

# MODEL 6410

Holding torque range:  
158-1284 ox-in.  
(1.12 to 9.07 Nm)

## Microstepping Drive Module. 0.625 to 5 A rms, 7.1 A peak (microstepping) per phase output. 24 to 75 Vdc

- Single power supply input
- Patented 4-phase Bipolar Chopper Drive for superior current regulation and low ripple current
- Output current adjustable from 0.625 A to 5 A rms with 3 position dipswitch
- Microstepping provides smooth operation and increased resolution
- Patented Digital Electronic Damping™ reduces instability at mid-speed ranges
- Idle current reduction reduces motor heating in many applications
- Selectable step filter rejects noise on step input
- Fault protection:
  - Line-to-line and line-to-neutral shorts
  - Internal power supply under-voltage
  - Bus overvoltage
- Compact size

Model 6410 is an economical, compact stepper drive that converts step and direction inputs into winding currents for two-phase stepper motors. The 6410 can operate with a single power supply ranging from 24 to 75 Vdc. Output voltage is equal to that of the power supply. Output current is adjustable from 0.625 to 5 A rms. The default output current is 5 A rms.

Its compact size of 1.5" W x 5" H x 4.3" deep requires only 7.5 square inches of panel space!

## TYPICAL APPLICATIONS

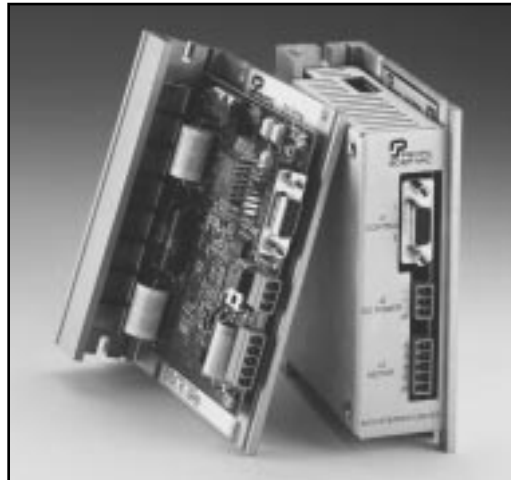
- X-Y tables and slides
- Packaging machinery
- Robotics
- Speciality machinery
- Index feed of materials
- Labeling machines

## MICROSTEPPING

Microstepping assures smooth, low speed operation, smoother operation through resonance regions and optimum system resolution. Resolution with 1.8° motors is adjustable to 50,000 steps per revolution with decimal step size selected and to 51,200 with binary step size selected. See the Step Size table on page C-8. The 6410 switches to full step operation above 150 RPM.

## FULL TORQUE AT ALL SPEEDS

A patented **Digital Electronic Damping** circuit ensures the availability of full motor torque at all speed ranges. This compensation damps motor oscillations common with stepper systems. Whether in the full step or microstepping mode, full motor torque is achieved throughout the speed range.



## HIGH EFFICIENCY BIPOLAR CHOPPING

Patented, 4-phase PWM chopping electronically controls the motor winding currents at 20 KHz frequency. This combines the best of recirculating and nonrecirculating current regulation to provide high back EMF rejection with low ripple current. The benefits include reduced heat dissipation, low electrical noise and improved current control during dynamic braking.

The patented 4 phase control circuit combined with Digital Electronic Damping, provides significantly more motor output power than from other drives.

## IDLE CURRENT REDUCTION

This useful function permits an automatic 50% reduction in motor winding current during motor idle conditions to minimize heating during dwell periods. If no step commands have been received for 0.1 second (0.05 and 1.0 seconds can also be selected through DIP switch settings - see page C-10), the current is automatically reduced. Current is restored to full amplitude upon arrival of a step command.

## HEAT SINKS

Heat can be removed from the rear of the drive (cold plate mounting) or from the side with an optional side mounted heat sink. See the drawing on page C-10. Providing alternate methods for heat removal allows flexibility for system packaging.

The optional side mounted heat sink adds only 1.0 inch to the width.

## FAULT PROTECTION

- Line-to-line and line-to-neutral shorts
- Internal power supply under-voltage
- Bus overvoltage

## AGENCY APPROVAL

UL recognized - 508C (Type R) - file # E137798

Meets CSA Standard, C22.2 #142-M1987

Meets IEC vibration standard, #68-2-6

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## GENERAL . . . Model 6410

Input Power Voltage	. . . . .	.24 Vdc to 75 Vdc																														
Input Power Current	. . . . .	.Motor and load dependent. Usually < motor phase current.																														
Output motor phase current	. . . . .	.See Figure C-4, page C-10 5 A rms max. (5 A peak full step, 7.1 A peak microstepping) Adjustable from 0.625 to 5 A rms in 0.625 amp increments																														
Inputs	. . . . .	.See Figures C-2 and C-3, page C-9																														
Step	. . . . .	.Optically isolated TTL compatible Minimum opto current (opto on): 5.5 ma Maximum opto current (opto on): 10 ma Minimum pulse width: 250 ns (1 $\mu$ s when step filter enabled) Maximum frequency: 2.0 MHz (500 KHz when step filter enabled) Motion occurs on low-to-high transition of STEP input (J3 Pin 6)																														
Dir	. . . . .	.Optically isolated TTL compatible For normal motor connections: Current in opto (opto on): Rotation CCW looking at motor shaft Minimum opto current (opto on): 3 ma Maximum opto current (opto on): 4.5 ma Minimum setup time: 50.0 $\mu$ s Minimum hold time: zero																														
Enable	. . . . .	.Optically isolated TTL compatible Sense of ENABLE input can be changed using ENBL_SENSE jumper: Jumper In: Current in opto (opto on) enables drive Jumper Out: Current in opto (opto on) disables drive Minimum opto current (opto on): 3 ma Maximum opto current (opto on): 4.5 ma																														
Outputs	. . . . .	.See Figures C-2 and C-3, page C-9																														
Enabled	. . . . .	.Optically isolated open collector, open emitter Drive Enabled: opto transistor on, $V_{sat} = 0.5$ V max. @ 2.0 ma Drive Disabled: opto transistor off, $V_{ce}$ max. = 35 V																														
Step Size	. . . . .	.See Figure C-4, page C-10 Set using 3 positions of DIP switch and decimal jumper Note: Binary values are in <b>Bold</b> .																														
		<table border="0"> <thead> <tr> <th><u>Step Size</u></th> <th><u>Steps per Revolution</u></th> <th><u>Maximum RPM*</u></th> </tr> </thead> <tbody> <tr> <td></td> <td>(1.8° motor)</td> <td></td> </tr> <tr> <td>Full (<b>1/2</b>)</td> <td>200 (<b>400</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/2 (<b>1/4</b>)</td> <td>400 (<b>800</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/5 (<b>1/8</b>)</td> <td>1000 (<b>1600</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/10 (<b>1/16</b>)</td> <td>2000 (<b>3200</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/25 (<b>1/32</b>)</td> <td>5000 (<b>6400</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/50 (<b>1/64</b>)</td> <td>10000 (<b>12800</b>)</td> <td>12000 (<b>9000</b>)</td> </tr> <tr> <td>1/125 (<b>1/128</b>)</td> <td>25000 (<b>25600</b>)</td> <td>4800 (<b>4600</b>)</td> </tr> <tr> <td>1/250 (<b>1/256</b>)</td> <td>50000 (<b>51200</b>)</td> <td>2400 (<b>2300</b>)</td> </tr> </tbody> </table>	<u>Step Size</u>	<u>Steps per Revolution</u>	<u>Maximum RPM*</u>		(1.8° motor)		Full ( <b>1/2</b> )	200 ( <b>400</b> )	12000 ( <b>12000</b> )	1/2 ( <b>1/4</b> )	400 ( <b>800</b> )	12000 ( <b>12000</b> )	1/5 ( <b>1/8</b> )	1000 ( <b>1600</b> )	12000 ( <b>12000</b> )	1/10 ( <b>1/16</b> )	2000 ( <b>3200</b> )	12000 ( <b>12000</b> )	1/25 ( <b>1/32</b> )	5000 ( <b>6400</b> )	12000 ( <b>12000</b> )	1/50 ( <b>1/64</b> )	10000 ( <b>12800</b> )	12000 ( <b>9000</b> )	1/125 ( <b>1/128</b> )	25000 ( <b>25600</b> )	4800 ( <b>4600</b> )	1/250 ( <b>1/256</b> )	50000 ( <b>51200</b> )	2400 ( <b>2300</b> )
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		*1. Consult factory if operating motor above 3000 RPM. 2. To determine maximum RPM when 500 KHz step filter is enabled multiply $\frac{1}{\text{steps per rev}}$ x 30 million. Note that maximum should not exceed 12000 RPM																														
Idle Current Reduction	. . . . .	.See Figure C-4, page C-10 Enabled or disabled with DIP switch, 50% output current reduction after 0.1 second from last step command (0.05 and 1.0 second timeouts can also be selected using a plug-on jumper. Consult factory for other current reduction options).																														
<b>DIGITAL ELECTRONIC DAMPING</b>	. . . . .	.See Figure C-4, page C-10 Enabled or disabled with DIP switch Max. delay from input step to change in motor excitation: Step frequency < 500 full steps/sec: 500 $\mu$ s Step frequency > 500 full steps/sec: 270° of step period																														
Protection	. . . . .	(Any fault disables the drive and must be cleared by cycling input power) Line-to-line short, line to neutral, internal supply under voltage bus over voltage (83 Vdc)																														
Mechanical																																
Dimensions	. . . . .	.5" x 1.5" x 4.3"																														
Weight	. . . . .	.1 lb nominal																														
Connectors	. . . . .	.See Figure C-2, Page C-9																														
Power Supply	. . . . .	.Contact plug-in screw terminal																														
Motor	. . . . .	.Contact plug-in screw terminal																														
Signal	. . . . .	.D-sub miniature socket																														

# ENVIRONMENTAL . . . Model 6410

- Storage Temperature . . . . . -55°C to +70°C
- Operating Temperature . . . . . Full rated current 0° to 50°C ambient air with or without cover  
provide chassis properly mounted so as not to exceed 60°C
- Maximum Chassis TEMPERATURE . . . . . 60°C  
Note: For optimal thermal performance, mount the 6410 chassis (back or side) to a cooling plate or heatsink. Use a thermal pad or grease if surface is irregular. A fan or idle current reduction may be employed to keep chassis below 60°C
- Convection Cooling . . . . . (6410 not mounted on cooling plate)
  - With optional heat sink . . . . . Full rating (5A) at 25°C Ambient  
2.5A max at 45°C Ambient
  - Without optional heat sink . . . . . 2.5A max at 25°C Ambient  
1.25A max at 45°C Ambient
- Humidity Range . . . . . 10% to 90%, non-condensing

