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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

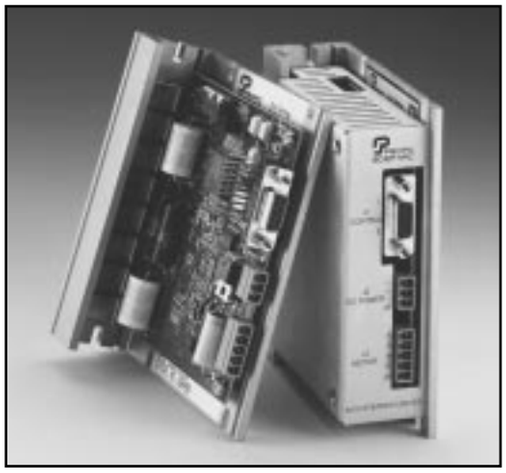
- X-Y tables and slides
- Packaging machinery
- Robotics
- Speciality machinery
- Index feed of materials
- Labeling machines

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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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 μs 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 μs
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 **Bold**.

Step Size	Steps per Revolution (1.8° motor)	Maximum RPM*
Full (**1/2**)	200 (**400**)	12000 (**12000**)
1/2 (**1/4**)	400 (**800**)	12000 (**12000**)
1/5 (**1/8**)	1000 (**1600**)	12000 (**12000**)
1/10 (**1/16**)	2000 (**3200**)	12000 (**12000**)
1/25 (**1/32**)	5000 (**6400**)	12000 (**12000**)
1/50 (**1/64**)	10000 (**12800**)	12000 (**9000**)
1/125 (**1/128**)	25000 (**25600**)	4800 (**4600**)
1/250 (**1/256**)	50000 (**51200**)	2400 (**2300**)

*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).
DIGITAL ELECTRONIC DAMPING . . .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 μs
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 . . . . . .3 contact plug-in screw terminal
Motor . . . . . .5 contact plug-in screw terminal
Signal . . . . . .9 socket D-sub miniature

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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 See Figure C-1 (below) for plot of drive power dissipation vs. output current
Humidity Range	10% to 90%, non-condensing

