

## FREQUENTLY ASKED QUESTIONS

### ***Q. What is a Linear Shaft Motor?***

A. Linear Shaft Motors are direct drive linear servomotors that consist of a shaft with permanent magnets and a forcer of cylindrically wound coils.

### ***Q. What routine maintenance is required for Linear Shaft Motors?***

A. The Linear Shaft Motor itself is entirely maintenance free. It does not have any parts that can wear out. NPA does recommend that you perform periodic minimal inspections. Please see the Maintenance and Service section of the Installation and Users Guide for a full list.

### ***Q. What is the price of a typical Linear Shaft Motor system?***

A. The price of the Linear Shaft Motor is comparable to other ironless core linear motors. Prices for other parts of the system are dependent upon the resolution and size of the system being produced.

### ***Q. What is the reliability of the Linear Shaft Motor?***

A. The Linear Shaft Motor is a non-contact device. As such, it does not have any parts that can wear out. If the system is designed properly, and the operating parameter limits are not exceeded, a Linear Shaft Motor should last indefinitely.

### ***Q. Can the shaft of the Linear Shaft Motor transmit a rotary force?***

A. Yes, it is possible. To determine which Linear Shaft Motor is most suitable for your specific application, an applications engineer must review the specifications.

### ***Q. Do magnets ever lose their magnetism over time?***

A. The Linear Shaft motors use a rare earth magnet, which will maintain their strength for 99 years. However, when operating at high temperatures (>150°C), these rare earth magnets can lose strength. Lower temperatures have no effect the magnets as long as frost does not form in the air gap.

### ***Q. What performance improvements can be expected when using the Linear Shaft Motor?***

A. In most applications, repeatability and accuracy will be increased. Move times and settling time will be decreased. Noise will also decrease as well as total power requirements.

### ***Q. How accurate are Linear Shaft Motors?***

A. By eliminating the conversion of rotary to linear motion, a major source of positioning error is removed. This results in high performance and accuracy. While the Linear Shaft Motor itself does not have inherent resolution, position accuracy is ultimately determined by the linear encoder feedback accuracy and the core stiffness of the Linear Shaft motor. Testing has shown that with encoder resolutions less than 10nm, the Linear Shaft Motor will, at worst case, enable a position accuracy of  $\pm 1.2$  pulses of encoder resolution. This position accuracy is not affected by the expansion and contraction of the shaft.

### ***Q. How fast can the Linear Shaft Motor go?***

A. While the Linear Shaft Motor itself does not have inherent speed limitations. There are several factors that can limit the maximum speed of a Linear Shaft Motor system. The control must provide sufficient bus voltage to support the speed requirements. The encoder itself must be able to respond to that speed and its output frequency must be within the controllers capability: for example, with a 0.5 micron encoder and a speed of 5 m/s, the controller must handle 10MHz. Finally the speed rating of the stage's bearing system must not be exceeded: for example, in a recalculating ball bearing, the balls start to skid (rather than roll) at about 5 m/s. Under the right conditions the Linear Shaft Motor can reach speeds exceeding 10 m/s.

**Q. What happens if the system loses power or velocity feedback?**

A. If a power loss occurs, the system loses all stiffness. So, if the payload is moving, it will continue to move until it hits a stop or until friction brings it to a stop. If the system is already stopped, it will not be affected. If the feedback loop is lost, it may lead to a runaway situation. This condition can be avoided with the use of soft and hard stops as well as braking systems.

**Q. What is cogging?**

A. Cogging is the tendency of some linear motors to move in discrete distances rather than infinitely variable distances. The effect is a result of varying magnetic forces along the length of motor travel. This effect is most often seen when ferrous material is used in the motor or stage construction.

**Q. Will the Linear Shaft Motor produce enough force for my application?**

A. The smallest Linear Shaft Motor will produce 0.29N [0.07 lbs] of continuous force. The largest can provide 36,000N [8180 lbs] of peak force.

**Q. Are linear motors difficult to integrate into a machine?**

A. Not difficult, just a little different. The Linear Shaft Motor is simpler to install, as it replaces the ball screw, nut, end bearings, motor mount, couplings, and rotary motor. Alignment of the Linear Shaft Motor is not critical (even for high performance packages) and consists of mainly ensuring there is some clearance between the forcer and shaft over the entire travel. Nippon Pulse will assist with selection of suitable components.

**Q. What is RMS Current?**

A. RMS is the average current flowing through the windings. RMS current for a given application should not exceed the rated continuous current for the selected Linear Shaft Motor.

$$I_{RMS} = \sqrt{\frac{(I_{accel}^2 \cdot T_{accel}) + (I_{@vel}^2 \cdot T_{@vel}) + (I_{decel}^2 \cdot T_{decel}) + (I_{settle}^2 \cdot T_{settle}) + \dots}{(T_{accel} + T_{@vel} + T_{decel} + T_{settle} + \dots)}}$$

**Q. What is motor power duty cycle for a linear motor?**

A. Duty cycle for a linear motor is different than other types of systems. While it is defined as (time on) / (time on + time off) per cycle, in a linear motor the motor can be on even when not in motion. So for a linear motor the duty cycle is based upon the time the motor is actually working (when current is applied) and NOT the % of time the motor is moving! Thus it is best defined as:

$$\text{Duty Cycle (\%)} = \left[ \frac{I_{RMS}}{I_{Continuous}} \right]^2 \times 100$$

Motion duty cycle is defined as time moving / total time. It is possible for Motor power duty to be 100% while the motor is not moving, or the motion duty to 100% with very low motor power duty.

**Q. Do standard rotary motor electronics work with linear motors?**

A. The Linear Shaft Motor is designed to operate with most off-the-shelf motor controls and drives. Basically, the Linear Shaft Motor uses the same electric circuit as other linear motors and rotary servo motors.

**Q. Can a Linear Shaft Motor be mounted vertically?**

A. Yes, a linear motor provides the same performance when mounted vertically or horizontally. However, it is recommended that a vertically mounted Linear Shaft Motor be counterbalanced.

**Q. Can more than one forcer be used with a single shaft?**

A. Yes, more than one forcer can be used in conjunction with a single shaft as long as the forcers do not physically interfere with each other. Two forcers may also be tied together and driven with one drive two double the output force.

**Q. Are versions of the Linear Shaft Motor available for use in waterproof, vacuum or clean room environments?**

A. Yes, the Linear Shaft Motor can be built for a variety of operating environments. To determine if and which Linear Shaft Motor is suitable for a specific application, an applications engineer must review the specifications.

**Q. What are the advantages of the Linear Shaft Motor over a lead screw?**

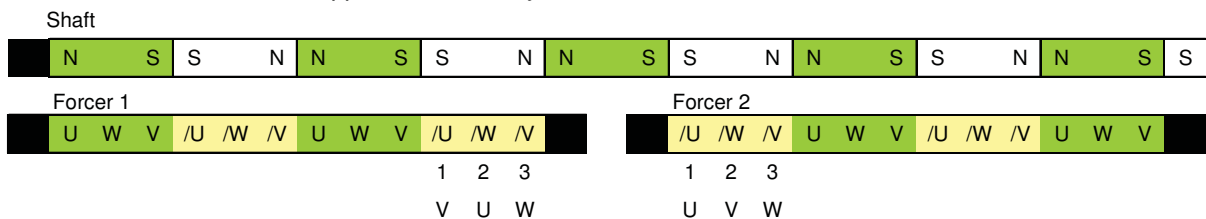
A. The advantages of the Linear Shaft Motor include higher velocities [ $>240$  in/sec ( $>6$  m/s)], non-wear moving part, free movement when power is off, no backlash because there are no mechanical linkages, easier alignments, and easier manufacturing.

**Q. What is the MTBF (Mean Time Between Failure) for the Linear Shaft Motor?**

A. The current published MTBF for the Linear Shaft motor is over 100,000 hours of operation.

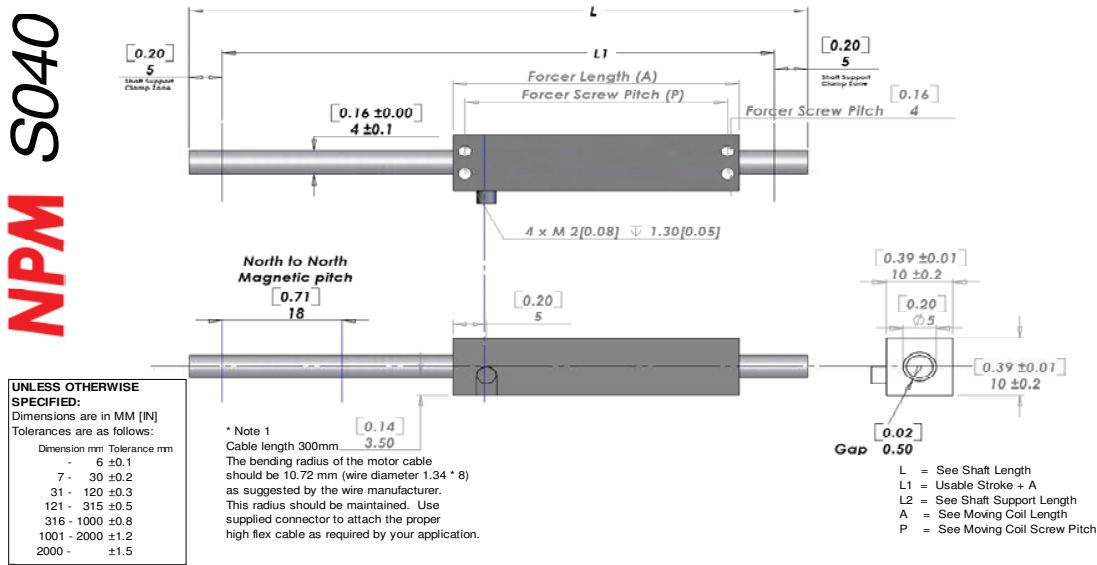
**Q. In a tandem or parallel drive application, where both coils are connected to one drive, and you wanted halls, does only one forcer need to have the halls or do both need halls?**

A. In an application where two coils are connected to the same drive, the same coil of each drive must be above the same magnet in order to run. (See drawing below) This is why when the second forcer is flipped the U and V leads must also be flipped. As such only one of the two coils needs to have halls.



# TECHNICAL DATA SHEETS

NPM S040



	S040D	S040T	S040Q	S040X
Continuous Force <sup>1</sup>	0.29N (0.07lbs)	0.45N (0.1lbs)	0.58N (0.13lbs)	0.94N (0.21lbs)
Continuous Current <sup>1</sup>	0.3Arms	0.3Arms	0.3Arms	0.6Arms
Peak Force <sup>2</sup>	1.2N (0.26lbs)	1.8N (0.4lbs)	2.3N (0.52lbs)	3.8N (0.85lbs)
Peak Current <sup>2</sup>	1.1Arms	1.1Arms	1.1Arms	2.2Arms
Force Constant	1.0N/amp (0.2lbs/amp)	1.6N/amp (0.4lbs/amp)	2.1N/amp (0.5lbs/amp)	1.7N/amp (0.4lbs/amp)
Back EMF	0.4V/m/s (0.01V/in/s)	0.5V/m/s (0.01V/in/s)	0.7V/m/s (0.02V/in/s)	0.6V/m/s (0.02V/in/s)
Resistance 25°C, <sup>3</sup>	11.2Ω	16.8Ω	22.4Ω	11.2Ω
Inductance <sup>3</sup>	0.5mH	0.7mH	1.0mH	0.5mH
Electrical Time Constant	0.045ms	0.042ms	0.044ms	0.045ms
Fundamental Motor Constant	0.31N/w	0.39N/w	0.44N/w	0.50N/w
Magnetic Pitch (North-North)	18mm (0.71in)	18mm (0.71in)	18mm (0.71in)	18mm (0.71in)

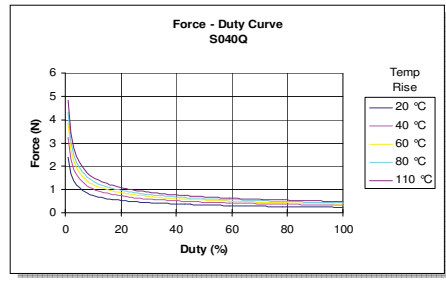
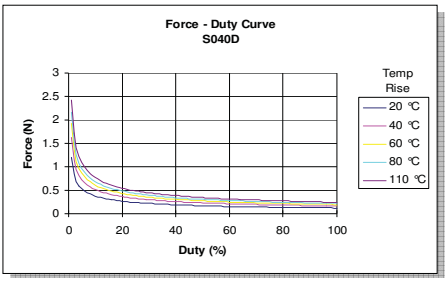
All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- Based on a temp rise of coil surface of 110°C over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- All winding parameters listed are measured line-to-line (phase-to-phase).

	S040D	S040T	S040Q	S040X
Max phase temperature <sup>4</sup>	135°C (275°F)	135°C (275°F)	135°C (275°F)	135°C (275°F)
Thermal Resistance (Coil) Kg	125.3°C/W	83.5°C/W	62.6°C/W	31.3°C/W

4) The standard temperature difference between the coil and the forcer surface is 10°C

		S040D	S040T	S040Q	S040X
Forcer Length	A	25mm (0.98in)	34mm ( 1.3in)	43mm ( 1.7in)	79mm ( 3.1in)
Forcer Width		10mm (0.39in)	10mm (0.39in)	10mm (0.39in)	10mm (0.39in)
Forcer Screw Pitch	P	21.5mm (0.85in)	30.5mm ( 1.2in)	39.5mm ( 1.55in)	75.5mm ( 2.97in)
Forcer Weight		9g (0.32oz)	11g (0.39oz)	14g ( 0.49oz)	35g ( 1.23oz)
Gap		0.50mm (0.019in)	0.50mm (0.019in)	0.50mm (0.019in)	0.50mm (0.019in)



**Mechanical Specifications**


**Shaft**

Shaft Diameter (D)	4 ±0.1mm (0.16in)			
Shaft Length (L)	<b>Maximum Stroke length 40mm (1.57in)</b>			
Motor Type	S040D	S040T	S040Q	S040X
Stroke				
20	55mm (2.2in)	64mm (2.5in)	73mm (2.9in)	109mm (4.3in)
30	65mm (2.6in)	74mm (2.9in)	83mm (3.3in)	119mm (4.7in)
40	75mm (3in)	84mm (3.3in)	93mm (3.7in)	129mm (5.1in)
Shaft Mass				
Motor Type	S040D	S040T	S040Q	S040X
Stroke				
20	5.5 g (0.19 oz)	6.4 g (0.23 oz)	7.3 g (0.26 oz)	10.9 g (0.38 oz)
30	6.5 g (0.23 oz)	7.4 g (0.26 oz)	8.3 g (0.29 oz)	11.9 g (0.42 oz)
40	7.5 g (0.26 oz)	8.4 g (0.3 oz)	9.3 g (0.33 oz)	12.9 g (0.46 oz)
Support and Bending				
Stroke		Shaft Support length (L2)	Max Bending	
All		5mm (0.2in)	0.00mm (0.00in)	

**Lead Wire**

Motor Cable	
Wire Type	UL 1430
Wire AWG	28
U phase	Red
V phase	White
W phase	Black
300mm lead wire bare leads	
The bending radius of the motor cable should be 10.72mm as suggested by the wire manufacturer.	
Connector (Motor Cable)	
Receptacle housing	XMR-03V
Plug Housing	XMP-03V
Retainer	XMS-03V
Pin contact	SXM-001T-P0.6
Socket contact	SXA-001T-P0.6
(To be installed by the user)	

**Tandem Forcer**



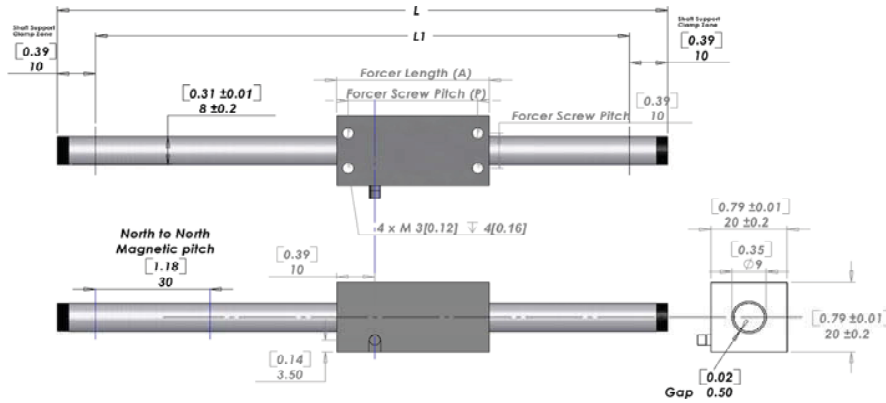
Forcer spacing distance	S040T	S040Q
Forcer spacing distance	2mm	2mm
Pole (North-South) distance	9mm	9mm
Forcer length	34mm	43mm
Flip forceers	No	Yes

**How to Order (Available Options)**

Motor Type	Forcer Size	Usable Stroke	Options	Options
S040	X	XX 20, 30, 40 mm	ST Standard	XX (Blank) FO Forcer Only SO Shaft Only XX Two digit for custom motor
Linear Shaft Motor	D	Double (2) windings		
	T	Triple (3) windings		
	Q	Quadruple (4) windings		
	X	Octuple (8) windings		

2007/12/14

# NPM S080



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 10.72 mm (wire diameter 1.34 \* 8) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S080D	S080T	S080Q
Continuous Force <sup>1</sup>	1.8N (0.4lbs)	2.7N (0.61lbs)	3.5N (0.79lbs)
Continuous Current <sup>1</sup>	0.8Arms	0.8Arms	0.8Arms
Peak Force <sup>2</sup>	7.2N (1.62lbs)	10.8N (2.43lbs)	14N (3.15lbs)
Peak Current <sup>2</sup>	3.4Arms	3.4Arms	3.4Arms
Force Constant Kf	2.1N/Arms (0.5lb/Arms)	3.2N/Arms (0.7lb/Arms)	4.2N/Arms (0.9lb/Arms)
Back EMF	0.7V/m/s (0.02 V/in/s)	1.1V/m/s (0.03 V/in/s)	1.4V/m/s (0.04 V/in/s)
Resistance 25 °C, <sup>3</sup>	4.7Ω	6.8Ω	9.0Ω
Inductance <sup>3</sup>	0.7mH	1.0mH	1.3mH
Electrical Time Constant	0.149ms	0.147ms	0.144ms
Fundamental Motor Constant	0.98N·W	1.23N·W	1.39N·W
Magnetic Pitch (North-North)	30mm (1.18in)	30mm (1.18in)	30mm (1.18in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

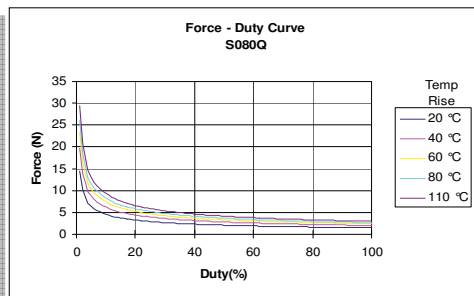
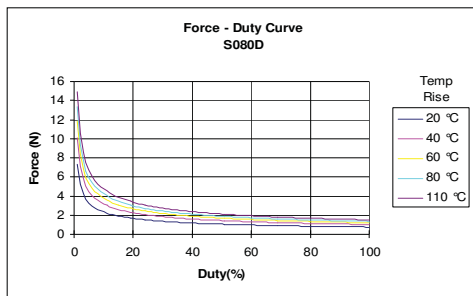
### Thermal Specifications

	S080D	S080T	S080Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	33.2 °C/W	22.9 °C/W	17.3 °C/W

4) The standard temperature difference between the coil and the forcer surface is 10 °C

### Mechanical Specifications

Forcer		S080D	S080T	S080Q
Forcer Length	A	40mm (1.57in)	55mm (2.17in)	70mm (2.76in)
Forcer Width		20mm (0.79in)	20mm (0.79in)	20mm (0.79in)
Forcer Screw Pitch	P	34mm (1.34in)	49mm (1.93in)	64mm (2.52in)
Forcer Weight		0.05kg (0.11lb)	0.06kg (0.13lb)	0.08kg (0.18lb)
Gap		0.50mm (0.019in)	0.50mm (0.019in)	0.50mm (0.019in)



**Mechanical Specifications**

**Shaft**

Shaft Diameter (D) 8 ±0.1mm (0.32in)

Shaft Length (L) Motor Type	Maximum Stroke length 300mm (11.8in)		
	S080D	S080T	S080Q
Stroke			
25	85mm (3.3in)	100mm (3.9in)	115mm (4.5in)
50	110mm (4.3in)	125mm (4.9in)	140mm (5.5in)
100	160mm (6.3in)	175mm (6.9in)	190mm (7.5in)
150	210mm (8.3in)	225mm (8.9in)	240mm (9.4in)
200	260mm (10.2in)	275mm (10.8in)	290mm (11.4in)
250	310mm (12.2in)	325mm (12.8in)	340mm (13.4in)
300	360mm (14.2in)	375mm (14.8in)	390mm (15.4in)

Stroke lengths from 25mm are available. Please consult Nippon Pulse America for more information.

**Support and Bending**

Stroke	Shaft Support length (L2)	Max Bending
All	10mm (0.4in)	0.05mm (0.00in)

**Hall Effect (Optional)**

**Forcer Length (A)**

**Forcer Screw Pitch (P) 0.39**

**Forcer Screw Pitch 10**

**1.10**

**28**

**0.79**

**20**

\* Note 2  
Sensor Cable (Lead wires) Specifications  
Wire Type UL1430  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - Red, GND - /Black  
Sensor 1 - White, Sensor 2 - Blue, Sensor 3 - Yellow

The bending radius of the sensor cable should be R 10.72 mm (wire diameter 1.38 \* 8) as suggested by the wire manufacturer.

This radius should be maintained. Attach the proper high flex cable as required by your application.

\* Note 1  
The bending radius of the motor cable should be 10.72 mm (wire diameter 1.34 \* 8) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

**How to Order (Available Options)**

Motor Type	Forcer Size	Usable Stroke	Options	Options	
S080	X	XX	XX	XX	Standard
Linear Shaft Motor	D	25 - 300 mm		(Blank)	Forcer Only
	T			FO	Shaft Only
	Q			SO	Two digit for custom motor
			ST	XX	
			WP		Standard
			HA		Waterproof
			CE		Digital Hall Effect
					CE type motor

**Shaft Mass**

Motor Type	S080D	S080T	S080Q
Stroke			
25	0.02kg (0.05lb)	0.03kg (0.06lb)	0.03kg (0.07lb)
50	0.03kg (0.07lb)	0.04kg (0.08lb)	0.04kg (0.09lb)
100	0.05kg (0.11lb)	0.05kg (0.12lb)	0.06kg (0.13lb)
150	0.07kg (0.15lb)	0.07kg (0.16lb)	0.08kg (0.17lb)
200	0.08kg (0.19lb)	0.09kg (0.2lb)	0.1kg (0.21lb)
250	0.1kg (0.22lb)	0.11kg (0.24lb)	0.11kg (0.25lb)
300	0.12kg (0.26lb)	0.12kg (0.28lb)	0.13kg (0.29lb)

**Lead Wire**

Motor Cable	
Wire Type	UL 1430
Wire AWG	28
U phase	Red
V phase	White
W phase	Black
300mm lead wire bare leads	
The bending radius of the motor cable should be 10.72mm as suggested by the wire manufacturer.	

**Supplied Connector (Motor Cable)**

Receptacle housing	XMR-03V
Plug Housing	XMP-03V
Retainer	XMS-03V
Pin contact	SXM-001T-P0.6
Socket contact	SXA-001T-P0.6
(To be installed by the user)	

**CE Type Motor Cable (Optional)**

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow
300mm lead wire blunt cut	
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.	