## POWER DISSIPATION VS. OUTPUT CURRENT

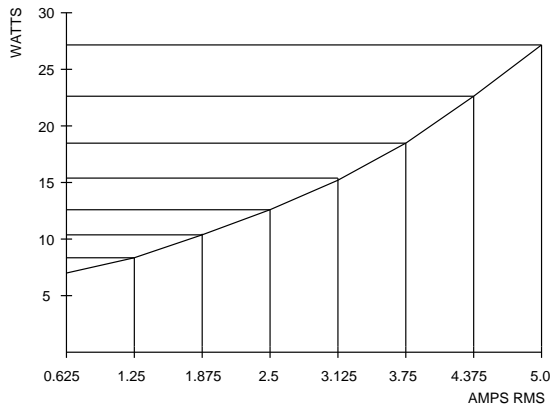


Figure C-1. Power Dissipation vs. Output Current

## CONNECTION DIAGRAM

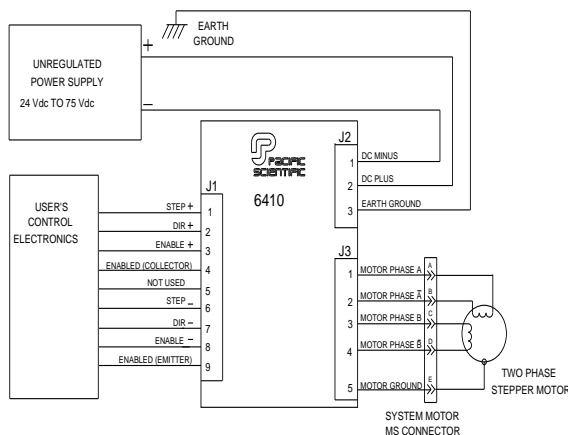
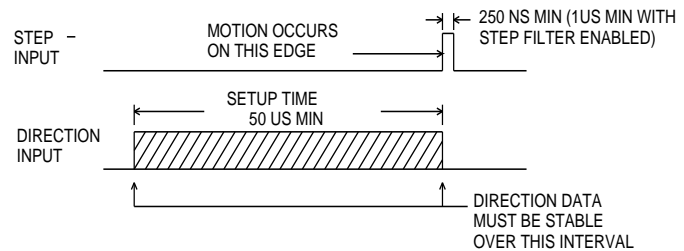
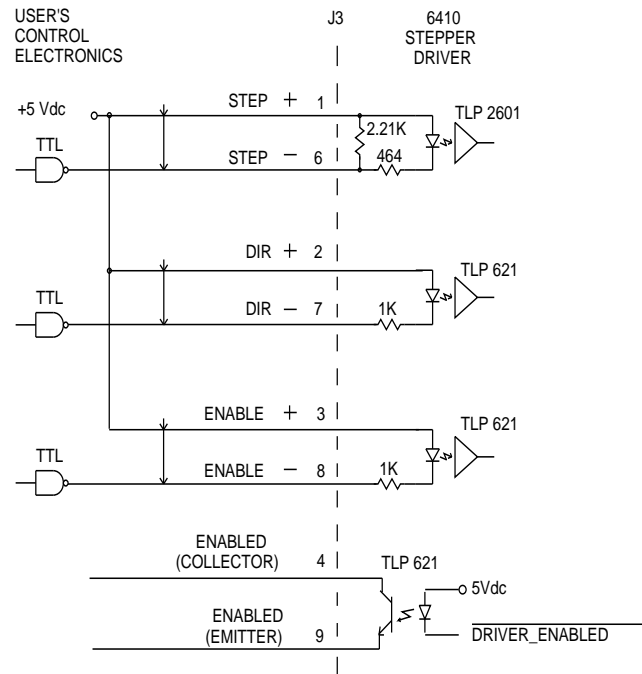


Figure C-2. Connection Diagram

## INTERFACE CIRCUITS



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## DIP SWITCH (S1) SETTINGS (FIG. 4). . .Model 6410

- Output motor phase current
- Step size and rate
- Idle current reduction

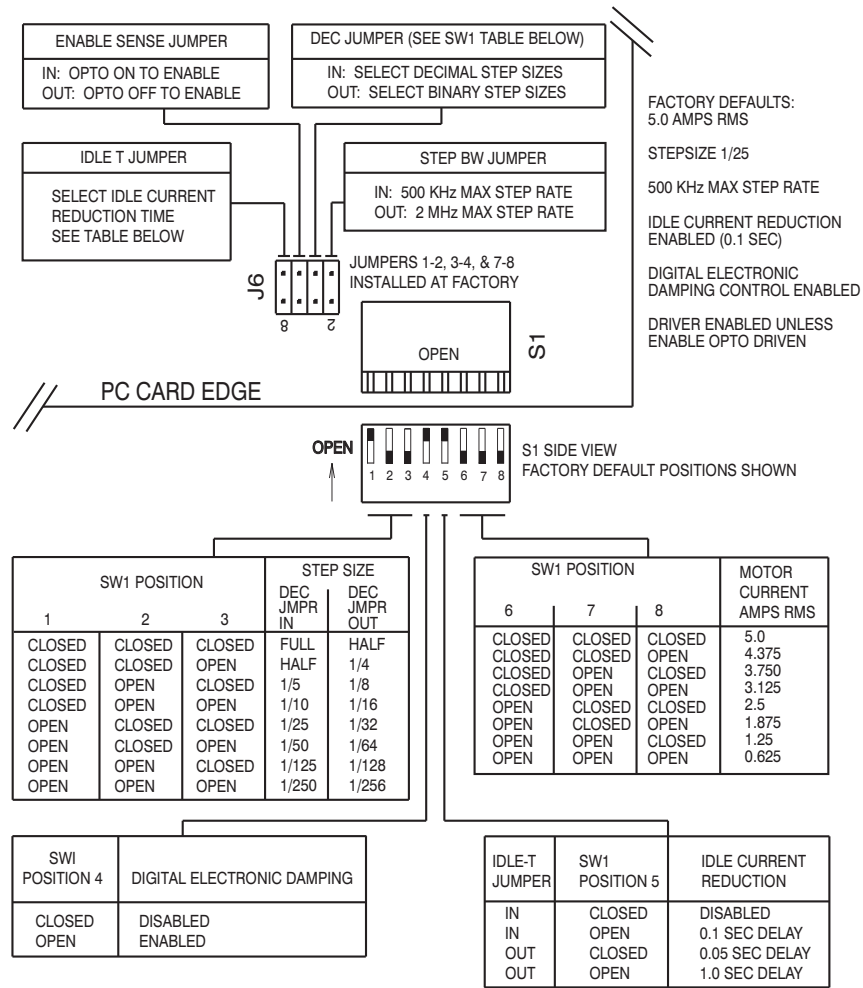
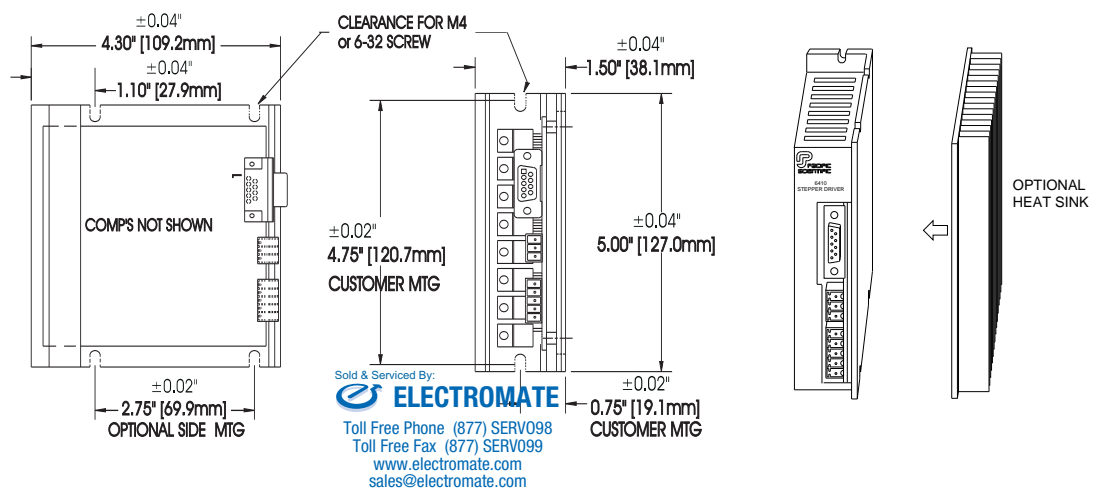


Figure C-4. DIP Switch (S1) Settings

## DIMENSIONS. . .Model 6410 [mm—dimensions for ref.]



## FUNCTIONAL ENHANCEMENT

The 6410 microstepping drive is the core component utilized in a full family of products adding enhanced functionality.

### ADDITIONAL PRODUCTS

#### 24-75 Vdc Input:

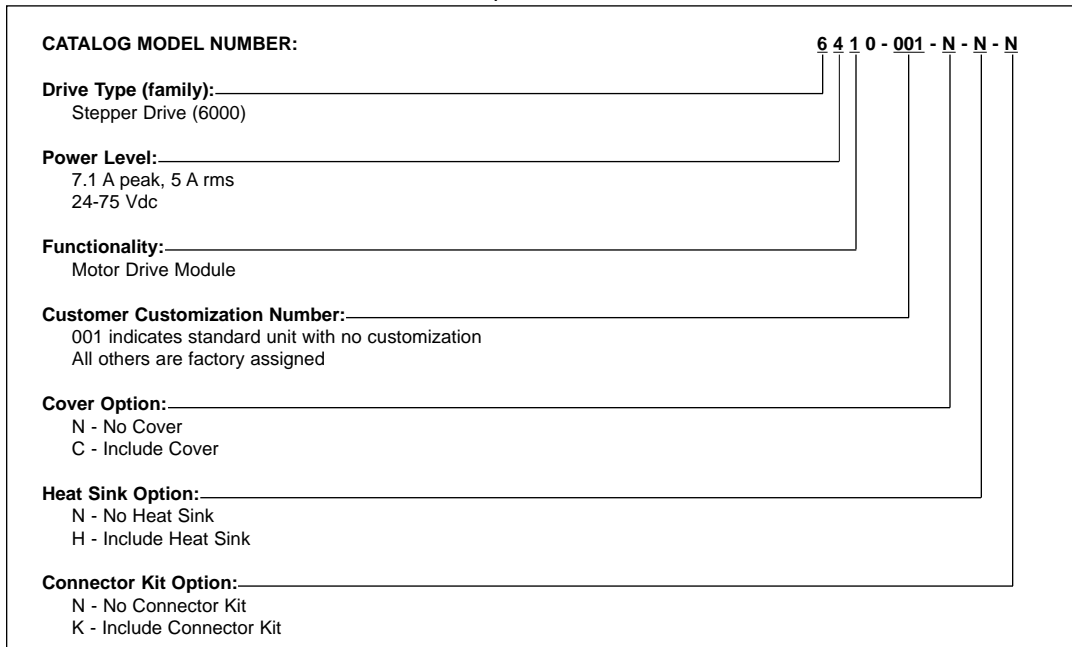
- 6415 Oscillator/Drive . . . . . ± 0-10 Vdc input or on board potentiometers
- 6420 Indexer/Drive . . . . . RS232/RS485 programmable package, mnemonic language, 8 BDIO

#### 120/240 VAC 50-60HZ INPUT:

- 6430 Package . . . . . 6410 drive with AC input
- 6435 Package . . . . . 6415 oscillator/drive with AC input
- 6440 Package . . . . . 6420 indexer/drive with AC input
- 6445 Package . . . . . 6410 drive with Stepper Basic indexer with AC input

## HOW TO ORDER. . . Model 6410 recommended systems

Order the 6410, accessories and motor as separate model numbers.



NOTE: Standard drive includes Data Sheet. Manual/Design Guide ordered separately.

