POWERMAX II®

POWERMAX II® sets the world performance standard for NEMA 23 step motors.

With POWERMAX II you also gain the cost advantages of design for manufacturability (DFM) and North America's most advanced step motor manufacturing line.

That makes POWERMAX II economical without sacrificing features - such as long life bearings, high temperature insulation and quality magnet materials.

Plus DFM means we can build POWERMAX II to your specifications, in the volumes you need, according to your JIT or other delivery schedule.

Standard

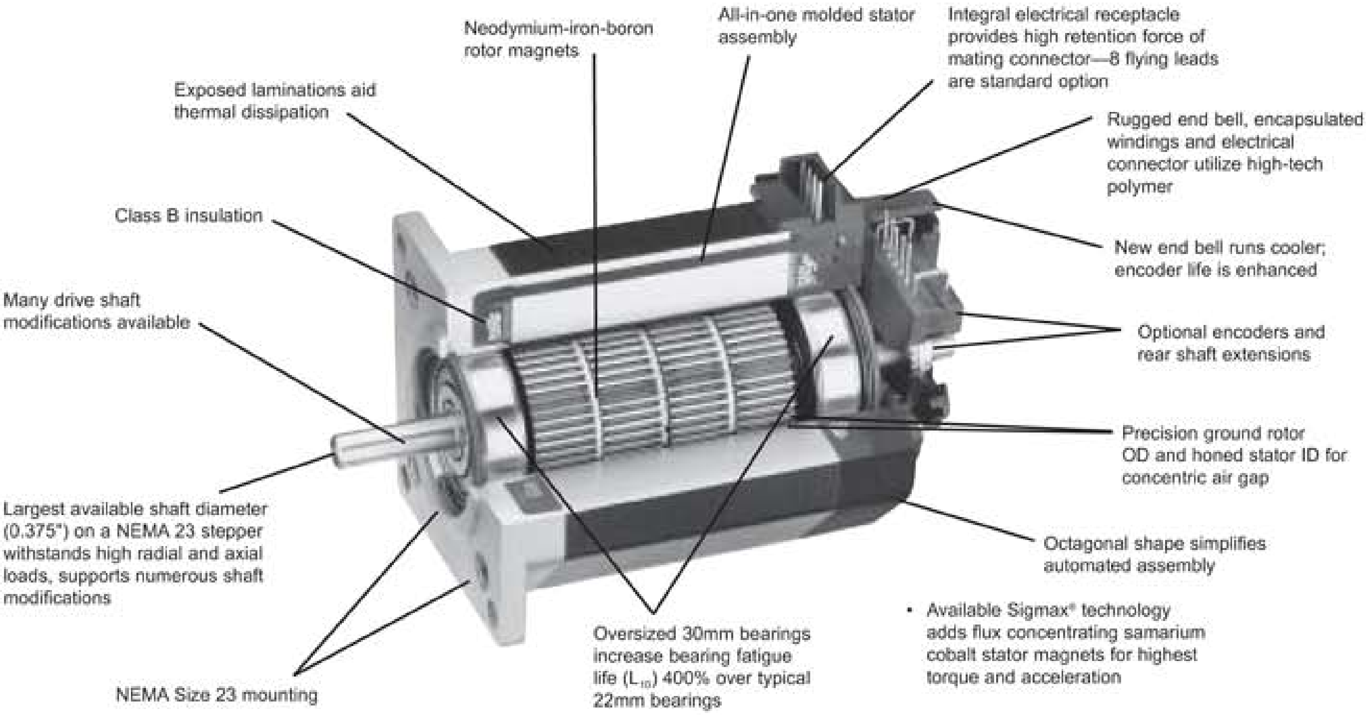
Standard POWERMAX II motors come in half, single and two stacks that provide holding torques from 42 to 253 oz-in.

Custom

POWERMAX II proves that an economical step motor doesn't have to limit your options. It's just the opposite, thanks to flexible manufacturing.

Whether you require a simple drive shaft flat or an integral lead screw, POWERMAX II motors are made to order.