**Hall Effect Cable (Optional)**

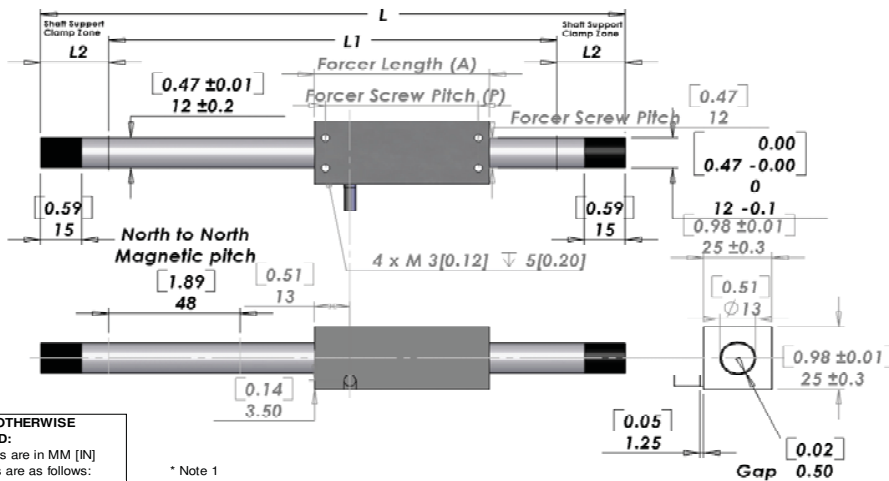
Wire Type	UL 1430
Wire AWG	28
VCC	Red
GND	Black
Sensor 1	White
Sensor 2	Blue
Sensor 3	Yellow
400mm lead wire bare leads	
The bending radius of the hall effect cable should be 10.72 mm as suggested by the wire manufacturer.	
Connector (Hall Effect Cable)	
None supplied	

**Tandem Forcer**

	S080T	S080Q
Forcer spacing distance	5	5
Pole (North-South) distance	15	15
Forcer length	55	70
Flip forcers	No	Yes

2008/9/30

# NPM S120



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 10.72 mm (wire diameter 1.34 \* 8) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S120D	S120T	S120Q
Continuous Force <sup>1</sup>	4.5N (1.01lbs)	6.6N (1.48lbs)	8.9N (2.00lbs)
Continuous Current <sup>1</sup>	0.4Arms	0.4Arms	0.4Arms
Peak Force <sup>2</sup>	18N (4.05lbs)	26.4N (5.93lbs)	36N (8.0lbs)
Peak Current <sup>2</sup>	1.6Arms	1.6Arms	1.6Arms
Force Constant Kf	11N/Arms (2.5lbs/Arms)	17N/Arms (3.7lbs/Arms)	22N/Arms (5.0lbs/Arms)
Back EMF	3.7V/m/s (0.09 V/in/s)	5.5V/m/s (0.14 V/in/s)	7.4V/m/s (0.19 V/in/s)
Resistance 25 °C, <sup>3</sup>	37Ω	54Ω	73Ω
Inductance <sup>3</sup>	12mH	18mH	24mH
Electrical Time Constant	0.32ms	0.33ms	0.33ms
Fundamental Motor Constant	1.82N√W	2.25N√W	2.60N√W
Magnetic Pitch (North-North)	48mm (1.89in)	48mm (1.89in)	48mm (1.89in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

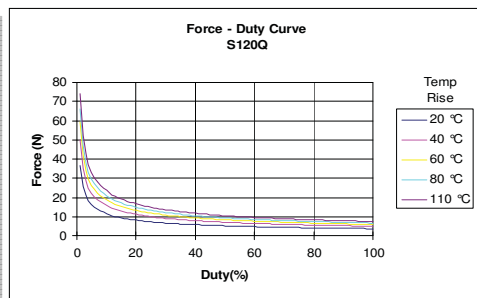
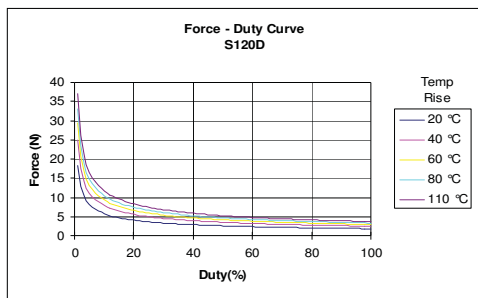
### Thermal Specifications

	S120D	S120T	S120Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	18.6 °C/W	12.7 °C/W	9.4 °C/W

4) The standard temperature difference between the coil and the forcer surface is 15°C

### Mechanical Specifications

	S120D	S120T	S120Q
Forcer Length A	64mm (2.52in)	88mm (3.46in)	112mm (4.41in)
Forcer Width	25mm (0.98in)	25mm (0.98in)	25mm (0.98in)
Forcer Screw Pitch P	56mm (2.2in)	80mm (3.15in)	104mm (4.1in)
Forcer Weight	0.09kg ( 0.20lb)	0.12kg ( 0.26lb)	0.16kg ( 0.35lb)
Gap	0.50mm (0.019in)	0.50mm (0.019in)	0.50mm (0.019in)





**Mechanical Specifications**

**Shaft**

Shaft Diameter (D) 12 ±0.2mm (0.16in)

Shaft Length (L) Motor Type	Maximum Stroke length 1750mm (68.9in)		
	S120D	S120T	S120Q
Stroke			
50	164mm (6.5in)	188mm (7.4in)	212mm (8.3in)
100	214mm (8.4in)	238mm (9.4in)	262mm (10.3in)
150	264mm (10.4in)	288mm (11.3in)	312mm (12.3in)
200	314mm (12.4in)	338mm (13.3in)	362mm (14.3in)
250	364mm (14.3in)	388mm (15.3in)	412mm (16.2in)
300	414mm (16.3in)	438mm (17.2in)	462mm (18.2in)
350	464mm (18.3in)	488mm (19.2in)	512mm (20.2in)
400	514mm (20.3in)	538mm (21.2in)	562mm (22.2in)
450	564mm (22.3in)	588mm (23.2in)	612mm (24.2in)
500	614mm (24.3in)	638mm (25.2in)	662mm (26.2in)
550	664mm (26.3in)	688mm (27.2in)	712mm (28.2in)
600	714mm (28.3in)	738mm (29.2in)	762mm (30.2in)
650	764mm (30.3in)	788mm (31.2in)	812mm (32.2in)
700	814mm (32.3in)	838mm (33.2in)	862mm (34.2in)
750	864mm (34.3in)	888mm (35.2in)	912mm (36.2in)
800	914mm (36.3in)	938mm (37.2in)	962mm (38.2in)
850	964mm (38.3in)	988mm (39.2in)	1012mm (40.2in)
900	1014mm (40.3in)	1038mm (41.2in)	1062mm (42.2in)
950	1064mm (42.3in)	1088mm (43.2in)	1112mm (44.2in)
1000	1114mm (44.3in)	1138mm (45.2in)	1162mm (46.2in)
1050	1164mm (46.3in)	1188mm (47.2in)	1212mm (48.2in)
1100	1214mm (48.3in)	1238mm (49.2in)	1262mm (50.2in)
1150	1264mm (50.3in)	1288mm (51.2in)	1312mm (52.2in)
1200	1314mm (52.3in)	1338mm (53.2in)	1362mm (54.2in)
1250	1364mm (54.3in)	1388mm (55.2in)	1412mm (56.2in)
1300	1414mm (56.3in)	1438mm (57.2in)	1462mm (58.2in)
1350	1464mm (58.3in)	1488mm (59.2in)	1512mm (60.2in)
1400	1514mm (60.3in)	1538mm (61.2in)	1562mm (62.2in)
1450	1564mm (62.3in)	1588mm (63.2in)	1612mm (64.2in)
1500	1614mm (64.3in)	1638mm (65.2in)	1662mm (66.2in)
1550	1664mm (66.3in)	1688mm (67.2in)	1712mm (68.2in)

Stroke lengths up to 1750mm available. Please consult Nippon Pulse America for more information.

**Support and Bending**

Stroke	Shaft Support length (L2)	Max Bending
0 → 350	25mm (0.98in)	0.00mm (0.00in)
351 → 800	40mm (1.57in)	0.30mm (0.012in)
801 → Max	60mm (2.36in)	0.50mm (0.019in)

**Hall Effect (Optional)**

**\* Note 2**  
Sensor Cable (Lead wires) Specifications  
HP-SB20276SR  
Wire Type UL758  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - White/Red, GND - White/Black  
Sensor 1 - Orange/Red, Sensor 2 - Orange/Black,  
Sensor 3 - Gray/Red

The bending radius of the sensor cable should be R 27.6 (wire diameter 4.6 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Attach the proper high flex cable as required by your application.

**\* Note 1**  
The bending radius of the motor cable should be 10.72 mm (wire diameter 1.34 \* 8) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

**How to Order (Available Options)**

Motor Type	Forcer Size	Usable Stroke	Options	Options	
S120	X	XX	XX	XX	Standard
Linear Shaft Motor	D	50 - 1750 mm	ST WP HA CE	(Blank)	Forcer Only
	T			FO	Shaft Only
	Q			SO	Two digit for custom motor
				XX	
				CE type motor	

**Shaft Mass**

Stroke	Motor Type		
	S120D	S120T	S120Q
50	0.1kg (0.2lb)	0.1kg (0.3lb)	0.1kg (0.3lb)
100	0.1kg (0.3lb)	0.2kg (0.4lb)	0.2kg (0.4lb)
150	0.2kg (0.4lb)	0.2kg (0.5lb)	0.2kg (0.5lb)
200	0.2kg (0.5lb)	0.2kg (0.5lb)	0.3kg (0.6lb)
250	0.3kg (0.6lb)	0.3kg (0.6lb)	0.3kg (0.7lb)
300	0.3kg (0.7lb)	0.3kg (0.7lb)	0.3kg (0.8lb)
350	0.3kg (0.8lb)	0.4kg (0.8lb)	0.4kg (0.8lb)
400	0.4kg (0.9lb)	0.4kg (0.9lb)	0.4kg (1lb)
450	0.4kg (1lb)	0.4kg (1lb)	0.5kg (1lb)
500	0.5kg (1lb)	0.5kg (1.1lb)	0.5kg (1.1lb)
550	0.5kg (1.1lb)	0.5kg (1.2lb)	0.6kg (1.2lb)
600	0.6kg (1.2lb)	0.6kg (1.3lb)	0.6kg (1.3lb)
650	0.6kg (1.3lb)	0.6kg (1.3lb)	0.6kg (1.4lb)
700	0.6kg (1.4lb)	0.7kg (1.4lb)	0.7kg (1.5lb)
750	0.7kg (1.5lb)	0.7kg (1.5lb)	0.7kg (1.6lb)
800	0.7kg (1.6lb)	0.7kg (1.6lb)	0.7kg (1.7lb)
850	0.8kg (1.7lb)	0.8kg (1.7lb)	0.8kg (1.8lb)
900	0.8kg (1.8lb)	0.8kg (1.8lb)	0.8kg (1.9lb)
950	0.8kg (1.9lb)	0.9kg (1.9lb)	0.9kg (1.9lb)
1000	0.9kg (1.9lb)	0.9kg (2lb)	0.9kg (2lb)
1050	0.9kg (2lb)	0.9kg (2.1lb)	1kg (2.1lb)
1100	1kg (2.1lb)	1kg (2.2lb)	1kg (2.2lb)
1150	1kg (2.2lb)	1kg (2.3lb)	1kg (2.3lb)
1200	1kg (2.3lb)	1.1kg (2.4lb)	1.1kg (2.4lb)
1250	1.1kg (2.4lb)	1.1kg (2.4lb)	1.1kg (2.5lb)
1300	1.1kg (2.5lb)	1.2kg (2.5lb)	1.2kg (2.6lb)
1350	1.2kg (2.6lb)	1.2kg (2.6lb)	1.2kg (2.7lb)
1400	1.2kg (2.7lb)	1.2kg (2.7lb)	1.3kg (2.8lb)
1450	1.3kg (2.8lb)	1.3kg (2.8lb)	1.3kg (2.9lb)
1500	1.3kg (2.9lb)	1.3kg (2.9lb)	1.3kg (2.9lb)

**Lead Wire**

Motor Cable	
Wire Type	UL 1430
Wire AWG	28
U phase	Red
V phase	White
W phase	Black
300mm lead wire bare leads	
The bending radius of the motor cable should be 10.72mm as suggested by the wire manufacturer.	

**Supplied Connector (Motor Cable)**

Receptacle housing	XMR-03V
Plug Housing	XMP-03V
Retainer	XMS-03V
Pin contact	SXM-001T-P0.6
Socket contact	SXA-001T-P0.6
(To be installed by the user)	

**CE Type Motor Cable (Optional)**

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow
300mm lead wire blunt cut	
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.	

**Hall Effect Cable (Optional)**

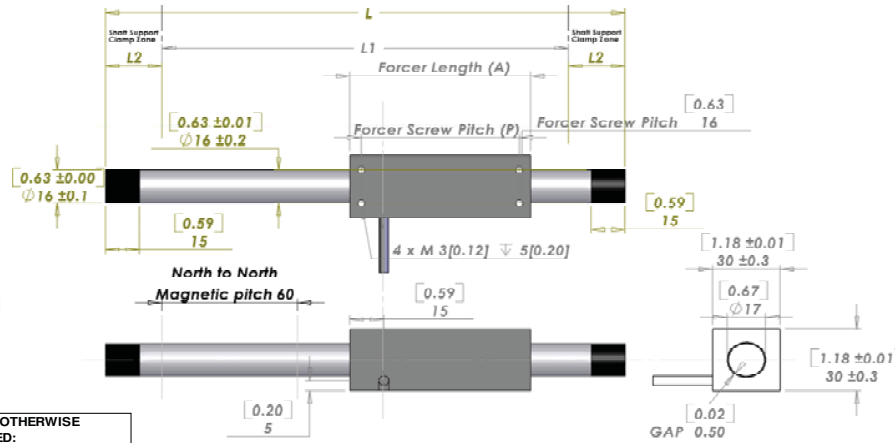
Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black
400mm lead wire bare leads	
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.	
Connector (Hall Effect Cable)	
None supplied	

**Tandem Forcer**

	S160T	S160Q
Forcer spacing distance	10	10
Pole (North-South) distance	30	30
Forcer length	110	140
Flip forcers	No	Yes

2007/12/24

# NPM S160



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 26.4 mm (wire diameter 4.4 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S160D	S160T	S160Q
Continuous Force <sup>1</sup>	10N (2.25lbs)	15N (3.37lbs)	20N (4.50lbs)
Continuous Current <sup>1</sup>	0.6Arms	0.6Arms	0.6Arms
Peak Force <sup>2</sup>	40N (9.0lbs)	60N (13.5lbs)	80N (18.0lbs)
Peak Current <sup>2</sup>	2.5Arms	2.5Arms	2.5Arms
Force Constant Kf	16N/Arms (3.6lbs/Arms)	24N/Arms (5.4lbs/Arms)	33N/Arms (7.3lbs/Arms)
Back EMF	5.4V/m/s (0.14 V/in/s)	8.1V/m/s (0.21 V/in/s)	11V/m/s (0.28 V/in/s)
Resistance 25 °C, <sup>3</sup>	21Ω	33Ω	43Ω
Inductance <sup>3</sup>	8.2mH	12mH	16mH
Electrical Time Constant	0.39ms	0.36ms	0.37ms
Fundamental Motor Constant	3.51N√W	4.20N√W	4.98N√W
Magnetic Pitch (North-North)	60mm (2.36in)	60mm (2.36in)	60mm (2.36in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

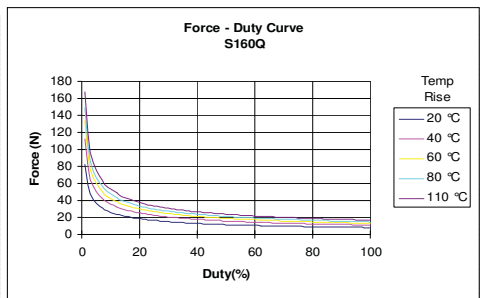
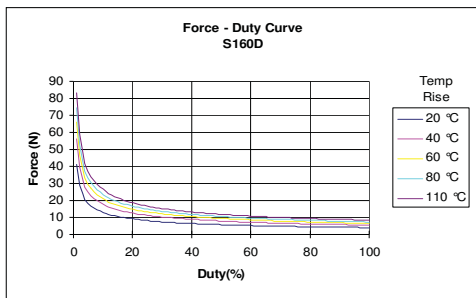
### Thermal Specifications

	S160D	S160T	S160Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	13.6 °C/W	8.7 °C/W	6.7 °C/W

4) The standard temperature difference between the coil and the forcer surface is 15 °C

### Mechanical Specifications

	S160D	S160T	S160Q
Forcer Length A	80mm (3.15in)	110mm (4.33in)	140mm (5.51in)
Forcer Width	30mm±0.3 (1.18in)	30mm±0.3 (1.18in)	30mm±0.3 (1.18in)
Forcer Screw Pitch P	70mm (2.8in)	100mm (3.9in)	130mm (5.1in)
Forcer Weight	0.15kg (0.33lb)	0.20kg (0.44lb)	0.30kg (0.66lb)
Gap	0.50mm (0.019in)	0.50mm (0.019in)	0.50mm (0.019in)



Mechanical Specifications

Shaft

Shaft Diameter (D) 16 ±0.1mm (0.63in)

Shaft Length (L) Motor Type	Maximum Stroke length 1750mm (68.9in)		
	S160D	S160T	S160Q
Stroke 100	230mm (9.06in)	260mm (10.24in)	290mm (11.42in)
150	280mm (11.02in)	310mm (12.2in)	340mm (13.39in)
200	330mm (12.99in)	360mm (14.17in)	390mm (15.35in)
250	380mm (14.96in)	410mm (16.14in)	440mm (17.32in)
300	430mm (16.93in)	460mm (18.11in)	490mm (19.29in)
350	480mm (18.9in)	510mm (20.08in)	540mm (21.26in)
400	560mm (22.05in)	590mm (23.23in)	620mm (24.41in)
450	610mm (24.02in)	640mm (25.2in)	670mm (26.38in)
500	660mm (25.98in)	690mm (27.17in)	720mm (28.35in)
550	710mm (27.95in)	740mm (29.13in)	770mm (30.31in)
600	760mm (29.92in)	790mm (31.1in)	820mm (32.28in)
650	810mm (31.89in)	840mm (33.07in)	870mm (34.25in)
700	860mm (33.86in)	890mm (35.04in)	920mm (36.22in)
750	910mm (35.83in)	940mm (37.01in)	970mm (38.19in)
800	960mm (37.8in)	990mm (38.98in)	1020mm (40.16in)
850	1050mm (41.34in)	1080mm (42.52in)	1110mm (43.7in)
900	1100mm (43.31in)	1130mm (44.49in)	1160mm (45.67in)
950	1150mm (45.28in)	1180mm (46.46in)	1210mm (47.64in)
1000	1200mm (47.24in)	1230mm (48.43in)	1260mm (49.61in)
1050	1250mm (49.21in)	1280mm (50.39in)	1310mm (51.57in)
1100	1300mm (51.18in)	1330mm (52.36in)	1360mm (53.54in)
1150	1350mm (53.15in)	1380mm (54.33in)	1410mm (55.51in)
1200	1400mm (55.12in)	1430mm (56.3in)	1460mm (57.48in)
1250	1450mm (57.09in)	1480mm (58.27in)	1510mm (59.45in)
1300	1500mm (59.06in)	1530mm (60.24in)	1560mm (61.42in)
1350	1550mm (61.02in)	1580mm (62.2in)	1610mm (63.39in)
1400	1600mm (62.99in)	1630mm (64.17in)	1660mm (65.35in)
1450	1650mm (64.96in)	1680mm (66.14in)	1710mm (67.32in)
1500	1700mm (66.93in)	1730mm (68.11in)	1760mm (69.29in)
1550	1750mm (68.9in)	1780mm (70.08in)	1810mm (71.26in)
1600	1800mm (70.87in)	1830mm (72.05in)	1860mm (73.23in)
1650	1850mm (72.83in)	1880mm (74.02in)	1910mm (75.2in)
1700	1900mm (74.8in)	1930mm (75.98in)	1960mm (77.17in)
1750	1950mm (76.77in)	1980mm (77.95in)	2010mm (79.13in)

Shaft Mass

Stroke	Motor Type		
	S160D	S160T	S160Q
100	0.28kg (0.63lb)	0.33kg (0.72lb)	0.37kg (0.81lb)
150	0.35kg (0.78lb)	0.4kg (0.87lb)	0.44kg (1lb)
200	0.42kg (0.94lb)	0.47kg (1lb)	0.51kg (1.1lb)
250	0.49kg (1.1lb)	0.54kg (1.2lb)	0.58kg (1.3lb)
300	0.56kg (1.2lb)	0.61kg (1.3lb)	0.65kg (1.4lb)
350	0.64kg (1.4lb)	0.68kg (1.5lb)	0.72kg (1.6lb)
400	0.72kg (1.6lb)	0.77kg (1.7lb)	0.81kg (1.8lb)
450	0.79kg (1.8lb)	0.84kg (1.8lb)	0.88kg (1.9lb)
500	0.86kg (1.9lb)	0.91kg (2lb)	0.95kg (2.1lb)
550	0.93kg (2.1lb)	1kg (2.2lb)	1kg (2.2lb)
600	1kg (2.2lb)	1kg (2.3lb)	1.1kg (2.4lb)
650	1.1kg (2.4lb)	1.1kg (2.5lb)	1.2kg (2.6lb)
700	1.1kg (2.5lb)	1.2kg (2.6lb)	1.2kg (2.7lb)
750	1.2kg (2.7lb)	1.3kg (2.8lb)	1.3kg (2.9lb)
800	1.3kg (2.8lb)	1.3kg (2.9lb)	1.4kg (3lb)
850	1.4kg (3lb)	1.4kg (3.1lb)	1.5kg (3.2lb)
900	1.5kg (3.2lb)	1.5kg (3.3lb)	1.5kg (3.4lb)
950	1.5kg (3.4lb)	1.6kg (3.4lb)	1.6kg (3.5lb)
1000	1.6kg (3.5lb)	1.6kg (3.6lb)	1.7kg (3.7lb)
1050	1.7kg (3.7lb)	1.7kg (3.8lb)	1.7kg (3.9lb)
1100	1.7kg (3.8lb)	1.8kg (3.9lb)	1.8kg (4lb)
1150	1.8kg (4lb)	1.9kg (4.1lb)	1.9kg (4.2lb)
1200	1.9kg (4.2lb)	1.9kg (4.3lb)	2kg (4.4lb)
1250	2kg (4.3lb)	2kg (4.4lb)	2kg (4.5lb)
1300	2kg (4.5lb)	2.1kg (4.6lb)	2.1kg (4.7lb)
1350	2.1kg (4.7lb)	2.2kg (4.7lb)	2.2kg (4.8lb)
1400	2.2kg (4.8lb)	2.2kg (4.9lb)	2.3kg (5lb)
1450	2.3kg (5lb)	2.3kg (5.1lb)	2.3kg (5.2lb)
1500	2.3kg (5.1lb)	2.4kg (5.2lb)	2.4kg (5.3lb)
1550	2.4kg (5.3lb)	2.4kg (5.4lb)	2.5kg (5.5lb)
1600	2.5kg (5.5lb)	2.5kg (5.6lb)	2.6kg (5.7lb)
1650	2.6kg (5.6lb)	2.6kg (5.7lb)	2.6kg (5.8lb)
1700	2.6kg (5.8lb)	2.7kg (5.9lb)	2.7kg (6lb)
1750	2.7kg (6lb)	2.7kg (6lb)	2.8kg (6.1lb)

Support and Bending

Stroke	Shaft Support length (L2)	Max Bending
0 → 350	25mm (0.98in)	0.00mm (0.00in)
351 → 500	40mm (1.57in)	0.30mm (0.012in)
501 → 800	40mm (1.57in)	0.50mm (0.019in)
801 → Max	60mm (2.36in)	0.50mm (0.019in)

Lead Wire

Motor Cable	
Wire Type	UL 2464
Wire AWG	24
U phase	Orange
V phase	White
W phase	Gray
300mm lead wire bare leads	
The bending radius of the motor cable should be 26.4mm as suggested by the wire manufacturer.	

Hall Effect (Optional)

\* Note 2  
Sensor Cable (Lead wires) Specifications  
HP-SB20276SS  
Wire Type UL758  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - White/Red, GND - White/Black  
Sensor 1 - Orange/Red, Sensor 2 - Orange/Black,  
Sensor 3 - Gray/Red

The bending radius of the sensor cable should be R 27.6 (wire diameter 4.6 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Attach the proper high flex cable as required by your application.

\* Note 1  
The bending radius of the motor cable should be 26.4 mm (wire diameter 4.4 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

Supplied Connector (Motor Cable)	
Receptacle housing	XMR-03V
Plug Housing	XMP-03V
Retainer	XMS-03V
Pin contact	SXM-001T-P0.6
Socket contact	SXA-001T-P0.6
(To be installed by the user)	

CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow
300mm lead wire blunt cut	
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.	

Hall Effect Cable (Optional)

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black
400mm lead wire bare leads	
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.	

