100W FAL motor (APMC-FAL01AM8Nx-8-AD) choose a Resolution (0x2002) of 262144. This is the 18-bit encoder. If using a 60mm FBL motor (APMC-FBLxxxxxx-8-AD) choose a Resolution (0x2002) of 524288. This is the 19-bit encoder.
	C	Open the **Motor Encoder Configuration** by clicking on the **Setting** button. For a detailed explanation of this window, please refer to "Encoder Configuration Explanation" on page 74.
	D	For a 19-bit encoder configuration, choose the following settings: • Singleturn bit=19 • Multiturn bit=16 • Alignment bit=2 bits This will put a value of 33558547 (0x02001013) into object 0x202A (Motor Encoder Configuration). 
	E	For an 18-bit encoder configuration, choose the following settings. • Singleturn bit=18 • Multiturn bit=16 • Alignment bit=3 bits This will put a value of 50335762 (0x03001012) into object 0x202A (Motor Encoder Configuration). 
	F	Select the behavior for the absolute encoder configuration (object 0x2005). If not using the battery backup for absolute mode, then choose configuration 1. • Config 0: Uses the absolute encoder as the absolute encoder. Uses the multi-turn data. • Config 1: Uses the absolute encoder as the incremental encoder. Does not display any battery-related alarm/warning. **Note:** Load Encoder is for the secondary encoder input (Encoder B).
	G	Click **Next**.

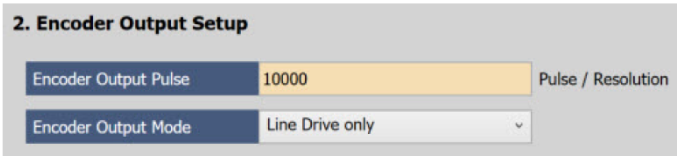
Step 5: Control Mode Selection

	Substep	Task
Torque Mode Step 5	A	On the **Select Control Mode** screen, select **Torque (3)** for Control Mode (Object 0x3000).  Click **Next**.
	B	Set the **Analog Torque Command Scale** (Object 0x221C). This is how much rated torque you want the motor to output at every volt increment when using the analog input. The analog input has a rated voltage swing of -10VDC to +10VDC. The example below will output 100% torque at +10VDC input (100 x 0.1%/V x 10V). 
	C	Set the **Speed Limit Function Select** dropdown to **Speed Limit Value**.
	D	Enter a **Speed Limit Value at Torque Control Mode** (Object 0x230E). In torque mode the motor will continue to spin faster and faster until the commanded torque is reached. Without a proper speed limit, the motor may reach dangerous speeds depending on your application. The default value is 1000RPM. For initial testing and setup, a smaller value is recommended (100RPM). The 0x230E value can be changed later in the **Object Dictionary**. For more information, see Section 10.5 and 13.5.4 "Torque Operation" in the User Manual.
	E	Click **Next**.