**6410 Accessories:** Order in accordance with the following model number codes:

<u>Part No.</u>	<u>Description</u>
CV6410	Cover (includes fastening screws)
HS6410	Heat Sink (includes fastening screws)
CK6410	Connector Kit (includes all mating connectors) 9-pin D-shell and Phoneix Connectors for J3-motor: Phoneix p/n: MC 1.5/5-ST-3.81 and J2-DC input: MC 1.5/3-ST-3.81
MA6410	User Manual / Design Guide
SPC-XXX-6410	With control connector and motor MS connector. Four conductor shielded wire plus ground. In place of XXX, specify length in even one foot increments from 001 to 050 feet. Consult factory for longer lengths.
SPC-CO-XXX	Motor Power Cable Only. Four conductor shielded wire plus ground. In place of XXX, specify length in even one foot increments.

  
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## SYSTEM RATINGS AND CHARACTERISTICS

5.0 A,  
65V per phase

### Model 6410 with recommended E Series motors

See E Series motors . . . NEMA 34 (3.4") and NEMA 42 (4.2") on page C-15.

OD (in)	Motor Model Number $\Delta$	Drive Current/Phase (amps DC)	Holding Torque (2 phases on) ox-in (Nm) $\pm 10\%$	Detent Torque oz-in (Nm)	Rotor inertia oz-in-S2 (kgm <sup>2</sup> x 10 <sup>-3</sup> )	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
<b>Maximum torque at low speed (see plot T in performance curve)</b>								
3.4	E31NX-HTLNN-NS500	5.0	319 (2.25)	21.5 (0.15)	0.0083 (0.051)	3.2 (1.45)	155	1350
3.4	E32NX-HTLNN-NS500	5.0	638 (4.51)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	160	750
3.4	E33NX-HTLNN-NS500	5.0	958 (6.77)	69.3 (0.45)	0.0250 (0.155)	7.6 (3.45)	175	600
3.4	E34HX-HTLNN-NS500	5.0	1222 (8.63)	83.0 (0.59)	0.0350 (0.217)	9.7 (4.41)	175	450
3.4	E41HX-HTLNN-NS500	5.0	1284 (9.07)	58.0 (0.41)	0.0800 (0.496)	14.0 (6.36)	177	450
<b>Maximum torque at HIGH speed (see plot P in performance curve)</b>								
3.4	E32NX-HPLNN-NS500	5.0	474 (3.35)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	240	1650
3.4	E33NX-HPLNN-NS500	5.0	711 (5.02)	69.3 (0.45)	0.0250 (0.155)	7.6 (3.45)	260	1200
3.4	E34HX-HPLNN-NS500	5.0	948 (6.69)	83.0 (0.59)	0.0350 (0.217)	9.7 (4.41)	240	900

2.5 A,  
65V per phase

### Model 6410 with recommended E Series motors

See E Series motors...NEMA 23 (2.3" and NEMA 34 (3.4") on page C-15.

OD (in)	Motor Model Number $\Delta$	Driver Current/Phase (amps DC)	Holding Torque (2 phases on) ox-in (Nm) $\pm 10\%$	Detent Torque oz-in (Nm)	Rotor inertia oz-in-S2 (kgm <sup>2</sup> x 10 <sup>-3</sup> )	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
<b>Maximum torque at low speed (see plot T in performance curve)</b>								
2.3	E22NX-LTLNN-NS500	2.5	225 (1.59)	9.6 (0.07)	0.0031 (0.019)	2.1 (0.95)	54	1650
3.4	E31NX-LTLNN-NS500	2.5	319 (2.25)	21.5 (0.15)	0.0083 (0.051)	3.2 (1.45)	75	600
3.4	E32NX-LTLNN-NS500	2.5	638 (4.51)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	80	450
<b>Maximum torque at HIGH speed (see plot P in performance curve)</b>								
2.3	E22NX-LPLNN-NS500	2.5	158 (1.12)	9.6 (0.07)	0.0031 (0.019)	2.1 (0.95)	155	2850
3.4	E31NX-LPLNN-NS500	2.5	237 (1.67)	21.5 (0.15)	0.0083 (0.051)	3.2 (1.45)	115	1500
3.4	E32NX-LPLNN-NS500	2.5	474 (3.35)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	120	900

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

$\Delta$  See page C-15 for motor options. X denotes the construction of the motor, refer to page C-11 for various options. Also refer to Model Number Codes in the system configured hybrid step motor section page C-82.

$\Delta$  When operated at listed drive current.

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## Model 6410 torque/speed curves with recommended motors

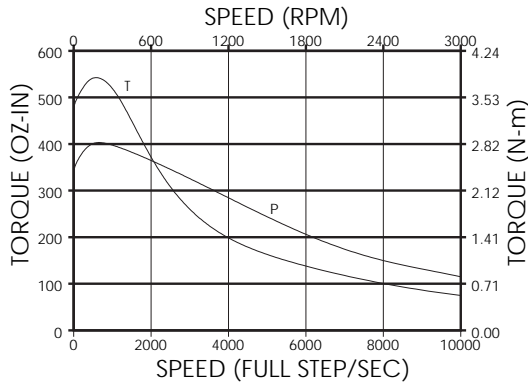
5.0 A,  
65V per phase

Motors will perform continuously as shown without the winding temperature rise exceeding 90°C when the motor is operated (without heat sink) in an ambient temperature of up to 40°C. The curves do not reflect systems resonance points which will vary with motor coupling and systems parameters. In addition to those shown below, Pacific Scientific offers a wide range of other motor windings to meet specific performance requirements. Consult factory.

### PERFORMANCE AT 5.0A (RMS)/65V PER PHASE

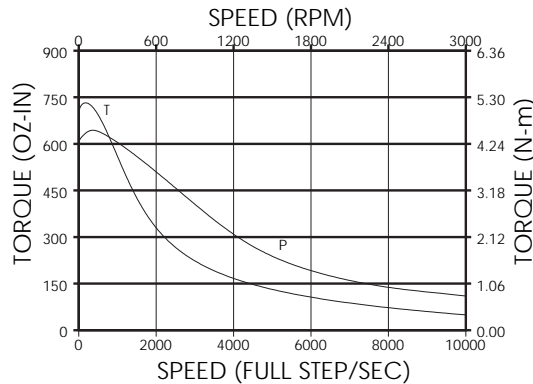
#### (3" MOTOR-TWO ROTOR STACK)

E32NX-HTLNN-NS00  
E32NX-HPLNN-NS00  
5.0A/65V PER PHASE



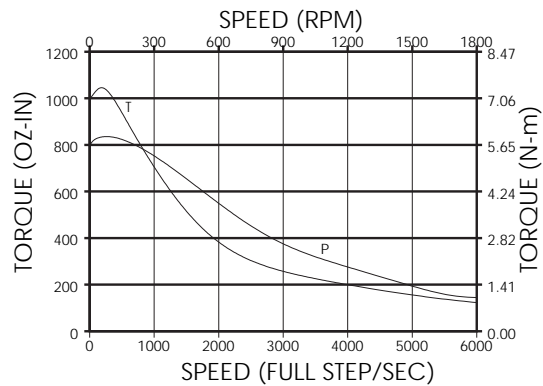
#### (3" MOTOR-THREE ROTOR STACKS)

E33NX-HTLNK-NS00  
E33NX-HPLNK-NS00  
5.0A/65V PER PHASE



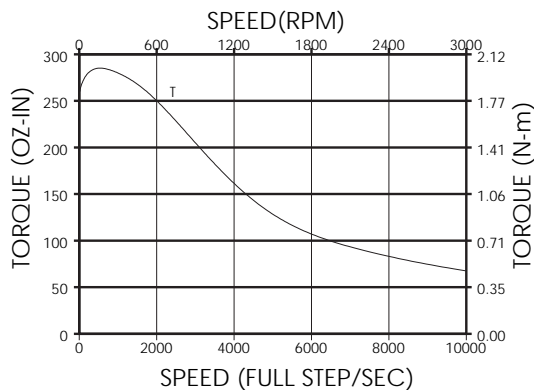
#### (3" MOTOR-FOUR ROTOR STACKS)

E34HX-HTLNK-NS00  
E32HX-HPLNK-NS00  
5.0A/65V PER PHASE



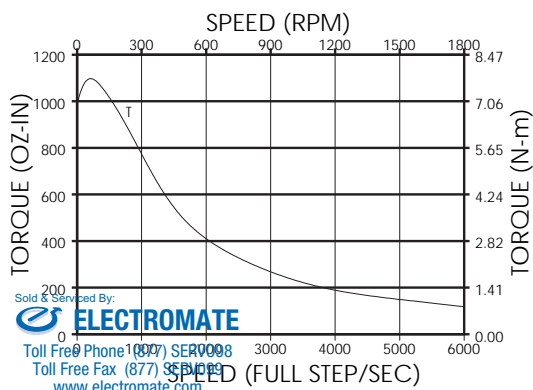
#### (3" MOTOR-ONE ROTOR STACK)

E31NX-HTLNN-NS00  
5.0A/65V PER PHASE



#### (4" MOTOR-ONE ROTOR STACK)

E41HX-HTLNK-NS00  
5.0A/65V PER PHASE



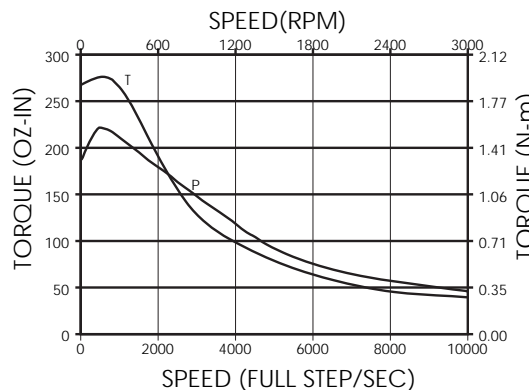
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**PERFORMANCE AT 2.5A (RMS)/65V PER PHASE**