POWER DISSIPATION VS. OUTPUT CURRENT

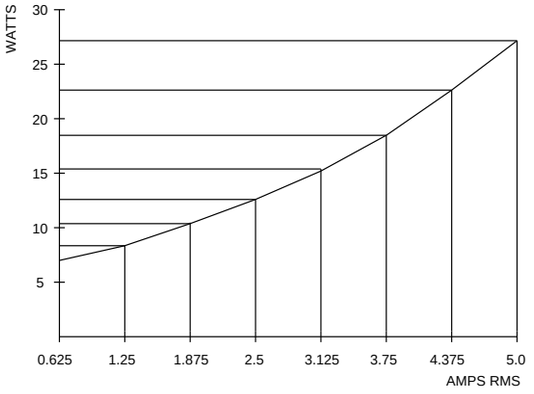

Figure C-1. Power Dissipation vs. Output Current

CONNECTION DIAGRAM

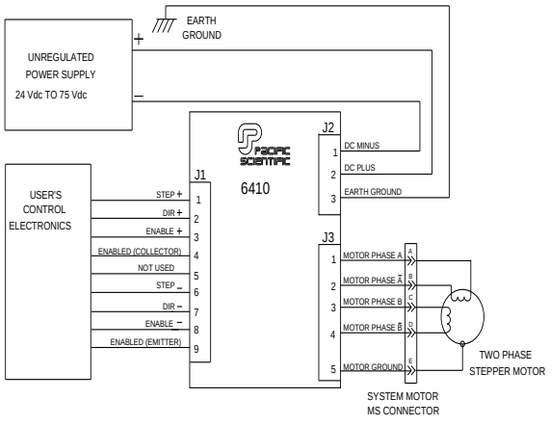

Figure C-2. Connection Diagram

INTERFACE CIRCUITS

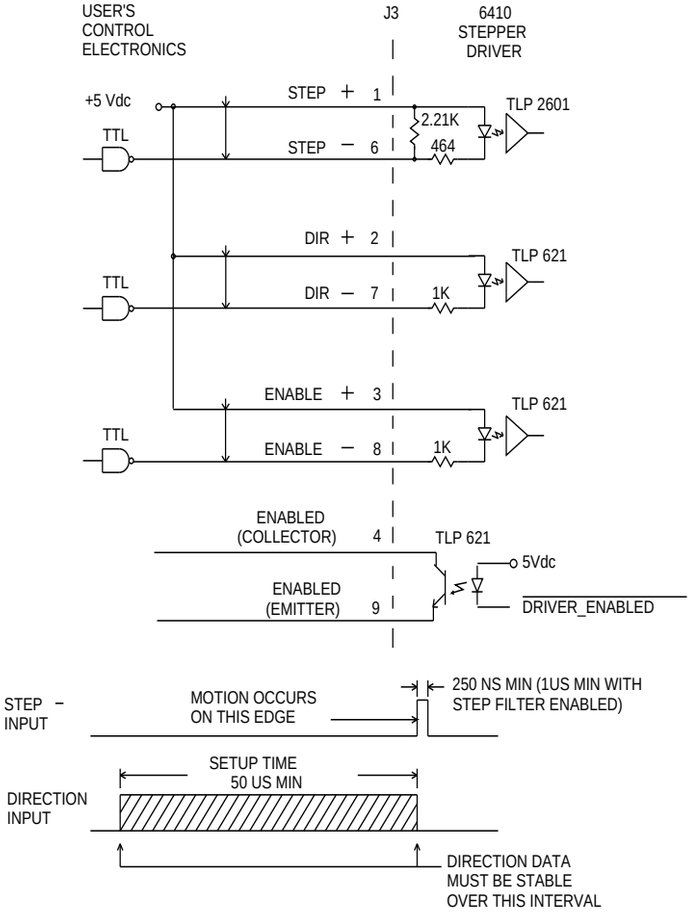

Figure C-3. Interface Circuits

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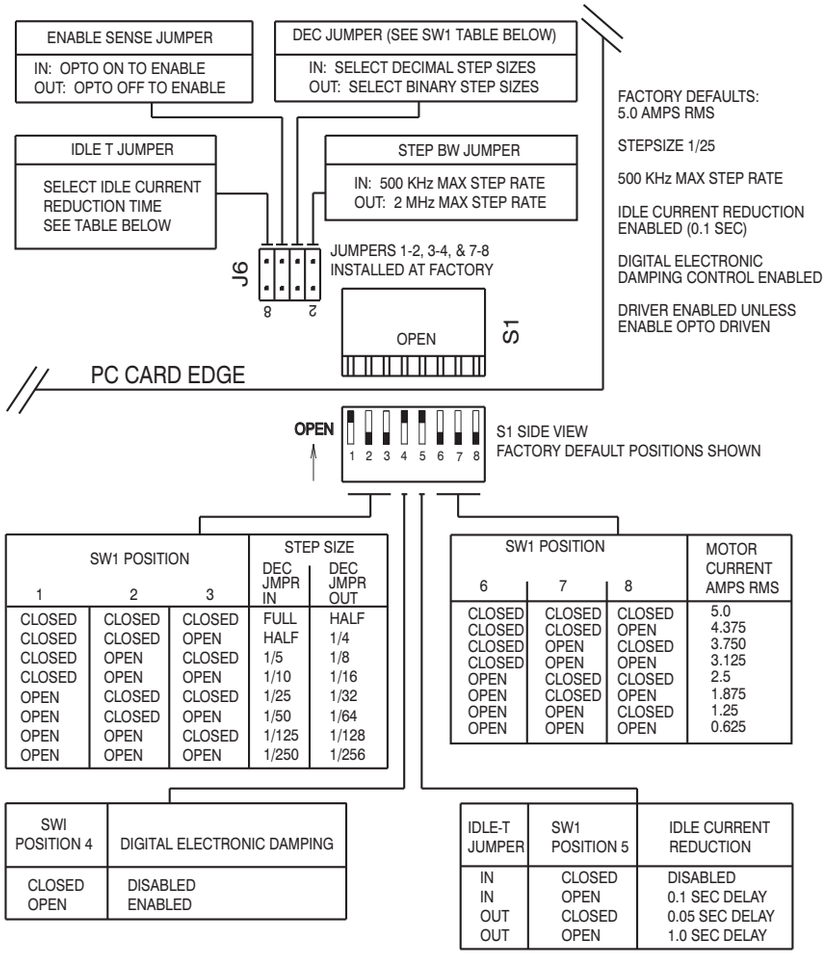
DIP SWITCH (S1) SETTINGS (FIG. 4). . .Model 6410

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



SW1 POSITION 1	2	3	STEP SIZE DEC JMPR IN	DEC JMPR OUT
CLOSED	CLOSED	CLOSED	FULL	HALF
CLOSED	CLOSED	OPEN	HALF	1/4
CLOSED	OPEN	CLOSED	1/5	1/8
CLOSED	OPEN	OPEN	1/10	1/16
OPEN	CLOSED	CLOSED	1/25	1/32
OPEN	CLOSED	OPEN	1/50	1/64
OPEN	OPEN	CLOSED	1/125	1/128
OPEN	OPEN	OPEN	1/250	1/256

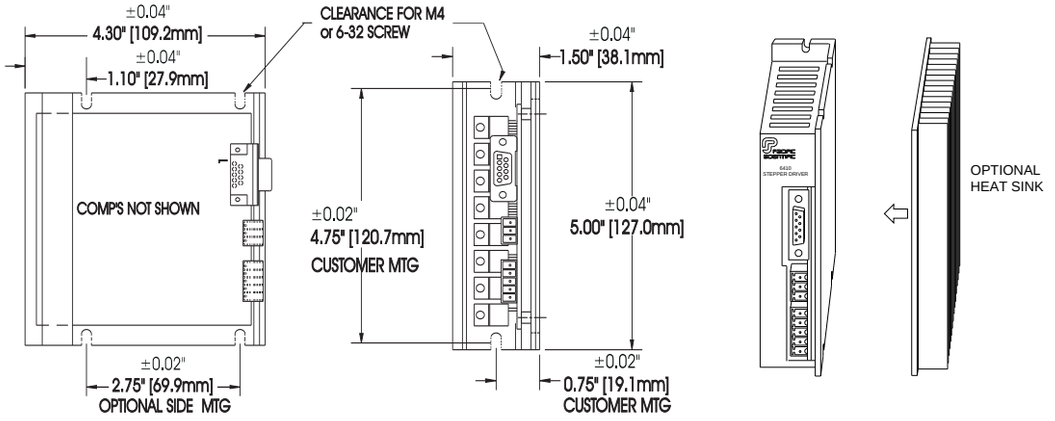
SW1 POSITION 6	7	8	MOTOR CURRENT AMPS RMS
CLOSED	CLOSED	CLOSED	5.0
CLOSED	CLOSED	OPEN	4.375
CLOSED	OPEN	CLOSED	3.750
CLOSED	OPEN	OPEN	3.125
OPEN	CLOSED	CLOSED	2.5
OPEN	CLOSED	OPEN	1.875
OPEN	OPEN	CLOSED	1.25
OPEN	OPEN	OPEN	0.625

SWI POSITION 4	DIGITAL ELECTRONIC DAMPING
CLOSED	DISABLED
OPEN	ENABLED

IDLE-T JUMPER	SW1 POSITION 5	IDLE CURRENT REDUCTION
IN	CLOSED	DISABLED
IN	OPEN	0.1 SEC DELAY
OUT	CLOSED	0.05 SEC DELAY
OUT	OPEN	1.0 SEC DELAY

Figure C-4. DIP Switch (S1) Settings

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



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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.

CATALOG MODEL NUMBER: **6 4 1 0 - 001 - N - N - N**

Drive Type (family):
Stepper Drive (6000)

Power Level:
7.1 A peak, 5 A rms
24-75 Vdc

Functionality:
Motor Drive Module

Customer Customization Number:
001 indicates standard unit with no customization
All others are factory assigned

Cover Option:
N - No Cover
C - Include Cover

Heat Sink Option:
N - No Heat Sink
H - Include Heat Sink

Connector Kit Option:
N - No Connector Kit
K - Include Connector Kit

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

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

Part No.	Description
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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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 ⚠	Drive Current/ Phase (amps DC)	Holding ⚠ Torque (2 phases on) ox-in (Nm) ±10%	Detent Torque oz-in (Nm)	Rotor intertia oz-in-S2 (kgm2 x 10¯3)	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
Maximum torque at low speed (see plot T in performance curve)								
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-HTLNK-NS500	5.0	1222 (8.63)	83.0 (0.59)	0.0350 (0.217)	9.7 (4.41)	175	450
3.4	E41HX-HTLNK-NS500	5.0	1284 (9.07)	58.0 (0.41)	0.0800 (0.496)	14.0 (6.36)	177	450
Maximum torque at HIGH speed (see plot P in performance curve)								
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-HPLNK-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 ⚠	Driver Current/ Phase (amps DC)	Holding ⚠ Torque (2 phases on) ox-in (Nm) ±10%	Detent Torque oz-in (Nm)	Rotor intertia oz-in-S2 (kgm2 x 10¯3)	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
Maximum torque at low speed (see plot T in performance curve)								
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
Maximum torque at HIGH speed (see plot P in performance curve)								
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.

