

Detailed Specifications

For user manuals and dimensional drawings, visit the product page resources tab on ni.com.

Last Revised: 2014-12-17 16:19:17.0

## Stepper Motors and Encoders



### Overview

National Instruments offers a complete stepper motion control solution – including stepper motors, drives, controllers, and software – that is easy to set up, configure, and program. Stepper motors available from NI offer high torque, precision, and easy connectivity to stepper motor drives. Due to their ease of use, simplified control needs, and freedom from expensive feedback requirements, stepper motors are an excellent solution for applications such as machine control, manufacturing test, semiconductor positioning, biomedical machines, and lab automation.

[Back to Top](#)

### Application and Technology

#### Stepper Motors

- NEMA 17, 23, and 34 frame sizes
- Up to 1710 oz-in. (12.1 N · m) holding torque
- 3000 rpm max speed
- 1.8 deg step angle
- Matched with P7000 drives for high performance

#### Encoders

- 1000 counts/revolution resolution
- NEMA 23 and 34 motor compatibility
- Low profile 1 in. (25.4 mm) height design and easy mounting
- Industrial construction

### Hardware

Stepper motors provide very precise, extremely cost-effective motion control. The 2-phase motors inherently move in small, precise, 1.8 degree increments at 200 steps/revolution and are brushless and maintenance-free. Stepping action is simple to control and does not require complicated, expensive feedback devices. National Instruments also offers encoders matched to the motors for applications where position verification is required. Stepper motors are available from NI in three different National Electrical Manufacturers Association (NEMA) frame sizes and with either a single or a dual shaft. The motors provide optimum performance and easy connectivity when matched with the P7000 series stepper drives available from NI.

[Back to Top](#)

### Support and Services

#### System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

## Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. To ensure the ongoing accuracy of your measurement hardware, NI offers basic or detailed recalibration service that provides ongoing ISO 9001 audit compliance and confidence in your measurements. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit [ni.com/calibration](http://ni.com/calibration).

## Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit [ni.com/support](http://ni.com/support) to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit [forums.ni.com](http://forums.ni.com) for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit [community.ni.com](http://community.ni.com) to find, contribute, or collaborate on customer-contributed technical content with users like you.

## Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit [ni.com/repair](http://ni.com/repair).

## Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training in cities worldwide** - the most comprehensive hands-on training taught by engineers.
- **On-site training at your facility** - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
- **Training memberships** and training credits - to buy now and schedule training later.

Visit [ni.com/training](http://ni.com/training) for more information.

## Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit [ni.com/warranty](http://ni.com/warranty).

## OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit [ni.com/oem](http://ni.com/oem).

## Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit [ni.com/alliance](http://ni.com/alliance).

[Back to Top](#)

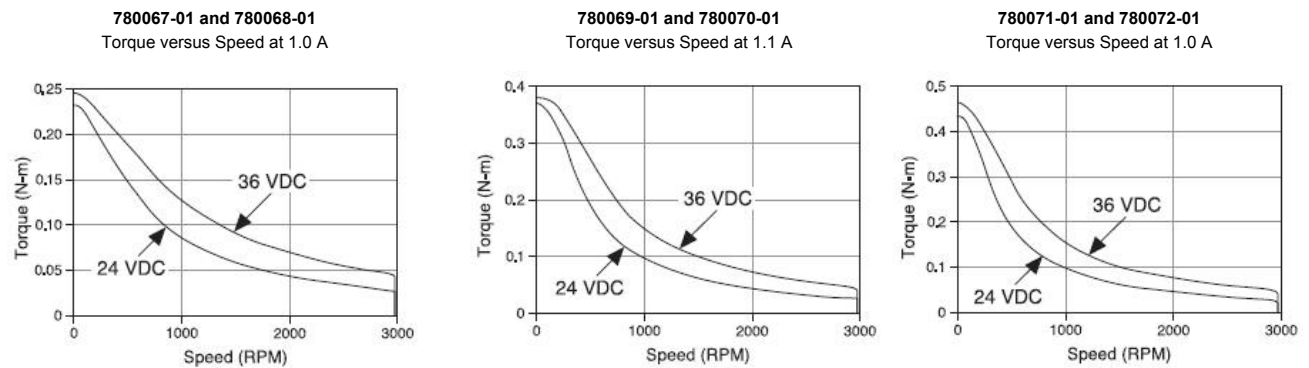
## Detailed Specifications

NEMA 17 Motor	
<b>Electrical</b>	
Step angle	1.8 deg
Steps per revolution	200
Angular accuracy	±3%
Phases	2
<b>Industry Standards</b>	
Industrial standards	CE, UR
Sealing standards	IP40
RoHS Compliance	Yes
<b>Physical</b>	
Operating temperature	-20 to 40 °C
Shaft load (20,000 hours at 1,500 rpm)	15 lb (6.8 kg) at shaft center