**2.5 A,  
65V per phase**

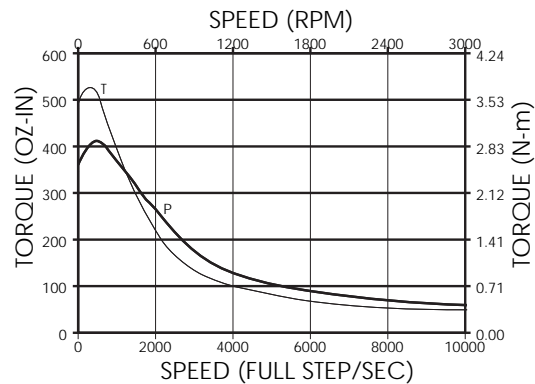
**(3" MOTOR-ONE ROTOR STACK)**

E31NX-LTLNN-NS00  
E31NX-LPLNN-NS00  
2.5A/65V PER PHASE



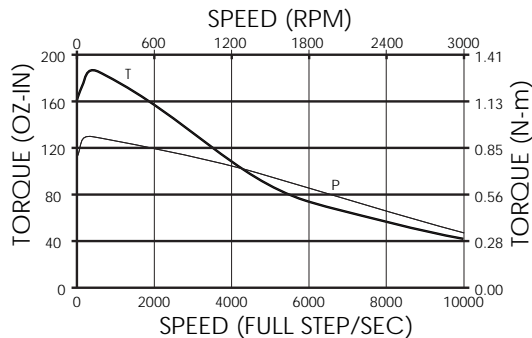
**(3" MOTOR-TWO ROTOR STACK)**

E32NX-LTLNN-NS00  
E32NX-LPLNN-NS00  
2.5A/65V PER PHASE



**(2" MOTOR-TWO ROTOR STACKS)**

E22NX-LTLNN-NS00  
E22NX-LPLNN-NS00  
2.5A/65V PER PHASE

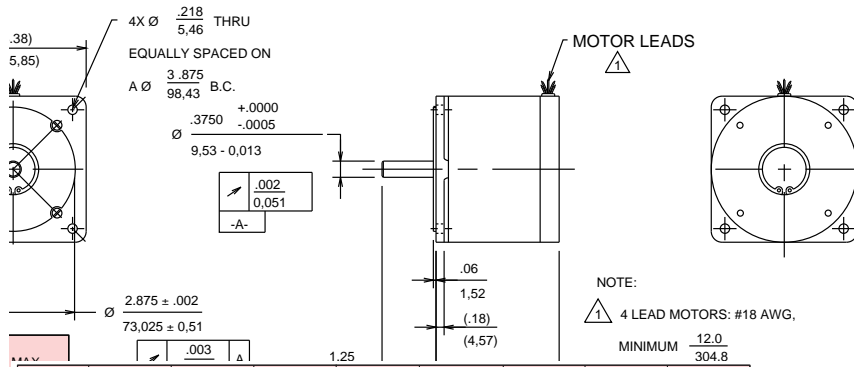


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# NEMA 23, 34 AND 42 MECHANICAL CONFIGURATIONS

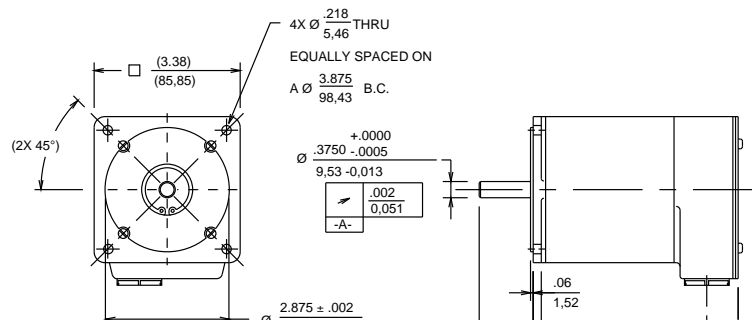
## REGULAR CONSTRUCTION/FLYING LEAD HOOK-UP



MODEL NUMBER	2HNX	21NX	22NX	31NX	32NX	33NX	33HX	34HX
A	1.56 39.63	2.06 52.33	3.06 77.73	3.76 65.54	3.76 95.51	5.06 128.53	5.33 135.39	6.58 162.14
B	0.81 20.57	0.81 20.57	0.81 20.57	1.25 31.75	1.25 31.75	1.25 31.75	1.25 31.75	1.25 31.75
D	0.25 6.35	0.25 6.35	0.25 6.35	0.375 9.53	0.375 9.53	0.375 9.53	0.5 12.7	0.5 12.7

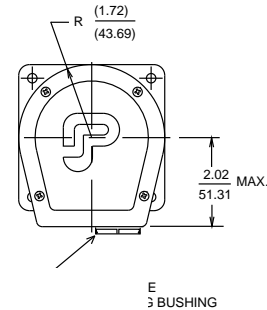
Note:  
Substitute R for X for flying lead

## SPLASHPROOF CONSTRUCTION

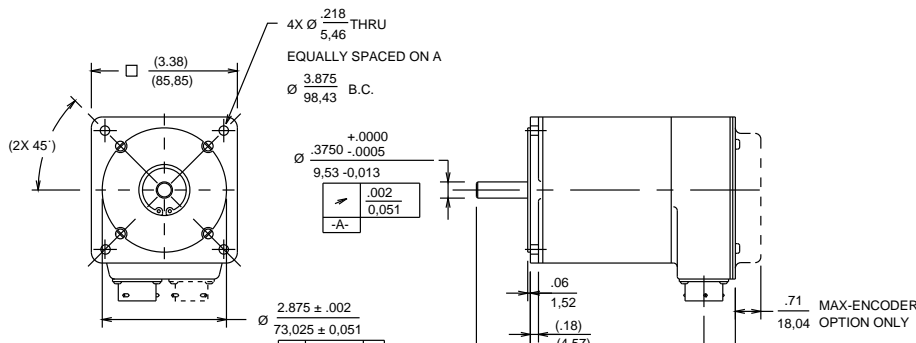


MODEL NUMBER	31NX	32NX	33NX	33HX	34HX	41HX	42HX	43HX
A	3.62 91.95	4.77 121.16	6.05 153.67	6.73 170.94	7.62 193.55	5.61 142.5	8.04 204.22	10.56 268.23
B	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.75 44.45	2.19 55.63	2.19 55.63
D	0.375 9.53	0.375 9.53	0.375 9.53	0.5 12.7	0.5 12.7	0.625 15.875	0.625 15.875	0.75 19.05

Note:  
Substitute L for X to specify conduit connection (1/2 NPS Tap)  
Substitute M for X to specify conduit connection (PDG 11 Tap)

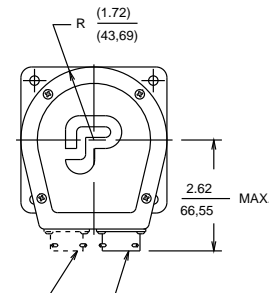


## SYSTEMS CONSTRUCTION



MODEL NUMBER	31NX	32NX	33NX	33HX	34HX	41HX	42HX	43HX
A	3.62 91.95	4.77 121.16	6.05 153.67	6.73 170.94	7.62 193.55	5.61 142.5	8.04 204.22	10.56 268.23
B	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.75 44.45	2.19 55.63	2.19 55.63
D	0.375 9.53	0.375 9.53	0.375 9.53	0.5 12.7	0.5 12.7	0.625 15.875	0.625 15.875	0.75 19.05

Note:  
Substitute C for X for MS connector termination



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# MODEL 6415

Holding torque range:  
158-1284 ox-in.  
(1.12 to 9.07 Nm)

**Module 0.625 to 5 A rms, 7.1 A peak (microstepping) per phase output. 24 to 75 Vdc**

- Single power supply input
- Patented 4-phase Bipolar Chopper Drive for superior current regulation and low ripple current
- Output current adjustable from 0.625 A to 5 A rms with 3 position dipswitch
- Microstepping up to 51,200 steps/revolution
- Patented Digital Electronic Damping™ reduces instability at mid-speed ranges
- Idle current reduction reduces motor heating
- Fault protection:
  - Line-to-line and line-to-neutral shorts
  - Internal power supply under-voltage
  - Bus overvoltage
- Compact size, panel or side mountable
- Low / high speed select input
- On-board multi-turn potentiometers
- External customer potentiometer
- Customer supplied  $\pm 10$ Vdc analog input
- Optional heat sink

The Pacific Scientific 6415 is an economical, high performance microstepping drive with an integral oscillator. The card is packaged with the highly popular 6410 drive and thus incorporates its many valuable features such as high resolution microstepping (200 to 51,200 steps per revolution) for smooth operation through resonance regions, mid-range **Digital Electronic Damping**, single supply operation, output current adjustment, and idle current reduction.

The 6415 contains a stable, wide range voltage controlled oscillator (VCO) which provides step pulses to the drive card. There are two frequency ranges, customer selectable by a jumper. Its compact size of 1.5" W x 5" H x 4.3" deep requires only 7.5 square inches of panel space!

## TYPICAL APPLICATIONS

- Clutch Brake Replacement
- Labeling Machines
- Packaging/Speciality Machinery
- Smart Conveyor Systems
- Semiconductor Wafer Polishing
- Constant Speed Applications

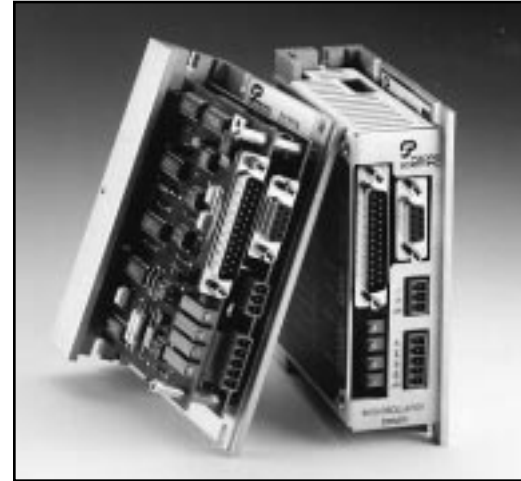
## MICROSTEPPING

Microstepping assures smooth, low speed operation, smoother operation through resonance regions and optimum system resolution. Resolution with 1.8° motors is adjustable to 50,000 steps per revolution with decimal step size selected and to 51,200 with binary step size selected. See the Step Size table on page C-17. The 6415 switches to full step operation above 150 RPM.

## FULL TORQUE AT ALL SPEEDS

A patented **Digital Electronic Damping** circuit ensures the availability of full motor torque at all speed ranges. This compensation damps motor oscillations common with stepper systems. Whether in the full step or microstepping mode, full motor torque is achieved throughout the speed range.

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## HIGH EFFICIENCY BIPOLAR CHOPPING

Patented, 4-phase PWM chopping electronically controls the motor winding currents at 20 KHz frequency. This combines the best of recirculating and nonrecirculating current regulation to provide high back EMF rejection with low ripple current. The benefits include reduced heat dissipation, low electrical noise and improved current control during dynamic braking.

The patented 4-phase control circuit combined with **Digital Electronic Damping**, provides significantly more motor output power than from other drives.

## IDLE CURRENT REDUCTION

This useful function permits an automatic 50% reduction in motor winding current during motor idle conditions to minimize heating during dwell periods. If no step commands have been received for 0.1 second (0.05 and 1.0 seconds can also be selected through DIP switch settings - see page C-22), the current is automatically reduced. Current is restored to full amplitude upon arrival of a step command.

## CONTROL FUNCTIONS

The 6415 has four potentiometers on board to control low speed, high speed, exponential accel and linear decel rates. Speed may also be adjusted via an external potentiometer or an analog input. Motion is controlled from a single or two independent Run/Stop inputs. A Min Speed threshold allows no drift at zero speed. The step outputs will drive up to four slaves synchronously.

