



# PHOX Series Servo Systems



## Drive features

- Power: 3 or 6 Amps, 24-80 VDC
- Supports EtherCAT, pulse input, and indexing control modes
- Switch between semi-closed loop control, fully-closed loop control, and dual feedback control
- Fully-closed loop control provides quick response with internal and external encoder position values as well as ensuring high-precision control during machine operation
- Dual feedback control - uses the motor encoder and allows the highest gains during motion, but uses the secondary encoder for precise positioning when the motor stops.
- Free Drive CM configuration software
- Multiple encoder support: the drive can accept standard incremental quadrature encoder input and can also accept BiSS Absolute (single turn or multi-turn 16-bit), BiSS general, Panasonic single-turn or multi-turn, Nikon, or SSI encoder formats
- High speed pulse input:
  - Positioning control through high speed pulses from a PLC or motion controller. Acceptable formats: quadrature (A+B), CW/CCW, Pulse+Direction
  - Provides position control through I/O without position control module
- Indexing control:
  - Select and command multiple moves with general purpose digital inputs (not high-speed)
  - Configure the move distances, speeds, accel/decels with DriveCM software and select them at runtime with digital inputs (from a PLC, selector switches, etc.)
- Analog input and preset speed/torque:
  - Use the analog input to control motor speed or torque when in Speed Mode or Torque Mode, or configure preset speed/torque values with DriveCM and select them with digital inputs
  - The analog input can also be used as a speed override signal to modify the motor speed when the drive is Indexing Control
  - The analog input can be used as a torque limit when the drive is in Indexing Mode (or in EtherCAT Profile Position Mode)
- Real-time control through EtherCAT:
  - High speed, real-time control and synchronization mechanism
  - Supports CoE, EoE, and FoE
  - Synchronous and Profile modes
  - Improved frequency response (1kHz)
  - Improved communication speed by applying 16-bit bus
- The 1 kHz bandwidth (frequency response) allows for high-level automatic tuning. Several modes of tuning are available including Off-Line Auto Tuning (the drive initiates its own move commands while Auto tuning), On-Line Auto Tuning (an external controller sends the move commands while the drive Auto tunes), and Manual Tuning (all tuning values are adjusted by the user).
- Variable switching frequency of motor power signals - 16/32/48 kHz. User can adjust the frequency to minimize electrical noise or interference.
- (4) Optically isolated configurable digital inputs and (4) user configurable outputs
- Advanced Scope feature that can monitor a variety of command and status signals, including output speed, torque, power, etc.



- STO: Safe Torque Off input eliminates the need for large contactors to drop power from the drive when an E-stop occurs
- Separate brake output connector: no interposing relay needed when using the dedicated 1A output for motor holding brake.
- Analog Outputs: use the two analog outputs to monitor

## Motor features

- Low inertia 3000rpm motors available:
  - 100W, 40mm frame size
  - 100W, 200W, and 300W, 60mm frame size
- Permanent magnet 3-phase synchronous motor
- Keyed drive shafts support clamp-on style couplings or key-style couplings (100W FAL01 motors have smooth shafts, no key)
- Integrated multi-turn absolute encoder with 19-bit resolution (524,288 pulses per revolution) except FAL01 motors with 18-bit (262,144 ppr)
- Optional 24 VDC spring-set holding brakes (AM8N2 and AMK2 motors)
- Professionally manufactured cables available for motor power, encoder feedback, and (optional) brake, in standard or continuous flexing versions (3m, 5m, 10m, or 20m lengths)
- Standard 26-pin DIN-rail mounted break-out kit for the drive's CN1 connector (with screw terminal connections), or 26-pin cables with flying leads

*Note: These parts available for sale to North American locations only.*





# PHOX Series Servo Systems

## Tuning Technology

The PHOX drive closes the loop on current, velocity, and position (depending on control mode selection). The 1kHz bandwidth in the drive assures precise speed and current control and easy tuning. Proportional gain, integral gain and compensation, feed forward compensation, command low pass filter, and four (4) notch filters (and Adaptive notch filters) for resonance suppression are available. Auto Tuning has been greatly improved and can tune motors up to 30:1 inertia mismatch.

There is an inertia estimation function that analyzes the motor and load during Auto Tuning to measure how much inertia is coupled to the motor.

The drive has several tuning methods available:

- Online Auto Tuning—the drive can either tune the load live while an external controller moves the load to different positions or using the drive's internal tuning motion profile.
- Offline Auto Tuning—the drive tunes the load using the drive's internal tuning motion profile.
- Manual Tuning—all parameters are available to give power users the ultimate flexibility to tune their systems.

## Control Modes

When connected to an EtherCAT® Master, the PHOX drive can run in Cyclic Synchronous Modes (Position, Velocity, Torque) where the Master controller sends an updated setpoint every EtherCAT® cycle (~1millisecond). In these modes, the upper controller plans the motion path.

The drive can also work in EtherCAT Profile Modes (Position, Velocity, Torque) where the Master Controller sends one setpoint for each move. In these cases, the drive's accel, decel, and max speed settings determine the motion path planning. The drive also has 21 different homing modes to accommodate most applications.

In non-EtherCAT applications the PHOX can work as a standard servo, accepting high-speed pulse inputs, Indexing commands (general purpose Digital inputs to initiate and select different Index moves), analog or preset modes, or analog or preset torque modes.

## Optional Holding Brake

Each servo motor can be ordered with an integrated 24VDC spring-set holding brake that holds the motor in place when power is removed.

## LS Electric MSS Series In-Line Planetary Precision Gearboxes for Servo Motors

Need more torque from the motor? Have an inertia balancing issue in your design? The LS Electric MSS series gearboxes easily mate to 60mm FBL motors. SureGear gearboxes are available for the 40mm 100W FAL motors. Everything you need for mounting is included!