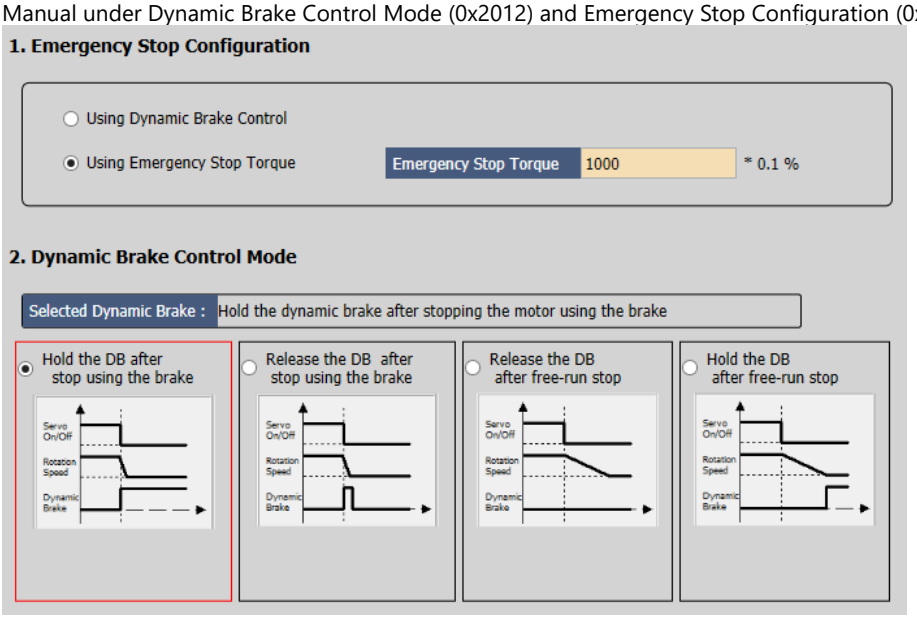
Step 6: Set Rotation Direction

	Substep	Task
Torque Mode Step 6	A	Set rotation direction on the **Rotation Direction Select** screen. This sets which motor direction is considered positive or negative. If this isn't known, it can be set later in 0x2004 (in the **Object Dictionary \ Basic** tab). 
	B	Click **Next**.

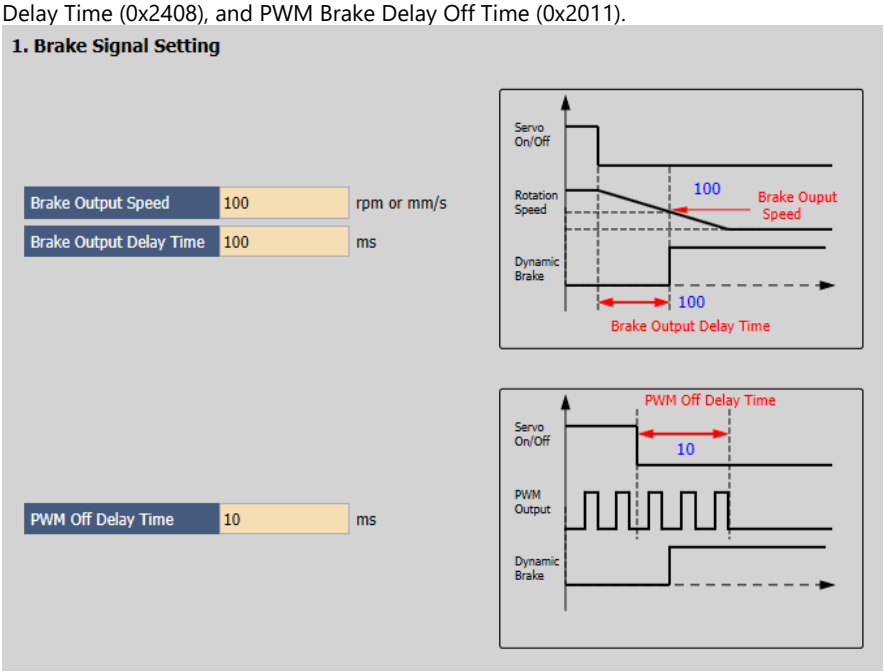
Step 7: Set Electronic Gear Ratio

	Substep	Task
Torque Mode Step 7	A	Leave the Electronic Gear Ratio settings at default values. They have no affect on Torque Mode.
	B	If your application will use the Encoder Output, enter the desired pulses per revolution and Output Mode/Logic. For initial test and setup, leave these settings at default. The PHOX drive only allows for Line Driver mode (0x3007). For more information, see section 11.14 Encoder Output Signal in the User Manual. Configure the Encoder Output signal if desired. If the definition isn't known, the Encoder Output can be configured later with Encoder Output Pulse (0x3006). Encoder Output Mode (0x3007) cannot be changed. The encoder output on the PHOX drive only supports Line Driver type. Pins 19–24 on the I/O connector are the A,B, & Z outputs. 
	C	Click **Next**.