## FAULT PROTECTION

- Line-to-line and line-to-neutral shorts
- Internal power supply under-voltage
- Bus overvoltage

## AGENCY APPROVAL

UL recognized - 508C (Type R) - file # E137798  
Meets CSA Standard, C22.2 #142-M1987  
Meets IEC vibration standard, #68-2-6

## GENERAL . . . Model 6415

Input Power Voltage	. . . . .	.24 Vdc to 75 Vdc																														
Input Power Current	. . . . .	Motor and load dependent. Usually < motor phase current.																														
Output motor phase current	. . . . .	See Figure C-15, page C-22 5 A rms max. (5 A peak full step, 7.1 A peak microstepping) Adjustable from 0.625 to 5 A rms in 0.625 amp increments																														
Run Speed Control	. . . . .	Analog input range. See Figures C-10 and C-11, page C-21 Also controllable with internal or external pots $\pm 10$ Vdc																														
Analog Input Impedance	. . . . .	.20 K $\Omega$ (differential amp)																														
High Frequency Range	. . . . .	Run Speed Control: 8 KHZ to 500 KHZ Low Speed Control: 8 KHZ to 370 KHZ																														
Low Frequency Range	. . . . .	Run Speed Control: 4 KHZ to 250 KHZ Low Speed Control: 4 KHZ to 180 KHZ																														
Run Speed/Low Speed																																
Stability Over Temp./Range	. . . . .	$\pm 1\%$ of full scale (typical)																														
Accel Ramp	. . . . .	Exponential Accel Pot Fully CW: 0.4 sec (single time constant) Accel Pot Fully CCW: 0.4 msec (single time constant)																														
Decel Ramp	. . . . .	Linear Decel Pot Fully CW: 1.4 sec Decel Pot Fully CCW: 6.0 msec																														
Min Speed	. . . . .	4 KHZ maximum (high frequency range) 2 KHZ maximum (low frequency range) Steps below this frequency are inhibited to insure no movement at end of decel ramp. This functionality can be disabled by inserting jumper E5 Note: Motor rpm = 0.3 * Freq. (Hz)/step size. For example: If frequency = 500 KHz and step size = 125, rpm = 1200.																														
Inputs	. . . . .	Optically isolated TTL compatible See Figures C-8 and C-9, page C-20																														
Outputs																																
VCO Input Monitor	. . . . .	.100 K $\Omega$ input impedance 8 Vdc full scale																														
+8 V Ref. Out	. . . . .	50 ma max. @ 25 deg C ambient 25 ma max. @ 50 deg C ambient																														
Step Out	. . . . .	See Figure C-9, page C-20 100 ma max. @ 25 deg C ambient 50 ma max. @ 50 deg C ambient (max reverse voltage = -50 Vdc)																														
Step Size	. . . . .	See Figure C-15, page C-22 Set using 3 positions of DIP switch and decimal jumper Note: Binary values are in <b>Bold</b>																														
		<table border="0"> <thead> <tr> <th><u>Step Size</u></th> <th><u>Steps per Revolution</u></th> <th><u>Maximum RPM*</u></th> </tr> </thead> <tbody> <tr> <td></td> <td>(1.8° motor)</td> <td></td> </tr> <tr> <td>Full (<b>1/2</b>)</td> <td>200 (<b>400</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/2 (<b>1/4</b>)</td> <td>400 (<b>800</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/5 (<b>1/8</b>)</td> <td>1000 (<b>1600</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/10 (<b>1/16</b>)</td> <td>2000 (<b>3200</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/25 (<b>1/32</b>)</td> <td>5000 (<b>6400</b>)</td> <td>12000 (<b>12000</b>)</td> </tr> <tr> <td>1/50 (<b>1/64</b>)</td> <td>10000 (<b>12800</b>)</td> <td>12000 (<b>9000</b>)</td> </tr> <tr> <td>1/125 (<b>1/128</b>)</td> <td>25000 (<b>25600</b>)</td> <td>4800 (<b>4600</b>)</td> </tr> <tr> <td>1/250 (<b>1/256</b>)</td> <td>50000 (<b>51200</b>)</td> <td>2400 (<b>2300</b>)</td> </tr> </tbody> </table>	<u>Step Size</u>	<u>Steps per Revolution</u>	<u>Maximum RPM*</u>		(1.8° motor)		Full ( <b>1/2</b> )	200 ( <b>400</b> )	12000 ( <b>12000</b> )	1/2 ( <b>1/4</b> )	400 ( <b>800</b> )	12000 ( <b>12000</b> )	1/5 ( <b>1/8</b> )	1000 ( <b>1600</b> )	12000 ( <b>12000</b> )	1/10 ( <b>1/16</b> )	2000 ( <b>3200</b> )	12000 ( <b>12000</b> )	1/25 ( <b>1/32</b> )	5000 ( <b>6400</b> )	12000 ( <b>12000</b> )	1/50 ( <b>1/64</b> )	10000 ( <b>12800</b> )	12000 ( <b>9000</b> )	1/125 ( <b>1/128</b> )	25000 ( <b>25600</b> )	4800 ( <b>4600</b> )	1/250 ( <b>1/256</b> )	50000 ( <b>51200</b> )	2400 ( <b>2300</b> )
<u>Step Size</u>	<u>Steps per Revolution</u>	<u>Maximum RPM*</u>																														
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1/250 ( <b>1/256</b> )	50000 ( <b>51200</b> )	2400 ( <b>2300</b> )																														
		*1. Consult factory if operating motor above 3000 RPM.																														
Idle Current Reduction	. . . . .	See Figure C-15, page C-22 Enabled or disabled with DIP switch, 50% output current reduction after 0.1 second from last step command (0.05 and 1.0 second time-outs can also be selected using a plug-on jumper. Consult factory for other current reduction options).																														
<b>DIGITAL ELECTRONIC DAMPING</b>	. . . . .	See Figure C-15, page C-22 Enabled or disabled with DIP switch Max. delay from input step to change in motor excitation: Step frequency < 500 full steps/sec: 500 $\mu$ s Step frequency > 500 full steps/sec: 270° of step period																														
Protection	. . . . .	(Any fault disables the drive and must be cleared by cycling input power) Line-to-line short, line to neutral, internal supply under voltage bus over voltage (83 Vdc)																														
Mechanical																																
Dimensions	. . . . .	.5" x 1.5" x 4.3"																														
Weight	. . . . .	.1 lb. nominal																														

  
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## GENERAL AND ENVIRONMENTAL. . .Model 6415

Connectors . . . . .	See Figure C-7, page C-19
Power Supply . . . . .	.3 contact plug-in screw terminal
Motor . . . . .	.5 contact plug-in screw terminal
Signal . . . . .	.25 contact plug D sub miniature
Storage Temperature . . . . .	-55°C to +70°C
Operating Temperature . . . . .	Full rated current 0° to 50°C ambient air with or without cover provided chassis properly mounted so as not to exceed 60°C.
Maximum Chassis Temperature . . . . .	60°C.
	Note: For optimal thermal performance, mount the 6415 chassis (back or side) to a cooling plate or heatsink. Use a thermal pad or grease if surface is irregular. A fan or idle current reduction may be employed to keep chassis below 60°C
Convection Cooling . . . . .	(6415 not mounted on cooling plate)
With optional heat sink . . . . .	Full rating (5A) at 25°C Ambient 2.5A max at 45°C Ambient
Without optional heat sink . . . . .	2.5A max at 25°C Ambient 1.25A max at 45°C Ambient
	See chart below for plot of drive power dissipation vs. output current.
Humidity Range . . . . .	10% to 90%, non-condensing

## DIMENSIONS. . .Model 6415

[mm—dimensions for ref. only]

## DRIVE POWER DISSIPATION CHART

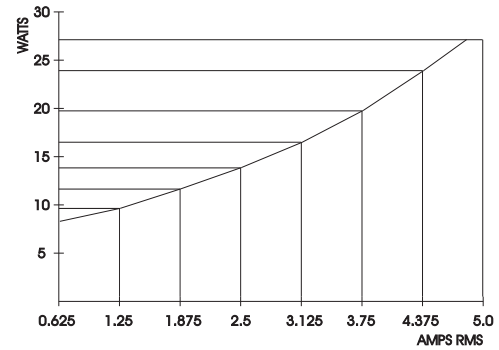
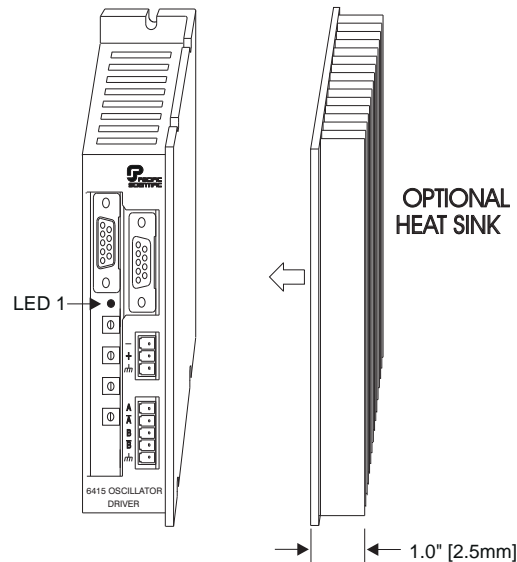


Figure C-5.

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**DIMENSIONS. . .Model 6415** [mm—dimensions for ref. only]

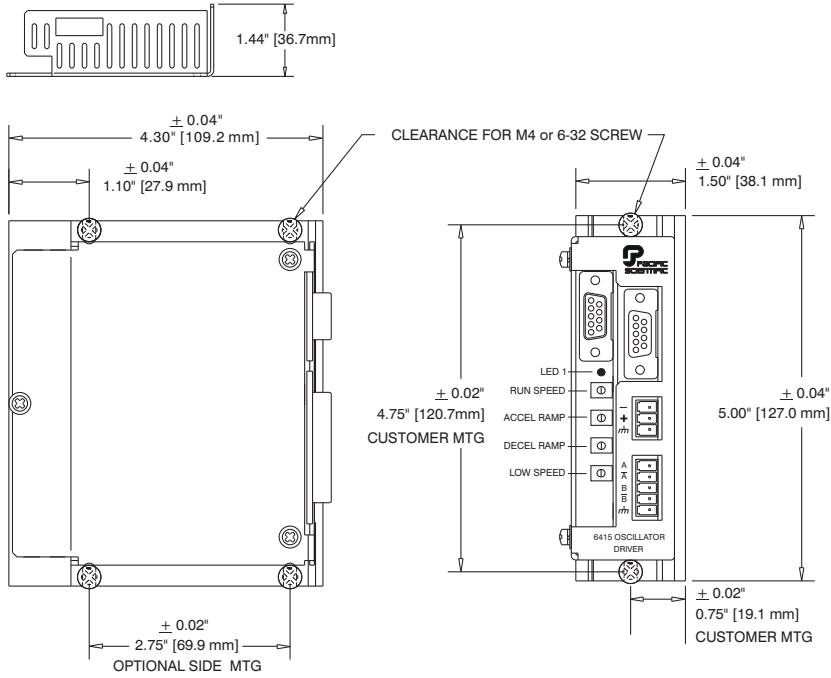


Figure C-6.