- Three MSS gear ratios available (5:1, 10:1, 20:1)
- Five SureGear gear ratios available for 40mm 100W FAL motors (5:1, 10:1, 15:1, 25:1, 50:1)
- Mounting hardware included for attaching to motors.
- Industry-standard mounting dimensions
- Thread-in mounting style
- Very low backlash: 7 arc-min or 9 arc-min (20:1 ratios).
- 1-year warranty



# PHOX Series Servo Systems

## Servo motor overview

### FAL/FBL Series Motor

#### Encoder Connector

9-pin watertight connector for the serial encoder. The encoder transmits motor/encoder identification information to the drive at power-up and sends position feedback during operation.

FAL 100W = 18-bit serial encoder (262,144 pulses per revolution)

All other motors = 19-bit serial encoder resolution (524,288 pulses per revolution).

All encoders have 16-bit multi-turn resolution (the shaft can turn  $2^{16} = 65536$  full revolutions before the count rolls over)

#### Brake Power Connector

2-pin watertight connector available on FAL/FBL brake motors only. The 24VDC brake is located between the motor coils and the encoder. Motors ending in NM82 and AMK2 have brakes. The brakes must have 24VDC applied to them before the motor is set in motion.

#### Low Inertia Motors

Low inertia designs result in high responsiveness at high speeds for lighter loads.

- 100–300W motors available
- FAL motors have 40mm flanges
- FBL motors have 60mm flanges

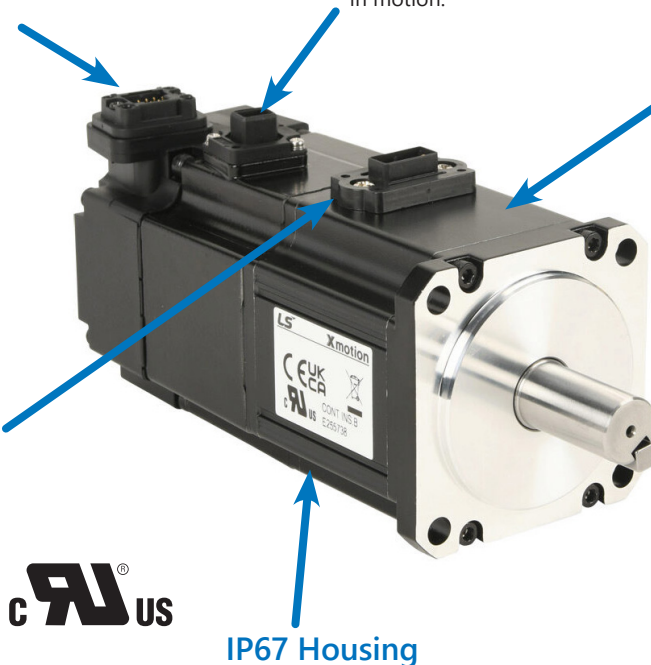
#### Motor Shafts

FBL motors are supplied with extra-large keyways, and slightly oversized keys which may need to be "fitted" into the keyway for performance and longevity. Clamp or compression couplings (without key) are recommended. FAL motors do not have a key/keyway.

- 100W FAL 8mm diameter shaft
- 100W FBL 14mm diameter shaft
- 200W FBL 14mm diameter shaft
- 300W FBL 14mm diameter shaft

#### Motor Power Connector

4-pin watertight connector for motor power (U, V, W, and ground)



IP67 Housing

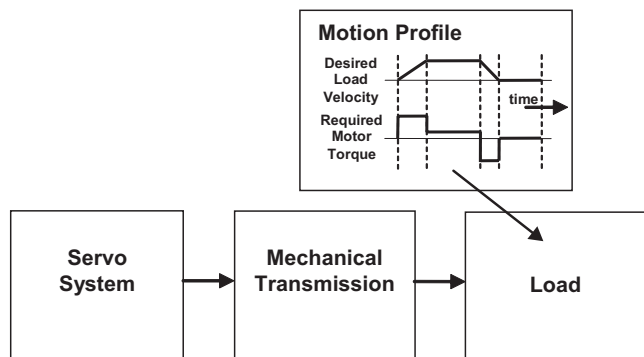
**All LS Electric FBL motors have keyed shafts for use with servo-grade clamp or compression couplings (recommended) or servo-grade keyed couplings. Some sanding/filing of the key may be required before pressing into the keyway. Do not modify the shaft/keyway.**

## How to select and apply PHOX systems

The primary purpose of the AC servo system is to precisely control the motion of the load. The most fundamental considerations in selecting the servo system are “reflected” load inertia, servo system maximum speed requirement, servo system continuous torque requirement, and servo system peak torque requirement. In a retrofit application, select the largest torque servo system that most closely matches these parameters for the system being replaced. In a new application, these parameters should be determined through calculation and/or

measurement. The Drive CM software has the ability to measure the load (reflected) inertia and accurately measure the motor torque output.

AutomationDirect has teamed with Copperhill Technologies to provide free servo-sizing software. “VisualSizer-SureServo” software will assist in determining the correct motor and drive for your application by calculating the reflected load inertia and required speed and torque based on the load configuration. “VisualSizer-SureServo” software can be downloaded from <https://support.automationdirect.com/products/lselectric.html>.



### 1. “Reflected” load inertia

The inertia of everything attached to the servo motor driveshaft needs to be considered and the total “reflected” inertia needs to be determined. This means that all elements of any mechanical transmission and load inertia need to be translated into an equivalent inertia as if attached directly to the motor driveshaft. The ratio of “reflected” load inertia to motor inertia needs to be carefully considered when selecting the servo system.