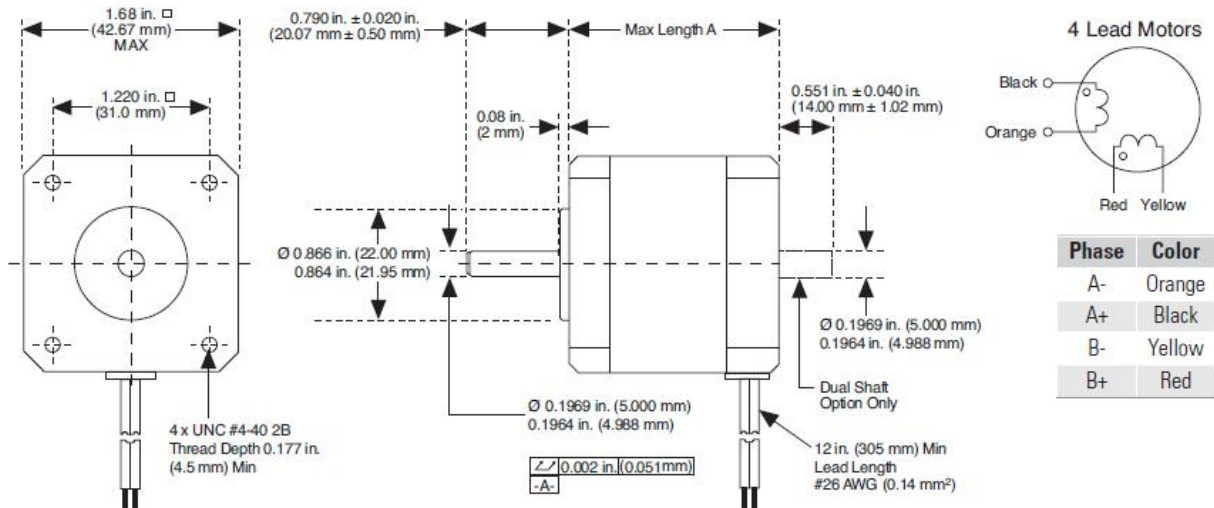
Radial	
Axial push	6 lb (2.7 kg)
Axial pull	15 lb (6.8 kg)
Recommended heat sink size	10 x 10 x 1/4 in. aluminum plate

NI Part Number	Manufacturer Part Number	Dual Shaft	Drive	Amps/Phase	Holding Torque oz-in. (N · m)	Rotor Inertia oz-in.-s <sup>2</sup> (kg-m <sup>2</sup> × 10 <sup>-3</sup> )	Phase Inductance mH	Phase Resistance Ω ±10%	Detent Torque oz-in. (N · m)	Thermal Resistance °C/watt	Max Speed rpm
780067-01	CTP10ELF10MAA00	no	P70530	1.0	43 (0.30)	0.0005 (0.0040)	7.7	5.25	1.98 (0.014)	6.21	3000
780068-01	CTP10ELF10MMA00	yes									
780069-01	CTP11ELF11MAA00	no		1.1	63 (0.44)	0.0008 (0.0050)	11	5.19	2.55 (0.018)	5.44	
780070-01	CTP11ELF11MMA00	yes									
780071-01	CTP12ELF10MAA00	no		1.0	80 (0.56)	0.0011 (0.0070)	12	6.51	2.97 (0.021)	4.71	
780072-01	CTP12ELF11MAA00	yes									

### Torque versus Speed



### Dimensions and Wiring



NI Part Number	Manufacturer Part Number	Dual Shaft	Max Length A in. (mm)	Net Weight lb (kg)
780067-01	CTP10ELF10MAA00	no	1.37	0.441
780068-01	CTP10ELF10MMA00	yes	(34.7)	(0.200)
780069-01	CTP11ELF11MAA00	no	1.61	0.573
780070-01	CTP11ELF11MMA00	yes	(40.9)	(0.260)
780071-01	CTP12ELF10MAA00	no	1.92	0.750
780072-01	CTP12ELF11MAA00	yes	(48.8)	(0.340)