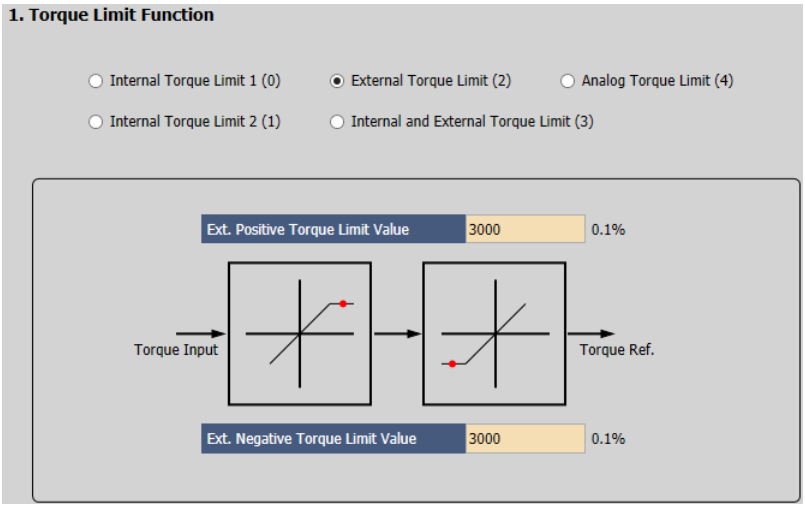
Step 8: Set Emergency Stop and Dynamic Brake Control

	Substep	Task
Torque Mode Step 8	A	For initial setup and testing, choose the defaults for these settings on the **Emergency Stop Configuration** and **Dynamic Brake Control Mode** screen. More information can be found in the User Manual under Dynamic Brake Control Mode (0x2012) and Emergency Stop Configuration (0x2013). 
	B	Click **Next**.

Step 9: Set Brake Signal Setting

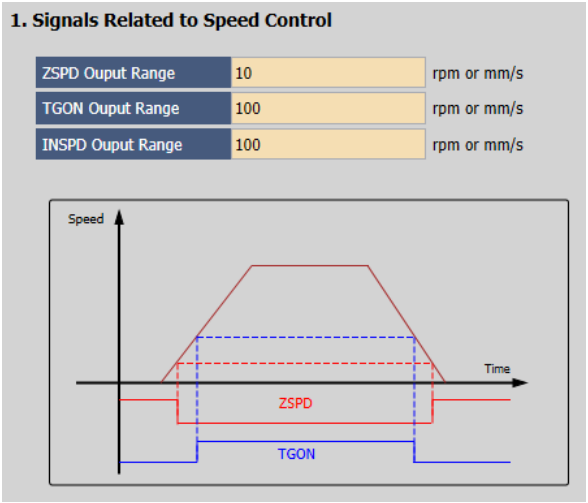
	Substep	Task
Torque Mode Step 9	A	For initial setup and testing, choose the defaults for these settings on the **Brake Signal Setting** screen. More information can be found in the User Manual under Brake Output Speed (0x2407), Brake Output Delay Time (0x2408), and PWM Brake Delay Off Time (0x2011). 
	B	Click **Next**.

Step 10: Set Torque Limit Function

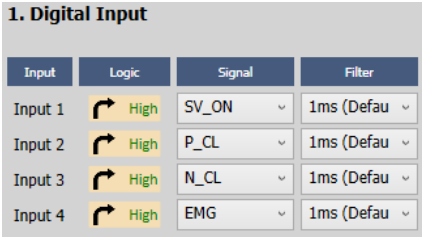
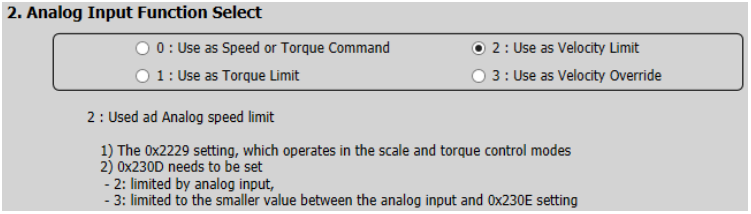
Torque Mode Step 10	*Substep*	*Task*
	A	Set the **Torque Limit Function**.  Select a method for limiting the torque applied to the load (0x2110). Here the Analog Torque Limit does not apply since the analog input must be used as a command and not a limit. Setting the desired torque limit registers will ensure Analog Torque command does not issue dangerous force on the load in either the FWD or REV direction. For initial testing and setup, a value less than max torque is recommended. The above example sets the torque limits to 50% of system rated torque. These values can be increased after initial commissioning by adjusting 0x60E0 and 0x60E1 in the **Object Dictionary \ Index** tab. Default values are 3000 (300%).
	B	Click **Next**.