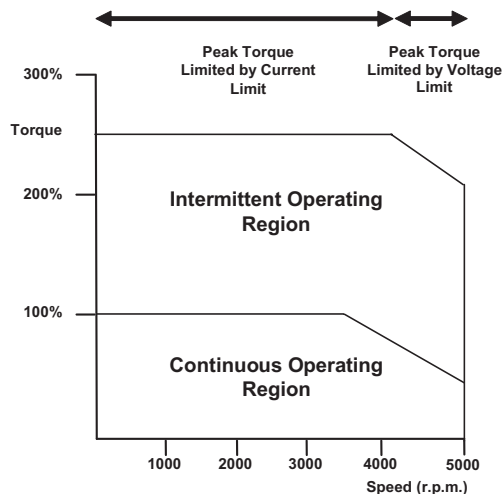
In general, applications that need high response or bandwidth

will benefit from keeping the ratio of load inertia to motor inertia as low as possible and ideally under 10:1. PHOX Auto Tuning will still tune a system with very high response, up to 30:1 inertia mismatch. Higher system ratios can be implemented, but corresponding lower bandwidth or responsiveness must be accepted. The servo response including the attached load inertia is determined by the servo tuning. The PHOX servo systems may be tuned automatically by the software/drive or manually by the user.

### 2. Torque and speed

With knowledge of the motion profile and any mechanical transmission between the motor and load, calculations can be made to determine the required servo motor continuous torque, peak torque, and maximum motor speed. The required amount of continuous torque must fall inside the continuous operating region of the system torque-speed curve (you can check the continuous torque at the average speed of the motion profile). The required amount of peak torque must also fall within the servo system’s intermittent operating region of the system torque-speed curve (you need to check this value at the required maximum speed or torque). If you have an PHOX system, these values are easily captured and recorded with the Scope feature built into the Drive CM software. If you are designing the system from scratch, use VisualSizer to define the system and calculate expected inertia and required power.

Compare the application’s continuous and intermittent torque requirements to the torque-speed curves found in Chapter 12.8 of the PHOX User Manual or in the system torque charts found on “PHOX AC servo drive, motor, and cable combinations” on page tSRV-28.



## Application tip - coupling considerations

The LS Electric FBL motors have keyed shafts that can be used with keyed couplings or with clamp-on or compression style couplings. FAL motors are smooth shaft only. For standard keyed couplings, the servo key must be "fitted" into the keyway for optimum performance and longevity. Some minor filing and pressing of the key may be required. "Servo-grade" clamp-on or compression style couplings are usually the best choice when

you consider stiffness, torque rating, and inertia. Higher stiffness (lb-in/radian) is needed for better response but there is a trade-off between stiffness and the added inertia of the coupling. Concerning the torque rating of the coupling, use a safety factor of 1.25 over the servo's **peak** torque requirement of your application.

[Click here for Available Couplings](#)

## Mechanical transmissions

Common mechanical transmissions include leadscrews, rack & pinion mechanisms, conveyors, gears, and timing belts. The use of leadscrew, rack & pinion, or conveyor are common ways to translate the rotary motion of the servo motor into linear motion of the load. Matched gearboxes are available from LS Electric that will work with the LS servo motors. Each gearbox is selected to accept the 300% maximum available torque that could be generated by the motor. Gearboxes are available in 5:1, 10:1, and 20:1 ratios. The use of a speed reducer such as a gearbox or timing belt can be very beneficial as follows:

### 1. Reduction of reflected load inertia

As a general rule, keep the reflected load inertia as low as possible while using the full range of servo speed. The LS Electric motors can rotate at a rated speed of 3000 rpm (rated torque at rated speed). Their max speed (slightly less available torque) is 3300 rpm. See the speed-torque curves for more information.

Example: A gearbox reduces the motor's required torque by a factor of the gear ratio, and reduces the reflected load inertia by a factor of the gear ratio squared. A 10:1 gearbox reduces output speed to 1/10, increases output torque 10 times, and decreases reflected inertia to 1/100.

However, when investigating the effect of different speed reduction ratios DO NOT forget to include the added inertia of couplings, gearbox, or timing belt pulleys. These added inertias can be significant, and can negate any inertia reduction due to the speed reduction.

### 2. Low speed and high torque applications

If the application requires low speed and high torque then it is common to introduce a speed reducer so that the servo system can operate over more of the available speed range. This could also have the added benefit of reducing the servo motor torque requirement which could allow you to use a smaller and lower cost servo system. Additional benefits are also possible with reduction in reflected inertia, increased number of motor encoder counts at the load, and increased ability to reject load disturbances due to mechanical advantage of the speed reducer.

### 3. Space limitations and motor orientation

LS Electric servo motors can be mounted in any orientation, but the shaft seal should not be immersed in oil (open-frame gearbox, etc.). Reducers can possibly allow the use of a smaller motor or allow the motor to be repositioned.



[Here is a link to our Timing Belts and Pulleys](#)

Motor	Brake Motor	Planetary In-Line Gearboxes					
		5:1 Gearbox	10:1 Gearbox	15:1 Gearbox	20:1 Gearbox	25:1 Gearbox	50:1 Gearbox
<a href="#">APMC-FAL01AM8N-8-AD</a>	<a href="#">APMC-FAL01AM8N2-8-AD</a>	<a href="#">PGA050-05A1</a>	<a href="#">PGA050-10A1</a>	<a href="#">PGA050-15A1</a>	<i>n/a</i>	<a href="#">PGA050-25A1</a>	<a href="#">PGD064-50A1</a>
<a href="#">APMC-FBL01AMK-8-AD</a>	<a href="#">APMC-FBL01AMK2-8-AD</a>	<a href="#">96200004</a>	<a href="#">96200005</a>	<i>n/a</i>	<a href="#">96200103</a>	<i>n/a</i>	<i>n/a</i>
<a href="#">APMC-FBL02AMK-8-AD</a>	<a href="#">APMC-FBL02AMK2-8-AD</a>						
<a href="#">APMC-FBL03AMK-8-AD</a>	<a href="#">APMC-FBL03AMK2-8-AD</a>						

## Ordering Guide

The following pages are your ordering guide for LS Electric PHOX servo systems. Each system has a torque-speed curve included for reference. This is the fundamental information that you need to select the servo motor and matching drive for your application.