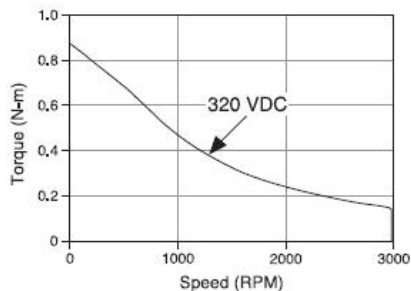
### NEMA 23 Motor

Electrical	
Step angle	1.8 deg
Steps per revolution	200
Angular accuracy	±3%
Phases	2
Industry Standards	
Industrial standards	CE, cUR, UR
RoHS Compliance	Yes
Physical	
Operating temperature	-20 to 40 °C
Rated ambient temperature	40 °C
Shaft load (20,000 hours at 1,500 rpm)	
Radial	20 lb (9.1 kg) at shaft center
Axial push	6 lb (2.7 kg)
Axial pull	50 lb (22.7 kg)
Recommended heat sink size	10 x 10 x 1/4 in. aluminum plate
Recommended encoder	780251-01

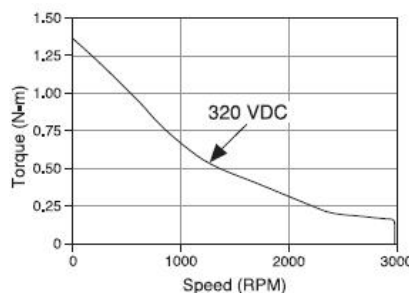
NI Part Number	Manufacturer Part Number	Dual Shaft	Drive	Amps/Phase	Holding Torque oz-in. (N . m)	Rotor Inertia oz-in.-s <sup>2</sup> (kg-m <sup>2</sup> x10 <sup>-3</sup> )	Phase Inductance mH	Phase Resistance Ω ±10%	Detent Torque oz-in. (N . m)	Thermal Resistance °C/watt	Max Speed rpm
780073-01	T21NRLC-LNN-NS-00	no	P70360	0.40	180 (1.27)	0.0034 (0.0248)	209	42.9	2.97 (0.021)	4.64	3000
780074-01	T21NRLC-LDN-NS-00	yes									
780075-01	T22NRLC-LNN-NS-00	no									
780076-01	T22NRLC-LDN-NS-00	yes									
780077-01	T23NRLC-LNN-NS-00	no									
780078-01	T23NRLC-LDN-NS-00	yes									
780079-01	T21NRLH-LNN-NS-00	no	P70530	2.7	180 (1.27)	0.0034 (0.0248)	4.6	0.85	2.97 (0.021)		
780080-01	T21NRLH-LDN-NS-00	yes									
780081-01	T22NRLG-LNN-NS-00	no									
780082-01	T22NRLG-LDN-NS-00	yes									
780083-01	T23NRLH-LNN-NS-00	no									
780084-01	T23NRLH-LDN-NS-00	yes									

### Torque versus Speed

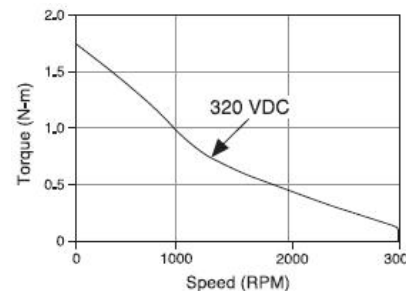
780073-01 and 780074-01  
Torque versus Speed at 0.36 A



780075-01 and 780076-01  
Torque versus Speed at 0.40 A



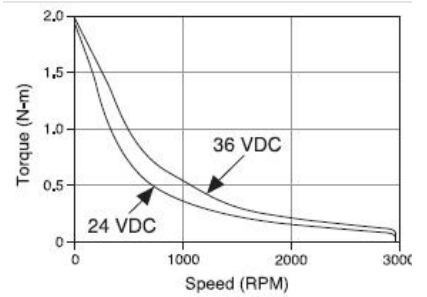
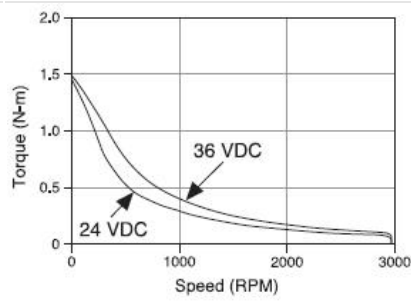
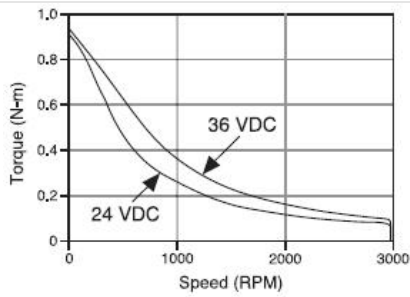
780077-01 and 780078-01  
Torque versus Speed at 0.52 A