Connector (Hall Effect Cable)

None supplied

How to Order (Available Options)

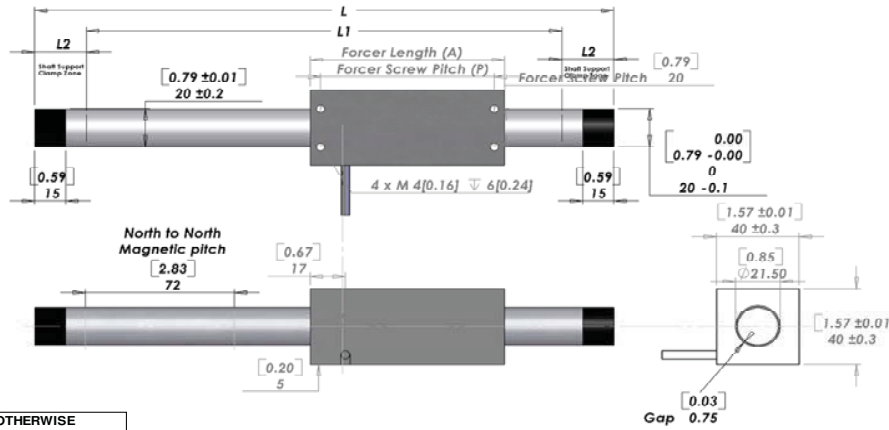
Motor Type	Forcer Size	Usable Stroke	Options	Options	Options
S160	X	XX	XX	XX	Standard
		100 - 1750 mm		(Blank)	Forcer Only
	D			FO	Shaft Only
	T			SO	Two digit for custom motor
	Q			XX	
S	Linear Shaft Motor		ST	Standard	
V	Vacuum Linear Shaft Motor		WP	Waterproof	
			HA	Digital Hall Effect	
			CE	CE type motor	

Tandem Forcer

	S160T	S160Q
Forcer spacing distance	10	10
Pole (North-South) distance	30	30
Forcer length	110	140
Flip forcers	No	Yes

2007/12/24

# NPM S200



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 26.4 mm (wire diameter 4.4 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S200D	S200T	S200Q
Continuous Force <sup>1</sup>	18N (4.05lbs)	28N (6.29lbs)	38N (8.54lbs)
Continuous Current <sup>1</sup>	0.6Arms	0.6Arms	0.6Arms
Peak Force <sup>2</sup>	72N (16.2lbs)	112N (25.2lbs)	152N (34.2lbs)
Peak Current <sup>2</sup>	2.4Arms	2.4Arms	2.4Arms
Force Constant Kf	31N/Arms (6.9lbs/Arms)	47N/Arms (10.7lbs/Arms)	64N/Arms (14.5lbs/Arms)
Back EMF	10V/m/s (0.26 V/in/s)	16V/m/s (0.40 V/in/s)	21 V/m/s (0.55 V/in/s)
Resistance 25 °C, <sup>3</sup>	28.7Ω	43Ω	56Ω
Inductance <sup>3</sup>	19.3mH	29mH	39mH
Electrical Time Constant	0.67ms	0.67ms	0.70ms
Fundamental Motor Constant	7.24N√W	8.61N√W	11.19N√W
Magnetic Pitch (North-North)	72mm (2.83in)	72mm (2.83in)	72mm (2.83in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

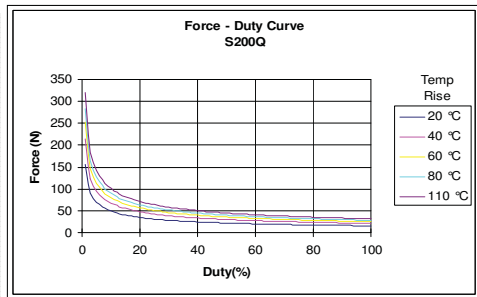
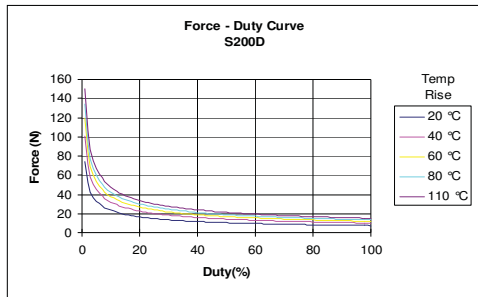
### Thermal Specifications

	S200D	S200T	S200Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	11 °C/W	7.3 °C/W	5.6 °C/W

4) The standard temperature difference between the coil and the forcer surface is 20 °C

### Mechanical Specifications

	S200D	S200T	S200Q
Forcer Length A	94mm (3.7in)	130mm (5.1in)	166mm (6.5in)
Forcer Width	40mm (1.57in)	40mm (1.57in)	40mm (1.57in)
Forcer Screw Pitch P	84mm (3.31in)	120mm (4.72in)	156mm (6.14in)
Forcer Weight	0.30kg (0.7lbs)	0.50kg (1.1lbs)	0.70kg (1.5lbs)
Gap	0.75mm (0.029in)	0.75mm (0.029in)	0.75mm (0.029in)



**Mechanical Specifications**

**Shaft**

Shaft Diameter (D) 20 ±0.2mm (0.79in)

Shaft Length (L)	Maximum Stroke length 2700mm (106.3in)			
	Motor Type	S200D	S200T	S200Q
100	244mm (9.6in)	280mm (11in)	316mm (12.4in)	
150	294mm (11.6in)	330mm (13in)	366mm (14.4in)	
200	344mm (13.5in)	380mm (15in)	416mm (16.4in)	
250	394mm (15.5in)	430mm (16.9in)	466mm (18.3in)	
300	444mm (17.5in)	480mm (18.9in)	516mm (20.3in)	
350	524mm (20.6in)	560mm (22in)	596mm (23.5in)	
400	574mm (22.6in)	610mm (24in)	646mm (25.4in)	
450	624mm (24.6in)	660mm (26in)	696mm (27.4in)	
500	674mm (26.5in)	710mm (28in)	746mm (29.4in)	
550	724mm (28.5in)	760mm (29.9in)	796mm (31.3in)	
600	774mm (30.5in)	810mm (31.9in)	846mm (33.3in)	
650	824mm (32.4in)	860mm (33.9in)	896mm (35.3in)	
700	874mm (34.4in)	910mm (35.8in)	946mm (37.2in)	
750	964mm (38in)	1000mm (39.4in)	1036mm (40.8in)	
800	1014mm (39.9in)	1050mm (41.3in)	1086mm (42.8in)	
850	1064mm (41.9in)	1100mm (43.3in)	1136mm (44.7in)	
900	1114mm (43.9in)	1150mm (45.3in)	1186mm (46.7in)	
950	1164mm (45.8in)	1200mm (47.2in)	1236mm (48.7in)	
1000	1214mm (47.8in)	1250mm (49.2in)	1286mm (50.6in)	
1050	1264mm (49.8in)	1300mm (51.2in)	1336mm (52.6in)	
1100	1314mm (51.7in)	1350mm (53.1in)	1386mm (54.6in)	
1150	1364mm (53.7in)	1400mm (55.1in)	1436mm (56.5in)	
1200	1414mm (55.7in)	1450mm (57.1in)	1486mm (58.5in)	
1250	1464mm (57.6in)	1500mm (59.1in)	1536mm (60.5in)	
1300	1514mm (59.6in)	1550mm (61in)	1586mm (62.4in)	
1350	1564mm (61.6in)	1600mm (63in)	1636mm (64.4in)	
1400	1614mm (63.5in)	1650mm (65in)	1686mm (66.4in)	
1450	1664mm (65.5in)	1700mm (66.9in)	1736mm (68.3in)	
1500	1714mm (67.5in)	1750mm (68.9in)	1786mm (70.3in)	
1550	1764mm (69.4in)	1800mm (70.9in)	1836mm (72.3in)	
1600	1814mm (71.4in)	1850mm (72.8in)	1886mm (74.3in)	
1650	1864mm (73.4in)	1900mm (74.8in)	1936mm (76.2in)	
1700	1914mm (75.4in)	1950mm (76.8in)	1986mm (78.2in)	
1750	1964mm (77.3in)	2000mm (78.7in)	2036mm (80.2in)	
1800	2014mm (79.3in)	2050mm (80.7in)	2086mm (82.1in)	
1850	2064mm (81.3in)	2100mm (82.7in)	2136mm (84.1in)	
1900	2114mm (83.2in)	2150mm (84.6in)	2186mm (86.1in)	
1950	2164mm (85.2in)	2200mm (86.6in)	2236mm (88in)	
2000	2214mm (87.2in)	2250mm (88.6in)	2286mm (90in)	

Stroke lengths up to 2700mm available. Please consult Nippon Pulse America for more information.

**Support and Bending**

Stroke	Shaft Support length (L2)	Max Bending
0 → 300	25mm (0.98in)	0.00mm (0.00in)
301 → 700	40mm (1.57in)	0.00mm (0.00in)
701 → 1000	60mm (2.36in)	0.70mm (0.028in)
1001 → Max	60mm (2.36in)	0.90mm (0.035in)

**Hall Effect (Optional)**

**Note 2**  
Sensor Cable (Lead wires) Specifications  
HP-SB20276SR  
Wire Type UL758  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - White/Red, GND - White/Black  
Sensor 1 - Orange/Red, Sensor 2 - Orange/Black, Sensor 3 - Gray/Red

**Note 1**  
The bending radius of the motor cable should be 26.4 mm (wire diameter 4.4 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

The bending radius of the sensor cable should be R 27.6 (wire diameter 4.6 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Attach the proper high flex cable as required by your application.

**How to Order (Available Options)**

Motor Type	Forcer Size	Usable Stroke	Options	Options	Standard
S200	X	XX	XX	XX	Standard
Linear Shaft Motor	D	Double (2) windings		(Blank)	Forcer Only
	T	Triple (3) windings		FO	Shaft Only
	Q	Quadruple (4) windings		SO	Two digit for custom motor
			ST	XX	
			WP		Standard
			HA		Waterproof
			CE		Digital Hall Effect
					CE type motor

**Shaft Mass**

Stroke	Motor Type		
	S200D	S200T	S200Q
100	0.5kg (1.1lb)	0.6kg (1.2lb)	0.6kg (1.4lb)
150	0.6kg (1.3lb)	0.7kg (1.5lb)	0.7kg (1.6lb)
200	0.7kg (1.5lb)	0.8kg (1.7lb)	0.9kg (1.9lb)
250	0.8kg (1.8lb)	0.9kg (1.9lb)	1kg (2.1lb)
300	0.9kg (2lb)	1kg (2.2lb)	1.1kg (2.4lb)
350	1.1kg (2.3lb)	1.1kg (2.5lb)	1.2kg (2.7lb)
400	1.2kg (2.6lb)	1.2kg (2.7lb)	1.3kg (2.9lb)
450	1.3kg (2.8lb)	1.4kg (3lb)	1.4kg (3.2lb)
500	1.4kg (3lb)	1.5kg (3.2lb)	1.5kg (3.4lb)
550	1.5kg (3.3lb)	1.6kg (3.5lb)	1.6kg (3.6lb)
600	1.6kg (3.5lb)	1.7kg (3.7lb)	1.8kg (3.9lb)
650	1.7kg (3.8lb)	1.8kg (3.9lb)	1.9kg (4.1lb)
700	1.8kg (4lb)	1.9kg (4.2lb)	2kg (4.4lb)
750	2kg (4.3lb)	2kg (4.5lb)	2.1kg (4.7lb)
800	2.1kg (4.6lb)	2.2kg (4.8lb)	2.2kg (4.9lb)
850	2.2kg (4.8lb)	2.3kg (5lb)	2.3kg (5.2lb)
900	2.3kg (5.1lb)	2.4kg (5.2lb)	2.5kg (5.4lb)
950	2.4kg (5.3lb)	2.5kg (5.5lb)	2.6kg (5.7lb)
1000	2.5kg (5.6lb)	2.6kg (5.7lb)	2.7kg (5.9lb)
1050	2.6kg (5.8lb)	2.7kg (6lb)	2.8kg (6.1lb)
1100	2.7kg (6lb)	2.8kg (6.2lb)	2.9kg (6.4lb)
1150	2.8kg (6.3lb)	2.9kg (6.5lb)	3kg (6.6lb)
1200	3kg (6.5lb)	3kg (6.7lb)	3.1kg (6.9lb)
1250	3.1kg (6.8lb)	3.1kg (6.9lb)	3.2kg (7.1lb)
1300	3.2kg (7lb)	3.3kg (7.2lb)	3.3kg (7.4lb)
1350	3.3kg (7.3lb)	3.4kg (7.5lb)	3.4kg (7.6lb)
1400	3.4kg (7.5lb)	3.5kg (7.7lb)	3.6kg (7.8lb)
1450	3.5kg (7.7lb)	3.6kg (7.9lb)	3.7kg (8.1lb)
1500	3.6kg (8lb)	3.7kg (8.2lb)	3.8kg (8.3lb)
1550	3.7kg (8.2lb)	3.8kg (8.4lb)	3.9kg (8.6lb)
1600	3.8kg (8.5lb)	3.9kg (8.6lb)	4kg (8.8lb)
1650	3.9kg (8.7lb)	4kg (8.9lb)	4.1kg (9.1lb)
1700	4.1kg (9.1lb)	4.1kg (9.1lb)	4.2kg (9.3lb)
1750	4.2kg (9.2lb)	4.2kg (9.4lb)	4.3kg (9.5lb)
1800	4.3kg (9.4lb)	4.4kg (9.6lb)	4.4kg (9.8lb)
1850	4.4kg (9.7lb)	4.5kg (9.8lb)	4.5kg (10lb)
1900	4.5kg (9.9lb)	4.6kg (10.1lb)	4.7kg (10.3lb)
1950	4.6kg (10.2lb)	4.7kg (10.3lb)	4.8kg (10.5lb)
2000	4.7kg (10.4lb)	4.8kg (10.6lb)	4.9kg (10.8lb)

**Lead Wire**

Motor Cable	UL 2464
Wire Type	24
U phase	Orange
V phase	White
W phase	Gray

300mm lead wire bare leads  
The bending radius of the motor cable should be 26.4mm as suggested by the wire manufacturer.

**Supplied Connector (Motor Cable)**

Receptacle housing	XMR-03V
Plug Housing	XMP-03V
Retainer	XMS-03V
Pin contact	SXM-001T-P0.6
Socket contact	SXA-001T-P0.6

(To be installed by the user)

**CE Type Motor Cable (Optional)**

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	Black
Wire Type	UL 1330
Wire AWG	20
FO (Frame Ground)	Green / Yellow

300mm lead wire blunt cut  
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.

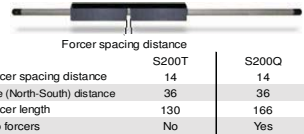
**Hall Effect Cable (Optional)**

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black

400mm lead wire bare leads  
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.

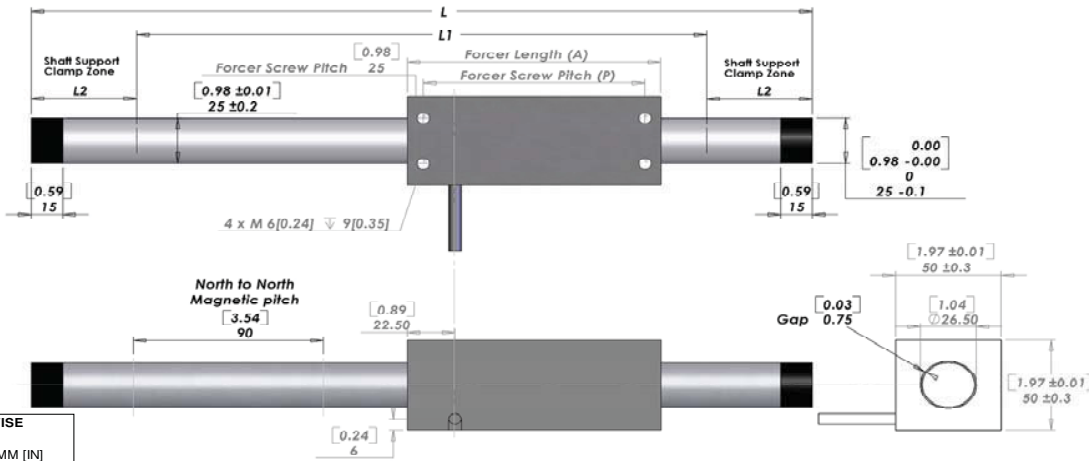
Connector (Hall Effect Cable)  
None supplied

**Tandem Forcer**



2007/12/24

**NPM S250**



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
-	6 ± 0.1
7 - 30	± 0.2
31 - 120	± 0.3
121 - 315	± 0.5
316 - 1000	± 0.8
1001 - 2000	± 1.2
2000 -	± 1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

**Electrical Specifications**

	<b>S250D</b>	<b>S250T</b>	<b>S250Q</b>	<b>S250X</b>
Continuous Force <sup>1</sup>	40N (9.0lbs)	60N (13.5lbs)	75N (16.9lbs)	140N (31.5lbs)
Continuous Current <sup>1</sup>	1.3Arms	1.3Arms	1.3Arms	2.4Arms
Peak Force <sup>2</sup>	160N (36.0lbs)	240N (54.0lbs)	300N (67.4lbs)	560N (126lbs)
Peak Current <sup>2</sup>	5.1Arms	5.1Arms	5.1Arms	9.6Arms
Force Constant K <sub>f</sub>	31N/Arms (7.0lbs/Arms)	47N/Arms (10.5lbs/Arms)	59N/Arms (13.2lbs/Arms)	58N/Arms (13.1lbs/Arms)
Back EMF	10.4V/m/s (0.26 V/in/s)	16V/m/s (0.40 V/in/s)	20V/m/s (0.50 V/in/s)	19V/m/s (0.48 V/in/s)
Resistance 25 °C, <sup>3</sup>	7.8Ω	12Ω	15Ω	7.5Ω
Inductance <sup>3</sup>	9.8mH	15mH	19mH	9.5mH
Electrical Time Constant	1.26ms	1.25ms	1.27ms	1.27ms
Fundamental Motor Constant	11.19N√W	13.53N√W	15.13N√W	21.30N√W
Magnetic Pitch (North-North)	90mm (3.54in)	90mm (3.54in)	90mm (3.54in)	90mm (3.54in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110 °K over 25 °C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

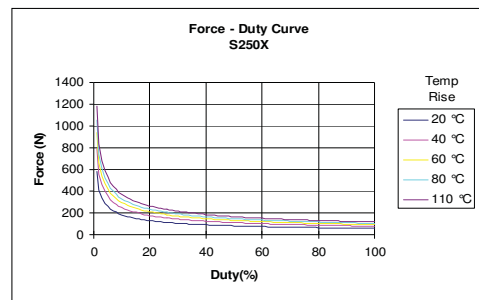
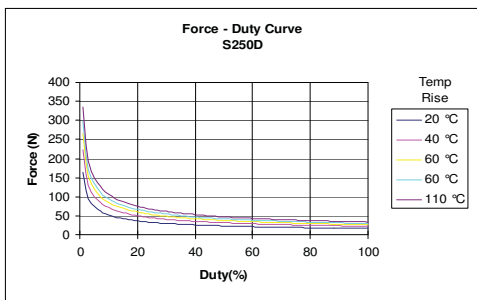
**Thermal Specifications**

	<b>S250D</b>	<b>S250T</b>	<b>S250Q</b>	<b>S250X</b>
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) K <sub>q</sub>	8.6 °C/W	5.6 °C/W	4.5 °C/W	2.5 °C/W

4) The standard temperature difference between the coil and the forcer surface is 20 °C

**Mechanical Specifications**

Forcer		<b>S250D</b>	<b>S250T</b>	<b>S250Q</b>	<b>S250X</b>
Forcer Length	A	120mm (4.7in)	165mm (6.5in)	210mm (8.3in)	390mm (15.4in)
Forcer Width		50mm (1.96in)	50mm (1.96in)	50mm (1.96in)	50mm (1.96in)
Forcer Screw Pitch	P	105mm (4.13in)	150mm (5.9in)	195mm (7.68in)	375mm (14.76in)
Forcer Weight		0.80kg (1.8lbs)	1.1kg (2.4lbs)	1.5kg (3.3lbs)	2.9kg (6.4lbs)
Gap		0.75mm (0.029in)	0.75mm (0.029in)	0.75mm (0.029in)	0.75mm (0.029in)



Mechanical Specifications

Shaft

Shaft Diameter (D) 25 ±0.2mm (0.98in)

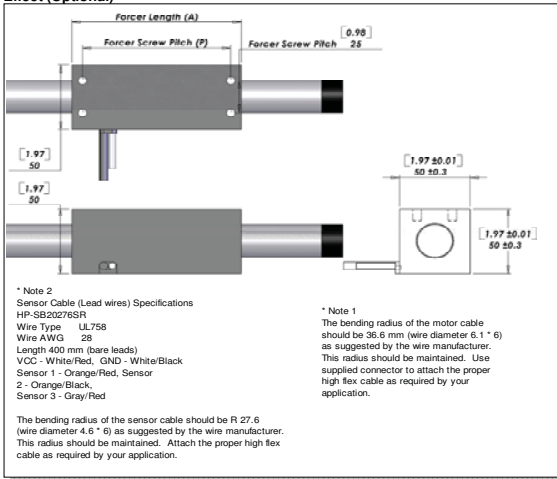
Shaft Length (L) Motor Type	Maximum Stroke length 2550mm (100.4in)			
	S250D	S250T	S250Q	S250X
100	320mm (12.6in)	365mm (14.4in)	410mm (16.1in)	590mm (23.2in)
150	370mm (14.6in)	415mm (16.3in)	460mm (18.1in)	640mm (25.2in)
200	420mm (16.5in)	465mm (18.3in)	510mm (20.1in)	690mm (27.2in)
250	470mm (18.5in)	515mm (20.3in)	560mm (22in)	740mm (29.1in)
300	520mm (20.5in)	565mm (22.2in)	610mm (24in)	790mm (31.1in)
350	570mm (22.4in)	615mm (24.2in)	660mm (26in)	840mm (33.1in)
400	620mm (24.4in)	665mm (26.2in)	710mm (28in)	890mm (35in)
450	670mm (26.4in)	715mm (28.1in)	760mm (29.9in)	940mm (37in)
500	720mm (28.3in)	765mm (30.1in)	810mm (31.9in)	990mm (39in)
550	770mm (30.3in)	815mm (32.1in)	860mm (33.9in)	1090mm (42.5in)
600	820mm (32.3in)	865mm (34.1in)	910mm (35.8in)	1130mm (44.5in)
650	870mm (34.3in)	915mm (36in)	960mm (37.8in)	1180mm (46.5in)
700	920mm (36.2in)	965mm (38in)	1010mm (39.8in)	1230mm (48.4in)
750	1010mm (39.8in)	1055mm (41.5in)	1100mm (43.3in)	1280mm (50.4in)
800	1060mm (41.7in)	1105mm (43.5in)	1150mm (45.3in)	1330mm (52.4in)
850	1110mm (43.7in)	1155mm (45.5in)	1200mm (47.2in)	1380mm (54.3in)
900	1160mm (45.7in)	1205mm (47.4in)	1250mm (49.2in)	1430mm (56.3in)
950	1210mm (47.6in)	1255mm (49.4in)	1300mm (51.2in)	1480mm (58.3in)
1000	1260mm (49.6in)	1305mm (51.4in)	1350mm (53.1in)	1530mm (60.2in)
1050	1310mm (51.6in)	1355mm (53.3in)	1400mm (55.1in)	1580mm (62.2in)
1100	1360mm (53.5in)	1405mm (55.3in)	1450mm (57.1in)	1630mm (64.2in)
1150	1410mm (55.5in)	1455mm (57.3in)	1500mm (59.1in)	1680mm (66.2in)
1200	1460mm (57.5in)	1505mm (59.3in)	1550mm (61in)	1730mm (68.1in)
1250	1510mm (59.4in)	1555mm (61.2in)	1600mm (63in)	1780mm (70.1in)
1300	1560mm (61.4in)	1605mm (63.2in)	1650mm (65in)	1830mm (72in)
1350	1610mm (63.4in)	1655mm (65.2in)	1700mm (66.9in)	1940mm (76.4in)
1400	1660mm (65.4in)	1705mm (67.1in)	1750mm (68.9in)	1990mm (78.3in)
1450	1710mm (67.3in)	1755mm (69.1in)	1800mm (70.9in)	2040mm (80.3in)
1500	1760mm (69.3in)	1805mm (71.1in)	1850mm (72.8in)	2090mm (82.3in)
1550	1810mm (71.3in)	1855mm (73.4in)	1900mm (74.8in)	2140mm (84.3in)
1600	1860mm (73.3in)	1905mm (75.4in)	1950mm (76.8in)	2190mm (86.2in)
1650	1910mm (75.3in)	1955mm (77.4in)	2010mm (79.1in)	2240mm (88.2in)
1700	1960mm (77.3in)	2005mm (79.3in)	2060mm (81.1in)	2290mm (90.2in)
1750	2010mm (79.3in)	2055mm (81.3in)	2110mm (83.1in)	2340mm (92.1in)
1800	2060mm (81.3in)	2105mm (83.3in)	2160mm (85.1in)	2390mm (94.1in)
1850	2110mm (83.3in)	2155mm (85.3in)	2210mm (87.1in)	2440mm (96.1in)
1900	2160mm (85.3in)	2205mm (87.3in)	2260mm (89.1in)	2490mm (98.1in)
1950	2210mm (87.3in)	2255mm (89.3in)	2310mm (91.1in)	2540mm (100in)
2000	2260mm (89.3in)	2305mm (91.3in)	2360mm (93.1in)	2590mm (102in)

Stroke lengths up to 2550mm available. Please consult Nippon Pulse America for more information.

Support and Bending

Stroke		Shaft Support length (L2)	Max Bending
D / T / Q	X		
0 → 700	0 → 500	50mm (1.97in)	0.00mm (0.00in)
701 → 1000	501 → 800	70mm (2.76in)	0.30mm (0.012in)
1001 → 1500	801 → 1300	70mm (2.76in)	0.70mm (0.028in)
1501 → Max	1301 → Max	100mm (3.94in)	0.70mm (0.028in)

Hall Effect (Optional)



How to Order (Available Options)

Motor Type	Forcer Size	Usable Stroke	Options	Options	
S250	X	100 - 2550 mm	XX	XX	Standard
Linear Shaft Motor	D	Double (2) windings	ST WP HA CE	(Blank)	Forcer Only
	T	Triple (3) windings		FO	Shaft Only
	Q	Quadruple (4) windings		SO	Two digit for custom motor
	X	Octuple (8) windings		XX	

Shaft Mass

Stroke	Motor Type			
	S250D	S250T	S250Q	S250X
100	0.9kg (2lb)	1.1kg (2.3lb)	1.2kg (2.7lb)	1.8kg (4lb)
150	1.1kg (2.4lb)	1.2kg (2.7lb)	1.4kg (3.1lb)	2kg (4.4lb)
200	1.2kg (2.7lb)	1.4kg (3.1lb)	1.6kg (3.4lb)	2.2kg (4.8lb)
250	1.4kg (3.1lb)	1.6kg (3.5lb)	1.7kg (3.8lb)	2.3kg (5.2lb)
300	1.6kg (3.5lb)	1.7kg (3.8lb)	1.9kg (4.2lb)	2.5kg (5.6lb)
350	1.8kg (3.9lb)	1.9kg (4.2lb)	2.1kg (4.6lb)	2.7kg (5.9lb)
400	1.9kg (4.3lb)	2.1kg (4.6lb)	2.2kg (4.9lb)	2.9kg (6.3lb)
450	2.1kg (4.6lb)	2.3kg (5lb)	2.4kg (5.3lb)	3kg (6.7lb)
500	2.3kg (5lb)	2.4kg (5.4lb)	2.6kg (5.7lb)	3.2kg (7.1lb)
550	2.4kg (5.4lb)	2.6kg (5.7lb)	2.8kg (6.1lb)	3.4kg (7.4lb)
600	2.6kg (5.8lb)	2.8kg (6.1lb)	2.9kg (6.5lb)	3.5kg (7.8lb)
650	2.8kg (6.2lb)	2.9kg (6.5lb)	3.1kg (6.8lb)	3.7kg (8.2lb)
700	3kg (6.5lb)	3.1kg (6.9lb)	3.3kg (7.2lb)	3.9kg (8.6lb)
750	3.2kg (7lb)	3.4kg (7.4lb)	3.5kg (7.7lb)	4.1kg (9.1lb)
800	3.4kg (7.4lb)	3.5kg (7.8lb)	3.7kg (8.1lb)	4.3kg (9.5lb)
850	3.5kg (7.8lb)	3.7kg (8.1lb)	3.8kg (8.5lb)	4.5kg (9.9lb)
900	3.7kg (8.2lb)	3.9kg (8.5lb)	4kg (8.8lb)	4.6kg (10.2lb)
950	3.9kg (8.6lb)	4kg (8.8lb)	4.2kg (9.2lb)	4.8kg (10.6lb)
1000	4.1kg (9.1lb)	4.2kg (9.3lb)	4.4kg (9.6lb)	5kg (11lb)
1050	4.2kg (9.3lb)	4.4kg (9.7lb)	4.5kg (10lb)	5.2kg (11.4lb)
1100	4.4kg (9.7lb)	4.6kg (10lb)	4.7kg (10.4lb)	5.3kg (11.7lb)
1150	4.6kg (10.1lb)	4.7kg (10.4lb)	4.9kg (10.8lb)	5.5kg (12.1lb)
1200	4.7kg (10.5lb)	4.9kg (10.8lb)	5.1kg (11.1lb)	5.7kg (12.5lb)
1250	4.9kg (10.8lb)	5.1kg (11.2lb)	5.2kg (11.5lb)	5.8kg (12.9lb)
1300	5.1kg (11.2lb)	5.2kg (11.6lb)	5.4kg (11.9lb)	6kg (13.3lb)
1350	5.3kg (11.6lb)	5.4kg (11.9lb)	5.6kg (12.3lb)	6.2kg (13.6lb)
1400	5.4kg (12lb)	5.6kg (12.3lb)	5.7kg (12.7lb)	6.4kg (14lb)
1450	5.6kg (12.3lb)	5.8kg (12.7lb)	5.9kg (13lb)	6.5kg (14.4lb)
1500	5.8kg (12.7lb)	5.9kg (13.1lb)	6.1kg (13.4lb)	6.7kg (14.8lb)
1550	6kg (13.3lb)	6.2kg (13.6lb)	6.3kg (14lb)	7kg (15.3lb)
1600	6.2kg (13.6lb)	6.3kg (13.9lb)	6.5kg (14.2lb)	7.1kg (15.6lb)
1650	6.3kg (14lb)	6.5kg (14.3lb)	6.6kg (14.6lb)	7.3kg (16lb)
1700	6.5kg (14.3lb)	6.7kg (14.7lb)	6.8kg (15lb)	7.4kg (16.4lb)
1750	6.7kg (14.7lb)	6.8kg (15.1lb)	7kg (15.4lb)	7.6kg (16.8lb)
1800	6.9kg (15.1lb)	7kg (15.5lb)	7.2kg (15.8lb)	7.8kg (17.2lb)
1850	7kg (15.5lb)	7.2kg (15.8lb)	7.3kg (16.2lb)	8kg (17.6lb)
1900	7.2kg (15.9lb)	7.4kg (16.2lb)	7.5kg (16.6lb)	8.1kg (17.9lb)
1950	7.4kg (16.3lb)	7.5kg (16.6lb)	7.7kg (17lb)	8.3kg (18.3lb)
2000	7.6kg (16.7lb)	7.7kg (17lb)	7.9kg (17.4lb)	8.5kg (18.7lb)

Lead Wire

Motor Cable	
Wire Type	UL 2464
Wire AWG	20
U phase	White
V phase	Black
W phase	Green / Yellow
300mm lead wire bare leads	
The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.	