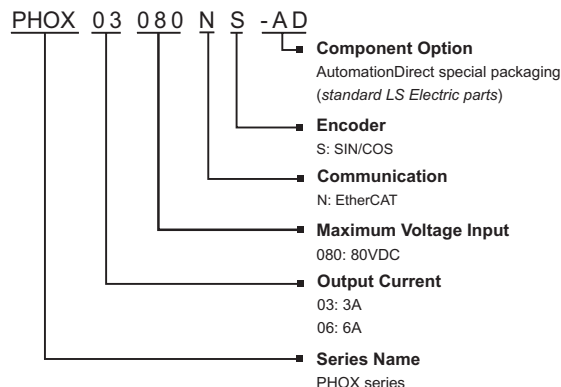
### Each system needs:

- Drive and Motor
- Motor Power Cable
- Motor Encoder Cable
- I/O connections (either a 26-pin CN1 cable+terminals kit or a 26-pin flying lead cable (user provides terminal blocks))
- Brake motors require a brake cable.
- STO cable (APCS-PHOX-STOxxA-AD) (optional). An STO connector (PHOX-CON-B) is included with each drive.

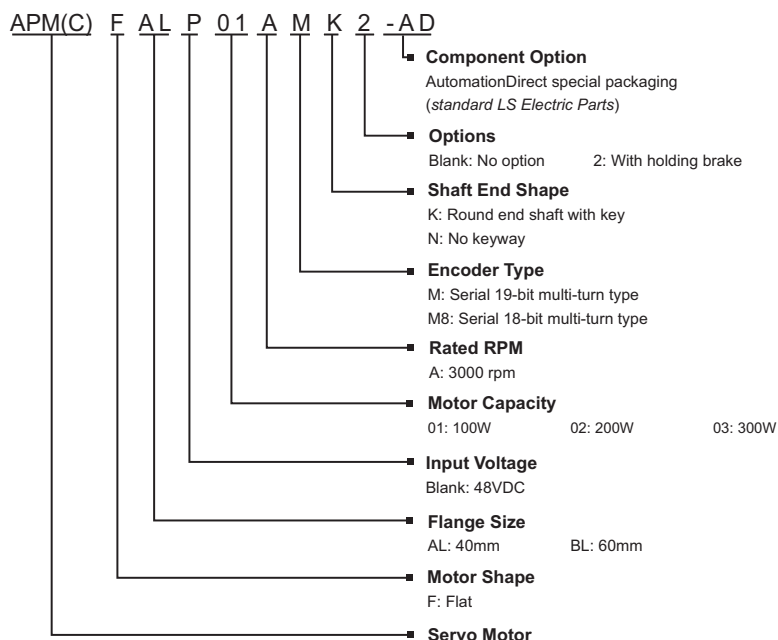


## PHOX series drives and motors part numbering system

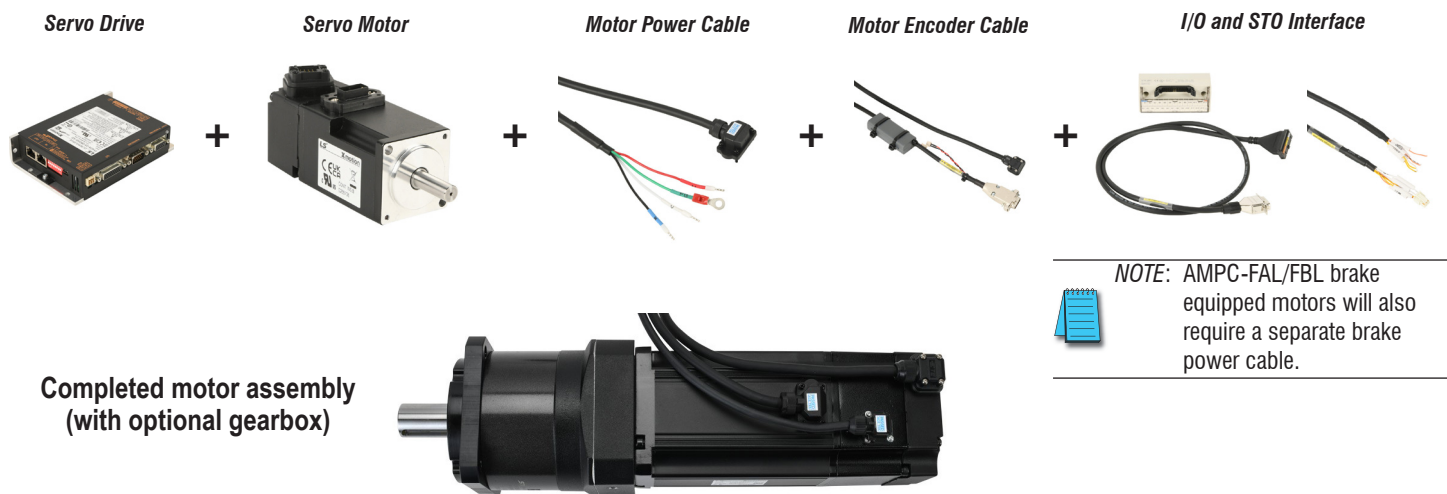
### Drives



### Motors



## Example of what you will need to build a complete servo system:



**NOTE:** Required programming software (free download). Use a standard USB-A to USB mini-B cable for connectivity (SV2-PGM-USB15, MOSAIC-CSU, or equivalent)



**NOTE:** If you need a gear box for your configuration, reference the gearbox chart on the previous page.





# PHOX Series Servo Systems

## Torque to PHOX System Quick Reference

System Rated Torque (N·m)	System Maximum Torque (N·m)	Suggested Servo Motor	Required Servo Drive
0.32	0.96	<a href="#">APMC-FAL01AM8N-8-AD</a>	<a href="#">PHOX-03-080NS-AD</a>
		<a href="#">APMC-FAL01AM8N2-8-AD</a>	
		<a href="#">APMC-FBL01AMK-8-AD</a>	
		<a href="#">APMC-FBL01AMK2-8-AD</a>	
0.64	1.92	<a href="#">APMC-FBL02AMK-8-AD</a>	<a href="#">PHOX-06-080NS-AD</a>
		<a href="#">APMC-FBL02AMK2-8-AD</a>	
0.95	2.54	<a href="#">APMC-FBL03AMK-8-AD</a>	
		<a href="#">APMC-FBL03AMK2-8-AD</a>	