FEATURES	BENEFITS
Two Year Warranty	High quality, dependable operation
Polymer Encapsulated Stator	Exceptional thermal dissipation
Polymer End Bell with Threaded Inserts	End bell runs cooler, provides greater flexibility in mounting encoder
Largest Available Shaft Diameter on a NEMA 23 Stepper	Supports numerous shaft modifications.
Oversized 30mm Bearings	Increases bearing fatigue life (L_{10}), extends motor life, reduces downtime
Sigmax® Technology	Increases available torque
Optional Low Inertia Rotor	Produces the highest acceleration rate possible
Exposed Laminations Aids Thermal Dissipation	Improved heat dissipation extends motor life, reduces downtime.
Precision Ground Rotor OD and Honed Stator ID for Concentric Air Gap in an Economical Motor Design	High quality performance in an economical motor design.



MODEL NUMBER CODE POWERMAX II® motors

P 2 1 N R X A - L N N - N S - 0 0

- **Type**: P=Standard, M=Enhanced (n/a half stack)
- **Size**: 2=NEMA 23 (2.25"across flats)
- **Number of Stacks**: H=Half stack, 1=1 Stack, 2=2 Stacks
- **Mounting**: N=NEMA, S=Special
- **Construction**: R=Regular
- **Termination**: X=Receptacle. For X (receptacle) designation, mating leaded connectors may be ordered separately.
- **Winding Type**: A...per assigned letter
- **Rotor Type**: L=Standard, J=Low inertia (n/a half stack)
- **Shaft Configuration (Diameter & Length)**: N=Single, D=Double, S=Special
- **Shaft Modifications**: N=Smooth, F=Flat, S=Special
- **Encoder Option**: NS=No Feedback
- **Sequence Number**: Insert 00 if all parts are standard. Factory assigned if any parts are custom.

The example model number above indicates a standard NEMA 23 frame motor with a one stack rotor. This motor is equipped with a standard NEMA mount, regular construction, receptacle and an A winding. It also has a standard rotor, a smooth single-ended shaft.

POWERMAX II® MOTOR TECHNOLOGY

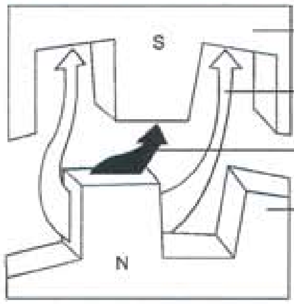
Kollmorgen developed POWERMAX II® for value and performance.

That's why you'll find so many standard POWERMAX II models in the universal NEMA 23 frame size. With POWERMAX II, you can tailor motor torque, acceleration and inertia to every axis of your design. And you can do this economically too, using a single mounting configuration and the stepper driver of your choice.

Does your application require that extra measure of performance? Then consider the POWERMAX II M Series, featuring the patented Sigmax® technology.*

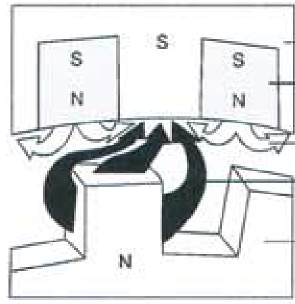
Samarium cobalt magnets in M Series motors concentrate magnetic flux at desired points between the rotor and stator. Sigmax technology optimizes flux paths to increase torque production and current utilization over conventional hybrid designs.

P SERIES STANDARD HYBRID



Typical paths of flux transfer in an energized conventional hybrid step motor. Some flux leakage occurs in normal operation.

M SERIES ENHANCED HYBRID SIGMAX® TECHNOLOGY



Patented Sigmax® technology* redirects magnetic flux to inhibit leakage and optimize torque production.

* Sigmax® technology is covered by U.S. patents 4,712,028, 4,713,470, 4,763,034 and 4,827,164.

TECHNICAL OVERVIEW

Types	
POWERMAX II M Series	Hybrid step motors with rare earth magnets in the stator teeth
POWERMAX II P Series	Hybrid step motors
Rotor construction	
POWERMAX II M and P Series; with "L" rotor designates	Laminated (high speed efficiency)
POWERMAX II M and P Series; with "J" rotor designates	Low mass/low inertia (fast start/stop, high acceleration)
Windings	
A, B, C, D, E, F, G	Standard winding to match any application
Phases	2
Full steps per revolution	200
Full step angle	1.8°
Angular accuracy	
POWERMAX II M and M "J"	±1.5% of one step, no load, non-cumulative
POWERMAX II P and P "J"	±3% of one step, no load, non-cumulative
Operating temperature	-20 to 40°C
Insulation	NEMA Class B, 130°C
Insulation resistance	100 Megohms @500V dc and 25°C
Shaft load ratings	
Max. radial load (at center of std. shaft extension)	20 lb.
Max. axial load (on front shaft extension toward motor)	13 lb.
Bearing life	Since large bearings (30 mm) are used, life is typically about 4 times that of 22 mm or smaller bearings used on other NEMA Size 23 motors. POWERMAX II bearing fatigue life (L_{10}) exceeds 10,000 hours at any rotational speed up to 10,000 full steps/second if operated within the max. radial and axial loads specified above.