Supplied Connector (Motor Cable)

Receptacle housing	HLR-03V
Plug Housing	HLP-03V
Retainer	HLS-03V
Pin contact	SSM-21T-P1.4
Socket contact	SSF-21T-P1.4
(To be installed by the user)	

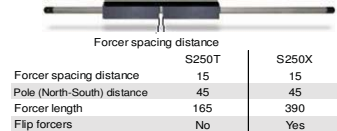
CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	Black
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow
300mm lead wire blunt cut	
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.	

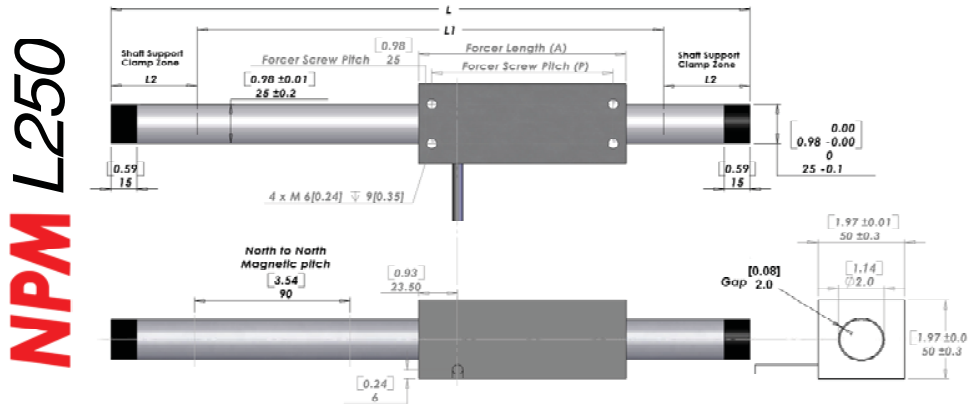
Hall Effect Cable (Optional)

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black
400mm lead wire bare leads	
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.	
Connector (Hall Effect Cable)	None supplied

Tandem Forcer







**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 31.8 mm (wire diameter 5.3 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

**Electrical Specifications**

	L250D	L250T	L250Q
Continuous Force <sup>1</sup>	34N (7.6lbs)	52N (11.7lbs)	69N (15.5lbs)
Continuous Current <sup>1</sup>	1.3Arms	1.3Arms	1.3Arms
Peak Force <sup>2</sup>	138N (31lbs)	207N (46.5lbs)	276N (62lbs)
Peak Current <sup>2</sup>	5.2Arms	5.2Arms	5.2Arms
Force Constant Kf	27N/Arms (6.07lbs/Arms)	40N/Arms (8.99lbs/Arms)	53N/Arms (11.91lbs/Arms)
Back EMF	8.8V/m/s (0.22 V/in/s)	13V/m/s (0.33 V/in/s)	18V/m/s (0.46 V/in/s)
Resistance 25 °C, <sup>3</sup>	8.4Ω	13Ω	17Ω
Inductance <sup>3</sup>	9.2mH	14mH	18mH
Electrical Time Constant	1.11ms	1.11ms	1.11ms
Fundamental Motor Constant	9.179N√W	11.23N√W	12.97N√W
Magnetic Pitch (North-North)	90mm (3.54in)	90mm (3.54in)	90mm (3.54in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25 °C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

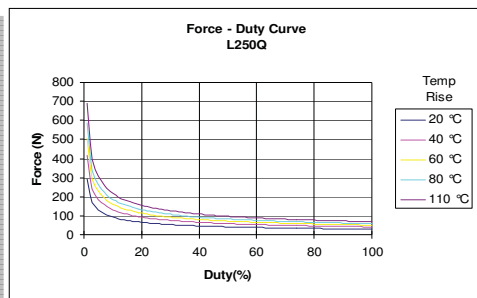
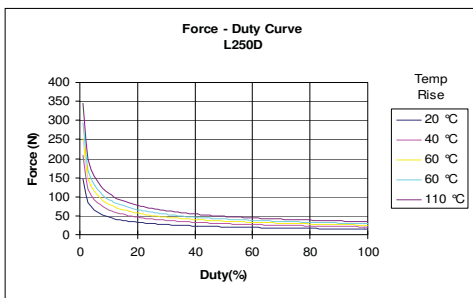
**Thermal Specifications**

	L250D	L250T	L250Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	7.8 °C/W	5.2 °C/W	3.9 °C/W

4) The standard temperature difference between the coil and the forcer surface is 20 °C

**Mechanical Specifications**

	L250D	L250T	L250Q
Forcer Length A	120mm (4.7in)	165mm (6.5in)	210mm (8.3in)
Forcer Width	50mm (1.96in)	50mm (1.96in)	50mm (1.96in)
Forcer Screw Pitch P	105mm (4.13in)	150mm (5.9in)	195mm (7.68in)
Forcer Weight	0.77kg (1.69lbs)	1.1kg (2.4lbs)	1.5kg (3.3lbs)
Gap	2.0mm (0.08in)	2.0mm (0.08in)	2.0mm (0.08in)





Mechanical Specifications

Shaft

Shaft Diameter (D) 25 ±0.2mm (0.98in)

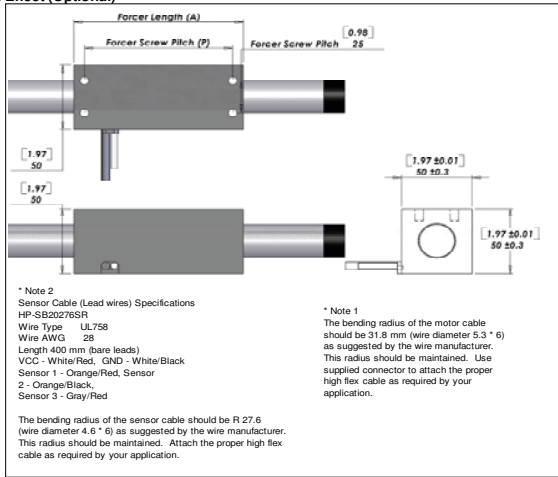
Shaft Length (L) Motor Type	Maximum Stroke length 3650mm (143.7in)		
	L250D	L250T	L250Q
100	320mm (12.6in)	365mm (14.4in)	410mm (16.1in)
150	370mm (14.6in)	415mm (16.3in)	460mm (18.1in)
200	420mm (16.5in)	465mm (18.3in)	510mm (20.1in)
250	470mm (18.5in)	515mm (20.3in)	560mm (22in)
300	520mm (20.5in)	565mm (22.2in)	610mm (24in)
350	570mm (22.4in)	615mm (24.2in)	660mm (26in)
400	620mm (24.4in)	665mm (26.2in)	710mm (28in)
450	670mm (26.4in)	715mm (28.1in)	760mm (29.9in)
500	720mm (28.3in)	765mm (30.1in)	810mm (31.9in)
550	770mm (30.3in)	815mm (32.1in)	860mm (33.9in)
600	820mm (32.3in)	865mm (34.1in)	910mm (35.8in)
650	870mm (34.3in)	915mm (36in)	960mm (37.8in)
700	920mm (36.2in)	965mm (38in)	1010mm (39.8in)
750	1010mm (39.8in)	1055mm (41.5in)	1100mm (43.3in)
800	1060mm (41.7in)	1105mm (43.5in)	1150mm (45.3in)
850	1110mm (43.7in)	1155mm (45.5in)	1200mm (47.2in)
900	1160mm (45.7in)	1205mm (47.4in)	1250mm (49.2in)
950	1210mm (47.6in)	1255mm (49.4in)	1300mm (51.2in)
1000	1260mm (49.6in)	1305mm (51.4in)	1350mm (53.1in)
1050	1310mm (51.6in)	1355mm (53.3in)	1400mm (55.1in)
1100	1360mm (53.5in)	1405mm (55.3in)	1450mm (57.1in)
1150	1410mm (55.5in)	1455mm (57.3in)	1500mm (59.1in)
1200	1460mm (57.5in)	1505mm (59.3in)	1550mm (61in)
1250	1510mm (59.4in)	1555mm (61.2in)	1600mm (63in)
1300	1560mm (61.4in)	1605mm (63.2in)	1650mm (65in)
1350	1610mm (63.4in)	1655mm (65.2in)	1700mm (66.9in)
1400	1660mm (65.4in)	1705mm (67.1in)	1750mm (68.9in)
1450	1710mm (67.3in)	1755mm (69.1in)	1800mm (70.9in)
1500	1760mm (69.3in)	1805mm (71.1in)	1850mm (72.8in)
1550	1810mm (71.3in)	1855mm (73.1in)	1900mm (74.8in)
1600	1860mm (73.3in)	1905mm (75.1in)	1950mm (76.8in)
1650	1910mm (75.3in)	1955mm (77.1in)	2000mm (78.7in)
1700	1960mm (77.3in)	2005mm (79.1in)	2050mm (80.7in)
1750	2010mm (79.3in)	2055mm (81.1in)	2100mm (82.7in)
1800	2060mm (81.3in)	2105mm (83.1in)	2150mm (84.7in)
1850	2110mm (83.3in)	2155mm (85.1in)	2200mm (86.7in)
1900	2160mm (85.3in)	2205mm (87.1in)	2250mm (88.7in)
1950	2210mm (87.3in)	2255mm (89.1in)	2300mm (90.7in)
2000	2260mm (89.3in)	2305mm (91.1in)	2350mm (92.7in)
	2310mm (91.3in)	2355mm (93.1in)	2410mm (94.9in)

Stroke lengths up to 3650mm available. Please consult Nippon Pulse America for more information.

Support and Bending

D / T / Q	Stroke	Shaft Support length (L2)	Max Bending
0 → 700		50mm (1.97in)	0.00mm (0.00in)
701 → 1000		70mm (2.76in)	0.30mm (0.012in)
1001 → 1500		70mm (2.76in)	0.70mm (0.028in)
1501 → Max		100mm (3.94in)	0.70mm (0.028in)

Hall Effect (Optional)



How to Order (Available Options)

Motor Type	Forcer Size	Usable Stroke	Options	Options
L250	X	XX	XX	XX
Linear Shaft Motor	D Double (2) windings T Triple (3) windings Q Quadruple (4) windings X Octuple (8) windings	100 - 3650 mm	ST Standard WP Waterproof HA Digital Hall Effect CE CE type motor	(Blank) Standard FO Forcer Only SO Shaft Only XX Two digit for custom motor

Shaft Mass

Stroke	Motor Type		
	L250D	L250T	L250Q
100	0.9kg (2lb)	1.1kg (2.3lb)	1.2kg (2.7lb)
150	1.1kg (2.4lb)	1.2kg (2.7lb)	1.4kg (3.1lb)
200	1.2kg (2.7lb)	1.4kg (3.1lb)	1.6kg (3.4lb)
250	1.4kg (3.1lb)	1.6kg (3.5lb)	1.7kg (3.8lb)
300	1.6kg (3.5lb)	1.7kg (3.8lb)	1.9kg (4.2lb)
350	1.8kg (3.9lb)	1.9kg (4.2lb)	2.1kg (4.6lb)
400	1.9kg (4.3lb)	2.1kg (4.6lb)	2.2kg (4.9lb)
450	2.1kg (4.6lb)	2.3kg (5lb)	2.4kg (5.3lb)
500	2.3kg (5lb)	2.4kg (5.4lb)	2.6kg (5.7lb)
550	2.4kg (5.4lb)	2.6kg (5.7lb)	2.8kg (6.1lb)
600	2.6kg (5.8lb)	2.8kg (6.1lb)	2.9kg (6.5lb)
650	2.8kg (6.2lb)	2.8kg (6.1lb)	3.1kg (6.8lb)
700	3kg (6.5lb)	3.1kg (6.9lb)	3.3kg (7.2lb)
750	3.2kg (7lb)	3.4kg (7.4lb)	3.5kg (7.7lb)
800	3.4kg (7.4lb)	3.5kg (7.8lb)	3.7kg (8.1lb)
850	3.5kg (7.8lb)	3.7kg (8.1lb)	3.8kg (8.5lb)
900	3.7kg (8.2lb)	3.9kg (8.5lb)	4kg (8.9lb)
950	3.9kg (8.6lb)	4kg (8.9lb)	4.2kg (9.2lb)
1000	4.1kg (8.9lb)	4.2kg (9.3lb)	4.4kg (9.6lb)
1050	4.2kg (9.3lb)	4.4kg (9.7lb)	4.5kg (10lb)
1100	4.4kg (9.7lb)	4.6kg (10lb)	4.7kg (10.4lb)
1150	4.6kg (10.1lb)	4.7kg (10.4lb)	4.9kg (10.8lb)
1200	4.7kg (10.5lb)	4.9kg (10.8lb)	5.1kg (11.1lb)
1250	4.9kg (10.8lb)	5.1kg (11.2lb)	5.2kg (11.5lb)
1300	5.1kg (11.2lb)	5.2kg (11.6lb)	5.4kg (11.9lb)
1350	5.3kg (11.6lb)	5.4kg (11.9lb)	5.6kg (12.3lb)
1400	5.4kg (12lb)	5.6kg (12.3lb)	5.7kg (12.7lb)
1450	5.6kg (12.3lb)	5.8kg (12.7lb)	5.9kg (13lb)
1500	5.8kg (12.7lb)	5.9kg (13.1lb)	6.1kg (13.4lb)
1550	6kg (13.3lb)	6.2kg (13.6lb)	6.3kg (14lb)
1600	6.2kg (13.6lb)	6.3kg (13.9lb)	6.5kg (14.2lb)
1650	6.3kg (14lb)	6.5kg (14.3lb)	6.6kg (14.6lb)
1700	6.5kg (14.3lb)	6.7kg (14.7lb)	6.8kg (15lb)
1750	6.7kg (14.7lb)	6.8kg (15.1lb)	7kg (15.4lb)
1800	6.9kg (15.1lb)	7kg (15.5lb)	7.2kg (15.8lb)
1850	7kg (15.5lb)	7.2kg (15.8lb)	7.3kg (16.2lb)
1900	7.2kg (15.9lb)	7.4kg (16.2lb)	7.5kg (16.6lb)
1950	7.4kg (16.3lb)	7.5kg (16.6lb)	7.7kg (17lb)
2000	7.6kg (16.7lb)	7.7kg (17lb)	7.9kg (17.4lb)

Lead Wire

Motor Cable	Wire Type	UL 2464FA
U phase	Red	
V phase	White	
W phase	Black	
300mm lead wire bare leads		
The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.		
Supplied Connector (Motor Cable)		
Receptacle housing	HLR-03V	
Plug Housing	HLP-03V	
Retainer	HLS-03V	
Pin contact	SSM-21T-P1.4	
Socket contact	SSF-21T-P1.4	
(To be installed by the user)		

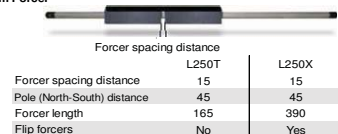
CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow
300mm lead wire blunt cut	
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.	

Hall Effect Cable (Optional)

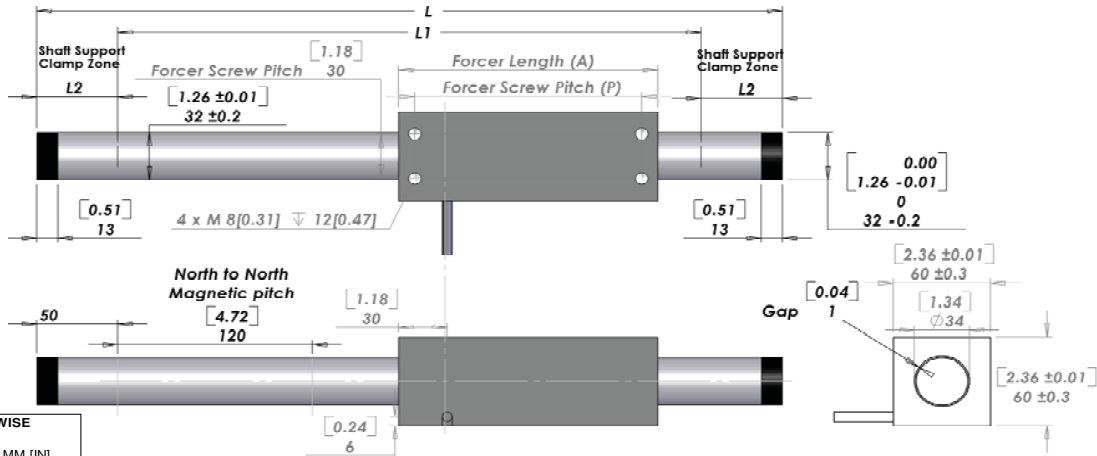
Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black
400mm lead wire bare leads	
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.	
Connector (Hall Effect Cable)	
None supplied	

Tandem Forcer



2008/4/16

# NPM S320



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
-	6 ±0.1
7 -	30 ±0.2
31 -	120 ±0.3
121 -	315 ±0.5
316 -	1000 ±0.8
1001 -	2000 ±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S320D	S320T	S320Q	S320X
Continuous Force <sup>1</sup>	56N (12.6lbs)	85N (19.1lbs)	113N( 25.4lbs)	140N (31.5lbs)
Continuous Current <sup>1</sup>	1.2Arms	1.2Arms	1.2Arms	2.5Arms
Peak Force <sup>2</sup>	224N (50.4lbs)	340N (76.4lbs)	452N (102lbs)	560N (126lbs)
Peak Current <sup>2</sup>	5.0Arms	5.0Arms	5.0Arms	10Arms
Force Constant K <sub>f</sub>	45N/Arms (10.12lbs/Arms)	68N/Arms (15.29lbs/Arms)	91N/Arms (20.37lbs/Arms)	91N/Arms (20.37lbs/Arms)
Back EMF	15V/m/s (0.38 V/in/s)	23V/m/s (0.58 V/in/s)	30V/m/s (0.77 V/in/s)	30V/m/s (0.77 V/in/s)
Resistance 25 °C, <sup>3</sup>	11Ω	17Ω	23Ω	11.5Ω
Inductance <sup>3</sup>	17.0mH	26.0mH	34.0mH	17.0mH
Electrical Time Constant	1.55ms	1.53ms	1.48ms	1.48ms
Fundamental Motor Constant	13.65N√W	16.49N√W	18.89N√W	26.72N√W
Magnetic Pitch (North-North)	120mm (4.72in)	120mm (4.72in)	120mm (4.72in)	120mm (4.72in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110 °K over 25 °C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

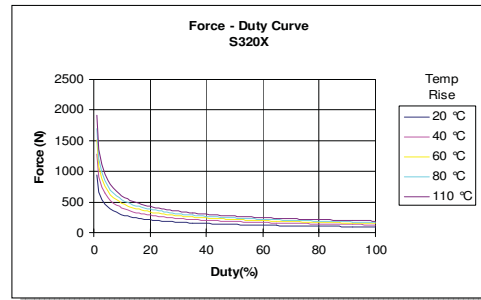
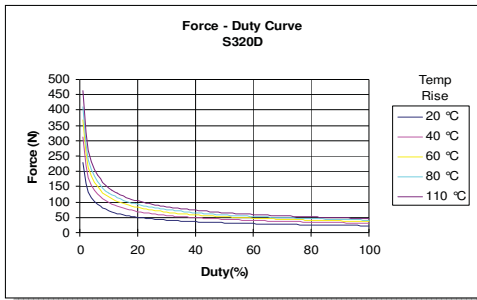
### Thermal Specifications

	S320D	S320T	S320Q	S320X
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) K <sub>q</sub>	6.3 °C/W	4.5 °C/W	3.1 °C/W	1.5 °C/W

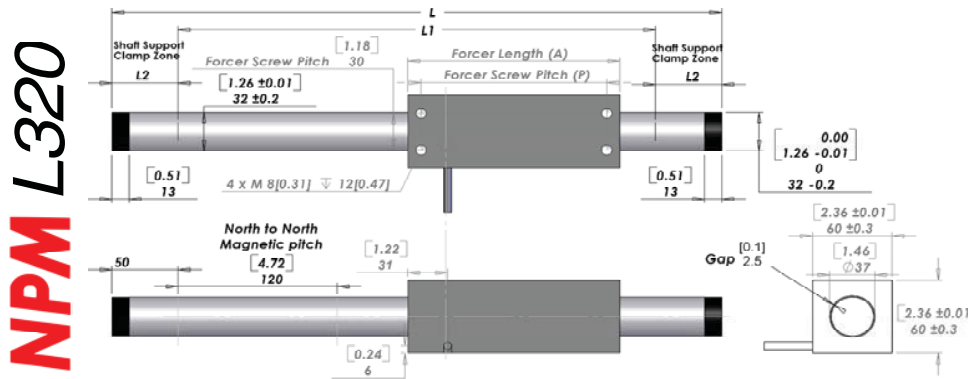
4) The standard temperature difference between the coil and the forcer surface is 25 °C

### Mechanical Specifications

Forcer		S320D	S320T	S320Q	S320X
Forcer Length	A	160mm (6.3in)	220mm (8.6in)	280mm (11in)	520mm (20.5in)
Forcer Width		60mm (2.36in)	60mm (2.36in)	60mm (2.36in)	60mm (2.36in)
Forcer Screw Pitch	P	140mm (5.51in)	200mm (7.87in)	260mm (10.24in)	500mm (19.69in)
Forcer Weight		1.2kg ( 2.6lbs)	1.7kg ( 3.7lbs)	2.2kg ( 4.9lbs)	2.6kg ( 5.7lbs)
Gap		1.00mm (0.039in)	1.00mm (0.039in)	1.00mm (0.039in)	1.00mm (0.039in)







**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 31.8 mm (wire diameter 5.3 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

**Electrical Specifications**

	L320D	L320T	L320Q
Continuous Force <sup>1</sup>	55N (12.4lbs)	82N (18.4lbs)	109N (24.5lbs)
Continuous Current <sup>1</sup>	1.3Arms	1.3Arms	1.3Arms
Peak Force <sup>2</sup>	218N (49lbs)	327N (73.5lbs)	436N (98lbs)
Peak Current <sup>2</sup>	5.0Arms	5.0Arms	5.0Arms
Force Constant Kf	44N/Arms (9.89lbs/Arms)	65N/Arms (14.61lbs/Arms)	87N/Arms (19.56lbs/Arms)
Back EMF	15V/m/s (0.38 V/in/s)	22V/m/s (0.56 V/in/s)	290V/m/s (0.74 V/in/s)
Resistance 25 °C, <sup>3</sup>	12Ω	17Ω	23Ω
Inductance <sup>3</sup>	14.0mH	21.0mH	28.0mH
Electrical Time Constant	1.22ms	1.22ms	1.22ms
Fundamental Motor Constant	12.83N√W	15.72N√W	18.15N√W
Magnetic Pitch (North-North)	120mm (4.72in)	120mm (4.72in)	120mm (4.72in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

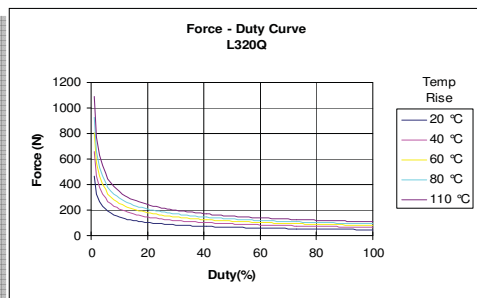
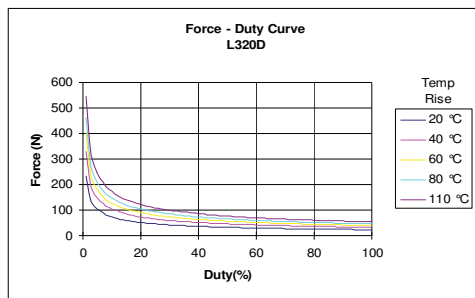
**Thermal Specifications**

	L320D	L320T	L320Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	6.1 °C/W	4.1 °C/W	3.1 °C/W

4) The standard temperature difference between the coil and the forcer surface is 25°C