# PHOX Series Servo Systems

## PHOX DC servo drive, motor, and cable combinations

xx = Cable length in meters

BN/EN/PN = Standard cable (not continuous flex)

BF/EF/PF = Flex-rated cable

AM8N/AMK motors = no brake

AM8N2/AMK2 motors = mechanical holding brake

## 48VDC AM8N/AMK Motor Systems

Type	System Torque Chart	PHOX Drive	APM/APMC Motor	Power Cable	Encoder Cable	Brake Cable	I/O Wiring Options
100W Low Inertia System (FAL motor)		PHOX-03-080NS-AD	<a href="#">APMC-FAL01AM8N-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	n/a	APCS-PHOX-IOTxx-AD (cable and breakout)  or  APCS-PHOX-IOxxA-AD (connector-to-pigtail cable)
				APCV-PFxxLS-AD	APCV-EFxxES1-AD		
			<a href="#">APMC-FAL01AM8N2-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	APCV-BNxxQS-AD	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD	APCV-BFxxQS-AD	
100W Low Inertia System (FBL motor)		PHOX-03-080NS-AD	<a href="#">APMC-FBL01AMK-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	n/a	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD		
			<a href="#">APMC-FBL01AMK2-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	APCV-BNxxQS-AD	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD	APCV-BFxxQS-AD	
200W Low Inertia System		PHOX-06-080NS-AD	<a href="#">APMC-FBL02AMK-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	n/a	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD		
			<a href="#">APMC-FBL02AMK2-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	APCV-BNxxQS-AD	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD	APCV-BFxxQS-AD	
300W Low Inertia System		PHOX-06-080NS-AD	<a href="#">APMC-FBL03AMK-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	n/a	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD		
			<a href="#">APMC-FBL03AMK2-8-AD</a>	APCV-PNxxLS-AD	APCV-ENxxES1-AD	APCV-BNxxQS-AD	
				APCV-PFxxLS-AD	APCV-EFxxES1-AD	APCV-BFxxQS-AD	

Note: Fxx cables are rated for continuous flexing applications, Nxx cables are not.





# PHOX Series Servo Systems

## Motor Specifications

PHOX Motor Specifications								
Model	<a href="#">APMC-FAL01AM8N-8-AD</a>	<a href="#">APMC-FAL01AM8N2-8-AD</a>	<a href="#">APMC-FBL01AMK-8-AD</a>	<a href="#">APMC-FBL01AMK2-8-AD</a>	<a href="#">APMC-FBL02AMK-8-AD</a>	<a href="#">APMC-FBL02AMK2-8-AD</a>	<a href="#">APMC-FBL03AMK-8-AD</a>	<a href="#">APMC-FBL03AMK2-8-AD</a>
Price	\$267.00	\$460.00	\$210.00	\$386.00	\$248.00	\$434.00	\$305.00	\$495.00
Drawing	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>
Input Voltage	24-80 VDC							
Drive Compatibility	<a href="#">PHOX-03-080NS-AD</a>				<a href="#">PHOX-06-080NS-AD</a>			
Integrated Brake	N	Y	N	Y	N	Y	N	Y
Flange Size (mm)	40		60					
Rated Power [W]	100W		100W		200W		300W	
Rated Torque [N·m] <sup>Note 1</sup>	0.32		0.32		0.64		0.95	
Max. Torque [N·m]	0.96		0.96		1.92		2.54	
Rated Speed [rpm]	3000							
Max. Speed [rpm]	3300							
Rated current [Amps] rms	2.71		2.5		5.54		6.79	
Max. Instantaneous Current [Amps] rms	8.13		7.50		16.62		18.0	
Rated Power Rate [kW/s]	24.24		11.13		27.57		36.81	
Rotor Inertia [x10 <sup>-4</sup> kg m <sup>2</sup> ]	0.042		0.091		0.147		0.248	
Allowable Load Inertia Ratio	30 times motor inertia		20 times motor inertia					
Speed/Position Detector	Serial multi-turn built-in encoder (18-bit)		Serial multi-turn built-in encoder (19-bit)					
Protection	Fully enclosed self cooling IP67 <sup>1</sup>							
Rated Time	Continuous							
Ambient Temperature	Operating	0 to 40°C (32 to 104°F)						
	Storage	-10 to 60°C (14 to 140°F)						
Ambient Humidity	Operating	Below 80% relative humidity						
	Storage	Below 90% relative humidity (non-condensing)						
Atmosphere	Avoid direct sunlight and corrosive/flammable gas or liquid							
Vibration Resistance	Vibration acceleration 49m/s <sup>2</sup> (5G)							
Weight [kg]	0.45	0.45	0.56	0.56	0.74	0.74	1.06	1.06

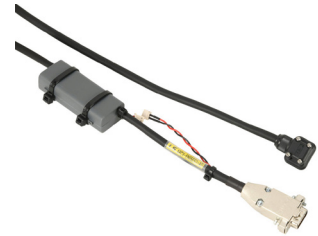
Note 1—Axis penetration not included. The IP rating for attached reducers is not guaranteed. Cables may not qualify marked IP rating if bent beyond designated specifications. Use specific cables for IP rating qualification.