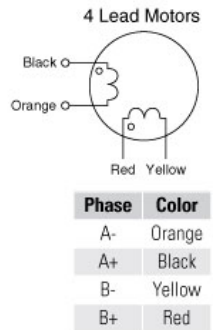
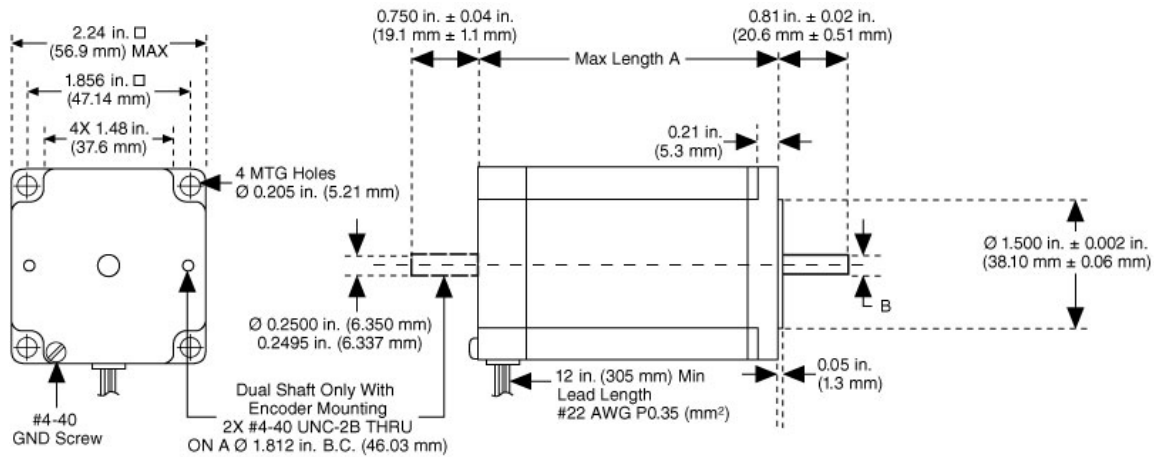
780079-01 and 780080-01  
Torque versus Speed at 2.7 A

780081-01 and 780082-01  
Torque versus Speed at 2.5 A

780083-01 and 780084-01  
Torque versus Speed at 3.0 A



## Dimensions and Wiring



NI Part Number	Manufacturer Part Number	Dual Shaft	Max Length A in. (mm)	B Diameter in. (mm)	Net Weight lb (kg)
780073-01	T21NRLC-LNN-NS-00	no	2.21 (56.1)	0.2500 (6.350)	1.6 (0.7)
780074-01	T21NRLC-LDN-NS-00	yes	2.21 (56.1)	0.2495 (6.337)	1.6 (0.7)
780075-01	T22NRLC-LNN-NS-00	no	3.06 (77.7)	0.2500 (6.350)	2.3 (1.0)
780076-01	T22NRLC-LDN-NS-00	yes	3.06 (77.7)	0.2495 (6.337)	2.3 (1.0)
780077-01	T23NRLC-LNN-NS-00	no	4.06 (103.1)	0.313 (7.940)	3.2 (1.5)
780078-01	T23NRLC-LDN-NS-00	yes	4.06 (103.1)	0.313 (7.940)	3.2 (1.5)
780079-01	T21NRLH-LNN-NS-00	no	2.21 (56.1)	0.2500 (6.350)	1.6 (0.7)
780080-01	T21NRLH-LDN-NS-00	yes	2.21 (56.1)	0.2495 (6.337)	1.6 (0.7)
780081-01	T22NRLG-LNN-NS-00	no	3.06 (77.7)	0.2500 (6.350)	2.3 (1.0)
780082-01	T22NRLG-LDN-NS00	yes	3.06 (77.7)	0.2495 (6.337)	2.3 (1.0)
780083-01	T23NRLH-LNN-NS00	no	4.06 (103.1)	0.313 (7.940)	3.2 (1.5)
780084-01	T23NRLH-LDN-NS00	yes	4.06 (103.1)	0.313 (7.940)	3.2 (1.5)