Option	*Description*
Internal Torque Limit 1 (0)	• Uses the value of 0x60E0 as the Fwd direction torque limit • Uses the value of 0x60E1 as the Rev direction torque limit
Internal Torque Limit 2 (1)	Uses a constant 300% of rated motor torque as the Fwd and Rev torque limits
External Torque Limit (2)	• Uses the value of 0x2111 as the Fwd direction torque limit • Uses the value of 0x2112 as the Rev direction torque limit
Internal and External Torque Limit (3)	• Uses the value of 0x60E0 when Digital Input P_CL is on and the value of 0x2111 when Digital Input P_CL is off for the Fwd direction torque limit • Uses the value of 0x60E1 when Digital Input N_CL is on and the value of 0x2112 when Digital Input N_CL is off for the Rev direction torque limit
Analog Torque Limit (4)	Not applicable in Torque Mode

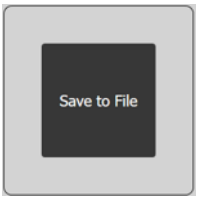
Step 11: Set Signals Related to Speed Control

	Substep	Task
Torque Mode Step 11	A	On the **Signals Related to Speed Control** screen, configure the speed output ranges that will trigger the digital outputs ZSPD, TGON, and INSPD. For initial testing and setup, these can be left as default. For more information, see section 11.4.3 Signals Related with Speed Control in the User Manual. To adjust these values later, see ZSPD (0x2404), TGON (0x2405), and INSPD (0x2406) in the **Object Dictionary \ Misc.** tab. 
	B	Click **Next**.

Step 12: Set the I/O Signal Setting

	Substep	Task
Torque Mode Step 12	A	On the **Digital Input** screen, configure Inputs 1 through 4 as shown below. Configure additional inputs and outputs as needed for your application. P_CL and N_CL are only needed if Internal and External Torque Limit (0x2110=3) was selected. The filter column allows for filtering out EMI and false triggering. 1 millisecond is the default and multiple processor cycles can be added to the filter time. 1 cycle =125 microseconds. 
	B	To use an analog function with the one analog input on the drive, choose an option for the application. Certain analog input functions will only work with certain control modes. See the following parameters for more information. 0x222B, 0x2229, 0x230D, 0x221C, and 0x2110. 
	C	Click **Next** to configure Digital Outputs. For initial setup and testing, these values can be left at defaults. For more information, see Sections 2.4.1 and 2.4.2 Names and Functions of Digital Input/Output Signals in the User Manual.
	D	Click **Next**.