CE RoHS

POWERMAX II® HYBRIDS

NEMA 23 FRAME (2.3")—Ratings and Characteristics

Review the Model Number Code to assure that all options are designated. In addition to those below, motors with characteristics for specific performance requirements are offered. Contact factory for more details.

Rated Currents are in descending order	Motor Model Number	Connection: Parallel	Connection: Series	Connection: Unipolar	Holding Torque (2 phases on) oz-in (Nm) ±10%	Rated Current/ Phase (amps DC)	Phase Resistance (ohms) ±10%	Phase Inductance (mH) Typical	Detent Torque oz-in (Nm)	Thermal Resistance (°C/watt)	Rotor Inertia oz-in-S² (kgm² x 10⁻³)	Weight lbs (kg)
Torque range: 42-61 oz-in. .29-.43 Nm	P2HNXXH-LXX-XX-00	•			59 (0.42)	5.2	0.22	0.5	2.5 (0.018)	6.6	0.0010 (0.007)	1.0 (0.45)
	P2HNXXH-LXX-XX-00		•		59 (0.42)	2.6	0.90	1.9				
	P2HNXXH-LXX-XX-00			•	42 (0.29)	3.68	0.44	0.5				
STANDARD P2H Series 1/2 rotor stack	P2HNXXB-LXX-XX-00	•			59 (0.42)	2.6	0.76	1.9				
	P2HNXXB-LXX-XX-00		•		59 (0.42)	1.3	3.04	7.6				
	P2HNXXB-LXX-XX-00			•	42 (0.29)	1.84	1.52	1.9				
	P2HNXXC-LXX-XX-00	•			61 (0.43)	2.5	0.84	2.3				
	P2HNXXC-LXX-XX-00		•		61 (0.43)	1.25	3.36	9.2				
	P2HNXXC-LXX-XX-00			•	43 (0.30)	1.77	1.68	2.3				
	P2HNXXF-LXX-XX-00	•			60 (0.42)	1.61	1.92	5.1				
	P2HNXXF-LXX-XX-00		•		60 (0.42)	0.80	7.68	20.4				
	P2HNXXF-LXX-XX-00			•	42 (0.30)	1.10	3.84	5.1				

All ratings typical and at 25°C unless otherwise noted.

⚠ Colored letter indicates winding.

⚠ With rated current applied. Windings at 130°C and motor unmounted and in still air at 40°C (without heat sink).

⚠ Windings at 130°C and motor in still air at 40°C (without heat sink). Operation of these motors above rated current may cause demagnetization. Contact factory.

⚠ Small signal inductance as measured with impedance bridge at 1kHz, 1 amp.

⚠ Thermal resistance measured with motor hanging in still air (unmounted).

NEMA 23 FRAME (2.3")—Ratings and Characteristics (Con't)

Review the Model Number Code, to assure that all options are designated. In addition to those below, motors with characteristics for specific performance requirements are offered. Contact factory for more details.