⚠ 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.

⚠ When operated at listed drive current.

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Model 6410 torque/speed curves with recommended motors

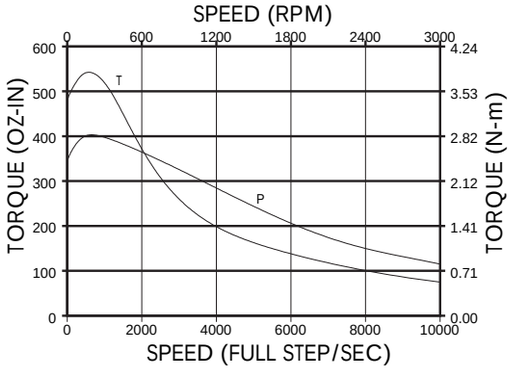
5.0 A, 65V per phase

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

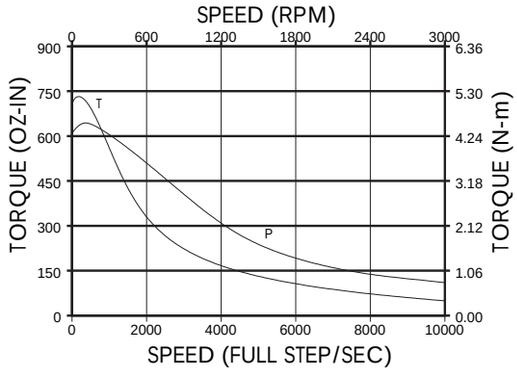
(3" MOTOR-TWO ROTOR STACK)

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



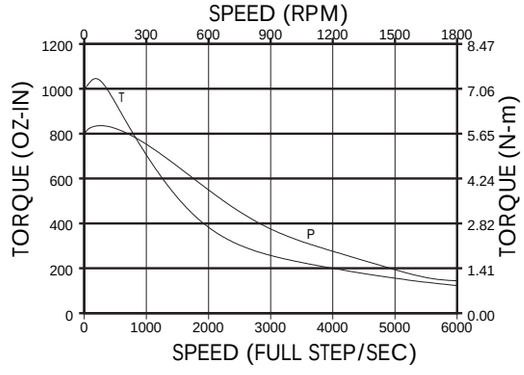
(3" MOTOR-THREE ROTOR STACKS)

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



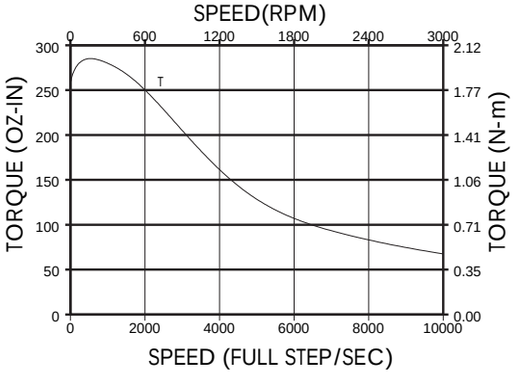
(3" MOTOR-FOUR ROTOR STACKS)

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



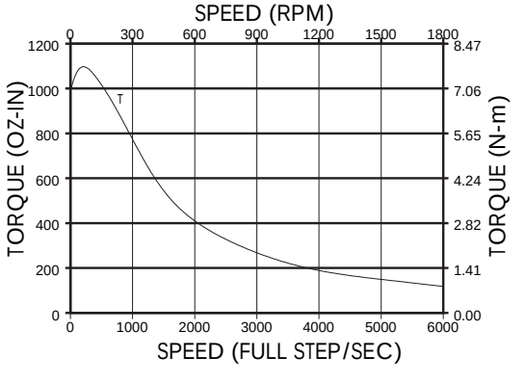
(3" MOTOR-ONE ROTOR STACK)

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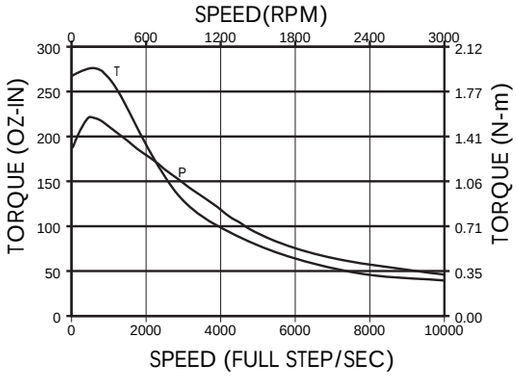
PERFORMANCE AT 2.5A (RMS)/65V PER PHASE

2.5 A, 65V per phase

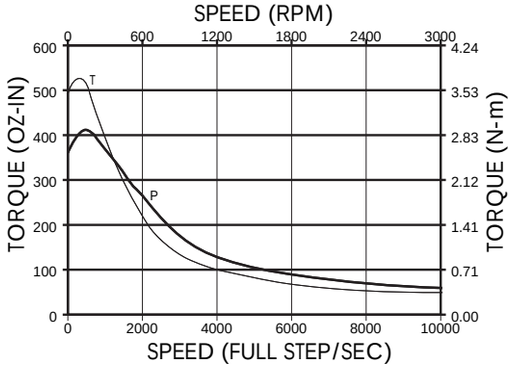
(3" MOTOR-ONE ROTOR STACK)

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



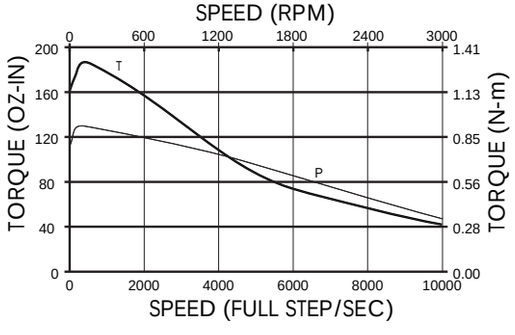
(3" MOTOR-TWO ROTOR STACK)

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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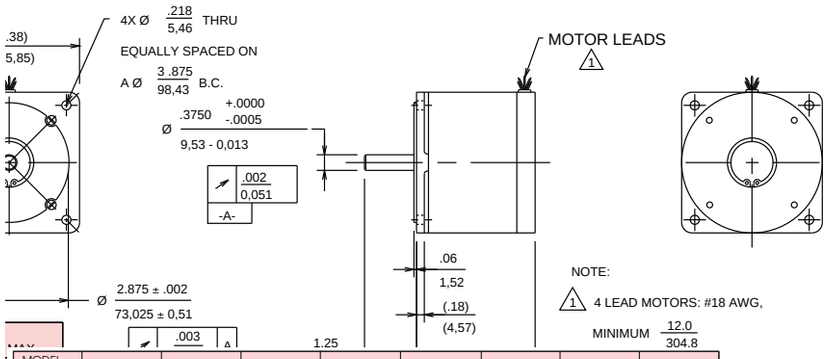
NEMA 23, 34 AND 42 MECHANICAL CONFIGURATIONS