## Accessories, continued

NOTE: These parts available for sale to North American locations only

### PHOX System Motor Encoder Cables

Part Number	Price	Flex Rated	Length	Gauge	Drawing	Compatible Motors
<a href="#">APCV-EN03ES1-AD</a>	\$107.00	N	3m [9.8 ft]	24AWG	<a href="#">PDF</a>	All PHOX APMC motors
<a href="#">APCV-EN05ES1-AD</a>	\$114.00		5m [16.4 ft]		<a href="#">PDF</a>	
<a href="#">APCV-EN10ES1-AD</a>	\$127.00		10m [32.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-EN20ES1-AD</a>	\$159.00		20m [65.6 ft]		<a href="#">PDF</a>	
<a href="#">APCV-EF03ES1-AD</a>	\$117.00	Y	3m [9.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-EF05ES1-AD</a>	\$127.00		5m [16.4 ft]		<a href="#">PDF</a>	
<a href="#">APCV-EF10ES1-AD</a>	\$159.00		10m [32.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-EF20ES1-AD</a>	\$221.00		20m [65.6 ft]		<a href="#">PDF</a>	



APCV-EN series encoder cable

### PHOX System Motor Power Cables

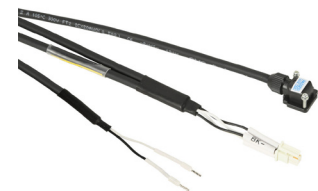
Part Number	Price	Flex Rated	Length	Gauge	Drawing	Compatible Motors
<a href="#">APCV-PN03LS-AD</a>	\$48.00	N	3m [9.8 ft]	24AWG	<a href="#">PDF</a>	All PHOX APMC motors
<a href="#">APCV-PN05LS-AD</a>	\$53.00		5m [16.4 ft]		<a href="#">PDF</a>	
<a href="#">APCV-PN10LS-AD</a>	\$67.00		10m [32.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-PN20LS-AD</a>	\$94.00		20m [65.6 ft]		<a href="#">PDF</a>	
<a href="#">APCV-PF03LS-AD</a>	\$56.00	Y	3m [9.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-PF05LS-AD</a>	\$67.00		5m [16.4 ft]		<a href="#">PDF</a>	
<a href="#">APCV-PF10LS-AD</a>	\$95.00		10m [32.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-PF20LS-AD</a>	\$147.00		20m [65.6 ft]		<a href="#">PDF</a>	



APCV-PN series power cable

### PHOX System Motor Brake Cables

Part Number	Price	Flex Rated	Length	Gauge	Drawing	Compatible Motors
<a href="#">APCV-BN03QS-AD</a>	\$48.00	N	3m [9.8 ft]	24AWG	<a href="#">PDF</a>	All PHOX APMC motors
<a href="#">APCV-BN05QS-AD</a>	\$52.00		5m [16.4 ft]		<a href="#">PDF</a>	
<a href="#">APCV-BN10QS-AD</a>	\$57.00		10m [32.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-BN20QS-AD</a>	\$72.00		20m [65.6 ft]		<a href="#">PDF</a>	
<a href="#">APCV-BF03QS-AD</a>	\$53.00	Y	3m [9.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-BF05QS-AD</a>	\$58.00		5m [16.4 ft]		<a href="#">PDF</a>	
<a href="#">APCV-BF10QS-AD</a>	\$73.00		10m [32.8 ft]		<a href="#">PDF</a>	
<a href="#">APCV-BF20QS-AD</a>	\$102.00		20m [65.6 ft]		<a href="#">PDF</a>	



APCV-BN series brake cable

Note: Each brake cable consists of 4 wires: 24VDC and Common (input to the drive), and BRK+ and BRK- output to the motor brake.

## Accessories, continued

**NOTE:** These parts available for sale to North American locations only

### L7C/L7P/iX7NH/PHOX System Planetary Gearboxes

Precision planetary gearboxes can increase the torque output of servo systems while reducing the reflected load inertia for higher response. Gearboxes offer high stiffness, high efficiency, and very quiet operation. Input motor shaft clamp, oversized output shaft key, and mounting hardware are included for mating to LS Electric motors.

**Features:**

- Maintenance free (no need to replace lubrication)
- IP65
- Operating temperature range of -10°C to +90°C [14°F to 194°F]
- Uses VIGO Grease RE #0



**MSS Series Planetary Gearbox**

MSS Series Planetary Gearbox Specifications										
Model	96200004	96200005	96200103	96200007	96200008	96200257	96200373	96200378	96200393	96200459
Manufacturer Part Number	MSS0601A-005KS-B3110103C14	MSS0601A-010KS-B3110103C14	MSS0902B-020KS-B3110103C14	MSS0901A-005KS-C3110103C19	MSS0901A-010KS-C3110103C19	MSS1152B-020KS-C4120103C19	MSS0901A-005KS-C4120103C19	MSS0901A-010KS-C4120103C19	MSS1152B-020KS-C4120103C19	MSS1151A-005KS-D3110103C22
Compatible Motors	APMC-FBL series 100, 200, 300, and 400 W motors			APMC FCL series 750W and 1kW motors			APM-FE series 900W and 1.5 kW motors			APM-FE series 1.6 kW motors
Price	\$288.00	\$296.00	\$528.00	\$387.00	\$387.00	\$762.00	\$350.00	\$350.00	\$699.00	\$499.00
Drawing	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>
Ratio	5:1	10:1	20:1	5:1	10:1	20:1	5:1	10:1	20:1	5:1
Nominal Output Torque	54 N·m	42 N·m	143 N·m	160 N·m	121 N·m	295 N·m	160 N·m	121 N·m	295 N·m	332 N·m
Inertia	0.13 kg/cm²	0.13 kg/cm²	0.13 kg/cm²	0.48 kg/cm²	0.44 kg/cm²	0.48 kg/cm²	0.48 kg/cm²	0.44 kg/cm²	0.48 kg/cm²	2.81 kg/cm²
Output Shaft Diameter	16mm	16mm	22mm	22mm	22mm	32mm	22mm	22mm	32mm	32mm
Stage	1	1	2	1	1	2	1	1	2	1
Frame	60mm	60mm	90mm	90mm	90mm	115mm	90mm	90mm	115mm	115mm
Nominal Input Speed (rpm)	5,000	5,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Max Input Speed (rpm)	10,000	10,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Emergency Stop Torque	3 times nominal output torque									
Noise (dB)	≤54	≤54	≤56	≤56	≤56	≤59	≤56	≤56	≤59	≤59
Efficiency (%)	≥97	≥97	≥94	≥97	≥97	≥94	≥97	≥97	≥94	≥97
Backlash (Arcmin)	≤7	≤7	≤9	≤7	≤7	≤9	≤7	≤7	≤9	≤7
Max Radial Load (N)	1,280	1,280	3,200	3,200	3,200	6,800	3,200	3,200	6,800	6,800
Max Axial Load (N)	690	690	1,600	1,600	1,600	3,400	1,600	1,600	3,400	3,400
Service Life (Hours)	20,000 (10,000 under continuous operation)									
Continued on next page										