### NEMA 34 Motor

#### Electrical

Step angle	1.8 deg
Steps per revolution	200
Angular accuracy	±3%
Phases	2

#### Industry Standards

Industrial standards	CE, cUR, UR
RoHS Compliance	Yes

#### Physical

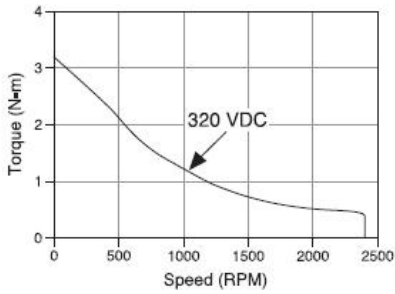
Operating temperature	-20 to 40 °C
-----------------------	--------------

Rated ambient temperature	40 °C
Shaft load (20,000 hours at 1,500 rpm)	
Radial	
N31, N32	65 lb (29.5 kg)
N33	110 lb (49.9 kg)
Axial	
N31, N32, N33	305 lb (138.3 kg)
Recommended heat sink size	10 x 10 x 1/4 in. aluminum plate
Recommended encoder	780252-01

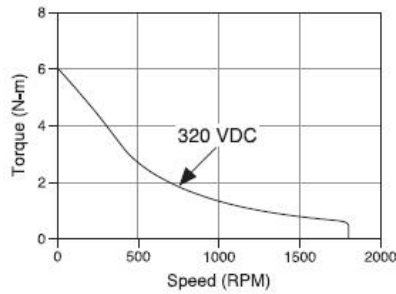
NI Part Number	Manufacturer Part Number	Dual Shaft	Drive	Amps/Phase	Holding Torque oz-in. (N . m)	Rotor Inertia oz-in.-s <sup>2</sup> (kg-m <sup>2</sup> x 10 <sup>-3</sup> )	Phase Inductance mH	Phase Resistance Ω ±10%	Detent Torque oz-in. (N . m)	Thermal Resistance °C/watt	Max Speed rpm
780085-01	N31HRLG-LNK-NS-00	no	P70360	0.86	641 (4.52)	0.0202 (0.1430)	138	16.2	18.0 (0.127)	2.65	2400
780086-01	N31HRLG-LEK-M2-00	yes									
780087-01	N32HRLG-LNK-NS-0	no									
780088-01	N32HRLG-LEK-M2-00	yes									
780089-01	N33HRLG-LNK-NS-0	no									
780090-01	N33HRLG-LEK-M2-00	yes									
780091-01	N31HRHJ-LNK-NS-0	no	P70530	5.5	645 (4.55)	0.0202 (0.1430)	3.5	0.42	18.0 (0.127)	2.65	3000
780092-01	N31HRHJ-LEK-M2-0	yes									
780093-01	N32HRHJ-LNK-NS-0	no									
780094-01	N32HRHJ-LEK-M2-0	yes									
780095-01	N33HRHJ-LNK-NS-0	no									
780096-01	N33HRHJ-LEK-M2-0	yes									

### Torque versus Speed

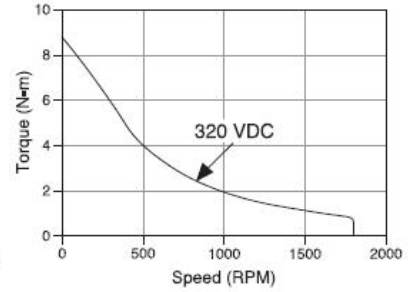
**780085-01 and 780086-01**  
Torque versus Speed at 0.81 A



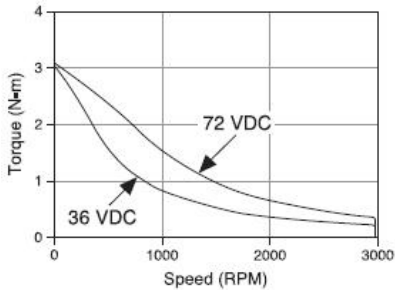
**780087-01 and 780088-01**  
Torque versus Speed at 0.88 A