REGULAR CONSTRUCTION/FLYING LEAD HOOK-UP

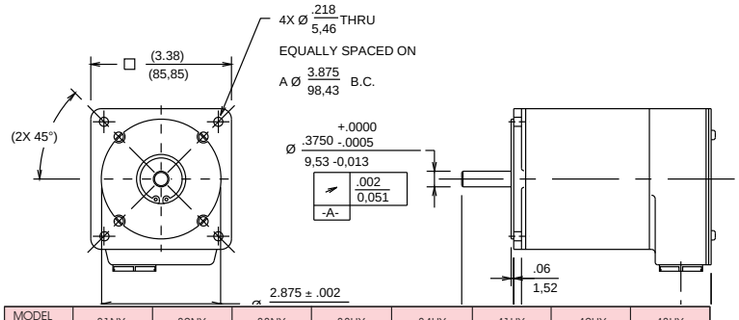


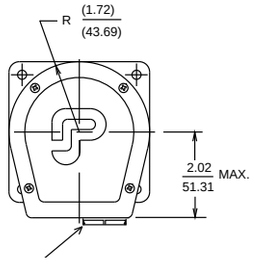
MODEL NUMBER	2HNX	21NX	22NX	31NX	32NX	33NX	33HX	34HX
A	1.56 39,63	2.06 52,33	3.06 77,73	2.58 65,54	3.76 95,51	5.06 128,53	5.33 135,39	6.58 162,14
B	0.81 20,57	0.81 20,57	0.81 20,57	1.25 31,75	1.25 31,75	1.25 31,75	1.25 31,75	1.25 31,75
D	0.25 6,35	0.25 6,35	0.25 6,35	0.375 9,53	0.375 9,53	0.375 9,53	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

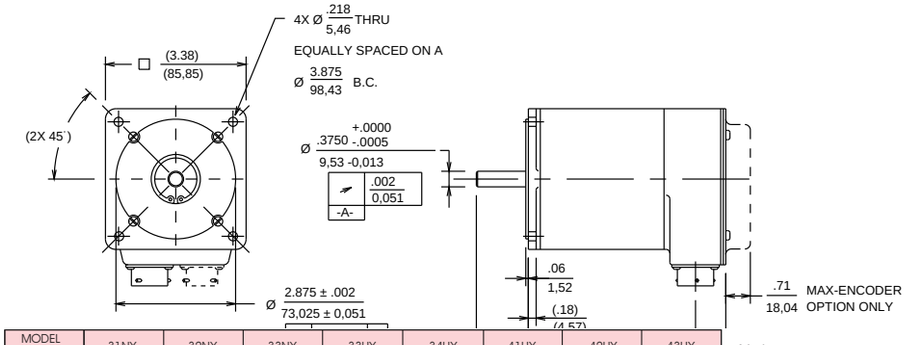
Note:

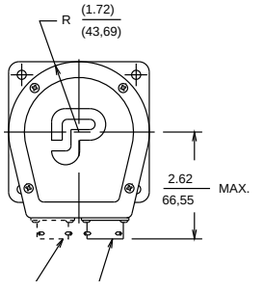
Substitute L for X to specify conduit connection (1/2 NPS Tap)

Substitute M for X to specify conduit connection (PDG 11 Tap)

32N (L OR M) 121,16 (102,11)

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 ±10Vdc 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

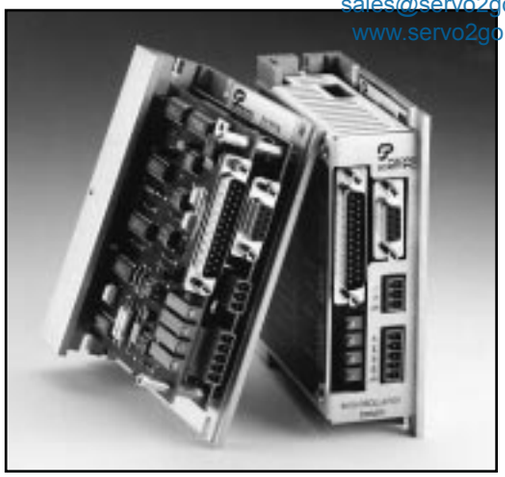
- Clutch Brake Replacement
- Labeling Machines
- Packaging/Speciality Machinery
- Smart Conveyor Systems
- Semiconductor Wafer Polishing
- Constant Speed Applications

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.



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

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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 ±10 Vdc
Analog Input Impedance . . . .20 KΩ (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 . . .±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 KΩ 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 **Bold**

Step Size	Steps per Revolution (1.8° motor)	Maximum RPM*
Full (**1/2**)	200 (**400**)	12000 (**12000**)
1/2 (**1/4**)	400 (**800**)	12000 (**12000**)
1/5 (**1/8**)	1000 (**1600**)	12000 (**12000**)
1/10 (**1/16**)	2000 (**3200**)	12000 (**12000**)
1/25 (**1/32**)	5000 (**6400**)	12000 (**12000**)
1/50 (**1/64**)	10000 (**12800**)	12000 (**9000**)
1/125 (**1/128**)	25000 (**25600**)	4800 (**4600**)
1/250 (**1/256**)	50000 (**51200**)	2400 (**2300**)

*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).
DIGITAL ELECTRONIC DAMPING . . .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 μs
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]

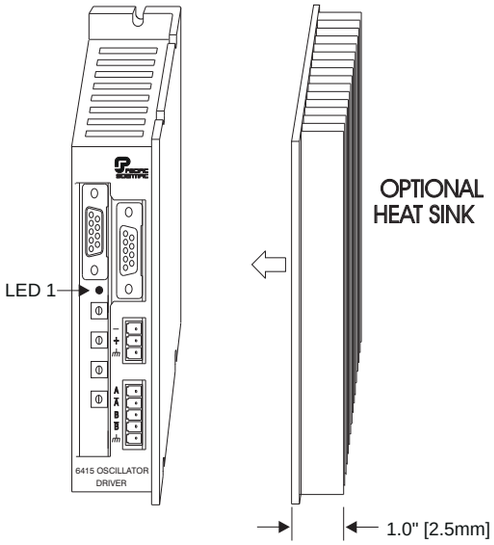
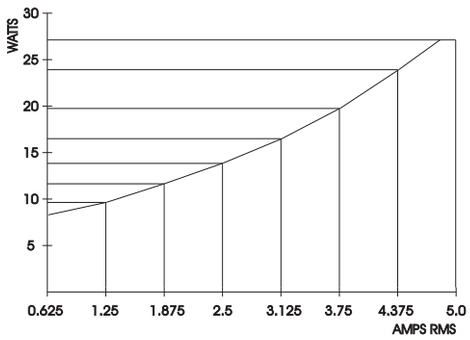


Figure C-5.