Rated Currents are in descending order

	Motor Model Number ⚠	Connection ⚠ Parallel	Series	Unipolar	Holding Torque ⚠ (2 phases on) oz-in (Nm) ±10%	Rated Current/ Phase ⚠ (amps DC)	Phase Resistance (ohms) ±10%	Phase Inductance ⚠ (mH) Typical	Detent Torque oz-in (Nm)	Thermal Resistance ⚠ (°C/watt)	Rotor Inertia oz-in-S² (kgm² x 10⁻⁵)	Weight lbs (kg)
Torque range: 95-144 oz-in. .67-1.02 Nm	M21NXXA-LXX-XX-00	•			142 (1.00)	5.6	0.23	0.7				
	M21NXXA-LXX-XX-00		•		142 (1.00)	2.8	0.92	2.8				
	M21NXXA-LXX-XX-00			•	100 (0.71)	4.0	0.46	0.7				
SIGMAX® M21 Series 1 rotor stack	M21NXXB-LXX-XX-00	•			137 (0.97)	4.6	0.32	1.0				
	M21NXXB-LXX-XX-00		•		137 (0.97)	2.3	1.28	4.0				
	M21NXXB-LXX-XX-00			•	97 (0.68)	3.3	0.64	1.0	9.4 (0.066)	5.5	0.0017 (0.012)	1.5 (0.68)
	M21NXXC-LXX-XX-00	•			144 (1.02)	3.5	0.53	2.0				
	M21NXXC-LXX-XX-00		•		144 (1.02)	1.75	2.12	8.0				
	M21NXXC-LXX-XX-00			•	102 (0.72)	2.5	1.06	2.0				
	M21NXXD-LXX-XX-00	•			135 (0.95)	1.51	2.61	8.7				
	M21NXXD-LXX-XX-00		•		135 (0.95)	0.76	10.4	34.8				
	M21NXXD-LXX-XX-00			•	95 (0.67)	1.07	5.22	8.7				
Torque range: 77-116 oz-in. .54-.82 Nm	P21NXXA-LXX-XX-00	•			114 (0.81)	5.6	0.23	0.8				
	P21NXXA-LXX-XX-00		•		114 (0.81)	2.8	0.92	3.2				
	P21NXXA-LXX-XX-00			•	81 (0.57)	4.0	0.46	0.8				
STANDARD P21 Series 1 rotor stack	P21NXXB-LXX-XX-00	•			111 (0.79)	4.6	0.32	1.1				
	P21NXXB-LXX-XX-00		•		111 (0.79)	2.3	1.28	4.4				
	P21NXXB-LXX-XX-00			•	79 (0.55)	3.3	0.64	1.1	4 (0.028)	5.5	0.0017 (0.012)	1.5 (0.68)
	P21NXXC-LXX-XX-00	•			116 (0.82)	3.5	0.53	2.3				
	P21NXXC-LXX-XX-00		•		116 (0.82)	1.75	2.12	9.2				
	P21NXXC-LXX-XX-00			•	82 (0.58)	2.5	1.06	2.3				
	P21NXXD-LXX-XX-00	•			109 (0.77)	1.51	2.61	10.3				
	P21NXXD-LXX-XX-00		•		109 (0.77)	0.76	10.4	41.2				
	P21NXXD-LXX-XX-00			•	77 (0.54)	1.07	5.22	10.3				

All ratings typical and at 25°C unless otherwise noted.

⚠ Colored letter indicates winding.

⚠ With rated current applied. Windings at 130°C and motor unmounted and in still air at 40°C (without heat sink).

⚠ Windings at 130°C and motor in still air at 40°C (without heat sink). Operation of these motors above rated current may cause demagnetization. Contact factory.

⚠ Small signal inductance as measured with impedance bridge at 1kHz, 1 amp.

⚠ Thermal resistance measured with motor hanging in still air (unmounted).

POWERMAX II® HYBRIDS

NEMA 23 FRAME (2.3")—Ratings and Characteristics (Con't.)

Review the Model Number Code, to assure that all options are designated. In addition to those below, motors with characteristics for specific performance requirements are offered. Contact factory for more details.