**Mechanical Specifications**

	L320D	L320T	L320Q
Forcer Length A	160mm (6.3in)	220mm (8.6in)	280mm (11in)
Forcer Width	60mm (2.36in)	60mm (2.36in)	60mm (2.36in)
Forcer Screw Pitch P	140mm (5.51in)	200mm (7.87in)	260mm (10.24in)
Forcer Weight	1.3kg (2.9lbs)	1.9kg (4.2lbs)	2.6kg (5.7lbs)
Gap	2.50mm (0.1in)	2.50mm (0.1in)	2.50mm (0.1in)



Mechanical Specifications

Shaft

Shaft Diameter (D) 32 ±0.2mm (1.26in)

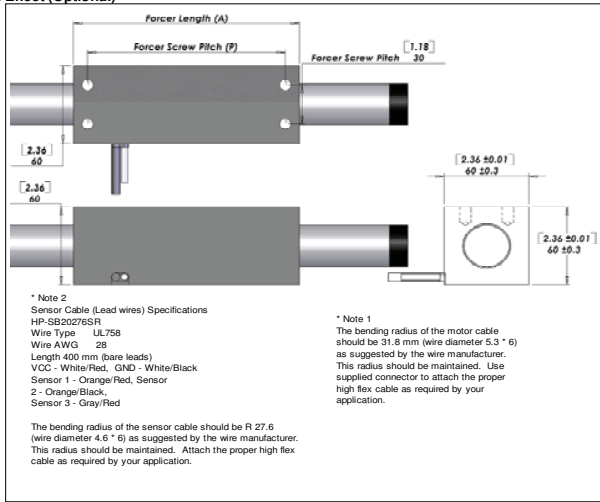
Shaft Length (L) Motor Type Stroke	Maximum Stroke length 3650mm (143.7in)		
	L320D	L320T	L320Q
150	410mm (16.1in)	470mm (18.5in)	530mm (20.9in)
200	460mm (18.1in)	520mm (20.5in)	580mm (22.8in)
250	510mm (20.1in)	570mm (22.4in)	630mm (24.8in)
300	560mm (22in)	620mm (24.4in)	680mm (26.8in)
350	610mm (24in)	670mm (26.4in)	730mm (28.7in)
400	660mm (26in)	720mm (28.3in)	780mm (30.7in)
450	710mm (28in)	770mm (30.3in)	830mm (32.7in)
500	760mm (29.9in)	820mm (32.3in)	880mm (34.6in)
550	810mm (31.9in)	870mm (34.3in)	930mm (36.6in)
600	860mm (33.9in)	920mm (36.2in)	980mm (38.6in)
650	910mm (35.8in)	970mm (38.2in)	1030mm (40.6in)
700	960mm (37.8in)	1020mm (40.2in)	1080mm (42.5in)
750	1010mm (39.8in)	1070mm (42.1in)	1130mm (44.5in)
800	1100mm (43.3in)	1160mm (45.7in)	1220mm (48in)
850	1150mm (45.3in)	1210mm (47.6in)	1270mm (50in)
900	1200mm (47.2in)	1260mm (49.6in)	1320mm (52in)
950	1250mm (49.2in)	1310mm (51.6in)	1370mm (53.9in)
1000	1300mm (51.2in)	1360mm (53.5in)	1420mm (55.9in)
1050	1350mm (53.1in)	1410mm (55.5in)	1470mm (57.9in)
1100	1400mm (55.1in)	1460mm (57.5in)	1520mm (59.8in)
1150	1450mm (57.1in)	1510mm (59.4in)	1570mm (61.8in)
1200	1500mm (59.1in)	1560mm (61.4in)	1620mm (63.8in)
1250	1550mm (61in)	1610mm (63.4in)	1670mm (65.7in)
1300	1600mm (63in)	1660mm (65.4in)	1720mm (67.7in)
1350	1650mm (65in)	1710mm (67.3in)	1770mm (69.7in)
1400	1700mm (66.9in)	1760mm (69.3in)	1820mm (71.7in)
1450	1750mm (68.9in)	1810mm (71.3in)	1870mm (73.6in)
1500	1800mm (70.9in)	1860mm (73.2in)	1920mm (75.6in)
1550	1910mm (75.2in)	1970mm (77.6in)	2030mm (79.9in)
1600	2020mm (79.5in)	2080mm (81.9in)	2140mm (84.3in)
1650	2130mm (83.9in)	2190mm (86.2in)	2250mm (88.6in)
1700	2240mm (88.2in)	2300mm (90.6in)	2360mm (92.9in)
1750	2350mm (92.5in)	2410mm (94.9in)	2470mm (97.2in)
1800	2460mm (96.9in)	2520mm (99.2in)	2580mm (101.6in)
1850	2570mm (101.2in)	2630mm (103.5in)	2690mm (105.9in)
1900	2680mm (105.5in)	2740mm (107.9in)	2800mm (110.2in)
1950	2790mm (109.8in)	2850mm (112.2in)	2910mm (114.6in)
2000	2900mm (114.2in)	2960mm (116.5in)	3020mm (118.9in)

Stroke lengths from 100mm and up to 3650mm are available. Please consult Nippon Pulse America for more information.

Support and Bending

Stroke D / T / Q	Shaft Support length (L2)	Max Bending
0 → 750	50mm (1.97in)	0.00mm (0.00in)
751 → 1000	70mm (2.76in)	0.30mm (0.012in)
1001 → 1500	70mm (2.76in)	0.70mm (0.028in)
1501 → Max	100mm (3.94in)	0.70mm (0.028in)

Hall Effect (Optional)



How to Order (Available Options)

Motor Type	Forcer Size	Usable Stroke	Options	Options	Options
L320	X	XX	XX	XX	Standard
Linear Shaft Motor	D	Double (2) windings	T	Triple (3) windings	Forcer Only
	T	Triple (3) windings	Q	Quadruple (4) windings	Shaft Only
	Q	Quadruple (4) windings	X	Octuple (8) windings	Two digit for custom motor
	X	Octuple (8) windings	ST	Standard	
			WP	Waterproof	
			HA	Digital Hall Effect	
			CE	CE type motor	

Shaft Mass

Stroke	Motor Type		
	L320D	L320T	L320Q
150	2.1kg (4.6lb)	2.4kg (5.4lb)	2.8kg (6.1lb)
200	2.4kg (5.2lb)	2.7kg (6lb)	3kg (6.7lb)
250	2.7kg (5.8lb)	3kg (6.6lb)	3.3kg (7.3lb)
300	2.9kg (6.5lb)	3.3kg (7.2lb)	3.6kg (8lb)
350	3.2kg (7.1lb)	3.6kg (7.8lb)	3.9kg (8.6lb)
400	3.5kg (7.7lb)	3.8kg (8.5lb)	4.2kg (9.2lb)
450	3.8kg (8.3lb)	4.1kg (9.1lb)	4.5kg (9.8lb)
500	4.1kg (8.9lb)	4.4kg (9.7lb)	4.7kg (10.4lb)
550	4.3kg (9.6lb)	4.7kg (10.3lb)	5kg (11.1lb)
600	4.6kg (10.2lb)	5kg (10.9lb)	5.3kg (11.7lb)
650	4.9kg (10.8lb)	5.2kg (11.6lb)	5.6kg (12.3lb)
700	5.2kg (11.4lb)	5.5kg (12.2lb)	5.9kg (12.9lb)
750	5.5kg (12.1lb)	5.8kg (12.8lb)	6.1kg (13.5lb)
800	5.8kg (12.9lb)	6.2kg (13.6lb)	6.5kg (14.4lb)
850	6.1kg (13.5lb)	6.5kg (14.3lb)	6.8kg (15lb)
900	6.4kg (14.1lb)	6.7kg (14.9lb)	7.1kg (15.6lb)
950	6.7kg (14.7lb)	7kg (15.5lb)	7.4kg (16.2lb)
1000	7kg (15.4lb)	7.3kg (16.1lb)	7.6kg (16.9lb)
1050	7.3kg (16lb)	7.6kg (16.7lb)	7.9kg (17.5lb)
1100	7.5kg (16.6lb)	7.9kg (17.4lb)	8.2kg (18.1lb)
1150	7.8kg (17.2lb)	8.2kg (18lb)	8.5kg (18.7lb)
1200	8.1kg (17.9lb)	8.4kg (18.6lb)	8.8kg (19.3lb)
1250	8.4kg (18.5lb)	8.7kg (19.2lb)	9.1kg (20lb)
1300	8.7kg (19.1lb)	9kg (19.8lb)	9.3kg (20.6lb)
1350	8.9kg (19.7lb)	9.3kg (20.5lb)	9.6kg (21.2lb)
1400	9.2kg (20.3lb)	9.6kg (21.1lb)	9.9kg (21.8lb)
1450	9.5kg (21lb)	9.8kg (21.7lb)	10.2kg (22.4lb)
1500	9.8kg (21.6lb)	10.1kg (22.3lb)	10.5kg (23.1lb)
1550	10.2kg (22.5lb)	10.5kg (23.3lb)	10.9kg (24lb)
1600	10.5kg (23.1lb)	10.8kg (23.9lb)	11.2kg (24.6lb)
1650	10.8kg (23.8lb)	11.1kg (24.5lb)	11.5kg (25.2lb)
1700	11.1kg (24.4lb)	11.4kg (25.1lb)	11.7kg (25.9lb)
1750	11.3kg (25lb)	11.7kg (25.7lb)	12kg (26.5lb)
1800	11.6kg (25.6lb)	12kg (26.4lb)	12.3kg (27.1lb)
1850	11.9kg (26.2lb)	12.2kg (27lb)	12.6kg (27.7lb)
1900	12.2kg (26.9lb)	12.5kg (27.6lb)	12.9kg (28.3lb)
1950	12.5kg (27.5lb)	12.8kg (28.2lb)	13.1kg (29lb)
2000	12.7kg (28.1lb)	13.1kg (28.8lb)	13.4kg (29.6lb)

Lead Wire

Motor Cable	
Wire Type	UL 2464FA
Wire AWG	20
U phase	Red
V phase	White
W phase	Black
300mm lead wire bare leads	

The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.

Supplied Connector (Motor Cable)

Receptacle housing	HLR-03V
Plug Housing	HLP-03V
Retainer	HLS-03V
Pin contact	SSM-21T-P1.4
Socket contact	SSF-21T-P1.4

(To be installed by the user)

CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow
300mm lead wire blunt cut	

The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.

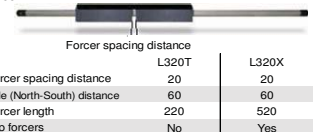
Hall Effect Cable (Optional)

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black
400mm lead wire bare leads	

The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.

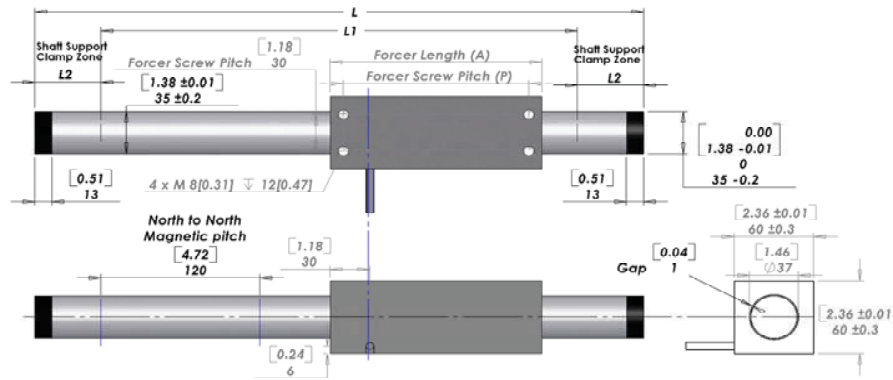
Connector (Hall Effect Cable)  
None supplied

Tandem Forcer



2008/4/16

**NPM S350**



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

**Electrical Specifications**

	<b>S350D</b>	<b>S350T</b>	<b>S350Q</b>
Continuous Force <sup>1</sup>	104N (23.4lbs)	148N (33.3lbs)	190N (42.7lbs)
Continuous Current <sup>1</sup>	1.5Arms	1.5Arms	2.7Arms
Peak Force <sup>2</sup>	416N (93.5lbs)	592N (133lbs)	760N (171lbs)
Peak Current <sup>2</sup>	6.0Arms	6.0Arms	10.8Arms
Force Constant Kf	69N/Arms (15.60lbs/Arms)	99N/Arms (22.2lbs/Arms)	70N/Arms (15.8lbs/Arms)
Back EMF	23V/m/s (0.59 V/in/s)	33V/m/s (0.84 V/in/s)	23V/m/s (0.60 V/in/s)
Resistance 25 °C, <sup>3</sup>	13.8Ω	20.2Ω	6.9Ω
Inductance <sup>3</sup>	21.8mH	33mH	10.9mH
Electrical Time Constant	1.58ms	1.63ms	1.58ms
Fundamental Motor Constant	18.66N√W	21.95N√W	26.79N√W
Magnetic Pitch (North-North)	120mm (4.72in)	120mm (4.72in)	120mm (4.72in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

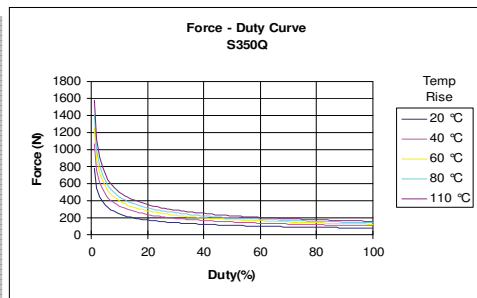
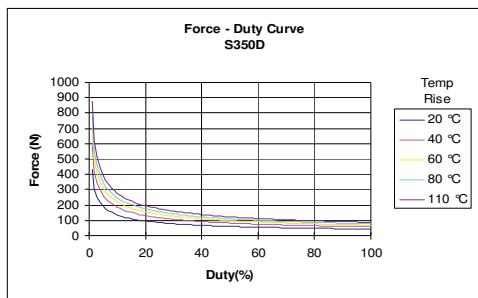
**Thermal Specifications**

	<b>S350D</b>	<b>S350T</b>	<b>S350Q</b>
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	3.5 °C/W	2.4 °C/W	2.2 °C/W

4) The standard temperature difference between the coil and the forcer surface is 25 °C

**Mechanical Specifications**

	<b>S350D</b>	<b>S350T</b>	<b>S350Q</b>
Forcer Length A	160mm (6.3in)	220mm (8.6in)	280mm (11in)
Forcer Width	60mm (2.4in)	60mm (2.4in)	60mm (2.4in)
Forcer Screw Pitch P	140mm (5.51in)	200mm (7.87in)	260mm (10.24in)
Forcer Weight	1.3kg (2.9lbs)	1.9kg (4.2lbs)	2.4kg ( 5.3lbs)
Gap	1.00mm (0.039in)	1.00mm (0.039in)	1.00mm (0.039in)



Mechanical Specifications

Shaft

Shaft Diameter (D) 35 ±0.2mm (1.37in)

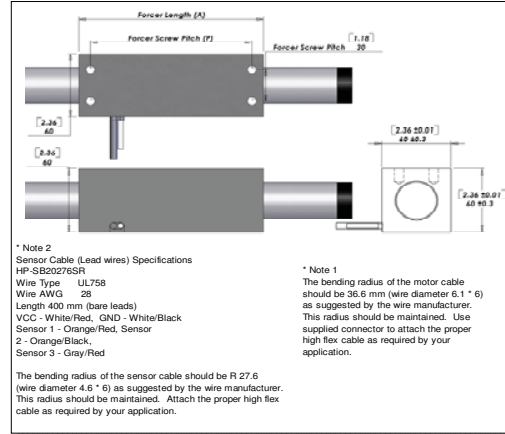
Shaft Length (L)	Maximum Stroke length 2500mm (98.43in)			
	Motor Type	S350D	S350T	S350Q
150		410mm (16.1in)	470mm (18.5in)	530mm (20.9in)
200		460mm (18.1in)	520mm (20.5in)	580mm (22.8in)
250		510mm (20.1in)	570mm (22.4in)	630mm (24.8in)
300		560mm (22in)	620mm (24.4in)	680mm (26.8in)
350		610mm (24in)	670mm (26.4in)	730mm (28.7in)
400		660mm (26in)	720mm (28.3in)	780mm (30.7in)
450		710mm (28in)	770mm (30.3in)	830mm (32.7in)
500		760mm (29.9in)	820mm (32.3in)	880mm (34.6in)
550		810mm (31.9in)	870mm (34.3in)	930mm (36.6in)
600		860mm (33.9in)	920mm (36.2in)	980mm (38.6in)
650		910mm (35.8in)	970mm (38.2in)	1030mm (40.6in)
700		960mm (37.8in)	1020mm (40.2in)	1080mm (42.5in)
750		1010mm (39.8in)	1070mm (42.1in)	1130mm (44.5in)
800		1100mm (43.3in)	1160mm (45.7in)	1220mm (48in)
850		1150mm (45.3in)	1210mm (47.6in)	1270mm (50in)
900		1200mm (47.2in)	1260mm (49.6in)	1320mm (52in)
950		1250mm (49.2in)	1310mm (51.6in)	1370mm (53.9in)
1000		1300mm (51.2in)	1360mm (53.5in)	1420mm (55.9in)
1050		1350mm (53.1in)	1410mm (55.5in)	1470mm (57.9in)
1100		1400mm (55.1in)	1460mm (57.5in)	1520mm (59.8in)
1150		1450mm (57.1in)	1510mm (59.4in)	1570mm (61.8in)
1200		1500mm (59.1in)	1560mm (61.4in)	1620mm (63.8in)
1250		1550mm (61in)	1610mm (63.4in)	1670mm (65.7in)
1300		1600mm (63in)	1660mm (65.4in)	1720mm (67.7in)
1350		1650mm (65in)	1710mm (67.3in)	1770mm (69.7in)
1400		1700mm (66.9in)	1760mm (69.3in)	1820mm (71.7in)
1450		1750mm (68.9in)	1810mm (71.3in)	1870mm (73.6in)
1500		1800mm (70.9in)	1860mm (73.2in)	1920mm (75.6in)
1550		1910mm (75.2in)	1970mm (77.6in)	2030mm (79.9in)
1600		1960mm (77.2in)	2020mm (79.5in)	2080mm (81.9in)
1650		2010mm (79.1in)	2070mm (81.5in)	2130mm (83.9in)
1700		2060mm (81.1in)	2120mm (83.5in)	2180mm (85.8in)
1750		2110mm (83.1in)	2170mm (85.4in)	2230mm (87.8in)
1800		2160mm (85in)	2220mm (87.4in)	2280mm (89.8in)
1850		2210mm (87in)	2270mm (89.4in)	2330mm (91.7in)
1900		2260mm (89in)	2320mm (91.3in)	2380mm (93.7in)
1950		2310mm (90.9in)	2370mm (93.3in)	2430mm (95.7in)
2000		2360mm (92.9in)	2420mm (95.3in)	2480mm (97.6in)

Stroke lengths from 100mm and up to 2500mm are available. Please consult Nippon Pulse America for more information.

Support and Bending

Stroke	Shaft Support length (L2)	Max Bending
0 → 750	50mm (1.97in)	0.00mm (0.00in)
751 → 1000	70mm (2.76in)	0.30mm (0.012in)
1001 → 1500	70mm (2.76in)	0.90mm (0.035in)
1501 → Max	100mm (3.94in)	1.00mm (0.04in)

Hall Effect (Optional)



How to Order (Available Options)

Motor Type	Forcer Size	Usable Stroke	Options	Options	Standard
S350	X	XX	XX	XX	Standard
		100 - 2500 mm		(Blank)	Forcer Only
Linear Shaft Motor	D	Double (2) windings		FO	Shaft Only
	T	Triple (3) windings		SO	Two digit custom motor
	Q	Quadruple (4) windings		XX	
			ST		Standard
			WP		Waterproof
			HA		Digital Hall Effect
			CE		CE type motor

Shaft Mass

Stroke	Motor Type		
	S350D	S350T	S350Q
150	2.7kg (6lb)	3.1kg (6.8lb)	3.5kg (7.7lb)
200	3kg (6.7lb)	3.4kg (7.6lb)	3.8kg (8.4lb)
250	3.4kg (7.4lb)	3.8kg (8.3lb)	4.2kg (9.2lb)
300	3.7kg (8.1lb)	4.1kg (9lb)	4.5kg (9.9lb)
350	4kg (8.9lb)	4.4kg (9.8lb)	4.8kg (10.6lb)
400	4.4kg (9.6lb)	4.8kg (10.5lb)	5.1kg (11.4lb)
450	4.7kg (10.3lb)	5.1kg (11.2lb)	5.5kg (12.1lb)
500	5kg (11.1lb)	5.4kg (11.9lb)	5.8kg (12.8lb)
550	5.3kg (11.8lb)	5.7kg (12.7lb)	6.1kg (13.5lb)
600	5.7kg (12.5lb)	6.1kg (13.4lb)	6.5kg (14.3lb)
650	6kg (13.2lb)	6.4kg (14.1lb)	6.8kg (15lb)
700	6.3kg (14lb)	6.7kg (14.8lb)	7.1kg (15.7lb)
750	6.7kg (14.7lb)	7.1kg (15.6lb)	7.5kg (16.4lb)
800	7.3kg (16lb)	7.7kg (16.9lb)	8.1kg (17.8lb)
850	7.6kg (16.7lb)	8kg (17.6lb)	8.4kg (18.5lb)
900	7.9kg (17.5lb)	8.3kg (18.3lb)	8.7kg (19.2lb)
950	8.3kg (18.2lb)	8.6kg (19.1lb)	9kg (19.9lb)
1000	8.6kg (18.9lb)	9kg (19.8lb)	9.4kg (20.7lb)
1050	8.9kg (19.6lb)	9.3kg (20.5lb)	9.7kg (21.4lb)
1100	9.2kg (20.4lb)	9.6kg (21.2lb)	10kg (22.1lb)
1150	9.6kg (21.1lb)	10kg (22lb)	10.4kg (22.8lb)
1200	9.9kg (21.8lb)	10.3kg (22.7lb)	10.7kg (23.6lb)
1250	10.2kg (22.6lb)	10.6kg (23.4lb)	11kg (24.3lb)
1300	10.6kg (23.3lb)	11kg (24.2lb)	11.4kg (25lb)
1350	10.9kg (24lb)	11.3kg (24.9lb)	11.7kg (25.8lb)
1400	11.2kg (24.7lb)	11.6kg (25.6lb)	12kg (26.5lb)
1450	11.6kg (25.5lb)	11.9kg (26.3lb)	12.3kg (27.2lb)
1500	11.9kg (26.2lb)	12.3kg (27.1lb)	12.7kg (27.9lb)
1550	12.6kg (27.8lb)	13kg (28.7lb)	13.4kg (29.5lb)
1600	12.9kg (28.5lb)	13.3kg (29.4lb)	13.7kg (30.3lb)
1650	13.3kg (29.3lb)	13.7kg (30.1lb)	14.1kg (31lb)
1700	13.6kg (30lb)	14kg (30.9lb)	14.4kg (31.7lb)
1750	13.9kg (30.7lb)	14.3kg (31.6lb)	14.7kg (32.5lb)
1800	14.3kg (31.4lb)	14.7kg (32.3lb)	15.1kg (33.2lb)
1850	14.6kg (32.2lb)	15kg (33lb)	15.4kg (33.9lb)
1900	14.9kg (32.9lb)	15.3kg (33.8lb)	15.7kg (34.6lb)
1950	15.2kg (33.6lb)	15.6kg (34.5lb)	16kg (35.4lb)
2000	15.6kg (34.3lb)	16kg (35.2lb)	16.4kg (36.1lb)

Lead Wire

Motor Cable	
Wire Type	UL 2464
Wire AWG	16
U phase	Red
V phase	White
W phase	Black

300mm lead wire bare leads  
The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.

Supplied Connector (Motor Cable)

Receptacle housing	VLR-03V
Plug Housing	VLP-03V
Retainer	VLS-03V
Pin contact	SVM-61T-P2.0
Socket contact	SVF-61T-P2.0

(To be installed by the user)

CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow

300mm lead wire blunt cut  
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.

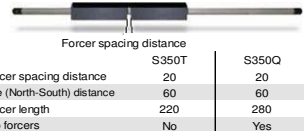
Hall Effect Cable (Optional)

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black

400mm lead wire bare leads  
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.