DRIVE POWER DISSIPATION CHART



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

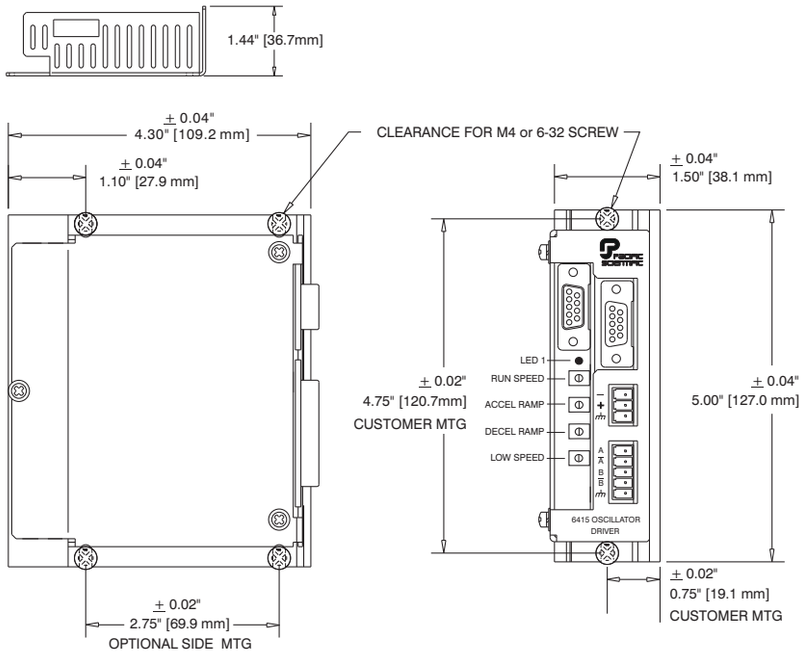

Figure C-6.

CONNECTION DIAGRAM. . .Model 6415

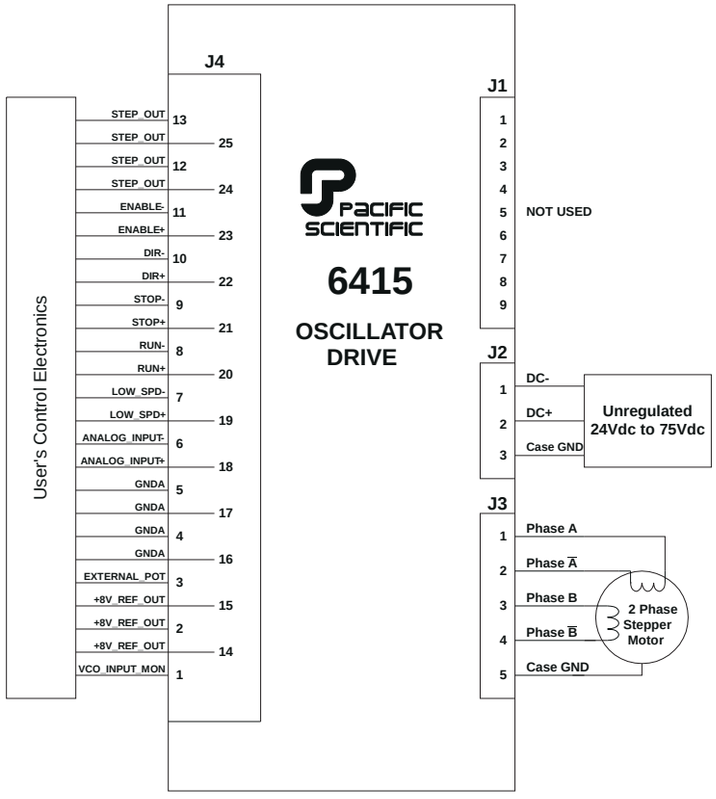

Figure C-7. Connection Diagram

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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.

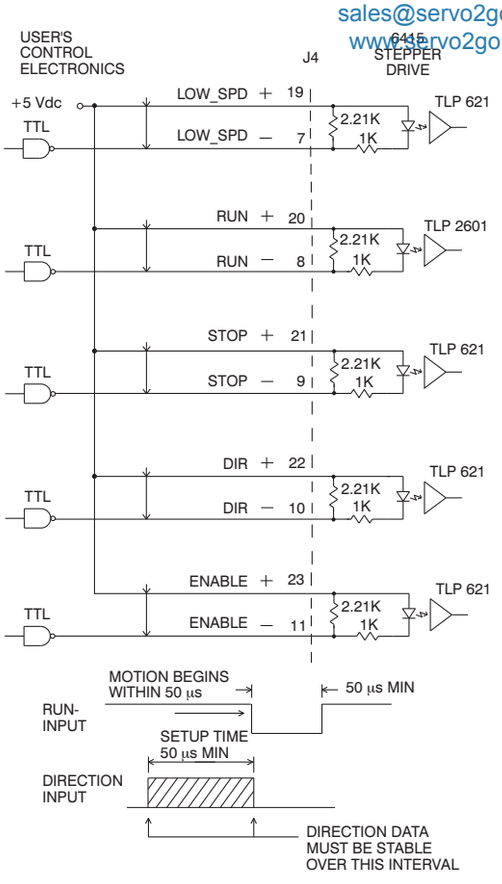

Figure C-8. Interface Circuits

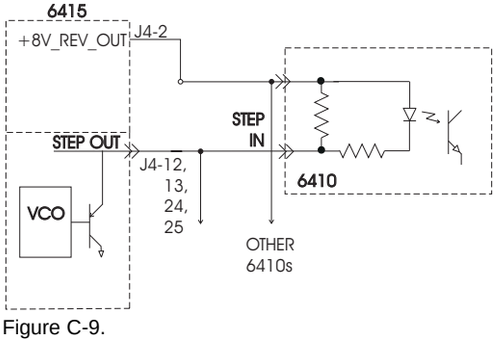

Figure C-9.

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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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.

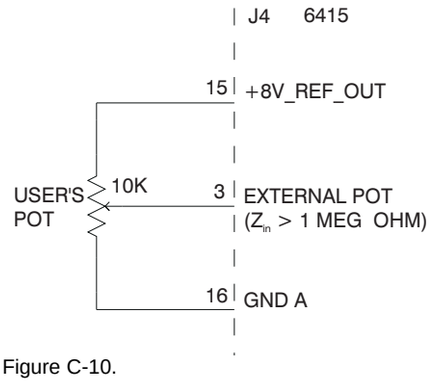

Figure C-10.