**CONNECTION DIAGRAM. . .Model 6415**

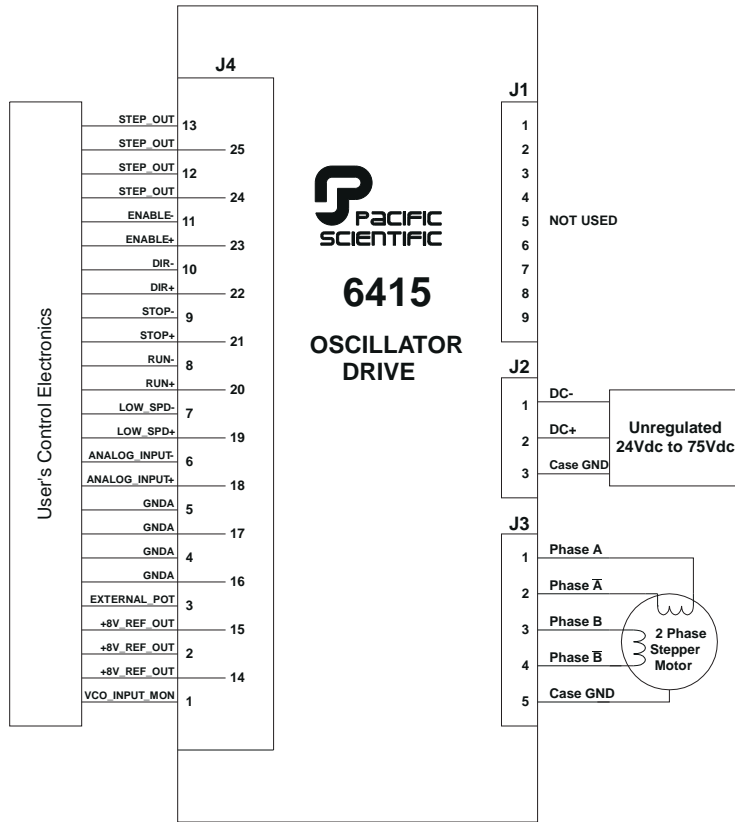


Figure C-7. Connection Diagram

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## DIGITAL INTERFACE CIRCUITRY. . .Model 6415

### Run+/Run-, Stop+/Stop-, Separate Latched Inputs

(E4 Jumper Installed-Default)

With the E4 jumper installed, (See Figure 8) the RUN/STOP (Clutch brake) mode of the 6415 is controlled by two separate optically isolated inputs. When the RUN opto is driven momentarily, the RUN/STOP latch is placed in the RUN state and the oscillator frequency ramps to the selected speed at a rate controlled by the ACCEL potentiometer. When the STOP opto is driven momentarily, the RUN/STOP latch is placed in the STOP state and the oscillator frequency ramps to zero frequency at a rate controlled by the DECEL potentiometer.

The RUN/STOP latch is designed to be in the STOP state after applying power to the 6415 to insure that motion does not occur unintentionally.

### SINGLE INPUT

(E4 Jumper Removed)

If the E4 jumper is removed, (See Figure 8) the RUN/STOP mode of the drive is controlled directly from the RUN input. When the RUN opto is driven, the oscillator frequency ramps to the selected speed at a rate controlled by the ACCEL potentiometer. When the RUN opto is off, the oscillator frequency ramps to zero frequency at a rate controlled by the DECEL potentiometer.

### EXTERNAL STEP PULSE

The step pulse output from the VCO is available on J4-12, J4-13, J4-24, and J4-25. This can be connected to up to four additional 6410 drives.

### ENABLE

The drive is enabled unless the Enable opto is driven. However, this functionality can be reversed by installing Enable sense Jumper J6 5-6 so that the opto must be driven to enable the drive.

### ENABLED LED

LED is lit when drive is enabled. A fault is indicated if the drive is commanded enabled but the LED is not lit.

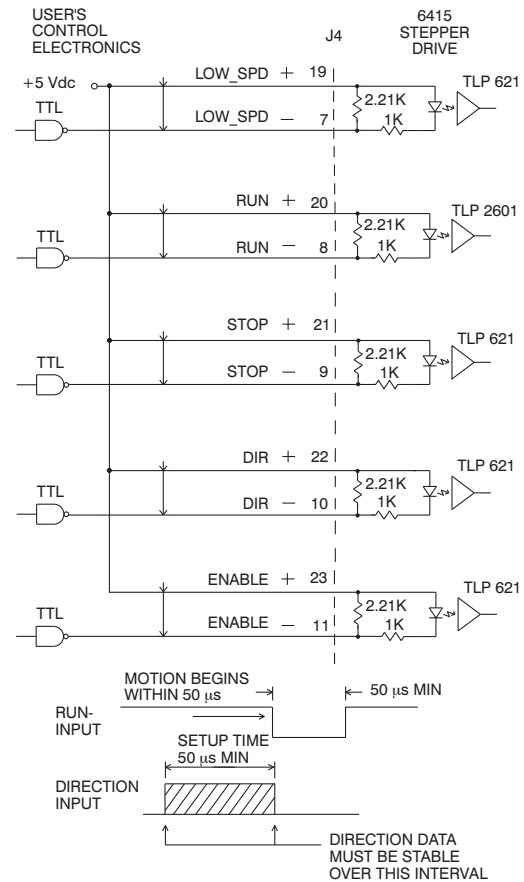


Figure C-8. Interface Circuits

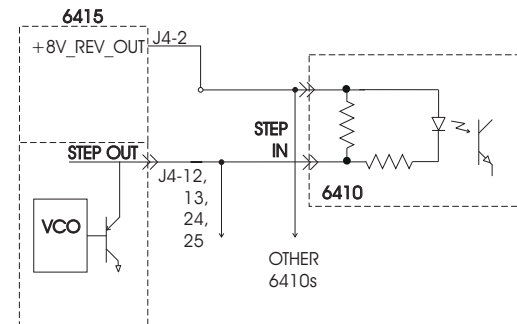


Figure C-9.

## SIGNAL INPUT REQUIREMENTS

Input	Min. Input Current – Opto ON	Max. Input Current	Max. Reverse Voltage
J4-19, J4-7 Low Speed	3.0 ma	4.6ma	5 volts
J4-22, J4-10 Direction	3.0 ma	4.5ma	5 volts
J4-23, J4-11 Enable	3.0 ma	4.5ma	5 volts
J4-20, J4-8 Run	3.0 ma	4.5ma	5 volts
J4-21, J4-9 Stop	3.0 ma	4.5ma	5 volts

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## ANALOG INTERFACE CIRCUITRY. . Model 6415

### LOW\_SPD+/LOW\_SPD-

This optically isolated input selects the source of the analog speed command. With the LOW\_SPD opto on (J4-7 Low), the analog speed command is derived from the LOW SPEED potentiometer.

With the LOW\_SPD opto off (J4-7 High), the analog speed command is derived from one of the following sources depending upon the E1 and E3 jumper configurations:

- Internal RUN SPEED potentiometer (E1 1-2 and E3 1-2 installed - Default)
- External potentiometer (E1 3-4 installed)
- External analog input (E1 5-6 and E3 1-2 installed)
- External analog input scaled (fine tuned) by internal RUN SPEED potentiometer (E1 1-2 and E3 3-4 installed)

The LOW\_SPD input can change at any time. The speed (oscillator frequency) will not change instantly, but will ramp to the newly selected speed at a rate controlled by the ACCEL or DECEL potentiometers depending upon whether the speed (magnitude) is increasing or decreasing.

Figure C-12 shows the velocity wave form in a typical application where the high speed is selected when the RUN input is pulsed and latched. Near the end of the motion profile, low speed is selected to insure a short and precise stopping distance when the STOP input is pulsed.

### Adjustment Potentiometers

Figures C-12 and C-13 show the typical velocity (pulse frequency) profile in response to a separate RUN/STOP or with a single RUN/STOP and RUN/LOW commands.

Adjustments for RUN SPEED, LOW SPEED, ACCEL RAMP, and DECEL RAMP are made with 4 multi-turn potentiometers.

LOW SPEED is typically set lower than RUN SPEED to allow for accurate stopping. It can also be used as a second RUN SPEED. ACCEL RAMP is typically set to minimize time to reach RUN SPEED without allowing the motor to stall. The DECEL RAMP is linear and stable, allowing a more precise, repeatable stopping position.

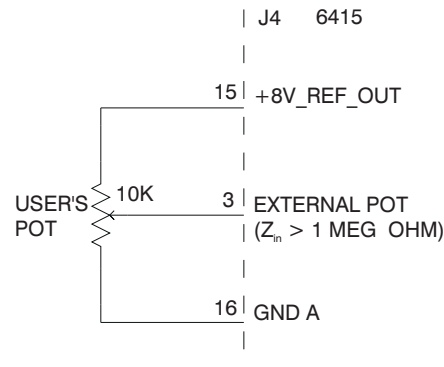


Figure C-10.

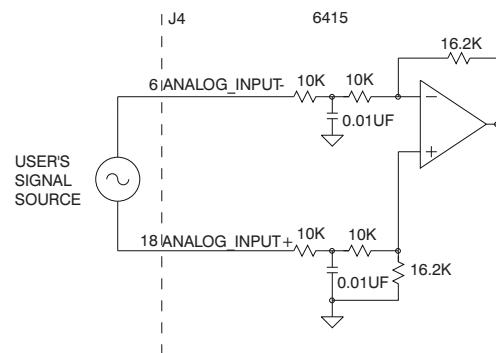


Figure C-11.

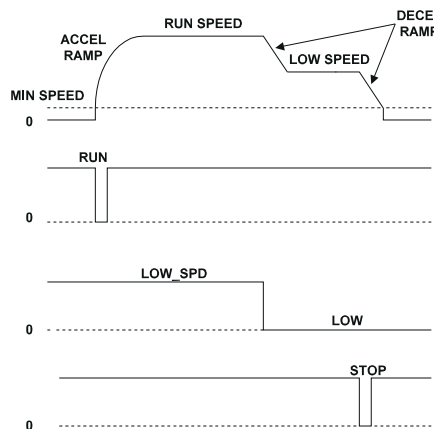


Figure C-12.

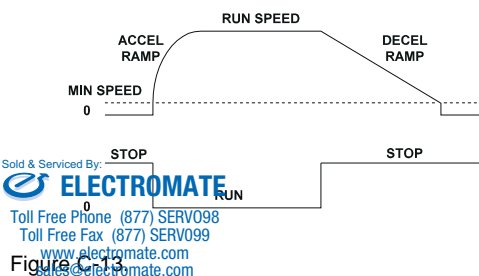


Figure C-13.

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## DIP SWITCH (S1) SETTINGS. . .Model 6415

### OSCILLATOR UPPER BOARD [factory defaults are in bold>

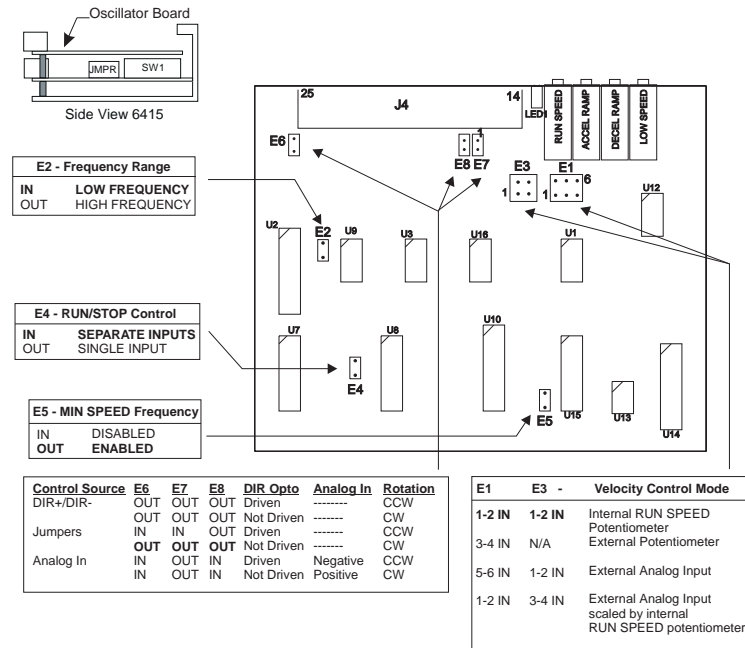


Figure C-14.