Rated Currents are in descending order	Motor Model Number	Connection Parallel	Connection Series	Connection Unipolar	Holding Torque (2 phases on) oz-in (Nm) ±10%	Rated Current/ Phase (amps DC)	Phase Resistance (ohms) ±10%	Phase Inductance (mH) Typical	Detent Torque oz-in (Nm)	Thermal Resistance (°C/watt)	Rotor Inertia oz-in-S² (kgm² x 10⁻³)	Weight lbs (kg)
Torque range: 161-253 oz-in. 1.13-1.79 Nm	M22NXXA-LXX-XX-00	•			230 (1.62)	6.5	0.21	0.7	17 (0.12)	4.5	0.0036 (0.025)	2.5 (1.13)
	M22NXXA-LXX-XX-00		•		230 (1.62)	3.3	0.84	2.8				
	M22NXXA-LXX-XX-00			•	163 (1.15)	4.6	0.42	0.7				
SIGMAX® M22 Series 2 rotor stack	M22NXXB-LXX-XX-00	•			253 (1.79)	4.6	0.38	1.7				
	M22NXXB-LXX-XX-00		•		253 (1.79)	2.3	1.52	6.8				
	M22NXXB-LXX-XX-00			•	179 (1.26)	3.3	0.76	1.7				
	M22NXXC-LXX-XX-00	•			238 (1.68)	3.1	0.78	3.1				
	M22NXXC-LXX-XX-00		•		238 (1.68)	1.55	3.12	12.4				
	M22NXXC-LXX-XX-00			•	168 (1.19)	2.2	1.56	3.1				
	M22NXXD-LXX-XX-00	•			238 (1.68)	2.5	1.22	5.0				
	M22NXXD-LXX-XX-00		•		238 (1.68)	1.25	4.88	20.0				
	M22NXXD-LXX-XX-00			•	168 (1.19)	1.77	2.44	5.0				
	M22NXXE-LXX-XX-00	•			227 (1.60)	1.64	2.71	10.1				
	M22NXXE-LXX-XX-00		•		227 (1.60)	0.82	10.8	40.4				
	M22NXXE-LXX-XX-00			•	161 (1.13)	1.16	5.42	10.1				
Torque range: 138-214 oz-in. .97-1.51 Nm	P22NXXA-LXX-XX-00	•			197 (1.39)	6.5	0.21	0.8	7 (0.049)	4.5	0.0036 (0.025)	2.5 (1.13)
	P22NXXA-LXX-XX-00		•		197 (1.39)	3.3	0.84	3.2				
	P22NXXA-LXX-XX-00			•	139 (0.98)	4.6	0.42	0.8				
STANDARD P22 Series 2 rotor stack	P22NXXB-LXX-XX-00	•			214 (1.51)	4.6	0.38	2.1				
	P22NXXB-LXX-XX-00		•		214 (1.51)	2.3	1.52	8.4				
	P22NXXB-LXX-XX-00			•	151 (1.07)	3.3	0.76	2.1				
	P22NXXC-LXX-XX-00	•			203 (1.43)	3.1	0.78	3.9				
	P22NXXC-LXX-XX-00		•		203 (1.43)	1.55	3.12	15.6				
	P22NXXC-LXX-XX-00			•	144 (1.01)	2.2	1.56	3.9				
	P22NXXD-LXX-XX-00	•			203 (1.43)	2.5	1.22	6.2				
	P22NXXD-LXX-XX-00		•		203 (1.43)	1.25	4.88	24.8				
	P22NXXD-LXX-XX-00			•	144 (1.01)	1.77	2.44	6.2				
	P22NXXE-LXX-XX-00	•			195 (1.38)	1.64	2.7	12.6				
	P22NXXE-LXX-XX-00		•		195 (1.38)	0.82	10.8	50.4				
	P22NXXE-LXX-XX-00			•	138 (0.97)	1.16	5.4	12.6				

All ratings typical and at 25°C unless otherwise noted.

⚠ Colored letter indicates winding.

⚠ With rated current applied. Windings at 130°C and motor unmounted and in still air at 40°C (without heat sink).

⚠ Windings at 130°C and motor in still air at 40°C (without heat sink). Operation of these motors above rated current may cause demagnetization. Contact factory.

⚠ Small signal inductance as measured with impedance bridge at 1kHz, 1 amp.

⚠ Thermal resistance measured with motor hanging in still air (unmounted).

POWERMAX II®
HYBRIDS WITH LOW INERTIA ROTORS

ROTOR INERTIA CHARACTERISTICS . . . POWERMAX II® motors

Single and double stack POWERMAX II® motors are available with both standard and low inertia rotors. Choose low inertia to produce the highest acceleration rates possible.

Low inertia rotor Standard rotor

ACCELERATION COMPARISON

	Model	Rotor Type	⚠ Inertia oz-in-S² x 10⁻³/ kgm² x 10⁻³	Theoretical Normalized ⚠ Acceleration comparison
Single Stack	P21NRXX-L	Standard	1.68/0.010	1
	P21NRXX-J	Low inertia	1.30/0.008	1.27
	M21NRXX-L	Standard	1.68/0.010	1.23
	M21NRXX-J	Low inertia	1.30/0.008	1.59
Double Stack	P22NRXX-L	Standard	3.57/0.022	1
	P22NRXX-J	Low inertia	2.59/0.016	1.30
	M22NRXX-L	Standard	3.57/0.022	1.16
	M22NRXX-J	Low inertia	2.59/0.016	1.63

⚠ Low inertia rotors not offered for half stack models

⚠ Comparative values for normalized acceleration of unloaded motors. Base value is standard hybrid motor with standard rotor, indicated for single and double stack lengths.

Actual acceleration capability depends on load, velocity profile and driver power. Comparisons made with 90°C temperature rise using bipolar driver.