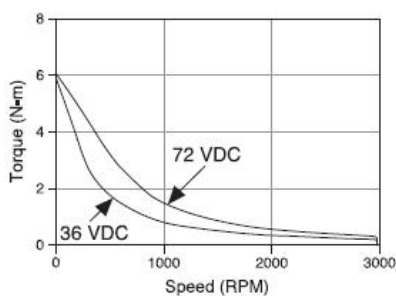
**780089-01 and 780090-01**  
Torque versus Speed at 1.24 A



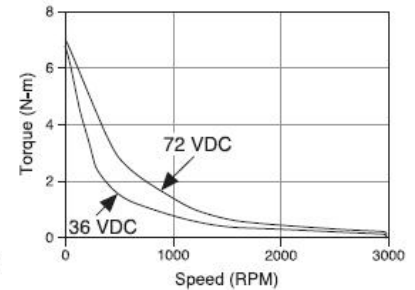
**780091-01 and 780092-01**  
Torque versus Speed at 5 A



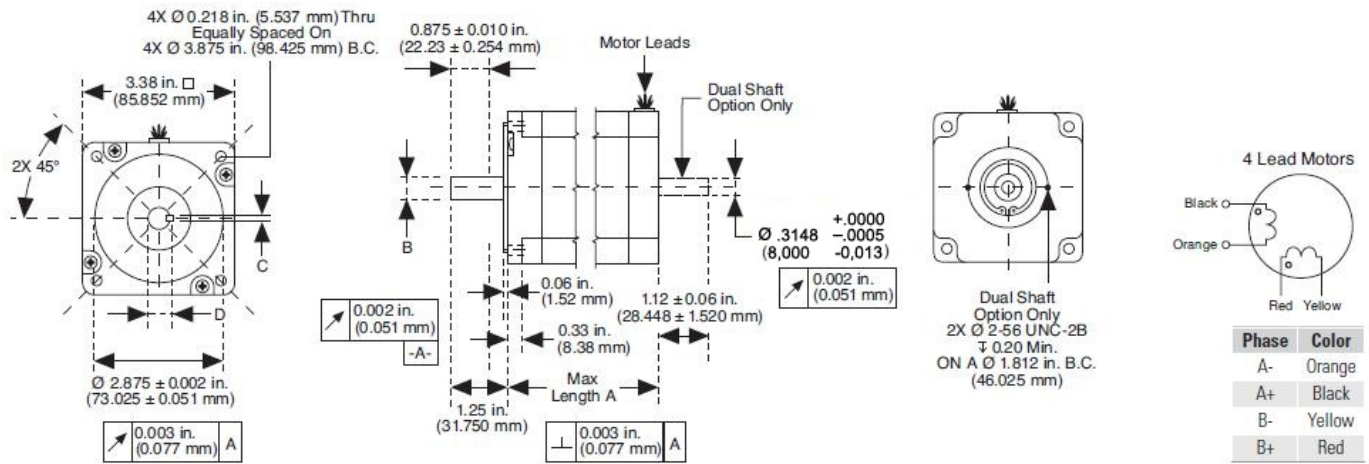
**780093-01 and 780094-01**  
Torque versus Speed at 5 A



**780095-01 and 780096-01**  
Torque versus Speed at 5 A



### Dimensions and Wiring



**Note:** Motor leads are 12.0 in. (304.8 mm) minimum.

NI Part Number	Manufacturer Part Number	Dual Shaft	Max Length A in. (mm)	B max and min in. (mm)	C max and min in. (mm)	D max and min in. (mm)	Net Weight lb (kg)
780085-01	N31HRLG-LNK-NS-00	no	3.13	0.5000 (12.700) 0.4995	0.1250 (3.175) 0.1230 (3.124)	0.555 (14.097) 0.538 (13.665)	5.0 (2.27)
780086-01	N31HRLG-LEK-M2-00	yes	(79.502)				
780087-01	N32HRLG-LNK-NS-00	no	4.65	0.5000 (12.700) 0.4995 (12.687)	0.1250 (3.175) 0.1230 (3.124)	0.555 (14.097) 0.538 (13.665)	8.4 (2.27)
780088-01	N32HRLG-LEK-M2-00	yes	(118.11)				
780089-01	N33HRLG-LNK-NS-00	no	6.13	0.6250 (15.875) 0.6245 (15.862)	0.1875 (4.763) 0.1855 (4.712)	0.705 (17.907) 0.688 (17.475)	11.9 (5.39)
780090-01	N33HRLG-LEK-M2-00	yes	(155.70)				
780091-01	N31HRHJ-LNK-NS-00	no	3.13	0.5000 (12.700) 0.4995 (12.687)	0.1250 (3.175) 0.1230 (3.124)	0.555 (14.097) 0.538 (13.665)	5.0 (2.27)
780092-01	N31HRHJ-LEK-M2-00	yes	(79.502)				
780093-01	N32HRHJ-LNK-NS-00	no	4.65	0.5000 (12.700) 0.4995 (12.687)	0.1250 (3.175) 0.1230 (3.124)	0.555 (14.097) 0.538 (13.665)	8.4 (2.27)
780094-01	N32HRHJ-LEK-M2-00	yes	(118.11)				
780095-01	N33HRHJ-LNK-NS-00	no	6.13	0.6250 (15.875) 0.6245 (15.862)	0.1875 (4.763) 0.1855 (4.712)	0.705 (17.907) 0.688 (17.475)	11.9 (5.39)
780096-01	N33HRHJ-LEK-M2-00	yes	(155.70)				