Connector (Hall Effect Cable)  
None supplied

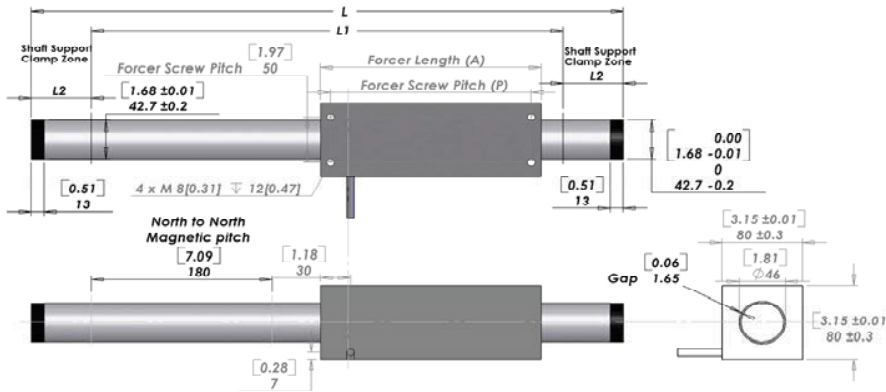
Tandem Forcer



2008/1/1



# NPM S427



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S427D	S427T	S427Q
Continuous Force <sup>1</sup>	100N (22.5lbs)	150N (33.7lbs)	200N (45lbs)
Continuous Current <sup>1</sup>	3.0Arms	3.0Arms	3.0Arms
Peak Force <sup>2</sup>	400N (90lbs)	600N (135lbs)	800N (180lbs)
Peak Current <sup>2</sup>	12Arms	12Arms	12Arms
Force Constant Kf	33N/Arms (7.5lbs/Arms)	50N/Arms (11.3lbs/Arms)	67N/Arms (15.0lbs/Arms)
Back EMF	11V/m/s (0.28V/in/s)	17V/m/s (0.42V/in/s)	22V/m/s (0.56V/in/s)
Resistance 25 °C, <sup>3</sup>	2.7Ω	3.9Ω	5.2Ω
Inductance <sup>3</sup>	7.3mH	11mH	15mH
Electrical Time Constant	2.70ms	2.82ms	2.88ms
Fundamental Motor Constant	20.27N√W	25.52N√W	29.21N√W
Magnetic Pitch (North-North)	180mm (7.09in)	180mm (7.09in)	180mm (7.09in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

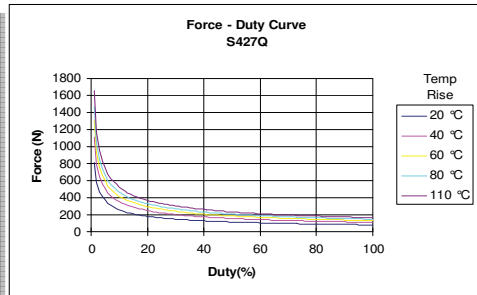
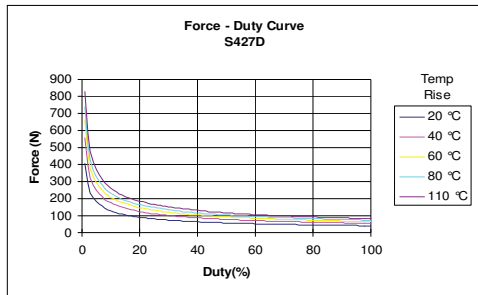
### Thermal Specifications

	S427D	S427T	S427Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	4.6 °C/W	3.2 °C/W	2.4 °C/W

4) The standard temperature difference between the coil and the forcer surface is 30 °C

### Mechanical Specifications

	S427D	S427T	S427Q
Forcer Length A	220mm (8.66in)	310mm (12.2in)	400mm (15.75in)
Forcer Width	80mm (3.15in)	80mm (3.15in)	80mm (3.15in)
Forcer Screw Pitch P	200mm (7.87in)	290mm (11.42in)	380mm (14.96in)
Forcer Weight	3.0kg ( 6.6lbs)	4.2kg ( 9.3lbs)	5.4kg ( 11.9lbs)
Gap	1.65mm (0.06in)	1.65mm (0.06in)	1.65mm (0.06in)





**Mechanical Specifications**

**Shaft**

Shaft Diameter (D) 42.7 ±0.2mm (1.68in)

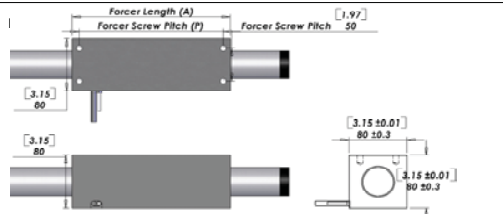
Shaft Length (L) Motor Type	Maximum Stroke length 3600mm (141.7in)		
	S427D	S427T	S427Q
200	540mm (21.3in)	630mm (24.8in)	720mm (28.3in)
250	590mm (23.2in)	680mm (26.8in)	770mm (30.3in)
300	640mm (25.2in)	730mm (28.7in)	820mm (32.3in)
350	690mm (27.2in)	780mm (30.7in)	870mm (34.3in)
400	740mm (29.1in)	830mm (32.7in)	920mm (36.2in)
450	790mm (31.1in)	880mm (34.6in)	970mm (38.2in)
500	840mm (33.1in)	930mm (36.6in)	1020mm (40.2in)
550	890mm (35in)	980mm (38.6in)	1070mm (42.1in)
600	940mm (37in)	1030mm (40.6in)	1120mm (44.1in)
650	990mm (39in)	1080mm (42.6in)	1170mm (46.1in)
700	1040mm (41in)	1130mm (44.6in)	1220mm (48.1in)
750	1090mm (43in)	1180mm (46.6in)	1270mm (50.1in)
800	1140mm (45in)	1230mm (48.6in)	1320mm (52.1in)
850	1190mm (47in)	1280mm (50.6in)	1370mm (54.1in)
900	1240mm (49in)	1330mm (52.6in)	1420mm (56.1in)
950	1290mm (51in)	1380mm (54.6in)	1470mm (58.1in)
1000	1340mm (53in)	1430mm (56.6in)	1520mm (60.1in)
1050	1390mm (55in)	1480mm (58.6in)	1570mm (62.1in)
1100	1440mm (57in)	1530mm (60.6in)	1620mm (64.1in)
1150	1490mm (59in)	1580mm (62.6in)	1670mm (66.1in)
1200	1540mm (61in)	1630mm (64.6in)	1720mm (68.1in)
1250	1590mm (63in)	1680mm (66.6in)	1770mm (70.1in)
1300	1640mm (65in)	1730mm (68.6in)	1820mm (72.1in)
1350	1690mm (67in)	1780mm (70.6in)	1870mm (74.1in)
1400	1740mm (69in)	1830mm (72.6in)	1920mm (76.1in)
1450	1790mm (71in)	1880mm (74.6in)	1970mm (78.1in)
1500	1840mm (73in)	1930mm (76.6in)	2020mm (80.1in)
1550	1890mm (75in)	1980mm (78.6in)	2070mm (82.1in)
1600	1940mm (77in)	2030mm (80.6in)	2120mm (84.1in)
1650	1990mm (79in)	2080mm (82.6in)	2170mm (86.1in)
1700	2040mm (81in)	2130mm (84.6in)	2220mm (88.1in)
1750	2090mm (83in)	2180mm (86.6in)	2270mm (90.1in)
1800	2140mm (85in)	2230mm (88.6in)	2320mm (92.1in)
1850	2190mm (87in)	2280mm (90.6in)	2370mm (94.1in)
1900	2240mm (89in)	2330mm (92.6in)	2420mm (96.1in)
1950	2290mm (91in)	2380mm (94.6in)	2470mm (98.1in)
2000	2340mm (93in)	2430mm (96.6in)	2520mm (100.1in)
2050	2390mm (95in)	2480mm (98.6in)	2570mm (102.1in)

Stroke lengths from 100mm and up to 4600mm are available. Please consult Nippon Pulse America for more information.

**Support and Bending Stroke**

Stroke	Shaft Support length (L2)	Max Bending
0 → 550	60mm (2.36in)	0.00mm (0.00in)
551 → 1000	80mm (3.15in)	0.15mm (0.006in)
1001 → 1500	100mm (3.94in)	0.60mm (0.024in)
1501 → 2000	100mm (3.94in)	1.10mm (0.043in)
2001 → 2500	100mm (3.94in)	2.00mm (0.079in)
2501 → Max	100mm (3.94in)	2.10mm (0.083in)

**Hall Effect (Optional)**



\* Note 2  
Sensor Cable (Lead wires) Specifications  
HP-SB20276SR  
Wire Type UL758  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - White/Red, GND - White/Black  
Sensor 1 - Orange/Red, Sensor 2 - Orange/Black, Sensor 3 - Gray/Red

The bending radius of the sensor cable should be R 27.6 (wire diameter 4.5 ± 0.6) as suggested by the wire manufacturer. This radius should be maintained. Attach the proper high flex cable as required by your application.

\* Note 1  
The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 ± 0.6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

**How to Order (Available Options)**

Motor Type	Forcer Size	Usable Stroke	Options	Options	Standard
S427	X	100 - 4600 mm	XX	XX	Forcer Only
Linear Shaft Motor	D	Double (2) windings	T	Triple (3) windings	Shaft Only
	T	Triple (3) windings	Q	Quadruple (4) windings	Two digit for custom motor
	Q	Quadruple (4) windings	ST	Standard	
			WP	Waterproof	
			HA	Digital Hall Effect	
			CE	CE type motor	

**Shaft Mass**

Stroke	Motor Type		
	S427D	S427T	S427Q
200	4.9kg (10.8lb)	5.8kg (12.8lb)	6.7kg (14.8lb)
250	5.4kg (11.9lb)	6.3kg (13.9lb)	7.2kg (15.9lb)
300	5.9kg (13lb)	6.8kg (15lb)	7.7kg (17lb)
350	6.4kg (14.1lb)	7.3kg (16.1lb)	8.2kg (18.1lb)
400	6.9kg (15.2lb)	7.8kg (17.2lb)	8.7kg (19.2lb)
450	7.4kg (16.3lb)	8.3kg (18.3lb)	9.2kg (20.3lb)
500	7.9kg (17.5lb)	8.8kg (19.4lb)	9.7kg (21.4lb)
550	8.4kg (18.6lb)	9.3kg (20.5lb)	10.2kg (22.5lb)
600	9.1kg (20lb)	10kg (22lb)	10.9kg (24lb)
650	9.6kg (21.1lb)	10.5kg (23.1lb)	11.4kg (25.1lb)
700	10.1kg (22.2lb)	11kg (24.2lb)	11.9kg (26.2lb)
750	10.6kg (23.4lb)	11.5kg (25.3lb)	12.4kg (27.3lb)
800	11.1kg (24.5lb)	12kg (26.4lb)	12.9kg (28.4lb)
850	11.6kg (25.6lb)	12.5kg (27.6lb)	13.4kg (29.5lb)
900	12.1kg (26.7lb)	13kg (28.7lb)	13.9kg (30.6lb)
950	12.6kg (27.8lb)	13.5kg (29.8lb)	14.4kg (31.8lb)
1000	13.1kg (28.9lb)	14kg (30.9lb)	14.9kg (32.9lb)
1050	13.6kg (30.0lb)	14.5kg (32.0lb)	15.4kg (34.0lb)
1100	14.1kg (31.1lb)	15kg (33.1lb)	15.9kg (35.1lb)
1150	14.6kg (32.2lb)	15.5kg (34.2lb)	16.4kg (36.2lb)
1200	15.1kg (33.3lb)	16kg (35.3lb)	16.9kg (37.3lb)
1250	15.6kg (34.4lb)	16.5kg (36.4lb)	17.4kg (38.4lb)
1300	16.1kg (35.5lb)	17kg (37.5lb)	17.9kg (39.5lb)
1350	16.6kg (36.6lb)	17.5kg (38.6lb)	18.4kg (40.6lb)
1400	17.1kg (37.7lb)	18kg (39.7lb)	18.9kg (41.7lb)
1450	17.6kg (38.8lb)	18.5kg (40.8lb)	19.4kg (42.8lb)
1500	18.1kg (39.9lb)	19kg (41.9lb)	19.9kg (43.9lb)
1550	18.6kg (41.0lb)	19.5kg (43.0lb)	20.4kg (45.0lb)
1600	19.1kg (42.1lb)	20kg (44.1lb)	20.9kg (46.1lb)
1650	19.6kg (43.2lb)	20.5kg (45.2lb)	21.4kg (47.2lb)
1700	20.1kg (44.3lb)	21kg (46.3lb)	21.9kg (48.3lb)
1750	20.6kg (45.4lb)	21.5kg (47.4lb)	22.4kg (49.4lb)
1800	21.1kg (46.5lb)	22kg (48.5lb)	22.9kg (50.5lb)
1850	21.6kg (47.6lb)	22.5kg (49.6lb)	23.4kg (51.6lb)
1900	22.1kg (48.7lb)	23kg (50.7lb)	23.9kg (52.7lb)
1950	22.6kg (49.8lb)	23.5kg (51.8lb)	24.4kg (53.8lb)
2000	23.1kg (50.9lb)	24kg (52.9lb)	24.9kg (54.9lb)

**Lead Wire**

Motor Cable	UL 2464
Wire Type	UL 2464
Wire AWG	16
U phase	White
V phase	Black
W phase	Green / Yellow

300mm lead wire bare leads  
The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.

**Supplied Connector (Motor Cable)**

Receptacle housing	VLR-03V
Plug Housing	VLP-03V
Retainer	VLS-03V
Pin contact	SVM-61T-P2.0
Socket contact	SVF-61T-P2.0

(To be installed by the user)

**CE Type Motor Cable (Optional)**

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow

300mm lead wire blunt cut  
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.

**Hall Effect Cable (Optional)**

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black

400mm lead wire bare leads  
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.

Connector (Hall Effect Cable)  
None supplied

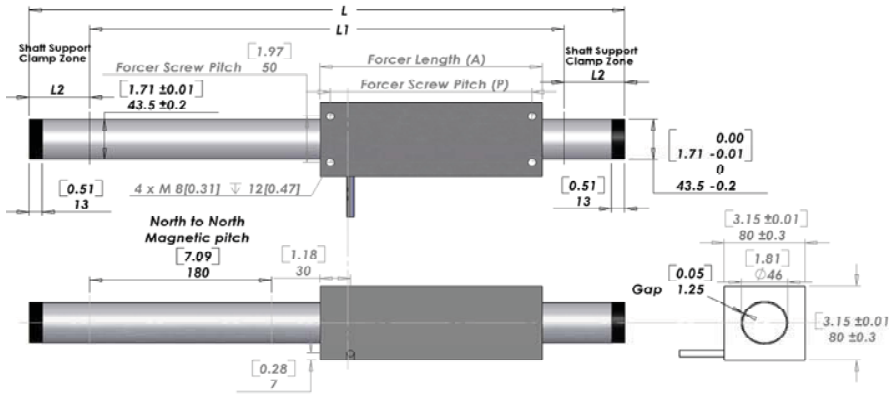
**Tandem Forcer**



	S427T	S427Q
Forcer spacing distance	50	50
Pole (North-South) distance	90	90
Forcer length	310	400
Flip forcers	No	Yes

2008/1/1

# NPM S435



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S435D	S435T	S435Q
Continuous Force <sup>1</sup>	116N (26.1lbs)	175N (39.3lbs)	233N (52.4lbs)
Continuous Current <sup>1</sup>	3.0Arms	3.0Arms	3.0Arms
Peak Force <sup>2</sup>	464N (104lbs)	700N (157lbs)	932N (210lbs)
Peak Current <sup>2</sup>	12Arms	12Arms	12Arms
Force Constant Kf	39N/Arms (8.77lbs/Arms)	58N/Arms (13.11lbs/Arms)	78N/Arms (17.53lbs/Arms)
Back EMF	13V/m/s (0.33 V/in/s)	19V/m/s (0.49 V/in/s)	26V/m/s (0.66 V/in/s)
Resistance 25 °C, <sup>3</sup>	2.7Ω	3.9Ω	5.2Ω
Inductance <sup>3</sup>	7.3mH	11mH	15mH
Electrical Time Constant	2.70ms	2.82ms	2.88ms
Fundamental Motor Constant	23.53N·W	29.54N·W	34.06N·W
Magnetic Pitch (North-North)	180mm (7.09in)	180mm (7.09in)	180mm (7.09in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

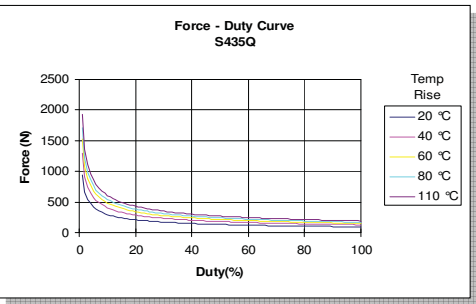
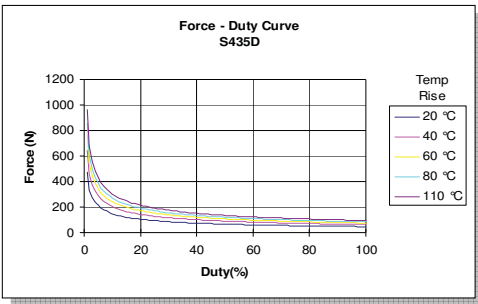
### Thermal Specifications

	S435D	S435T	S435Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	4.6 °C/W	3.2 °C/W	2.4 °C/W

4) The standard temperature difference between the coil and the forcer surface is 30 °C

### Mechanical Specifications

	S435D	S435T	S435Q
Forcer Length A	220mm (8.66in)	310mm (12.2in)	400mm (15.75in)
Forcer Width	80mm (3.15in)	80mm (3.15in)	80mm (3.15in)
Forcer Screw Pitch P	200mm (7.87in)	290mm (11.42in)	380mm (14.96in)
Forcer Weight	3.0kg ( 6.6lbs)	4.2kg ( 9.3lbs)	5.4kg ( 11.9lbs)
Gap	1.25mm (0.05in)	1.25mm (0.05in)	1.25mm (0.05in)



Mechanical Specifications

Shaft

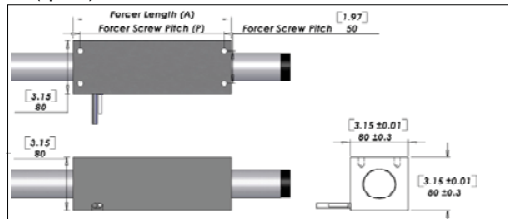
Shaft Diameter (D) 43.5 ±0.2mm (1.71in)

Shaft Length (L) Stroke	Maximum Stroke length 2600mm (102.4in)		
	Motor Type S435D	S435T	S435Q
200	540mm (21.3in)	630mm (24.8in)	720mm (28.3in)
250	590mm (23.2in)	680mm (26.8in)	770mm (30.3in)
300	640mm (25.2in)	730mm (28.7in)	820mm (32.3in)
350	690mm (27.2in)	780mm (30.7in)	870mm (34.3in)
400	740mm (29.1in)	830mm (32.7in)	920mm (36.2in)
450	790mm (31.1in)	880mm (34.6in)	970mm (38.2in)
500	840mm (33.1in)	930mm (36.6in)	1020mm (40.2in)
550	890mm (35in)	980mm (38.6in)	1070mm (42.1in)
600	940mm (37in)	1030mm (40.6in)	1120mm (44.1in)
650	990mm (39in)	1080mm (42.6in)	1170mm (46.1in)
700	1040mm (41in)	1130mm (44.6in)	1220mm (48.1in)
750	1090mm (43in)	1180mm (46.6in)	1270mm (50.1in)
800	1140mm (45in)	1230mm (48.6in)	1320mm (52.1in)
850	1190mm (47in)	1280mm (50.6in)	1370mm (54.1in)
900	1240mm (49in)	1330mm (52.6in)	1420mm (56.1in)
950	1290mm (51in)	1380mm (54.6in)	1470mm (58.1in)
1000	1340mm (53in)	1430mm (56.6in)	1520mm (60.1in)
1050	1390mm (55in)	1480mm (58.6in)	1570mm (62.1in)
1100	1440mm (57in)	1530mm (60.6in)	1620mm (64.1in)
1150	1490mm (59in)	1580mm (62.6in)	1670mm (66.1in)
1200	1540mm (61in)	1630mm (64.6in)	1720mm (68.1in)
1250	1590mm (63in)	1680mm (66.6in)	1770mm (70.1in)
1300	1640mm (65in)	1730mm (68.6in)	1820mm (72.1in)
1350	1690mm (67in)	1780mm (70.6in)	1870mm (74.1in)
1400	1740mm (69in)	1830mm (72.6in)	1920mm (76.1in)
1450	1790mm (71in)	1880mm (74.6in)	1970mm (78.1in)
1500	1840mm (73in)	1930mm (76.6in)	2020mm (80.1in)
1550	1890mm (75in)	1980mm (78.6in)	2070mm (82.1in)
1600	1940mm (77in)	2030mm (80.6in)	2120mm (84.1in)
1650	1990mm (79in)	2080mm (82.6in)	2170mm (86.1in)
1700	2040mm (81in)	2130mm (84.6in)	2220mm (88.1in)
1750	2090mm (83in)	2180mm (86.6in)	2270mm (90.1in)
1800	2140mm (85in)	2230mm (88.6in)	2320mm (92.1in)
1850	2190mm (87in)	2280mm (90.6in)	2370mm (94.1in)
1900	2240mm (89in)	2330mm (92.6in)	2420mm (96.1in)
1950	2290mm (91in)	2380mm (94.6in)	2470mm (98.1in)
2000	2340mm (93in)	2430mm (96.6in)	2520mm (100.1in)
2050	2390mm (95in)	2480mm (98.6in)	2570mm (102.1in)
2100	2440mm (97in)	2530mm (100.6in)	2620mm (104.1in)
2150	2490mm (99in)	2580mm (102.6in)	2670mm (106.1in)
2200	2540mm (101in)	2630mm (104.6in)	2720mm (108.1in)
2250	2590mm (103in)	2680mm (106.6in)	2770mm (110.1in)
2300	2640mm (105in)	2730mm (108.6in)	2820mm (112.1in)
2350	2690mm (107in)	2780mm (110.6in)	2870mm (114.1in)
2400	2740mm (109in)	2830mm (112.6in)	2920mm (116.1in)
2450	2790mm (111in)	2880mm (114.6in)	2970mm (118.1in)
2500	2840mm (113in)	2930mm (116.6in)	3020mm (120.1in)
2550	2890mm (115in)	2980mm (118.6in)	3070mm (122.1in)
2600	2940mm (117in)	3030mm (120.6in)	3120mm (124.1in)

Stroke lengths from 100mm and up to 2600mm are available. Please consult Nippon Pulse America for more information.

Support and Bending Stroke	Shaft Support length (L2)	Max Bending
0 → 550	60mm (2.36in)	0.00mm (0.00in)
551 → 1000	80mm (3.15in)	0.15mm (0.006in)
1001 → 1500	100mm (3.94in)	0.60mm (0.024in)
1501 → 2000	100mm (3.94in)	1.10mm (0.043in)
2001 → 2500	100mm (3.94in)	2.00mm (0.079in)
2501 → Max	100mm (3.94in)	2.10mm (0.083in)

Hall Effect (Optional)

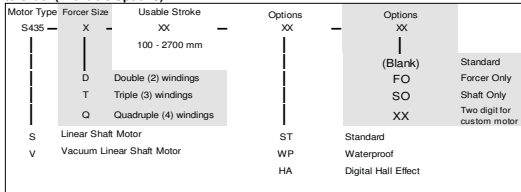


\* Note 2  
Sensor Cable (Lead wires) Specifications  
HP-SB20276SR  
Wire Type UL758  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - White/Red, GND - White/Black  
Sensor 1 - Orange/Red, Sensor 2 - Orange/Black, Sensor 3 - Gray/Red

The bending radius of the sensor cable should be R 27.6 (wire diameter 4.6 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Attach the proper high flex cable as required by your application.

\* Note 1  
The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

How to Order (Available Options)



Shaft Mass Stroke	Motor Type		
	S435T	S435T	S435Q
200	5.1kg (11.2lb)	6kg (13.2lb)	7kg (15.4lb)
250	5.6kg (12.3lb)	6.6kg (14.6lb)	7.5kg (16.5lb)
300	6.1kg (13.4lb)	7.1kg (15.7lb)	8kg (17.6lb)
350	6.7kg (14.8lb)	7.6kg (16.8lb)	8.5kg (18.7lb)
400	7.2kg (15.9lb)	8.1kg (17.9lb)	9kg (19.8lb)
450	7.7kg (17lb)	8.6kg (19lb)	9.6kg (21.2lb)
500	8.2kg (18.1lb)	9.2kg (20.3lb)	10.1kg (22.3lb)
550	8.7kg (19.2lb)	9.7kg (21.4lb)	10.6kg (23.4lb)
600	9.4kg (20.7lb)	10.4kg (22.9lb)	11.3kg (24.9lb)
650	10kg (22lb)	10.9kg (24lb)	11.8kg (26lb)
700	10.5kg (23.1lb)	11.4kg (25.1lb)	12.3kg (27.1lb)
750	11kg (24.3lb)	11.9kg (26.2lb)	12.9kg (28.4lb)
800	11.5kg (25.4lb)	12.5kg (27.6lb)	13.4kg (29.5lb)
850	12kg (26.5lb)	13kg (28.7lb)	13.9kg (30.6lb)
900	12.6kg (27.8lb)	13.5kg (29.8lb)	14.4kg (31.7lb)
950	13.1kg (28.9lb)	14kg (30.9lb)	14.9kg (32.8lb)
1000	13.6kg (30lb)	14.5kg (32lb)	15.5kg (34.2lb)
1050	14.3kg (31.5lb)	15.2kg (33.5lb)	16.2kg (35.7lb)
1100	14.8kg (32.6lb)	15.7kg (34.6lb)	16.7kg (36.8lb)
1150	15.3kg (33.7lb)	16.3kg (35.9lb)	17.2kg (37.9lb)
1200	15.9kg (35.1lb)	16.8kg (37lb)	17.7kg (39lb)
1250	16.4kg (36.2lb)	17.3kg (38.1lb)	18.2kg (40.1lb)
1300	16.9kg (37.3lb)	17.8kg (39.2lb)	18.8kg (41.4lb)
1350	17.4kg (38.4lb)	18.4kg (40.6lb)	19.3kg (42.5lb)
1400	17.9kg (39.5lb)	18.9kg (41.7lb)	19.8kg (43.7lb)
1450	18.5kg (40.8lb)	19.4kg (42.8lb)	20.3kg (44.8lb)
1500	19kg (41.9lb)	19.9kg (43.9lb)	20.8kg (45.9lb)
1550	19.5kg (43lb)	20.4kg (45lb)	21.4kg (47.2lb)
1600	20kg (44.1lb)	21kg (46.3lb)	21.9kg (48.3lb)
1650	20.5kg (45.2lb)	21.5kg (47.4lb)	22.4kg (49.4lb)
1700	21.1kg (46.5lb)	22kg (48.5lb)	22.9kg (50.5lb)
1750	21.6kg (47.6lb)	22.5kg (49.6lb)	23.4kg (51.6lb)
1800	22.1kg (48.7lb)	23kg (50.7lb)	24kg (52.9lb)
1850	22.6kg (49.8lb)	23.5kg (51.8lb)	24.5kg (54lb)
1900	23.1kg (50.9lb)	24kg (52.9lb)	25kg (55.1lb)
1950	23.7kg (52.2lb)	24.6kg (54.2lb)	25.5kg (56.2lb)
2000	24.2kg (53.4lb)	25.1kg (55.3lb)	26kg (57.3lb)

Lead Wire

Motor Cable	UL 2464
Wire Type	UL 2464
Wire AWG	16
U phase	White
V phase	Black
W phase	Green / Yellow

300mm lead wire bare leads  
The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.

Supplied Connector (Motor Cable)

Receptacle housing	VLR-03V
Plug Housing	VLP-03V
Retainer	VLS-03V
Pin contact	SVM-61T-P2.0
Socket contact	SVF-61T-P2.0

(To be installed by the user)

CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow

300mm lead wire blunt cut  
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.