NEMA 23 FRAME (2.3")—Ratings and Characteristics

Review the Model Number Code, to assure that all options are designated. Contact factory for more details.

	Motor Model Number ⚠	Connection ⚠ Parallel	Series	Unipolar	Holding Torque ⚠ (2 phases on) oz-in (Nm) ±10%	Rated Current/ Phase ⚠ (amps DC)	Phase Resistance (ohms) ±10%	Phase Inductance ⚠ (mH) Typical	Detent Torque oz-in (Nm)	Thermal Resistance ⚠ (°C/watt)	Rotor Inertia oz-in-S² (kgm² x 10⁻⁵)	Weight lbs (kg)
Torque range: 99-140 oz-in. .70-.99 Nm	M21NXXA-JXX-XX-00	•			140 (0.99)	5.6	0.23	0.7	9.4 (0.066)	5.5	0.0013 (0.009)	1.5 (0.68)
SIGMAX® M21 Series 1 rotor stack	M21NXXA-JXX-XX-00		•		140 (0.99)	2.8	0.92	2.8				
	M21NXXA-JXX-XX-00			•	99 (0.70)	4.0	0.46	0.7				
Torque range: 79-111 oz-in. .55-.78 Nm	P21NXXA-JXX-XX-00	•			111 (0.78)	5.6	0.23	0.9	4 (0.028)			
STANDARD P21Series 1 rotor stack	P21NXXA-JXX-XX-00		•		111 (0.78)	2.8	0.92	3.6				
	P21NXXA-JXX-XX-00			•	79 (0.55)	4.0	0.46	0.9				
Torque range: 178-252 oz-in. 1.26-1.78 Nm	M22NXXB-JXX-XX-00	•			252 (1.78)	4.6	0.38	1.5	17 (0.12)	4.5	0.0026 (0.018)	2.5 (1.13)
SIGMAX® M22 Series 2 rotor stack	M22NXXB-JXX-XX-00		•		252 (1.78)	2.3	1.52	6.0				
	M22NXXB-JXX-XX-00			•	178 (1.26)	3.3	0.76	1.5				
Torque range: 142-201 oz-in. 1.00-1.42 Nm	P22NXXB-JXX-XX-00	•			201 (1.42)	4.6	0.38	1.8	7 (0.049)			
STANDARD P22 Series 2 rotor stack	P22NXXB-JXX-XX-00		•		201 (1.42)	2.3	1.52	7.2				
	P22NXXB-JXX-XX-00			•	142 (1.00)	3.3	0.76	1.8				

All ratings typical and at 25°C unless otherwise noted.

⚠ With rated current applied. Windings at 130°C and motor unmounted and in still air at 40°C (without heat sink).

⚠ Thermal resistance measured with motor hanging in still air (unmounted).

⚠ Windings at 130°C and motor in still air at 40°C (without heat sink). Operation of these motors above rated current may cause demagnetization. Contact factory

⚠ Small signal inductance as measured with impedance bridge at 1kHz, 1 amp.

INSTALLATION BULLETIN

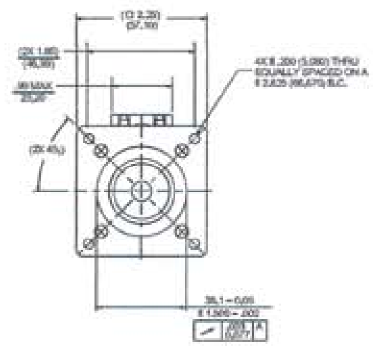
POWERMAX II® Hybrid Step Motors

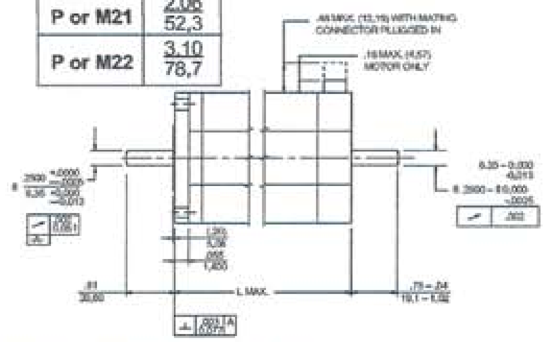
- Dimensions
- Connections
- Encoder Option
- Installation Guidelines
- Warranty/Return Authorization