# LS Electric AC Servo Systems

## Accessories, continued

MSS Series Planetary Gearbox Specifications											
Model	96200464	96200479	96200010	96200011	96200445	96200013	96200014	96200701	96200016	96200017	96200862
Manufacturer Part Number	MSS1151A-010KS-D3110103C22	MSS1422B-020KS-D3110103C22	MSS1151A-005KS-D3110103C24	MSS1151A-010KS-D3110103C24	MSS1422B-020KS-D3110103C24	MSS1421A-005KS-E3110103C35	MSS1421A-010KS-E3110103C35	MSS1802B-020KS-E3110103C35	MSS1801A-005KS-F3110103C42	MSS1801A-010KS-F3110103C42	MSS1802A-015KS-F3110103C42
Compatible Motors	APM-FE series 1.6 kW motors		APM-FE series 2.2 kW motors			APM-FF series 3.5 kW and 5.5 kW motors			APM-FF series 7.5 kW motors		
Price	\$499.00	\$1,030.00	\$499.00	\$499.00	\$1,030.00	\$770.00	\$770.00	\$1,850.00	\$1,480.00	\$1,480.00	\$1,850.00
Drawing	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>	<a href="#">PDF</a>
Ratio	10:1	20:1	5:1	10:1	20:1	5:1	10:1	20:1	5:1	10:1	15:1
Nominal Output Torque	262 N·m	295 N·m	332 N·m	262 N·m	295 N·m	634 N·m	500 N·m	1060 N·m	1195 N·m	960 N·m	897 N·m
Inertia	2.59 kg/cm <sup>2</sup>	2.81 kg/cm <sup>2</sup>	2.81 kg/cm <sup>2</sup>	2.59 kg/cm <sup>2</sup>	2.81 kg/cm <sup>2</sup>	7.52 kg/cm <sup>2</sup>	7.05 kg/cm <sup>2</sup>	7.52 kg/cm <sup>2</sup>	24.29 kg/cm <sup>2</sup>	23.51 kg/cm <sup>2</sup>	24.29 kg/cm <sup>2</sup>
Output Shaft Diameter	32mm	40mm	32mm	32mm	40mm	40mm	40mm	55mm	55mm	55mm	55mm
Stage	1	2	1	1	2	1	1	2	1	1	2
Frame	115mm	142mm	115mm	115mm	142mm	142mm	142mm	180mm	180mm	180mm	180mm
Nominal Input Speed (rpm)	4,000	3,000	4,000	4,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Max Input Speed (rpm)	8,000	6,000	8,000	8,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Emergency Stop Torque	3 times nominal output torque										
Noise (dB)	≤59	≤62	≤59	≤59	≤62	≤62	≤62	≤64	≤64	≤64	≤64
Efficiency (%)	≥97	≥94	≥97	≥97	≥94	≥97	≥97	≥94	≥97	≥97	≥94
Backlash (Arcmin)	≤7	≤9	≤7	≤7	≤9	≤7	≤7	≤9	≤7	≤7	≤9
Max Radial Load (N)	6,800	9,300	6,800	6,800	9,300	9,300	9,300	15,100	15,100	15,100	15,100
Max Axial Load (N)	3,400	4,500	3,400	3,400	4,500	4,500	4,500	7,500	7,500	7,500	7,500
Service Life (Hours)	20,000 (10,000 under continuous operation)										

# Precision Servo Gearboxes

## SureGear® Servo Gearbox Overview

### **PGA In-line Series**

The SureGear PGA series of high-precision servo gear reducers is an excellent choice for applications that require good accuracy and reliability at an exceptional value. This in-line planetary gear reducer has a thread-in mounting style, along with a level of precision and torque capacity that is best in its class. Offered in a concentric shaft design with a maximum seven arc-min backlash rating, the SureGear PGA series is an accurate, high-performance, and cost effective solution for any OEM.

The machining quality of the SureGear PGA helical planetary gears provides a very quiet and more efficient reducer than other competitive products that are similarly priced. The SureGear PGA series easily mates to SureServo motors, and is the perfect solution for applications such as gantries, injection-molding machines, pick-and-place automation, and linear slides.

### **PGB Right-angle Series**

The SureGear PGB series of high-precision right-angle servo gear reducers is an excellent choice for applications that require a more compact footprint.

The PGB right-angle planetary gear reducers offer similar technical specifications to the PGA series in-line gear reducers, and provides the customer with an excellent solution when space and clearance requirements are limited.

Offered with a six arc-min backlash rating for 2-stage and nine arc-min backlash for 3-stage, the SureGear PGB series performs to OEMs' demanding expectations.

### **PGD Hub Style In-line Series**

The SureGear PGD series sets a new standard in applications requiring extremely high-torque ratings and rigidity. The compact design and hub-style output is ideal for equipment that requires high-speed, high-precision indexing movement. The remarkable torsion stiffness and the low backlash of the planetary gearing combine to provide outstanding positioning accuracy.

With a backlash rating less than 3 arc-minutes and exceptional torque handling capabilities, the PGD series offers a high performance robust planetary solution for OEM customers. The PGD reducer is often used for larger indexing applications and dial tables commonly found in packaging and filling equipment and assembly automation systems.