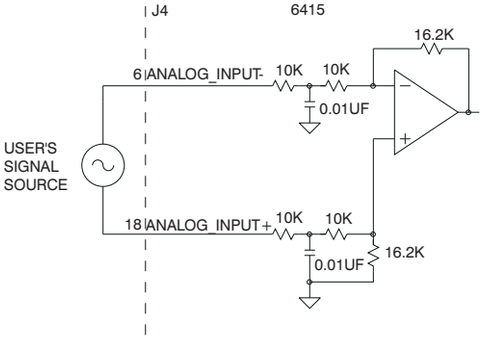

Figure C-11.

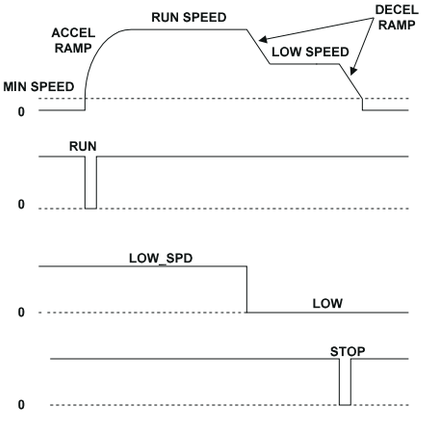

Figure C-12.

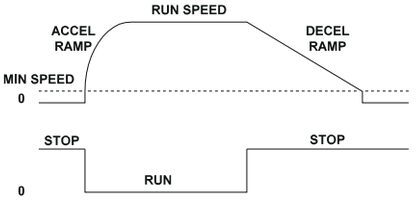

Figure C-13.

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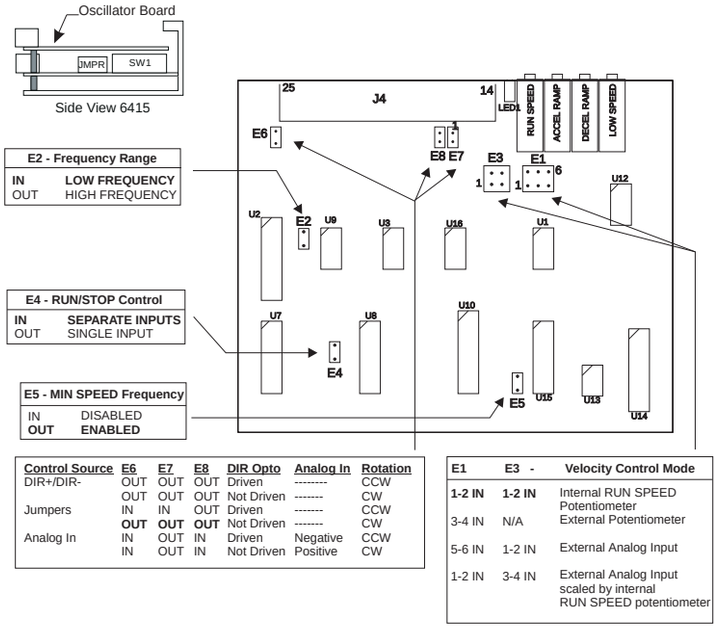
OSCILLATOR UPPER BOARD [factory defaults are in bold]

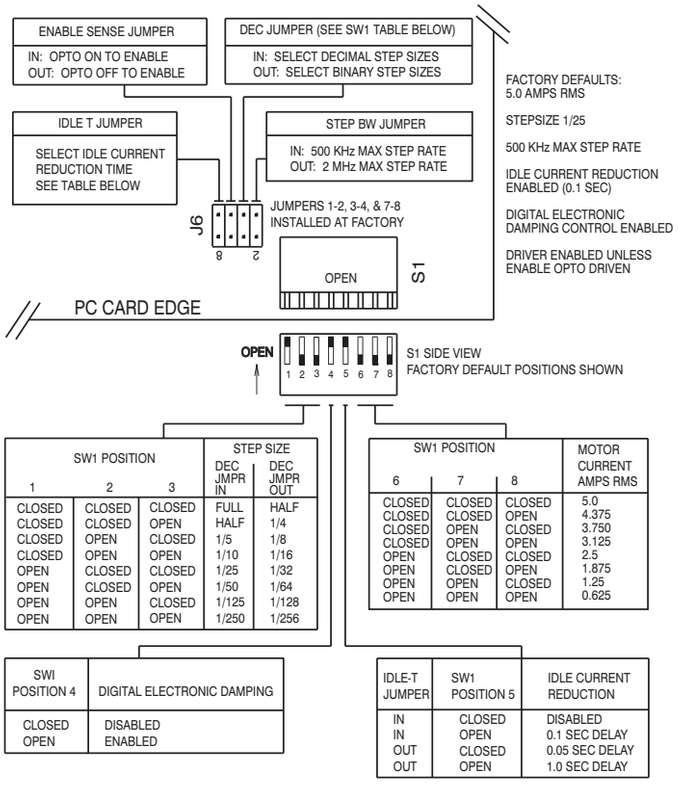


Control Source	E6	E7	E8	DIR Opto	Analog In	Rotation
DIR+/DIR-	OUT	OUT	OUT	Driven	--------	CCW
	OUT	OUT	OUT	Not Driven	-------	CW
Jumpers	IN	IN	OUT	Driven	-------	CCW
	OUT	**OUT**	**OUT**	Not Driven	-------	CW
Analog In	IN	OUT	IN	Driven	Negative	CCW
	IN	OUT	IN	Not Driven	Positive	CW

E1	E3 -	Velocity Control Mode
1-2 IN	**1-2 IN**	Internal RUN SPEED Potentiometer
3-4 IN	N/A	External Potentiometer
5-6 IN	1-2 IN	External Analog Input
1-2 IN	3-4 IN	External Analog Input scaled by internal RUN SPEED potentiometer

Figure C-14.