Hall Effect Cable (Optional)

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black

400mm lead wire bare leads  
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.

Connector (Hall Effect Cable)  
None supplied

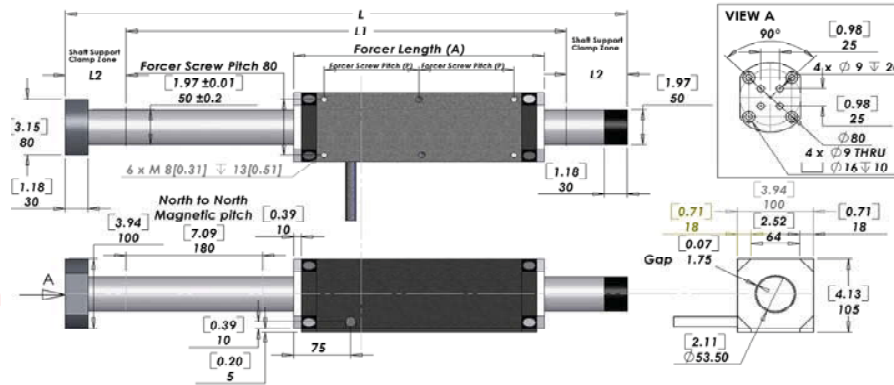
Tandem Forcer



	S435T	S435Q
Forcer spacing distance	50	50
Pole (North-South) distance	90	90
Forcer length	310	400
Flip force bars	No	Yes

2008/1/1

**NPM S500**



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM [IN]  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

\* Note 1  
 Cable length 300mm  
 The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

**Electrical Specifications**

	S500D	S500T	S500Q
Continuous Force <sup>1</sup>	289N (65.0lbs)	440N (98.9lbs)	585N (132lbs)
Continuous Current <sup>1</sup>	3.8Arms	5.8Arms	7.7Arms
Peak Force <sup>2</sup>	1156N (260lbs)	1760N (369lbs)	2340N (526lbs)
Peak Current <sup>2</sup>	15.2Arms	23.2Arms	30.8Arms
Force Constant Kf	76N/Arms (17.1lbs/Arms)	76N/Arms (17.1lbs/Arms)	76N/Arms (17.1lbs/Arms)
Back EMF	25V/m/s (0.64 V/in/s)	25V/m/s (0.64 V/in/s)	25V/m/s (0.64 V/in/s)
Resistance 25 °C, <sup>3</sup>	4.4Ω	3.3Ω	2.2Ω
Inductance <sup>3</sup>	27mH	19.8mH	13.8mH
Electrical Time Constant	6.14ms	6.0ms	6.0ms
Fundamental Motor Constant	36.28N√W	41.76N√W	51.22N√W
Magnetic Pitch (North-North)	180mm (7.09in)	180mm (7.09in)	180mm (7.09in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 110°K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

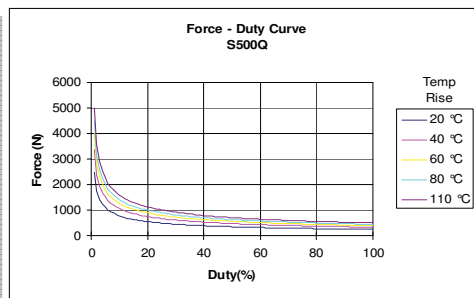
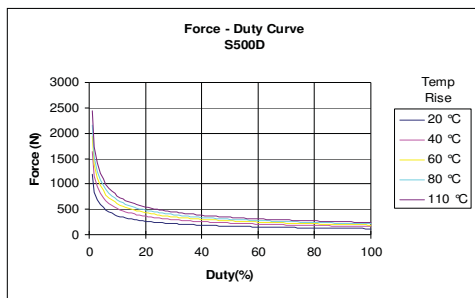
**Thermal Specifications**

	S500D	S500T	S500Q
Max phase temperature <sup>4</sup>	135 °C (275 °F)	135 °C (275 °F)	135 °C (275 °F)
Thermal Resistance (Coil) Kq	1.7 °C/W	1 °C/W	0.8 °C/W

4) The standard temperature difference between the coil and the forcer surface is 40 °C

**Mechanical Specifications**

	S500D	S500T	S500Q
Forcer Length A	240mm (9.45in)	330mm (12.99in)	420mm (16.54in)
Forcer Width	100 x 105mm (3.94 x 4.13in)	100 x 105mm (3.94 x 4.13in)	100 x 105mm (3.94 x 4.13in)
Forcer Screw Pitch P	80mm (3.15in)	125mm (4.92in)	170mm (6.69in)
Forcer Weight	10kg ( 22.0lbs)	13kg ( 28.7lbs)	15kg (33.1 lbs)
Gap	1.75mm (0.07in)	1.75mm (0.07in)	1.75mm (0.07in)



Mechanical Specifications

Shaft

Shaft Diameter (D) 50 ±0.2mm (1.96in)

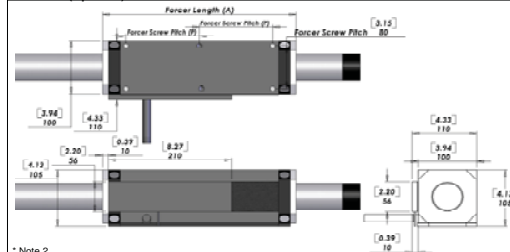
Shaft Length (L) Motor Type	Maximum Stroke length 3850mm (151.6in)		
	S500D	S500T	S500Q
200	600mm (23.6in)	690mm (27.2in)	780mm (30.7in)
250	650mm (25.6in)	740mm (29.1in)	830mm (32.7in)
300	700mm (27.6in)	790mm (31.1in)	880mm (34.6in)
350	750mm (29.5in)	840mm (33.1in)	930mm (36.6in)
400	800mm (31.5in)	890mm (35in)	980mm (38.6in)
450	850mm (33.5in)	940mm (37in)	1030mm (40.6in)
500	900mm (35.4in)	990mm (39in)	1080mm (42.5in)
550	950mm (37.4in)	1040mm (40.9in)	1130mm (44.5in)
600	1000mm (39.4in)	1090mm (42.9in)	1180mm (46.5in)
650	1050mm (41.3in)	1140mm (44.9in)	1230mm (48.4in)
700	1100mm (43.3in)	1190mm (46.9in)	1280mm (50.4in)
750	1150mm (45.3in)	1240mm (48.8in)	1330mm (52.4in)
800	1240mm (48.8in)	1330mm (52.4in)	1420mm (55.9in)
850	1290mm (50.8in)	1380mm (54.3in)	1470mm (57.9in)
900	1340mm (52.8in)	1430mm (56.3in)	1520mm (59.8in)
950	1390mm (54.7in)	1480mm (58.3in)	1570mm (61.8in)
1000	1440mm (56.7in)	1530mm (60.2in)	1620mm (63.8in)
1050	1490mm (58.7in)	1580mm (62.2in)	1670mm (65.7in)
1100	1540mm (60.6in)	1630mm (64.2in)	1720mm (67.7in)
1150	1590mm (62.6in)	1680mm (66.1in)	1770mm (69.7in)
1200	1640mm (64.6in)	1730mm (68.1in)	1820mm (71.7in)
1250	1690mm (66.5in)	1780mm (70.1in)	1870mm (73.6in)
1300	1740mm (68.5in)	1830mm (72in)	1920mm (75.6in)
1350	1790mm (70.5in)	1880mm (74in)	1970mm (77.6in)
1400	1840mm (72.4in)	1930mm (76in)	2020mm (79.5in)
1450	1890mm (74.4in)	1980mm (78in)	2070mm (81.5in)
1500	1940mm (76.4in)	2030mm (79.9in)	2120mm (83.5in)
1550	1990mm (78.3in)	2080mm (81.9in)	2170mm (85.4in)
1600	2040mm (80.3in)	2130mm (83.9in)	2220mm (87.4in)
1650	2090mm (82.3in)	2180mm (85.8in)	2270mm (89.4in)
1700	2140mm (84.3in)	2230mm (87.8in)	2320mm (91.3in)
1750	2190mm (86.2in)	2280mm (89.8in)	2370mm (93.3in)
1800	2240mm (88.2in)	2330mm (91.7in)	2420mm (95.3in)
1850	2290mm (90.2in)	2380mm (93.7in)	2470mm (97.2in)
1900	2340mm (92.1in)	2430mm (95.7in)	2520mm (99.2in)
1950	2390mm (94.1in)	2480mm (97.6in)	2570mm (101.2in)
2000	2440mm (96.1in)	2530mm (99.6in)	2620mm (103.1in)

Stroke lengths from 100mm and up to 3850mm are available. Please consult Nippon Pulse America for more information.

Support and Bending

Stroke	Shaft Support length (L2)	Max Bending
0 → 550	80mm (3.15in)	0.00mm (0.00in)
551 → 750	80mm (3.15in)	0.15mm (0.006in)
751 → 1500	100mm (3.94in)	0.60mm (0.024in)
1501 → Max	120mm (4.72in)	1.10mm (0.043in)

Hall Effect (Optional)



\* Note 2  
Sensor Cable (Lead wires) Specifications  
HF-SB20276SR  
Wire Type UL758  
Wire AWG 28  
Length 400 mm (bare leads)  
VCC - White/Red, GND - White/Black  
Sensor 1 - Orange/Red, Sensor 2 - Orange/Black, Sensor 3 - Gray/Red

The bending radius of the sensor cable should be R 27.6 (wire diameter 4.6 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Attach the proper high flex cable as required by your application.

\* Note 1  
The bending radius of the motor cable should be 36.6 mm (wire diameter 6.1 \* 6) as suggested by the wire manufacturer. This radius should be maintained. Use supplied connector to attach the proper high flex cable as required by your application.

How to Order (Available Options)

Motor Type	Forcer Size	Usable Stroke	Options	Options	Options
S500	X	XX	XX	XX	XX
		100 - 3850 mm			
Linear Shaft Motor	D	Double (2) windings	T	Triple (3) windings	Q
		Quadruple (4) windings			
			ST	Standard	
			WP	Waterproof	
			HA	Digital Hall Effect	
				(Blank)	Standard
				FO	Forcer Only
				SO	Shaft Only
				XX	Two digit for custom motor

Shaft Mass

Stroke	Motor Type		
	S500D	S500T	S500Q
200	7.9kg (17.4lb)	9.1kg (20lb)	10.2kg (22.6lb)
250	8.5kg (18.8lb)	9.7kg (21.4lb)	10.9kg (24lb)
300	9.2kg (20.3lb)	10.4kg (22.9lb)	11.6kg (25.5lb)
350	9.8kg (21.7lb)	11.1kg (24.3lb)	12.2kg (26.9lb)
400	10.5kg (23.2lb)	11.7kg (25.8lb)	12.9kg (28.4lb)
450	11.2kg (24.6lb)	12.3kg (27.2lb)	13.5kg (29.8lb)
500	11.8kg (26.1lb)	13kg (28.7lb)	14.2kg (31.3lb)
550	12.5kg (27.5lb)	13.7kg (30.1lb)	14.8kg (32.7lb)
600	13.1kg (28.9lb)	14.3kg (31.6lb)	15.5kg (34.2lb)
650	13.8kg (30.4lb)	15kg (33lb)	16.1kg (35.6lb)
700	14.4kg (31.8lb)	15.6kg (34.4lb)	16.8kg (37.1lb)
750	15.1kg (33.3lb)	16.3kg (35.9lb)	17.5kg (38.5lb)
800	16.3kg (35.9lb)	17.5kg (38.5lb)	18.6kg (41.1lb)
850	16.9kg (37.3lb)	18.1kg (39.9lb)	19.3kg (42.6lb)
900	17.6kg (38.8lb)	18.8kg (41.4lb)	20kg (44lb)
950	18.3kg (40.2lb)	19.4kg (42.8lb)	20.6kg (45.4lb)
1000	18.9kg (41.7lb)	20.1kg (44.3lb)	21.3kg (46.9lb)
1050	19.6kg (43.1lb)	20.7kg (45.7lb)	21.9kg (48.3lb)
1100	20.2kg (44.6lb)	21.4kg (47.2lb)	22.6kg (49.8lb)
1150	20.9kg (46lb)	22.1kg (48.6lb)	23.2kg (51.2lb)
1200	21.5kg (47.5lb)	22.7kg (50.1lb)	23.9kg (52.7lb)
1250	22.2kg (48.9lb)	23.4kg (51.5lb)	24.6kg (54.1lb)
1300	22.8kg (50.4lb)	24kg (53lb)	25.2kg (55.6lb)
1350	23.5kg (51.8lb)	24.7kg (54.4lb)	25.9kg (57lb)
1400	24.2kg (53.3lb)	25.3kg (55.9lb)	26.5kg (58.5lb)
1450	24.8kg (54.7lb)	26kg (57.3lb)	27.2kg (59.9lb)
1500	25.5kg (56.2lb)	26.7kg (58.8lb)	27.8kg (61.4lb)
1550	26.1kg (57.6lb)	27.3kg (60.2lb)	28.5kg (62.8lb)
1600	26.8kg (59.1lb)	28kg (61.7lb)	29.1kg (64.3lb)
1650	27.4kg (60.5lb)	28.6kg (63.1lb)	29.8kg (65.7lb)
1700	28.1kg (61.9lb)	29.3kg (64.6lb)	30.5kg (67.2lb)
1750	28.8kg (63.4lb)	29.9kg (66lb)	31.1kg (68.6lb)
1800	29.4kg (64.8lb)	30.6kg (67.4lb)	31.8kg (70.1lb)
1850	30.1kg (66.3lb)	31.2kg (68.9lb)	32.4kg (71.5lb)
1900	30.7kg (67.7lb)	31.9kg (70.3lb)	33.1kg (72.9lb)
1950	31.4kg (69.2lb)	32.6kg (71.8lb)	33.7kg (74.4lb)
2000	32kg (70.6lb)	33.2kg (73.2lb)	34.4kg (75.8lb)

Lead Wire

Motor Cable	UL 1277
Wire Type	UL 1277
Wire AWG	14
U phase	White
V phase	Black
W phase	Green / Yellow

300mm lead wire bare leads  
The bending radius of the motor cable should be 36.6mm as suggested by the wire manufacturer.

Supplied Connector (Motor Cable)

Receptacle housing	VLR-03V
Plug Housing	VLP-03V
Retainer	VLS-03V
Pin contact	SVM-61T-P2.0
Socket contact	SVF-61T-P2.0

(To be installed by the user)

CE Type Motor Cable (Optional)

Wire Type	UL 1330
Wire AWG	24
U phase	Red
V phase	White
W phase	Black
Ground Cable	
Wire Type	UL 1330
Wire AWG	20
FG (Frame Ground)	Green / Yellow

300mm lead wire blunt cut  
The bending radius of the motor cable should be 16.96mm or more as suggested by the wire manufacturer.

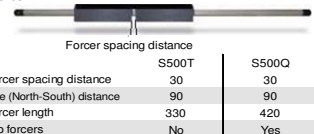
Hall Effect Cable (Optional)

Wire Type	UL 758
Wire AWG	28
VCC	White / Red
GND	White / Black
Sensor 1	Orange / Red
Sensor 2	Orange / Black
Sensor 3	Gray / Red
No Connection	Gray / Black

400mm lead wire bare leads  
The bending radius of the hall effect cable should be 27.6mm as suggested by the wire manufacturer.

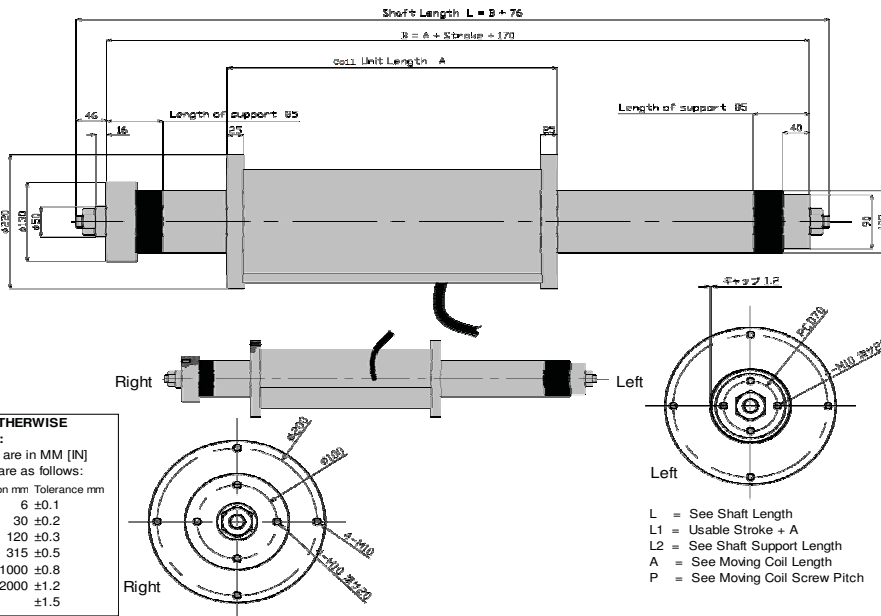
Connector (Hall Effect Cable)  
None supplied

Tandem Forcer



2008/1/1

# NPM S1000



**UNLESS OTHERWISE SPECIFIED:**  
 Dimensions are in MM (IN)  
 Tolerances are as follows:

Dimension mm	Tolerance mm
6	±0.1
7 - 30	±0.2
31 - 120	±0.3
121 - 315	±0.5
316 - 1000	±0.8
1001 - 2000	±1.2
2000 -	±1.5

L = See Shaft Length  
 L1 = Usable Stroke + A  
 L2 = See Shaft Support Length  
 A = See Moving Coil Length  
 P = See Moving Coil Screw Pitch

### Electrical Specifications

	S1000D	S1000T	S1000Q
Continuous Force <sup>1</sup>	1056N (267lbs)	1591N (358lbs)	2125N (488lbs)
Continuous Current <sup>1</sup>	7.9Arms	11.9Arms	15.9Arms
Peak Force <sup>2</sup>	4225N (950lbs)	6364N (1431lbs)	8503N (1912lbs)
Peak Current <sup>2</sup>	31.6Arms	47.6Arms	63.6Arms
Force Constant Kf	133.7N/Arms (29.9lbs/Arms)	133.7N/Arms (29.9lbs/Arms)	133.7N/Arms (29.9lbs/Arms)
Back EMF	44.57V/m/s (1.31V/in/s)	44.57V/m/s (1.31V/in/s)	44.57V/m/s (1.31V/in/s)
Resistance 20°C, <sup>3</sup>	2.0Ω	1.3Ω	1.0Ω
Inductance <sup>3</sup>	9.8mH	6.5mH	4.9mH
Electrical Time Constant	4.9ms	5.0ms	4.9ms
Fundamental Motor Constant	94.54N√W	117.26N√W	133.7N√W
Magnetic Pitch (North-North)	270mm (10.6in)	270mm (10.6in)	270mm (10.6in)

All specifications are for reference only. Specifications may change depending on servo driver selected. Consult Nippon Pulse America.

- 1) Based on a temp rise of coil surface of 40 °K over 25°C ambient temperature stalled forcer, and no external cooling or heat sinking. Addition of 25 cm x 25 cm x 2.5 cm aluminum heat sink increases continuous force by 20%.
- 2) Can be maintained for a maximum of 40 seconds, consult Nippon Pulse America.
- 3) All winding parameters listed are measured line-to-line (phase-to-phase).

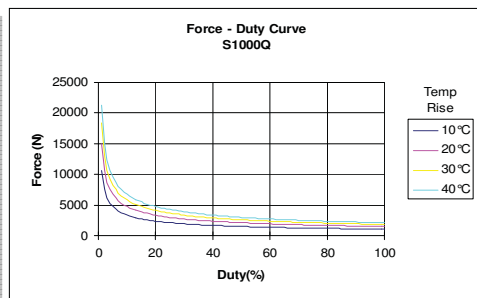
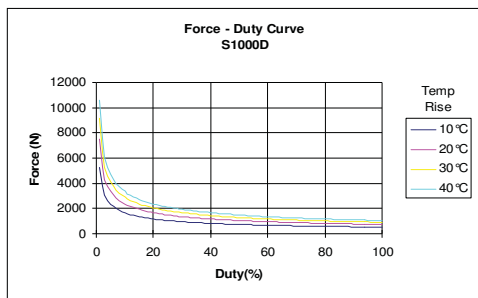
### Thermal Specifications

	S1000D	S1000T	S1000Q
Max phase temperature <sup>4</sup>	65°C (149°F)	65°C (149°F)	65°C (149°F)
Thermal Resistance (Coil) Kq	0.32°C/W	0.22°C/W	0.16°C/W

4) The standard temperature difference between the coil and the forcer surface is 40 °C

### Mechanical Specifications

	S1000D	S1000T	S1000Q
Forcer Length A	364mm (14.33in)	499mm (19.64in)	634mm (24.96in)
Forcer Width	200mm (7.87in)	200mm (7.87in)	200mm (7.87in)
Forcer Screw Pitch P			
Forcer Weight	37kg (81.6lbs)	55kg (121lbs)	73kg (161lbs)
Gap	1.2mm (0.047in)	1.2mm (0.047in)	1.2mm (0.047in)



2008/1/1

## GLOSSARY OF TERMS

### A

#### ***Abbe Error***

Motion errors caused by angular moments between the measuring feedback element and the point of interest.

#### ***Abbe Offset***

The linear distance between the measuring feedback element and the point of interest.

#### ***Absolute Move***

A move referenced from a fixed zero position.

#### ***Acceleration***

Change in velocity as a function of time, going from slower to faster.

#### ***Accuracy***

Difference between expected position and achieved position.

### B

#### ***Back EMF***

The peak phase-to-phase voltage generated when the motor is traveling at a velocity of 1m/s.

#### ***Backlash***

The non-responsive lost motion between a drive screw and its nut that occurs at the point of change in rotation direction.

#### ***Brushless Servomotor***

A class of servomotors, which operates using electronic commutation of phase currents rather than electromechanical (brushes) commutation.

### C

#### ***Cantilevered Load***

A load that has its center of mass offset from the balance point of a bearing system.

#### ***Closed Loop***

Implementing feedback to regulated position and/or velocity with respect to commanded.

#### ***Cogging***

A term used to describe non-uniform angular velocity. Cogging appears as jerkiness, especially at low speeds. Changes in force at low velocity, caused by magnetic "detenting" forces created by

relative motion between a motor's permanent magnets and its ferrous core coil windings.

#### ***Commutation***

The switching sequence of drive voltage into motor phase windings necessary to ensure continuous motor movement. A brushed motor relies upon brush/bar contact to switch the windings mechanically. A brushless Linear Shaft Motor requires a device that senses rotor position information relative to the shaft, and then feeds that data to a drive, which determines the next switching sequence.

#### ***Commutation, Sinusoidal***

The three phase currents applied to a motor closely follow the sine wave shape of the motor's natural back emf waves, thereby providing the lowest velocity ripple and the smoothest possible motion. This is a very important factor for scanning applications. Sinusoidal commutation is electronically generated at the servo controller.

#### ***Commutation, Trapezoidal***

The three phase currents applied to a motor resemble a trapezoidal profile. Slight force ripple is present due to the mismatch between the three phase trapezoidal shape and the motor's back emf sinewave profile. Trapezoidal commutation is typically generated by Hall effect sensors secured near the motor's moving coils. Trapezoidal commutation is suitable for most high-speed motion applications.

#### ***Continuous Current***

The current required to heat the motor phases to their maximum operating temperature when the ambient temperature is 25°C, the motor is not moving, and there is no cooling.

#### ***Continuous Force***

Continuous force is the force produced when the continuous current is applied to the motor. It is the product of Force constant X Continuous current. The motor is not moving and there is no cooling.

#### ***Continuous Working Voltage***

The maximum allowable continuous voltage between any two phases or between any phase and the motor safety earth.

#### ***Counts per Meter***

Counts per Meter is equal to 1 divided by resolution on encoder (Example for 50nm encoder: Pulses per Meter =  $1/(50 \times 10^{-9}) = 20000000$ )



**Coefficient of Kinetic Friction ( $\mu_k$ )**

It is the proportional value of the force required to maintain motion to the normal force of the mass being moved.

**Coefficient of Static Friction ( $\mu_s$ )**

It is the proportional value of the force required to overcome static friction, to the normal force of the mass to be moved.

**Cosine Error**

Results from a parallel misalignment between a linear bearing system and the linear feedback element.

**Current**

The value of current when two motor phases are joined, and a current is passed between those two phases and the third. Example, a current of 1 ampere means that 1 ampere will be flowing in one phase and 0.5 ampere in each of the other two phases.

**Current/Torque Amplifiers**

Current/Torque amplifiers produce a force proportional to the command signal. The speed with which the motor will move is therefore controlled entirely by the external servo controller. The most common type of programmable digital servo controller used with current amplifiers employs a PIDF algorithm to control the position of the motor.

**D****Deceleration**

Change in velocity as a function of time, going from faster to slower.

**Duty Cycle, Motion**

The percentage of the time in motion to the total time (motion time  $\div$  total time)  $\times$  100%.

**Duty Motor Power**

The percentage of the application process power to a motor's continuous power limits [(IRMS  $\div$  ICont)<sup>2</sup>  $\times$  100%]. This value should not exceed 100% for a prolonged period of time.

**E****Electrical Time Constant**

The time taken for a step current input to the motor to reach 63.2% of its value.

**Encoder**

A position-sensing device that translates mechanical motion into electronic signals used for monitoring position or velocity.

**F****Flatness**

The deviation from the theoretically perfect line of travel, and is measured as displacement in the vertical plane.

Note that the frame or mounting surface to which the module or gantry system is fixed will affect the flatness of the system.

**Friction**

Resistance to motion of two surfaces that touch.

**Force Constant**

Force constant is the k force produced when 1 ampere flows into one phase and 0.5 ampere flows out of the remaining two phases

**Forcer**

The coil assembly of the Linear Shaft Motor. It is typically available in one of five configurations: D, two sets of windings; T, three sets of windings; Q, four sets of windings; H, six sets of windings, S, one sets of windings, or X, eight sets of windings.

**H****Hall Sensors**

A feedback device, which is used in some brushless servo systems to provide information for the amplifier to electronically commutate the motor. In a Linear Shaft Motor, the hall sensors sense the position of the forcer and send a signal to the driver to switch on the next sequential winding (the process of commutation) in the forcer, which causes linear movement.