### OSCILLATOR LOWER BOARD

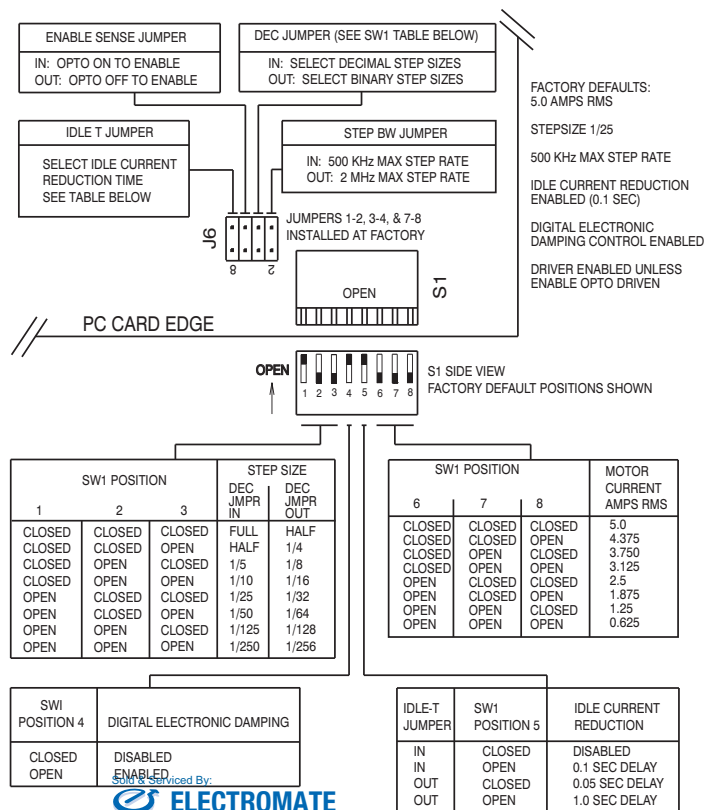


Figure C-15.

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## FUNCTIONAL ENHANCEMENT

The 6415 microstepping oscillator drive is one of a full family of products adding enhanced functionality.

### Additional Products

#### 24-75 Vdc Input:

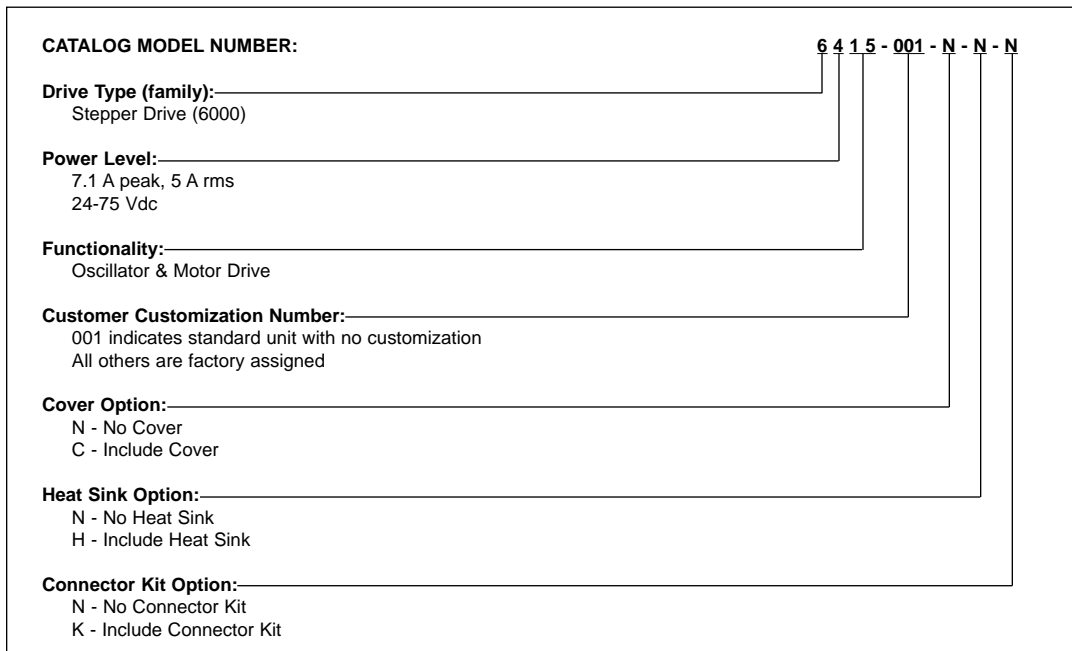
- 6410 Step Motor Drive . . . . . Step and direction input drive
- 6420 Indexer/Drive . . . . . RS232/RS485 programmable package mnemonic language 8 BDIO

#### 120/240 Vac 50-60Hz Input:

- 6430 Package . . . . . 6410 drive with AC input
- 6435 Package . . . . . 6415 oscillator/drive with AC input
- 6440 Package . . . . . 6420 indexer/drive with AC input
- 6445 Package . . . . . 6410 drive with Stepper Basic indexer and AC input functionality.

## HOW TO ORDER. . . Model 6415 recommended systems

Order the 6415, accessories and motor as separate model numbers.



NOTE: Standard drive includes Data Sheet. Manual/Design Guide ordered separately.

**6415 Accessories:** Order in accordance with the following model number codes:

<b>Part No.</b>	<b>Description</b>
CV6415	Cover (includes fastening screws)
HS6410	Heat Sink (includes fastening screws)
CK6415	Connector Kit (includes all mating connectors) 25-pin D-shell and Phoenix Connectors for J3-motor: Phoenix p/n: MC 1.5/5-ST-3.81 and J2-DC input: MC 1.5/3-ST-3.81
MA6415	User Manual / Design Guide
SPC-XXX-6410	With control connector and motor MS connector. Four conductor shielded wire plus ground. In place of XXX, specify length in even one foot increments from 001 to 050 feet. Consult factory for longer lengths.
SPC-CO-XXX	Motor Power Cable Only. Four conductor shielded wire plus ground. In place of XXX, specify length in even one foot increments.

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## SYSTEM RATINGS AND CHARACTERISTICS

### Model 6415 with recommended E Series motors

5.0 A,  
65V per phase

See E Series motors. . . NEMA 34 (3.4") and NEMA 42 (4.2") on page C-27.

OD (in)	Motor Model Number $\Delta$	Drive Current/Phase (amps DC)	Holding Torque $\Delta$ (2 phases on) oz-in (Nm) $\pm 10\%$	Detent Torque oz-in (Nm)	Rotor inertia oz-in-S2 (kgm <sup>2</sup> x 10 <sup>-3</sup> )	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
<b>Maximum torque at low speed (see plot T in performance curve)</b>								
3.4	E31NX-HTLNN-NS00	5.0	319 (2.25)	21.5 (0.15)	0.0083 (0.051)	3.2 (1.45)	155	1350
3.4	E32NX-HTLNN-NS00	5.0	638 (4.51)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	160	750
3.4	E33NX-HTLNN-NS00	5.0	958 (6.77)	69.3 (0.45)	0.0250 (0.155)	7.6 (3.45)	175	600
3.4	E34HX-HTLNN-NS00	5.0	1222 (8.63)	83.0 (0.59)	0.0350 (0.217)	9.7 (4.41)	175	450
3.4	E41HX-HTLNN-NS00	5.0	1284 (9.07)	58.0 (0.41)	0.0800 (0.496)	14.0 (6.36)	177	450
<b>Maximum torque at HIGH speed (see plot P in performance curve)</b>								
3.4	E32NX-HPLNN-NS00	5.0	474 (3.35)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	240	1650
3.4	E33NX-HPLNN-NS00	5.0	711 (5.02)	69.3 (0.45)	0.0250 (0.155)	7.6 (3.45)	260	1200
3.4	E34HX-HPLNN-NS00	5.0	948 (6.69)	83.0 (0.59)	0.0350 (0.217)	9.7 (4.41)	240	900

### Model 6415 with recommended E Series motors

2.5 A,  
65V per phase

See E Series motors . . . NEMA 23 (2.3") and NEMA 34 (3.4") on page C-27.

OD (in)	Motor Model Number $\Delta$	Driver Current/Phase (amps DC)	Holding Torque $\Delta$ (2 phases on) oz-in (Nm) $\pm 10\%$	Detent Torque oz-in (Nm)	Rotor inertia oz-in-S2 (kgm <sup>2</sup> x 10 <sup>-3</sup> )	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
<b>Maximum torque at low speed (see plot T in performance curve)</b>								
2.3	E22NX-LTLNN-NS00	2.5	225 (1.59)	9.6 (0.07)	0.0031 (0.019)	2.1 (0.95)	54	1650
3.4	E31NX-LTLNN-NS00	2.5	319 (2.25)	21.5 (0.15)	0.0083 (0.051)	3.2 (1.45)	75	600
3.4	E32NX-LTLNN-NS00	2.5	638 (4.51)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	80	450
<b>Maximum torque at HIGH speed (see plot P in performance curve)</b>								
2.3	E22NX-LPLNN-NS00	2.5	158 (1.12)	9.6 (0.07)	0.0031 (0.019)	2.1 (0.95)	155	2850
3.4	E31NX-LPLNN-NS00	2.5	237 (1.67)	21.5 (0.15)	0.0083 (0.051)	3.2 (1.45)	115	1500
3.4	E32NX-LPLNN-NS00	2.5	474 (3.35)	41.6 (0.29)	0.0170 (0.102)	5.3 (2.41)	120	900

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

$\Delta$  See page C-27 for motor options. X denotes the construction of the motor, refer to page C-23 for various options. Also refer to Model Number Codes in the system configured hybrid step motor section page C-82.

$\Delta$  When operated at listed drive current.

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# MODEL 6415 TORQUE/SPEED CURVES with recommended motors

5.0 A,  
65V per phase

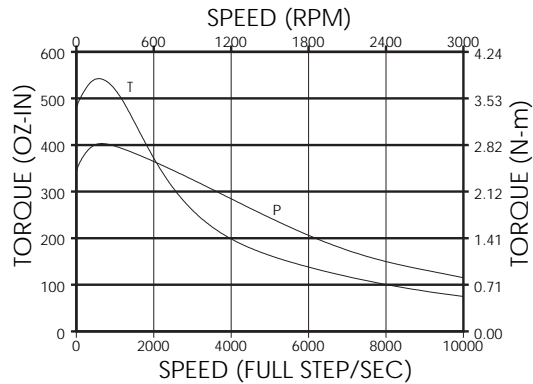
Motors will perform continuously as shown without the winding temperature rise exceeding 90°C when the motor is operated (without heat sink) in an ambient temperature of up to 40°C. The curves do not reflect systems resonance points which will vary with motor coupling and systems parameters.

In addition to those shown below, Pacific Scientific offers a wide range of other motor windings to meet specific performance requirements. Consult factory.