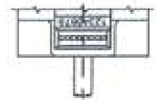
DIMENSIONS...POWERMAX II® Hybrids

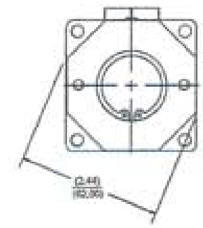
in./mm (metric dim. for ref. only)

Motor Model	L Max.
P2H	1.60 / 40,7
P or M21	2.06 / 52,3
P or M22	3.10 / 78,7



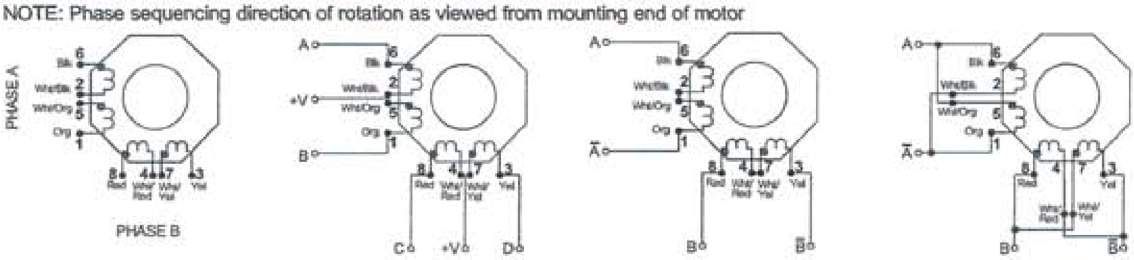






CONNECTION INFORMATION...Terminations and phase sequencing

NOTE: Phase sequencing direction of rotation as viewed from mounting end of motor



8 lead motor (reference only)

6-Lead connection (Unipolar)

4-Lead motor (Bipolar)

DRIVER CONNECTION ⚠ (CCW ↓ / CW ↑)

STEP	A	B	C	D
1	GND	O	GND	O
2	O	GND	GND	O
3	O	GND	O	GND
4	GND	O	O	GND
1	GND	O	GND	O

Unipolar full step

DRIVER CONNECTION ⚠ (CCW ↓ / CW ↑)

STEP	A	$\overline{A}$	B	$\overline{B}$
1	+	–	–	+
2	–	+	–	+
3	–	+	+	–
4	+	–	+	–
1	+	–	–	+

Bipolar full step

Notes:

⚠ 0 = off or open
\+ = positive current flow
\- = negative current flow
GND = ground

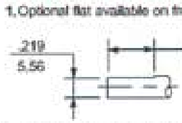
Four different leaded connectors are available.
Order the "GW" part number as a separate item.

Part Number	Phase Connection	Pin No.	Connector/Leadwire Assembly Lead Colors	Driver Connection
GW0000F (8 Lead)	bipolar series	6	Black	A
		1	Orange	$\overline{A}$
		8	Red	B
		3	Yellow	$\overline{B}$
		2 & 5	Wht/Blk & Wht/Org	none
		4 & 7	Wht/Red & Wht/Yel	none
	bipolar parallel	6 & 5	Blk & Wht/Org	A
		1 & 2	Org & Wht/Blk	$\overline{A}$
		8 & 7	Red & Wht/Yel	B
		3 & 4	Yel & Wht/Red	$\overline{B}$
	unipolar	6	Black	A
		1	Orange	B
		8	Red	C
		3	Yellow	D
		2 & 5	Wht/Blk & Wht/Org	+V
		4 & 7	Wht/Red & Wht/Yel	+V
GW0000E (6 Lead)	unipolar	6	Black	A
		1	Orange	B
		8	Red	C
		3	Yellow	D
		2 & 5	Wht/Blk & Org	+V
		4 & 7	Wht/Red & Yel	+V
GW0000H (4 Lead)	bipolar parallel	6 & 5	Black	A
		1 & 2	Orange	$\overline{A}$
		8 & 7	Red	B
		3 & 4	Yellow	$\overline{B}$
GW0000L (4 Lead)	bipolar series	6	Black	A
		1	Orange	$\overline{A}$
		8	Red	B
		3	Yellow	$\overline{B}$

Motor Model	L Max.
P2H	1.60 / 40,7
P or M21	2.06 / 52,3
P or M22	3.10 / 78,7

STANDARD SHAFT OPTIONS

1. Optional flat available on front shaft as shown.



⚠ Optional rear shaft extension available as shown. Same diameter as front shaft extension.

Typical leaded connector (4-lead shown)