## Features

- Thread-in mounting style
- Best-in-class backlash
- Four gear ratios available (5:1, 10:1, 15:1, 25:1), Two additional for PGD models (35:1 and 50:1)
- Mounting hardware included for attaching to SureServo motors
- Helical-cut planetary gears for quiet operation and reduced vibration
- Right-angle reducer utilizes a spiral bevel gear; motor can be located at a 90° position from the reducer, providing a more compact footprint
- Uncaged needle roller bearings for high rigidity and torque
- Adapter bushing connection for simple and effective attachment to most servo motors
- High-viscosity, anti-separation grease does not migrate away from the gears; no leakage through the seal
- Maintenance free: No need to replace the grease for the life of the unit
- At nominal speed, service life is 20,000 hours
- Can be positioned in any orientation
- IP55 environmental rating
- 5-year warranty



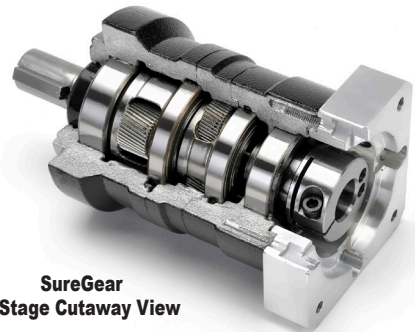
**SureGear  
PGA Gearbox**



**SureGear PGB Gearbox**



**SureGear  
Hub Style PGD Gearbox**



**SureGear  
2-Stage Cutaway View**

## Applications

- Gantries
- Injection-molding machines
- Pick-and-place automation
- Linear slides
- Packaging machines
- Conveyors



# Precision Servo Gearboxes

SureGear® Servo Gearbox Selection												
Servo Motor	Gear Ratio	SureGear Gearbox	Frame Size (mm)	Motor Nominal Output Torque		Combo Nominal Output Torque		Nominal Output Speed ( rpm )	Max Output Speed ( rpm )	Available Load Inertia @ 5:1 Mismatch *		
				N·m	lb·in	N·m	lb·in			kg·cm2	lb·in·s2	
SV2L-201(x) APMC-FAL01xxx	5:1	PGD047-05A1	47	0.32	2.83	1.52	13.44	600	1200.00	6.76	0.006	
		PGA050-05A1	50							6.94	0.006	
		PGA070-05A1	70			1.49	13.16			5.91	0.005	
		PGB070-05A1	70							1.59**	0.001**	
	10:1	PGD047-10A1	47			3.04	26.89	300	600.00	28.15	0.025	
		PGA050-10A1	50							28.35	0.025	
		PGA070-10A1	70			2.98	26.32			25.75	0.023	
		PGB070-10A1	70							8.35**	0.007**	
	15:1	PGA050-15A1	50			4.32	38.21	200	400.00	62.66	0.055	
		PGA070-15A1	70							58.16	0.051	
		PGB070-15A1	70			4.22	37.36			54.11	0.048	
	25:1	PGD047-25A1	47			7.20	63.68	120	240.00	174.69	0.155	
		PGA050-25A1	50							174.69	0.155	
		PGA070-25A1	70			7.04	62.26			162.81	0.144	
		PGB070-25A1	70							151.56	0.134	
	50:1	PGD064-50A1	64			14.40	127.35	60	120.00	661.25	0.585	
SV2L-202(x)	5:1	PGD064-05A2	64	0.64	5.7	3.04	27.08	600	1200.00	28.75	0.025	
		PGA070-05A2	70							29.33	0.026	
		PGB070-05A2	70			2.98				26.51	25.00	0.022
	10:1	PGD064-10A2	64			6.08	54.15	300	600.00	118.80	0.105	
		PGA070-10A2	70							119.40	0.106	
		PGB070-10A2	70			5.95				53.01	102.00	0.090
	15:1	PGA070-15A2	70			8.64	76.95	200	400.00	268.88	0.238	
		PGB070-15A2	70							264.83	0.234	
		PGB090-15A2	90			8.45				75.24	204.75	0.181
	25:1	PGD064-25A2	64			14.40	128.25	120	240.00	747.50	0.662	
		PGA070-25A2	70							748.13	0.662	
		PGB070-25A2	70			14.08	125.40			736.88	0.652	
		PGB090-25A2	90							581.25	0.514	
		PGD090-25A2	90			14.40				128.25	700.00	0.620
	50:1	PGD090-50A2	90			28.80	256.50	60	120.00	2875.00	2.544	
		PGD110-50A2	110							2125.00	1.881	
SV2L-204(x)	5:1	PGD064-05A2	64	1.27	11.2	6.03	53.20	600	1200.00	53.75	0.048	
		PGA070-05A2	70							54.33	0.048	
		PGB070-05A2	70			5.91				52.08	50.00	0.044
	10:1	PGD064-10A2	64			12.07	106.40	300	600.00	218.80	0.194	
		PGA070-10A2	70							219.40	0.194	
		PGB070-10A2	70			11.81				104.16	202.00	0.179
	15:1	PGA070-15A2	70			17.15		151.20	200	400.00	493.88	0.437
		PGB070-15A2	70				16.76				147.84	489.83
		PGB090-15A2	90			429.75						0.380
	25:1	PGD064-25A2	64			28.58	252.00	120	240.00	1372.50		1.215
		PGA070-25A2	70							1373.13	1.215	
		PGB070-25A2	70			27.94	246.40			1361.88	1.205	
		PGB090-25A2	90							1206.25	1.068	
		PGD090-25A2	90			28.58				252.00	1325.00	1.173
	50:1	PGD090-50A2	90			57.15	504.00	60	120.00	5375.00	4.757	
		PGD110-50A2	110							4625.00	4.093	

\* Available load inertia is calculated based on servo motor inertia using the formula: Available Inertia = (5 x Motor Inertia – Gearbox Inertia) x (Gear Ratio)<sup>2</sup> A 5:1 inertia mismatch is a good target for design purposes. Systems with lower or higher mismatch may be possible, depending on operating conditions.

\*\* This gearbox is NOT a suitable choice at a 5:1 mismatch. If inertia balancing is a selection criteria for your end use, please use a mismatch of 8:1 to 10:1.