## PERFORMANCE AT 5.0A (RMS)/65V PER PHASE

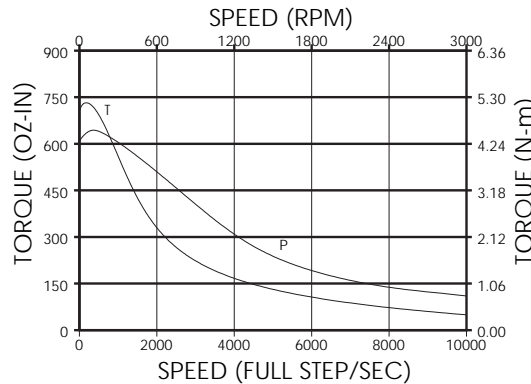
### (3" MOTOR-TWO ROTOR STACK)

E32NX-HTLNN-NS00  
E32NX-HPLNN-NS00  
5.0A/65V PER PHASE



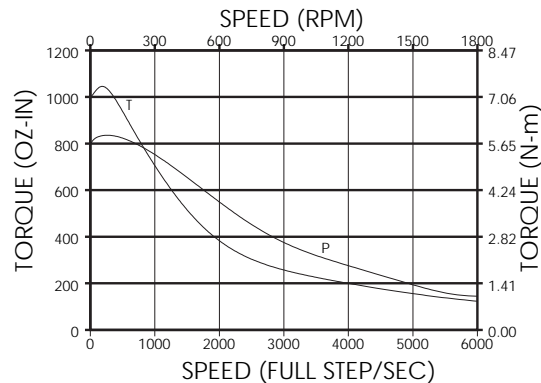
### (3" MOTOR-THREE ROTOR STACKS)

E33NX-HTLNK-NS00  
E33NX-HPLNK-NS00  
5.0A/65V PER PHASE



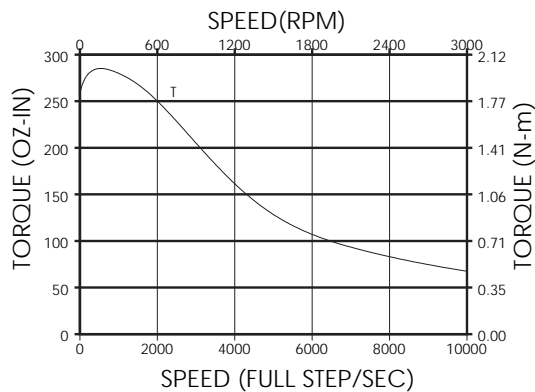
### (3" MOTOR-FOUR ROTOR STACKS)

E34HX-HTLHK-NS00  
E32HX-HPLNK-NS00  
5.0A/65V PER PHASE



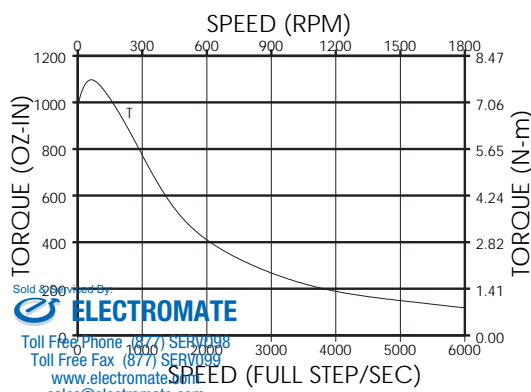
### (3" MOTOR-ONE ROTOR STACK)

E31NX-HTLNN-NS00  
5.0A/65V PER PHASE



### (4" MOTOR-ONE ROTOR STACK)

E41HX-HTLHK-NS00  
5.0A/65V PER PHASE



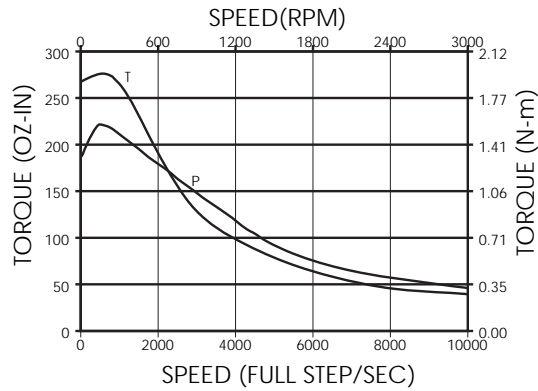
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**PERFORMANCE AT 2.5A (RMS)/65V PER PHASE**

**2.5 A,  
65V per phase**

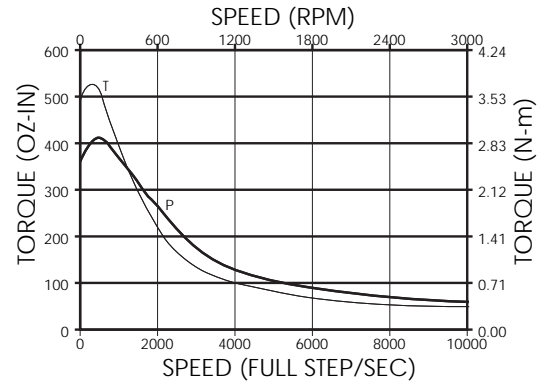
**(3" MOTOR-ONE ROTOR STACK)**

E31NX-LTLNN-NS00  
E31NX-LPLNN-NS00  
2.5A/65V PER PHASE



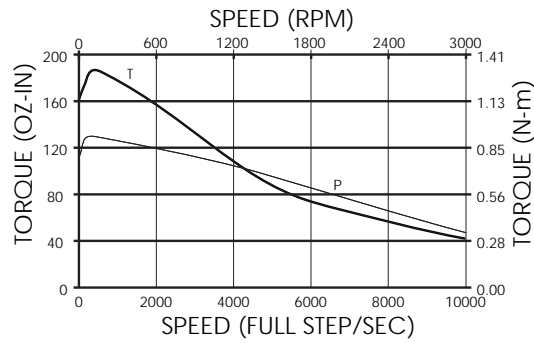
**(3" MOTOR-TWO ROTOR STACK)**

E32NX-LTLNN-NS00  
E32NX-LPLNN-NS00  
2.5A/65V PER PHASE



**(2" MOTOR-TWO ROTOR STACKS)**

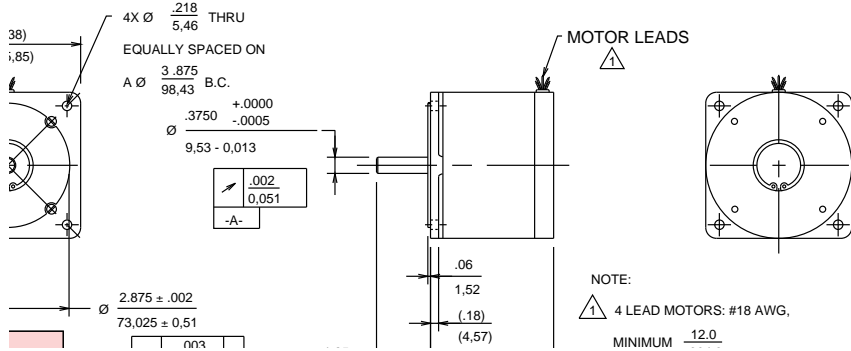
E22NX-LTLNN-NS00  
E22NX-LPLNN-NS00  
2.5A/65V PER PHASE



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# NEMA 23, 34 AND 42 MECHANICAL CONFIGURATIONS

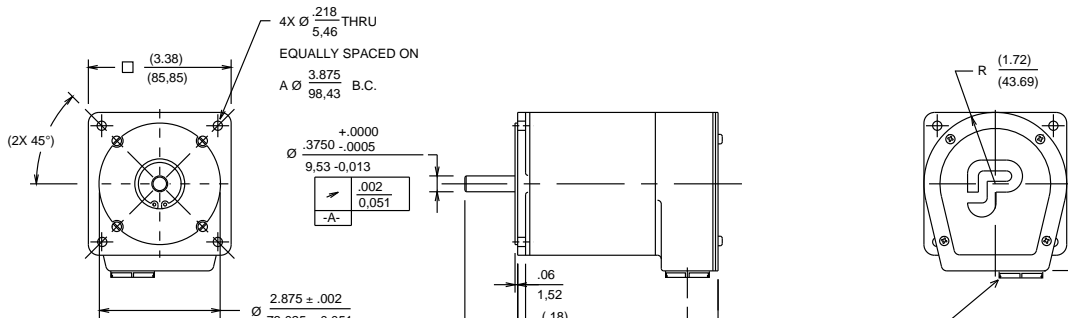
## REGULAR CONSTRUCTION/FLYING LEAD HOOK-UP



MODEL NUMBER	2HNX	21NX	22NX	31NX	32NX	33NX	33HX	34HX
A	1.56 39.63	2.06 52.33	3.06 77.73	2.58 65.54	3.76 95.51	5.06 128.53	5.33 135.39	6.58 162.14
B	0.81 20.57	0.81 20.57	0.81 20.57	1.25 31.75	1.25 31.75	1.25 31.75	1.25 31.75	1.25 31.75
D	0.25 6.35	0.25 6.35	0.25 6.35	0.375 9.53	0.375 9.53	0.375 9.53	0.5 12.7	0.5 12.7

Note:  
Substitute R for X for flying lead

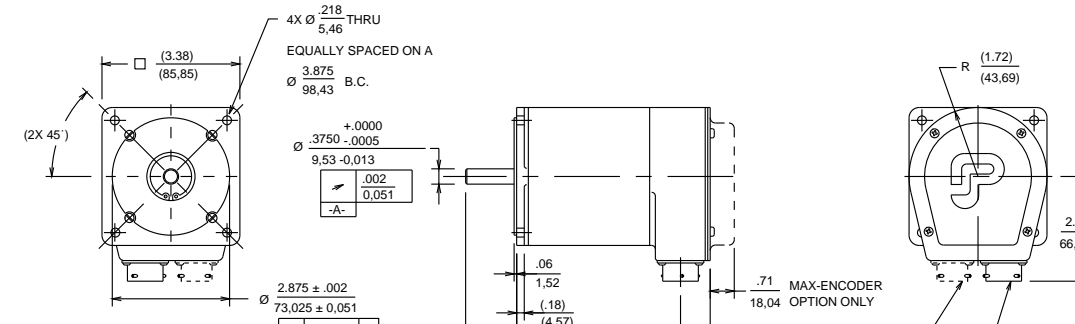
## SPLASHPROOF CONSTRUCTION



MODEL NUMBER	31NX	32NX	33NX	33HX	34HX	41HX	42HX	43HX
A	3.62 91.95	4.77 121.16	6.05 153.67	6.73 170.94	7.62 193.55	5.61 142.5	8.04 204.22	10.56 268.23
B	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.75 44.45	2.19 55.63	2.19 55.63
D	0.375 9.53	0.375 9.53	0.375 9.53	0.5 12.7	0.5 12.7	0.625 15.875	0.625 15.875	0.75 19.05

Note:  
Substitute L for X to specify conduit connection (1/2 NPS Tap)  
Substitute M for X to specify conduit connection (PDG 11 Tap)

## SYSTEMS CONSTRUCTION



MODEL NUMBER	31NX	32NX	33NX	33HX	34HX	41HX	42HX	43HX
A	3.62 91.95	4.77 121.16	6.05 153.67	6.73 170.94	7.62 193.55	5.61 142.5	8.04 204.22	10.56 268.23
B	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.125 31.75	1.75 44.45	2.19 55.63	2.19 55.63
D	0.375 9.53	0.375 9.53	0.375 9.53	0.5 12.7	0.5 12.7	0.625 15.875	0.625 15.875	0.75 19.05

Note:  
Substitute C for X for MS connector termination

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