OSCILLATOR LOWER BOARD



SW1 POSITION 1	2	3	STEP SIZE DEC JMPR IN	DEC JMPR OUT
CLOSED	CLOSED	CLOSED	FULL	HALF
CLOSED	CLOSED	OPEN	HALF	1/4
CLOSED	OPEN	CLOSED	1/5	1/8
CLOSED	OPEN	OPEN	1/10	1/16
OPEN	CLOSED	CLOSED	1/25	1/32
OPEN	CLOSED	OPEN	1/50	1/64
OPEN	OPEN	CLOSED	1/125	1/128
OPEN	OPEN	OPEN	1/250	1/256

SW1 POSITION 6	7	8	MOTOR CURRENT AMPS RMS
CLOSED	CLOSED	CLOSED	5.0
CLOSED	CLOSED	OPEN	4.375
CLOSED	OPEN	CLOSED	3.750
CLOSED	OPEN	OPEN	3.125
OPEN	CLOSED	CLOSED	2.5
OPEN	CLOSED	OPEN	1.875
OPEN	OPEN	CLOSED	1.25
OPEN	OPEN	OPEN	0.625

SWI POSITION 4	DIGITAL ELECTRONIC DAMPING
CLOSED	DISABLED
OPEN	ENABLED

IDLE-T JUMPER	SW1 POSITION 5	IDLE CURRENT REDUCTION
IN	CLOSED	DISABLED
IN	OPEN	0.1 SEC DELAY
OUT	CLOSED	0.05 SEC DELAY
OUT	OPEN	1.0 SEC DELAY

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.

CATALOG MODEL NUMBER: **6 4 1 5 - 001 - N - N - N**

Drive Type (family):
Stepper Drive (6000)

Power Level:
7.1 A peak, 5 A rms
24-75 Vdc

Functionality:
Oscillator & Motor Drive

Customer Customization Number:
001 indicates standard unit with no customization
All others are factory assigned

Cover Option:
N - No Cover
C - Include Cover

Heat Sink Option:
N - No Heat Sink
H - Include Heat Sink

Connector Kit Option:
N - No Connector Kit
K - Include Connector Kit

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

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

Part No.	Description
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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5.0 A, 65V per phase

Model 6415 with recommended E Series motors

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

OD (in)	Motor Model Number ⚠	Drive Current/ Phase (amps DC)	Holding ⚠ Torque (2 phases on) ox-in (Nm) ±10%	Detent Torque oz-in (Nm)	Rotor intertia oz-in-S2 (kgm2 x 10¯3)	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
Maximum torque at low speed (see plot T in performance curve)								
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-HTLNK-NS00	5.0	1222 (8.63)	83.0 (0.59)	0.0350 (0.217)	9.7 (4.41)	175	450
3.4	E41HX-HTLNK-NS00	5.0	1284 (9.07)	58.0 (0.41)	0.0800 (0.496)	14.0 (6.36)	177	450
Maximum torque at HIGH speed (see plot P in performance curve)								
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-HPLNK-NS00	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 6415 with recommended E Series motors

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

OD (in)	Motor Model Number ⚠	Driver Current/ Phase (amps DC)	Holding ⚠ Torque (2 phases on) ox-in (Nm) ±10%	Detent Torque oz-in (Nm)	Rotor intertia oz-in-S2 (kgm2 x 10¯3)	Weight lbs (kg)	Peak Shaft Power (watts)	Rated Speed at Peak Power (RPM)
Maximum torque at low speed (see plot T in performance curve)								
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
Maximum torque at HIGH speed (see plot P in performance curve)								
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.

⚠ 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.

⚠ When operated at listed drive current.

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MODEL 6415 TORQUE/SPEED CURVES with recommended motors

5.0 A, 65V per phase

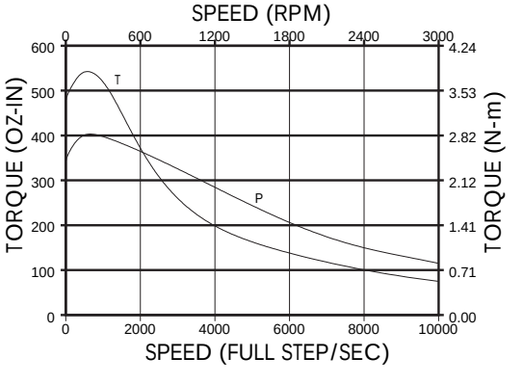
Motors will perform continuously as shown without the winding temperature rise exceeding 90°C when the motor is operated (without heat sink) in an ambient temperature of up to 40°C. The curves do not reflect systems resonance points which will vary with motor coupling and systems parameters.

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

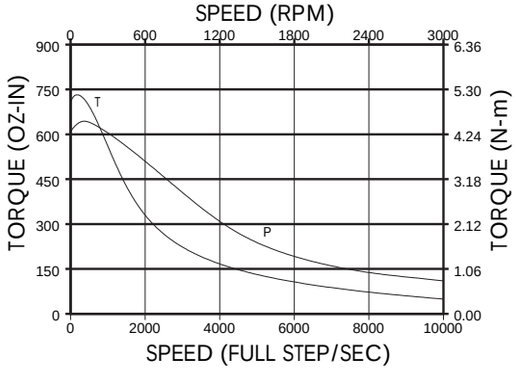
(3" MOTOR-TWO ROTOR STACK)

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



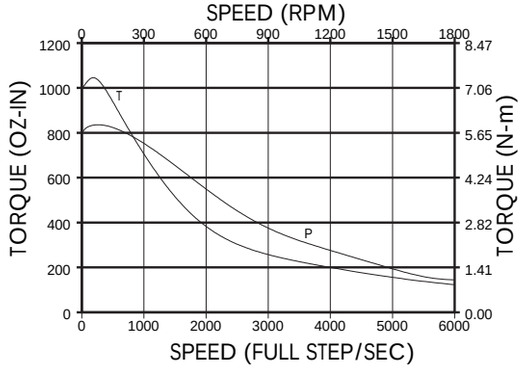
(3" MOTOR-THREE ROTOR STACKS)

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



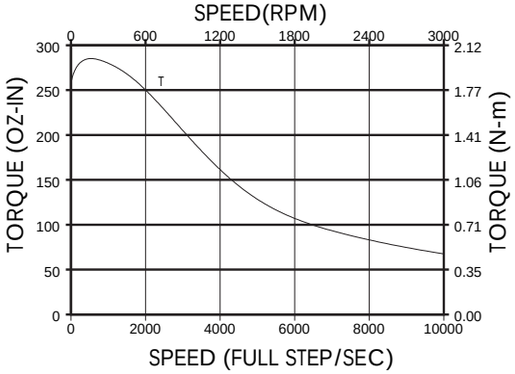
(3" MOTOR-FOUR ROTOR STACKS)

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



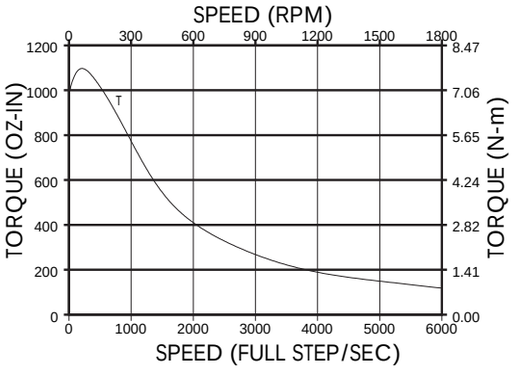
(3" MOTOR-ONE ROTOR STACK)