Step 13: Save Your Configuration

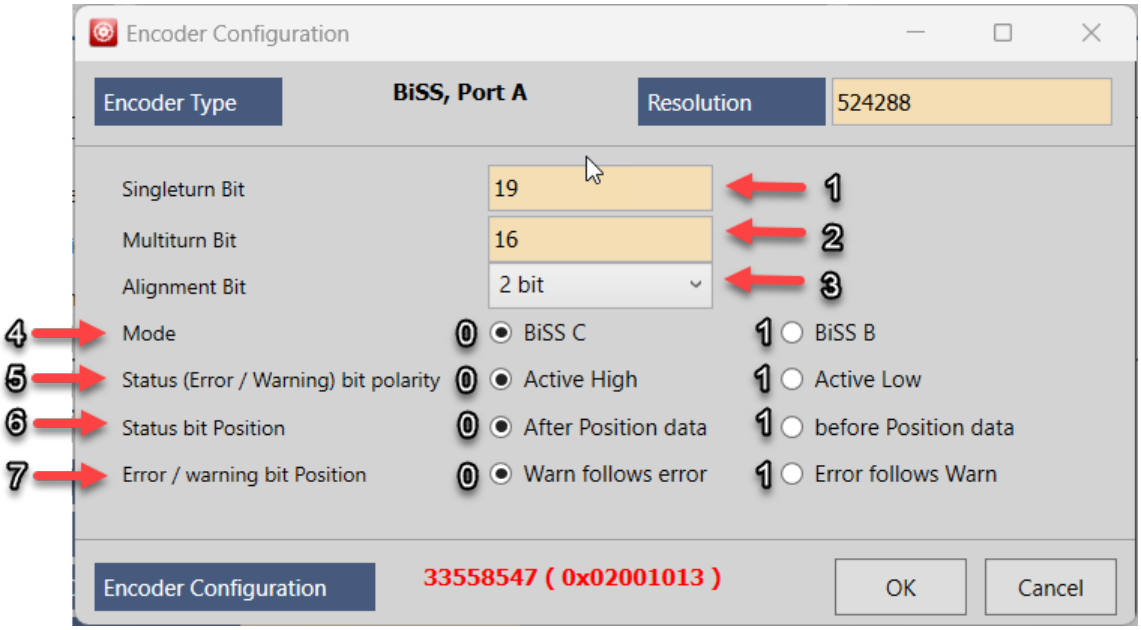
Torque Mode Step 13	*Substep*	*Task*
	A	Select **Save to File** to save the configuration file to your PC. 
	B	Select **Write to Drive** to download the configuration to the drive. The drive **MUST NOT** be enabled during download. The software will not acknowledge that certain parameters were not changed, so ensure that the drive is not enabled before pressing **Write to Drive**. This **Write to Drive** button also saves the settings to memory. 
	C	After download is complete either power cycle the drive (ensuring the LED display turns off) or click on the **Software Reset** icon in the upper toolbar. 
	D	Torque Mode Commissioning is now complete.

Encoder Configuration Explanation

The Drive CM Setup Wizard steps you through the setup of the servo motor and encoder. This section adds more detail of how to manually setup the BiSS encoder configuration (for secondary encoders, non-LS BiSS encoders, etc.).

The PHOX drive when used with the APMC-FALxxxx-8-AD or APMC-FBLxxxx-8-AD motors use the BiSS-C serial encoder standard. See the "BiSS Align Bit setting method" in the PHOX user manual in object 0x202A setting details. This requires that the data length message be equal to 19, 22, 39, 41, or 42. The sum of the [singleturn bit + multiturn bit + align bit + warning bit + error bit] must equal 19, 22, 39, 41, or 42. The Warning and Error bits are always 1 since they are part of the protocol.

The encoder configuration screen will configure 0x202A. See the LS Electric PHOX user manual for details on this parameter and the example below.



1) Bits 0~5 (Single turn data) [0x020010**13**] : This is the pulse resolution of one revolution of the motor shaft and is the second number on the motor nameplate (18 or 19 bits), 13 hex = 19 decimal.

2) Bits 8~12 (Multi turn data) [0x020**10**13]: This is the number of shaft revolution the drive can keep track of before the position register rolls over. 16 bits = 65,535-1 revolutions per direction. This is the first number on the motor nameplate (16 bits)
3) Bits 24~26 (Alignment bit) [0x0**2**001013]: A user selected value from 0~7 to ensure the message data length is 19, 22, 39, 41, or 42
4) Bit 16 (BiSS Mode) [0x020**0**1013]: What type of encoder is being used. This bit is not part of the data length sum, it is for telling the drive what type of BiSS protocol to expect.
   a) 0= BiSS-C
   b) 1= BiSS-B

5) Bit 20 (Status bit polarity) [0x02**0**01013]: This will determine if the Error and Warning bits are active high or active low. This drive configuration bit is not part of the data length sum.
   a) 0= Active high
   b) 1= Active low
6) Bit 21 (Status bit position) [0x02**0**01013]: This will configure the drive to expect the status bit to arrive behind (after) or in front (before) of the position data. This drive configuration bit is not part of the data length sum.
   a) 0= Status bit arrives after the position data
   b) 1= Status bit arrives before the position data
7) Bit 22 (Error/Warning bit position) [0x02**0**01013]: This will configure the drive to expect the Error bit or Warning bit first. This drive configuration bit is not part of the data length sum.
   a) 0= Warning bit arrives after Error bit
   b) 1= Error bit arrives after Warning bit