### Encoders for NEMA 23 and NEMA 34 Motors

#### Electrical

Resolution	1000 counts/revolution
Input voltage	5 V ±10%
Input current	100 mA max (65 mA typical) with no output load
Channel configuration	Quadrature A, B, and Index
Output type	Differential line driver
Noise immunity	Tested to BS EN61000-6-2; BS EN50081-02; BS EN61000-4-2; BS EN61000-4-3; BS EN61000-4-6; BS EN500811
Symmetry	180 deg (±18 deg) electrical
Quadrature phasing	90 deg (±22.5 deg) electrical
Minimum edge separation	67.5 deg electrical
Accuracy	Within 0.017 deg mechanical or 1 arc-minute from true position

#### Industry Standards

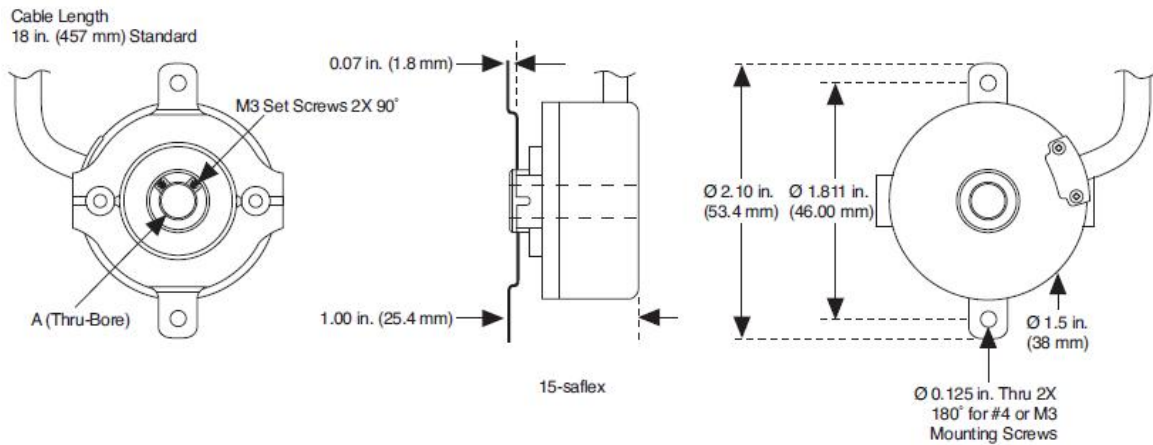
Industrial standards	CE
Sealing standards	IP40
RoHS Compliance	Yes

#### Physical

Operating temperature	-20 to 85 °C
Model type	Thru-bore
Bore size	1/4 in. (780251-01), 8 mm (780252-01)
Mounting	1.812 in. (46 mm) two-hole flex mount
Maximum frequency	200 kHz
Operating temperature	20 to 85 °C
Max shaft speed	8000 rpm

Bore tolerance	-0.0000 in./+0.0006 in.
User shaft tolerances	
Radial runout	0.008 in. max
Axial endplay	±0.030 in. max
Starting torque	0.300 oz-in. (0.212 N . m)
Moment of inertia	$6.7 \times 10^{-5}$ oz-in.-sec <sup>2</sup> (4.8 gm-cm <sup>2</sup> )
Max acceleration	$1 \times 10^5$ rad/sec <sup>2</sup>
Weight	3 oz typical
Storage temperature	-25 to 85 °C
Humidity	98% RH noncondensing
Vibration	10 g @ 58 to 500 Hz
Shock	80 g @ 11 ms duration