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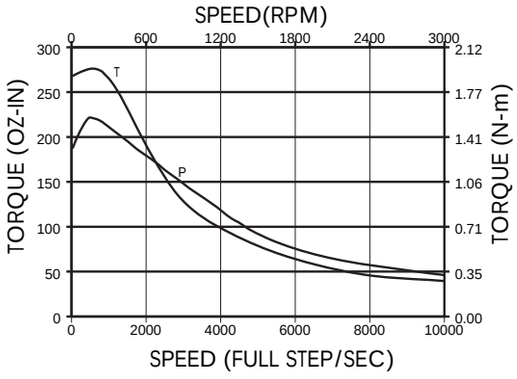
PERFORMANCE AT 2.5A (RMS)/65V PER PHASE

2.5 A, 65V per phase

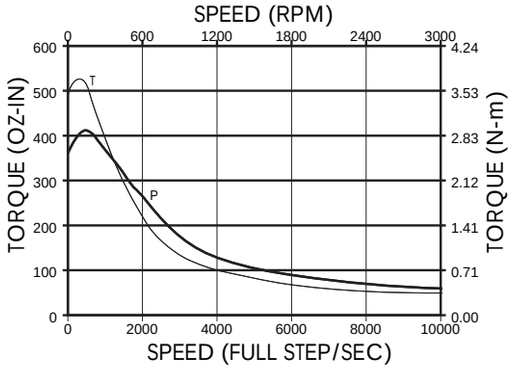
(3" MOTOR-ONE ROTOR STACK)

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



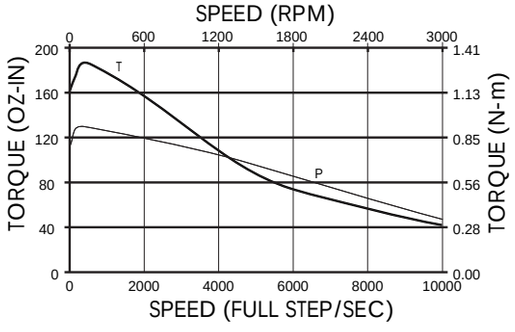
(3" MOTOR-TWO ROTOR STACK)

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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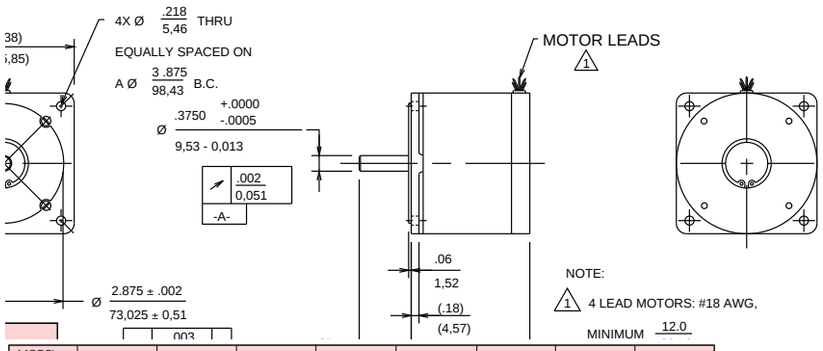
NEMA 23, 34 AND 42 MECHANICAL CONFIGURATIONS

REGULAR CONSTRUCTION/FLYING LEAD HOOK-UP

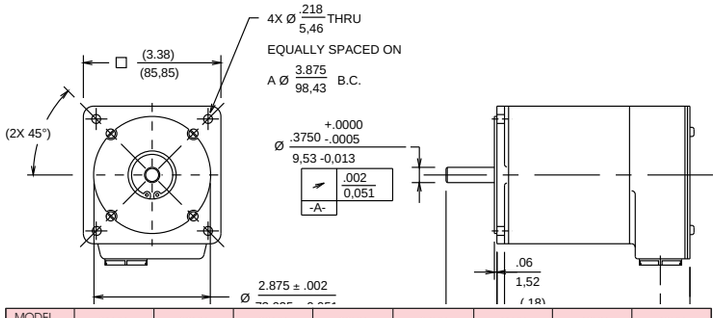


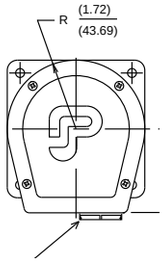
MODEL NUMBER	2HNX	21NX	22NX	31NX	32NX	33NX	33HX	34HX
A	1.56 39,63	2.06 52,33	3.06 77,73	2.58 65,54	3.76 95,51	5.06 128,53	5.33 135,39	6.58 162,14
B	0.81 20,57	0.81 20,57	0.81 20,57	1.25 31,75	1.25 31,75	1.25 31,75	1.25 31,75	1.25 31,75
D	0.25 6,35	0.25 6,35	0.25 6,35	0.375 9,53	0.375 9,53	0.375 9,53	0.5 12,7	0.5 12,7

Note:

Substitute R for X for flying lead

SPLASHPROOF CONSTRUCTION





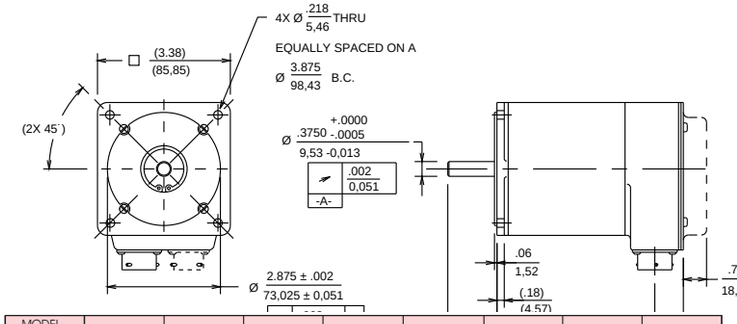
MODEL NUMBER	31NX	32NX	33NX	33HX	34HX	41HX	42HX	43HX
A	3.62 91,95	4.77 121,16	6.05 153,67	6.73 170,94	7.62 193,55	5.61 142,5	8.04 204,22	10.56 268,23
B	1.125 31,75	1.125 31,75	1.125 31,75	1.125 31,75	1.125 31,75	1.75 44,45	2.19 55,63	2.19 55,63
D	0.375 9,53	0.375 9,53	0.375 9,53	0.5 12.7	0.5 12.7	0.625 15,875	0.625 15,875	0.75 19,05

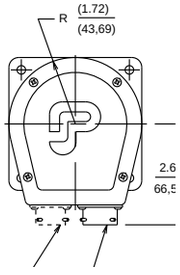
Note:

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