### Dimensions, Wiring and Timing Diagrams



**Note:** All dimensions have a tolerance of ±0.005 in. or ±0.01 in. unless otherwise specified.

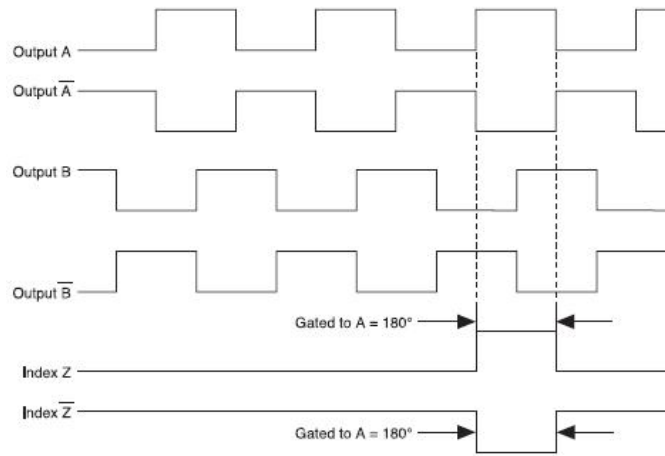
NI Part Number	Manufacturer Part Number	A (Thru-Bore Diameter)
780251-01	15T-01SA-1000-N5RHV-F00-CE	1/4 in., 0.250 in.
780252-02	15T-14SA-1000-N5RHV-F00-CE	8 mm

### Wire Description

Pin #	Wire Color	Function
1	Brown	A
2	White	+VDC
3	Yellow	$\bar{A}$
4	Red	B
5	Green	$\bar{B}$
6	Orange	Z
7	Black	COM
8	Blue	$\bar{Z}$

### Quadrature Waveform





## Glossary

<b>amps/phase</b>	The maximum amount of current allowed through a phase of the stepper motor. Holding torque, the speed versus torque curve, and so on are determined when the motor is excited by this value. The specifications listed in this data sheet are adjusted for the winding configuration.
<b>angular accuracy</b>	A percentage of the step angle that defines the accuracy of each full step.
<b>detent torque (cogging torque)</b>	The amount of torque necessary to rotate the stepper motor one full step when the motor is deenergized.
<b>differential line driver</b>	A type of electrical digital output that can transmit digital data over a long distance. It consists of a complementary pair of digital lines.
<b>electrical symmetry</b>	How close each quadrature channel is to a 50 percent duty cycle when at a constant speed.
<b>holding torque</b>	The amount of torque necessary to rotate the stepper motor one full step (microstepping turned off) when the motor is energized at the rated amps/phase of that motor.
<b>minimum edge separation</b>	Defines in degrees how close (electrically) an edge on channel A can be to an edge on channel B.
<b>NEMA</b>	National Electrical Manufacturers Association (NEMA). NEMA is a U.S.-based association that creates standards for mountings. The NEMA size of a motor defines its shaft size and mounting configuration.
<b>phase inductance</b>	The inductance of each phase of the stepper motor. The specifications listed in this data sheet are already adjusted for the winding configuration.
<b>phases</b>	A wound wire in the stepper motor that is excited with current to produce electromagnetic force. Two or more phases work together by alternating between positively energized, deenergized, and negatively energized states to rotate the stepper motor.
<b>quadrature phasing</b>	The electrical phase shift between channels A and B in a quadrature encoder.
<b>step angle</b>	The distance the motor rotates each full step of the stepper motor. Also defined as 360 degrees divided by the steps per revolution.

[Back to Top](#)

©2010 National Instruments. All rights reserved. CompactRIO, CVI, FieldPoint, LabVIEW, Measurement Studio, National Instruments, National Instruments Alliance Partner, NI, and ni.com are trademarks of National Instruments. The mark LabWindows is used under a license from Microsoft Corporation. Windows is a registered trademark of Microsoft Corporation in the United States and other countries. Other product and company names listed are trademarks or trade names of their respective companies. A National Instruments Alliance Partner is a business entity independent from National Instruments and has no agency, partnership, or joint-venture relationship with National Instruments.

[My Profile](#) | [RSS](#) | [Privacy](#) | [Legal](#) | [Contact NI](#) © 2014 National Instruments Corporation. All rights reserved.