**Hysteresis**

The non-responsive lost motion which may occur at the point of change in direction. The composite error results from many contributing factors (backlash, elasticity of structure, etc.).

**I****Incremental Move**

A move referenced from the current position.

**Inductance**

The property of an electric circuit by which an electromotive force is induced in it as the result of a changing magnetic flux. This electrical characteristic is an indicator of how fast the current can rise and fall when voltage is applied to the windings.



**Inertia**

The property of an element's mass and shape that resists changes in velocity when exposed to an outside force. The larger an object's mass, the greater its inertia and the greater the magnitude of force required to accelerate it at a given rate.

**Intelligent Amplifiers**

Servo amplifiers do not require external control signals in order to position the motor. Depending on the unit, they can perform very simple point to point moves up to very sophisticated moves with external synchronization and I/O handling. Generally, they can operate in either position/velocity, or force control modes.

**L****Limits or Limit Switches**

Properly designed motion control systems have sensors called limits, or limit switches, which alert the control electronics that the physical end of travel is being approached and that motion should stop. These are safety devices at each end of the movement to prevent damage due to over travel of the forcer.

**Linear Bearing**

A support device that allows a smooth, low friction motion between two surfaces loaded against each other.

**M****Magnetic Pitch (Pole Pitch)**

The distance in millimeters for one complete electrical cycle (between like magnetic poles). Example: North to North.

**Maximum Phase Temperature**

The maximum operating temperature for the motor phases. It is limited to provide a safe operating temperature for the coil.

**O****Open Loop**

A motion system which does not utilize a feedback element.

**Orthogonality**

The degree to which stages are aligned with their motion at right angles to one another. Motion of an X-Y system is typically 90° apart in a single plane. X-Y-Z systems are all mutually at a 90° relationship in a 3D space. The specification is typically the angle measured between the best-fit-straight-line of

X-axis motion and the best-fit-straight-line of Y-axis motion.

**P****Parallelism**

The deviation between the perpendicular distance between axes (with one being the reference axis).

**Peak Current**

The current that can be applied for short periods of time for accelerating or decelerating. The peak current can be safely applied the Linear Shaft Motor for a maximum of 40 seconds, before the motor phases reach their maximum operating temperature when the ambient temperature is 25°C, the motor is not moving, there is no and no additional heat sinking.

**Peak Force**

The force produced when the peak current is applied to the Linear Shaft Motor. It is the product of Force constant X Peak current. The motor is not moving, there is no cooling and no additional heat sinking.

**Pulses per Meter**

Pulses per Meter is equal to 1 divided by resolution on encoder divided by 4 (Example for 50nm encoder: Pulses per Meter =  $1/(50 \times 10^{-9})/4 = 5000000$ )

**R****Repeatability, Bi-directional**

The error from nominal when repeatedly approaching a position from opposite directions.

**Repeatability, Uni-directional**

The error from nominal when repeatedly approaching a position from the same direction.

**Resistance**

The opposition to the flow of charge through a conductor.

**Resonance**

Oscillatory behavior in a mechanical body when subjected to a periodic force occurring at its natural frequency.

**Resolution, Electrical**

The smallest increment that can be commanded by a servo system. The value results from the feedback's precision (encoder, laser, etc.) and the controller's logic multiplication factor.

**Resolution, Mechanical**

The smallest increment that can be controlled by a motion system. The value is affected by friction, static friction, driving mechanism precision, etc.

**S****Scale Error**

Errors associated with the precision of the feedback elements.

**Settling Time**

The time it takes after a move completes to settle to within a specified tolerance band (i.e.: to within  $\pm 1\mu\text{m}$ ).

**Servo Driver**

A three phase brushless DC servomotor driver used to drive and control the position of a servo motor. It is comprised of a servo controller and amplifier combination. There are many different makes and models of amplifiers available, but they tend to fall into one of three possible categories:

1. Intelligent amplifiers that have built in servo controllers
2. Velocity amplifiers capable of controlling only the velocity of the motor
3. Current/Torque amplifiers that control only the force of a linear motor (torque in a rotary motor)

**Shaft**

The magnetic assembly of the Linear Shaft Motor. It is typically is a stainless steel shaft and not designed to be load bearing.

**Straightness**

The deviation from the theoretical perfect line of travel, and is measured as displacement in the horizontal plane.

**Stiction**

Frictional resistance to initial motion.

**T****Thermal Resistance**

The equivalent thermal resistance of the motor, determined by the ratio of coil temperature rise to the total power motor losses in the three phases.

**V****Velocity**

A change in position as a function of time (speed).

**Velocity amplifiers**

Servo amplifiers are used to move the motor at a velocity determined by an analog command. The unit requires an external servo controller to determine the move profiles. In addition, some are available where the command can be input to the drive through a serial link. Units of this nature can sometimes be given a position set point that can be used to move the motor to a defined position. The motor will move towards the required position at a predefined velocity and acceleration. Encoder feedback is required to calculate the motor's velocity. The advantages of using such a system is that the processing by the main controller is reduced, and the update time within the amp for the velocity loop can usually be much higher than the servo controller.

**W****Weight**

The force of gravity acting on a body. Weight equals mass x acceleration due to gravity.

**Working Envelope**

The effective area available for the system to operate, without interfering with other parts of the system.

**Y****Yaw**

Angular motion of a linear stage, about an axis which is between to the bearing system and which is at right angles to the direction of travel.

## APPENDIX A PART NUMBER AND ORDERING INFORMATION

A typical Linear Shaft Motor consists of one forcer plus one magnet shaft. In a given Linear Shaft Motor series the magnet shafts are compatible with all forcer coil models. Note that the effective motor travel length is track length minus coil length. Non-standard shaft lengths are available in 1mm increments.

### Linear Shaft Motor Part Number

	Shaft Size (D)	Forcer Size (A)	Usable Stroke	Options	Options
S	040	X	XXX	XX	XX
	080				
	120				
	160				
	200				
	250				
	320				
	350				
	427				
	435				
	500				
	1000				

FO Forcer Only  
 SO Shaft Only  
 XX Two digit for custom motor

ST Standard  
 WP Waterproof  
 HA Digital Hall Effect  
 CE CE type motor  
**(only needed if ordering forcer)**

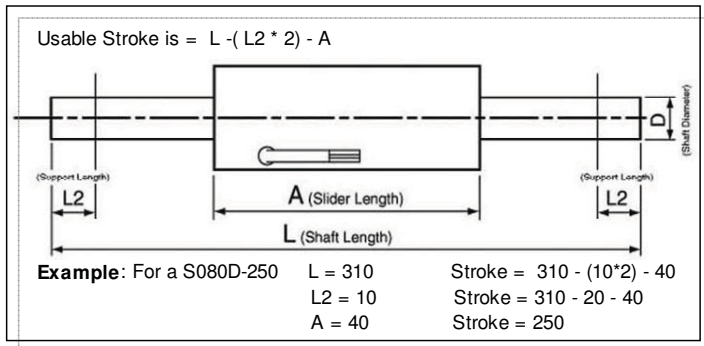
usable stroke in millimeters

XX usable stroke in millimeters  
**(only needed if ordering shaft)**

S Single winding  
 D Double (2) windings  
 T Triple (3) windings  
 Q Quadruple (4) windings  
 H Hextuple (6) windings  
 X Octuple (8) windings

XX Shaft diameter in mm \*10

S Linear Shaft Motor  
 L Long Stroke Linear Shaft Motor  
 V Vacuum Linear Shaft Motor



Examples:

**S160T-350-ST**

A standard 16 mm Shaft Motor with a triple coil and a 350 mm usable stroke length.

**S250Q-WP-FO**

A Waterproof 25 mm Shaft Motor with a quadruple coil only.

**S080D-250-SO**

A standard 8 mm Shaft only for a double coil with a 250 mm usable stroke length. Total shaft length of 310 mm.

[www.LinearShaftMotor.com](http://www.LinearShaftMotor.com)

2/11/2008

You can order the Linear Shaft Motor from Nippon Pulse America directly at:

Mail: 4 Corporate Drive, Radford, VA 24141, USA

Phone: 1-540-633-1677

E-mail: [info@linearshaftmotor.com](mailto:info@linearshaftmotor.com)

Web: <http://www.linearshaftmotor.com>

# APPENDIX B ENGINEERING NOTES

## Selection guide for Linear Shaft Motor

One of the most straightforward tasks in the design of a linear motion system is to specify a motor and drive combination that can provide the force, speed and acceleration that is required by the mechanical design. This is all too often the most overlooked aspect of the linear motion system design. Making the motor the most costly aspect of there system, not only from the perspective of the initial purchase cost but also from the aspect of service maintenance, and energy cost.

The unique properties of the Linear Shaft Motor make it's sizing for applications slightly different then that of other liner motors. Nevertheless, the proper sizing of a Linear Shaft Motor is rather straightforward. Nippon Pulse America provides the NPA Smart sizing software to assist in the selection of a proper motor and drive combination for your mechanical design. Please use the following chart to assist in organizing the operation conditions for your system.

**1. Operation Condition**

Item	Symbol	Value	Unit	Notes
Load mass	$M_L$		Kg	Mass of the moving part of your system less the mass of the motor.
Load (thrust) Force	$F_L$		N	Thrust Force is added to all segments of the motion profile. This is in addition to force needed to overcome mass, acceleration, and friction.
Run (pre-load) Friction	$F_r$		N	Pre-load Force is considered in all moving segments of the motion profile. Keep in mind all external forces that disturb the movement.
Moving Motor Mass	$M_C$		Kg	If you are not sure which motor you are going to need, start with a value of 1/10 of Load mass
Friction coefficient	$\mu$			
Incline Angle	$\alpha$		°	0° is Horizontal while 90° is Vertical
Available Voltage	V		Vac	
Available Current	A		Arms	
Max Allowable temperature			°C	

Example: Table, Encoder  
 Example of use: As the motor moves, it needs to maintain 20 lbs of force on an object.  
 Example: Cable Chain, Bearing wipers, Preloaded Guide, springs

FYI Blue on Blue cells are for user input.

Next is to define what motion if any your system will be making.

**2. Motion Profile**

Item	Symbol	Value	Unit	Notes
Stroke	X		mm	
Velocity	V		m/s	
Acceleration time	$T_a$		s	
Continuous time	$T_c$		s	
Deceleration time	$T_d$		s	
Settling time	$T_s$		s	
Waiting time	$T_w$		s	

Note: This application note walks you through sizing with only one segment. It is recommended that for the best sizing of a Linear Shaft Motor, a complete cycle should be used for sizing. Stroke out and back. The NPA SMART sizing software allows for sizing with up to 6 segments.

**3. Selection Flow**

1. Calculations for load condition  
 The chart shown here helps to calculate a load force. The frictional load of the linear guide and the resistance force of the cable carrier ( $F_c$ ) are run friction and treated as load force.  
 For your initial calculations, it is suggested that you use 1/10 the load mass, as the value for Forcer mass ( $M_C$ ).

2. Calculations for required thrust  
 You will need to calculate a thrust value for each section of the motion profile.  
 In these equations, "μ" is the coefficient of friction on the guide. "g" is as the acceleration of gravity. g = 9.81 m/sec<sup>2</sup>. "α" is the angle of incline. For Vertical or incline moves use Fr for against gravity moves and Frd for with gravity moves.

$F_i$	Force (Inertia)	$F_i = (M_L + M_C) * (V / T_a)$
$F_f$	Force (Friction)	$F_f = (M_L + M_C) * g * [\sin(\alpha) + \mu * \cos(\alpha)] + F_r$
$F_{fd}$	Force (Friction) down	$F_{fd} = (M_L + M_C) * g * [\sin(\alpha) + \mu * \cos(\alpha) * -1] + F_r$

F1	acceleration force	$F1 = F_i + F_L + F_r$	inertia force + external force
F2	continuous force	$F2 = F_L + F_r$	load of external force
F3	deceleration force	$F3 = F_i - (F_L + F_r)$	inertia force - external force
F4	dwell force	$F4 = (M_L + M_C) * g * [\sin(\alpha)] + FL$	

3. Temporary selection  
 The largest thrust value calculated in section 2, must be less then peak thrust of the selected Linear Shaft Motor. It is good practice to add 20 to 50% to the peak thrust as a safety margin. Please note that the peak thrust of the Linear Shaft Motor may vary with operation speed.

4. Confirm that  $M_C$  (forcer mass) is smaller than the value used in section 1. If it is larger, please return to section 1 to recalculate using the new  $M_C$  value.

5. Confirm Effective thrust  $F_{eff}$   
 Please confirm that effective force ( $F_{eff}$ ) is less than the continuous rated force (Frated) of the motor plus a safety factor (SF) of 30% to 50%.

6. motor whose the rated force (Frated) is met in the equation.

$$F_{eff} = \frac{\sqrt{(F_1^2 * T_a) + (F_2^2 * T_c) + (F_3^2 * T_d) + (F_4^2 * \{T_s + T_w\})}}{(T_a + T_c + T_d + T_s + T_w)}$$

### Other Useful Formulas

#### Amplifier Sizing

Voltage due to Back EMF	$V_{BEMF} = \text{Back EMF} * \text{Velocity}$
Voltage due to R * I	$V_{ri} = 1.225 * \text{Resistance} * \text{Peak Current}$
Voltage due to Inductance	$V_L = \frac{7.695 * \text{Velocity} * \text{Inductance} * \text{Peak Current}}{\text{Magnetic Pitch}}$
Minimum Bus Voltage needed in application	$V_{bus} = 1.15 * \sqrt{\{ (V_{bemf} + V_{ri})^2 + V_L^2 \}}$
Peak Current (rms value)	$I_{prms} = \text{Peak Current} * 1.2$
Continuous Current (rms value)	$I_{crms} = \text{Continuous Current} * 1.2$

These formulas add a 20% safety margin for current and a 15% safety margin for voltage.

#### Encoder

Encoder Resolution	$E_r = \frac{\text{Scale Pitch}}{(4 * \text{Interpolation})}$
Encoder Output Frequency (A-B Phase)	$E_{OF} = \frac{\text{Velocity} * 10^6}{(4 * \text{Encoder Resolution})}$
Encoder Output Frequency (Sine - Cosine)	$E_{OF} = \frac{\text{Velocity} * 10^6}{\text{Scale Pitch}}$
Encoder Pulses per meter	$E_{Im} = \left( \frac{1}{\text{Encoder Resolution}} \right) / 4$
Encoder Counts per meter	$E_{OF} = \frac{\text{Velocity} * 10^6}{\text{Scale Pitch}}$
Encoder lines per meter	$E_{OF} = \frac{\text{Velocity} * 10^6}{(4 * \text{Encoder Resolution})}$

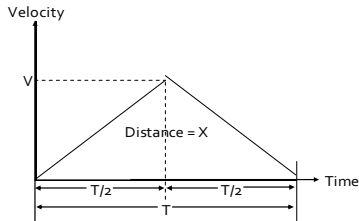
#### Conversions

Units to Convert		Multiply by	Units to Convert		Multiply by
<b>Force</b>					
newton	▶ pound force	0.2248	kilogram	▶ pound	2.2046
newton	▶ gram force	101.97	kilogram	▶ gram	1000
newton	▶ ounce force	3.5969	kilogram	▶ ounce	35.274
pound force	▶ newton	4.4482	pound	▶ kilogram	0.4536
gram force	▶ newton	0.0098	gram	▶ kilogram	0.0010
ounce force	▶ newton	0.2780	ounce	▶ kilogram	0.0283
<b>Length</b>					
mm	▶ inch	0.0394	<b>Velocity</b>		
mm	▶ feet	0.0033	mm/sec	▶ in/sec	0.0394
mm	▶ cm	0.1	m/sec	▶ in/sec	39.370
micron	▶ inch	0.00003937	in/sec	▶ mm/sec	25.4
nanometer	▶ inch	0.0000003937	in/sec	▶ m/sec	0.0254
meter	▶ feet	3.2808	mm/sec	▶ m/sec	0.001
inch	▶ mm	25.4	m/sec	▶ mm/sec	1000
feet	▶ mm	304.8	<b>Acceleration</b>		
cm	▶ mm	10	G	▶ m/sec <sup>2</sup>	9.8067
feet	▶ meter	0.3048	G	▶ mm/sec <sup>2</sup>	9806.7
inch	▶ micron	25400	G	▶ in/sec <sup>2</sup>	386.09
inch	▶ nanometer	25400000	G	▶ foot/sec <sup>2</sup>	32.144
<b>Temperature</b>			m/sec <sup>2</sup>	▶ G	0.1020
°C	▶ °F	*1.8 then +32	mm/sec <sup>2</sup>	▶ G	0.0001
°F	▶ °C	-32 then /1.8	in/sec <sup>2</sup>	▶ G	0.0026
			foot/sec <sup>2</sup>	▶ G	0.0311

### Formulas for three of the most common types of Motion Profiles

#### Triangular Profile 1/2, 1/2

Accelerate to speed and decelerate back to original speed or zero, rest and repeat the process as needed. This is very simple and is common in applications such as pick & place.

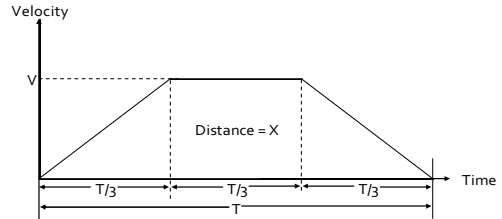


	Have	X (m) T (sec)	V (m/sec) T (sec)	A (m/sec <sup>2</sup> ) T (sec)	A (m/sec <sup>2</sup> ) V (m/sec) X (m)
Solve for					
Distance X (m)			$X = (1/2) * V * T$	$X = (1/4) * A * T^2$	$X = V^2 / A$
Velocity V (m/sec)		$V = 2 * (X/T)$		$V = (A * T) / 2$	$V = \sqrt{A * X}$
Acceleration A (m/sec <sup>2</sup> )		$A = 4 * (X/T^2)$	$A = 2 * (V/T)$		$A = V^2 / X$

#### Trapezoidal Profile

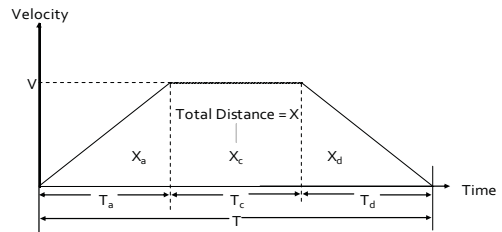
Accelerate to constant speed, travel at that constant speed, and then decelerate back to original speed or zero. This is common in applications such as scanning inspection. There are two types

#### 1/3<sup>rd</sup> Trapezoidal Profile 1/3, 1/3, 1/3



	Have	X (m) T (sec)	V (m/sec) T (sec)	A (m/sec <sup>2</sup> ) T (sec)	A (m/sec <sup>2</sup> ) V (m/sec) X (m)
Solve for					
Distance X (m)			$X = (2/3) * V * T$	$X = (1/4.5) * A * T^2$	$X = 2 * (V^2 / A)$
Velocity V (m/sec)		$V = 1.5 * (X/T)$		$V = (A * T) / 3$	$V = \sqrt{(A * X) / 2}$
Acceleration A (m/sec <sup>2</sup> )		$A = 4.5 * (X/T^2)$	$A = 3 * (V/T)$		$A = 2 * (V^2 / X)$

And the Variable Trapezoidal Profile.



	Have	X <sub>a</sub> (m) T <sub>a</sub> (sec)	V (m/sec) T <sub>a</sub> (sec)	A <sub>a</sub> (m/sec <sup>2</sup> ) T <sub>a</sub> (sec)	A <sub>d</sub> (m/sec <sup>2</sup> ) V (m/sec) X (m)
Solve for					
Distance X <sub>a</sub> (m)			$X = (V * T) / 2$	$X = (A * T^2) / 2$	$X = V^2 / (2 * A)$
Velocity V (m/sec)		$V = (2 * X) / T$		$V = A * T$	$V = \sqrt{(2 * A * X)}$
Acceleration A <sub>a</sub> (m/sec <sup>2</sup> )		$A = (2 * X) / T^2$	$A = V / T$		$A = V^2 / (2 * X)$

These formulas can be used for Acceleration (a) or Deceleration (d) only.

To get total distance traveled use the following formula:

$$X = 1/2 * (V * T_a) + (V * T_c) + 1/2 * (V * T_d)$$

**The Trapezoidal Profile 1/3, 1/3, 1/3 is the most power efficient motion profile for Linear Servo motor applications.**

### Motor Sizing Example

Let's assume we want to move horizontally a mass of 6 kg point to point for a distance of 100 mm (X) in 160 msec including settling time (Tm) to +/- 1 micron. Total travel is 400 mm, and a dwell time of 200 msec is needed after each move.

Item	Symbol	Value	Unit
Load mass	M <sub>L</sub>	7	Kg
Load (thrust) Force	F <sub>L</sub>	0	N
Run (pre-load) Friction	F <sub>r</sub>	20	N
Moving Motor Mass	M <sub>c</sub>	1.9	Kg
Friction coefficient	μ	0.005	
Incline Angle	α	0	°
Available Voltage	V	120	Vac
Available Current	A	7	Arms
Max Allowable temperature		110	°C

### Move profile

We will assume an estimated settling time of 10 msec (Ts).

So the move cycle time (Tc) is 160+200 = 360 msec

Using previous move formula:

$$T \text{ (msec)} = T_m - (T_s)$$

$$T \text{ (msec)} = 160 - 10 = 150 \text{ msec}$$

We will assume an efficient trapezoidal profile (1/3, 1/3, 1/3)

Acceleration needed here (see previous move formula):

$$A = (4.5) \cdot (0.1 \cdot 0.15^2)$$

$$A = 20 \text{ m/sec}^2 \text{ (about } 2 \text{ "g")}$$

$$V = (1.5) \cdot (0.1 / 0.15)$$

$$V = 1 \text{ m/sec}$$

The acceleration and deceleration time becomes (150/3) = 50 msec

The time at constant speed is (150/3) = 50 msec

We can estimate the acceleration force of the load only (see previously mentioned formula) at 2g\*9.81\*6 kg = 117 N.

Based on this we can select S350T (peak force = 592 N, continuous force = 148 N) assuming a coil mounting plate of 1 kg.

Total moving mass: 6 kg (load) + 1 kg (plate) + 1.9 kg (coil mass) = 8.9 kg

Coil resistance 20.2 ohm, Coil Force constant 99 N/A, Thermal Resistance 2.4°C/W, Back EMF 33 V/m/sec,

Inductance p-p 33 mH, Electrical cycle length 120 mm

We assume a good set of linear bearings with μ=0.005 and 20 N of friction.

Item	Symbol	Value	Unit
Stroke	X	100	mm
Velocity	V	1	m/s
Acceleration time	T <sub>a</sub>	0.05	s
Continuous time	T <sub>c</sub>	0.05	s
Deceleration time	T <sub>d</sub>	0.05	s
Settling time	T <sub>s</sub>	0.01	s
Waiting time	T <sub>w</sub>	0.2	s

Friction Force:	F <sub>r</sub> (N) = 8.9*9.81*[sin(0) + 0.005*cos(0)] + 20 = 20.4 N
Inertial Force:	F <sub>i</sub> (N) = 8.9*20 = 178 N
Total Acceleration Force	F <sub>1</sub> (N) = 178 + 20.4 = 198.4 N
Total Constant Velocity Force	F <sub>2</sub> (N) = 20.4 N
Total Deceleration Force	F <sub>3</sub> (N) = 178 - 20.4 = 157.6 N
Total Dwell Force	F <sub>4</sub> (N) = 0 N
RMS Force	F <sub>eff</sub> (N) = √[(198.4 <sup>2</sup> *0.05)+(20.4 <sup>2</sup> *0.025)+(157.6 <sup>2</sup> *0.05)/0.36]
	F <sub>eff</sub> (N) = 94.7 N
RMS Current	I <sub>c</sub> = 94.7/99 = 0.96 Amp rms
Peak Current	I <sub>p</sub> = 198.4/99 = 2 Amp rms
Motor Resistance Hot	R <sub>hot</sub> = 20.2 * 1.423 = 28.7Ω
Voltage due B EMF	V <sub>bemf</sub> = 33 * 1 = 33 Vac
Voltage due I*R	V <sub>ir</sub> = 1.225 * 28.7 * 2 = 70.32 Vac
Voltage due Inductance	V <sub>L</sub> = 7.695 * 1 * 33 * 2 / 120 = 4.23 Vac
Bus Voltage needed	V <sub>bus</sub> = 1.15 * √[(33 + 70.3) <sup>2</sup> + 4.23 <sup>2</sup> ] = 118.8 Vac

More information on Linear shaft motor sizing can be found in the "Linear Shaft Motor sizing Application Note" and accompanying "LSM Sizing Example" excel file.

## APPENDIX C SERVOMOTOR DRIVES

Any three phase brushless servomotor driver can be used to drive the Linear Shaft Motor. There are many different makes and models of servomotor driver available, but the ones listed below have been tested by NPA, The driver manufacture, and or our customers.

When selecting a servomotor driver, always confirm it is compatible with your controller and feed back system. Linear Shaft Motor does not come with Hall Effect sensors in its standard configuration; they will need to be selected as an option if required by your selected driver.

The following Servo Drives which have been *tested and certified* by there respective *manufacturers* to work with the Linear Shaft Motor series of products.

<i>Manufacturer</i>	<i>Model(s)</i>	<i>Hall Required</i>
Elmo Motion Control	BAS, CEL, COR, HAR, TUB, TWE, WHI (All SimplIQ Digital Drives)	NO
Hitachi	AD Series	NO

The following Servo Drives have been *tested* by their respective *manufacturers* to work with the Linear Shaft Motor series of products.

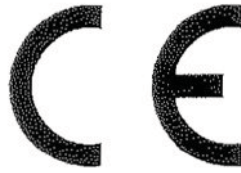
<i>Manufacturer</i>	<i>Model(s)</i>	<i>Hall Required</i>
Advanced Motion Controls (AMC)	DigiFlex® Performance™ series digital drivers (DPC,DPQ, DPR and DZ)	NO
G.E. Fanuc	*contact Fanuc for more information	
Technosoft	IBL2403, IDM240/640, ISCM4805/8005 *contact Technosoft about other drives.	NO
Yaskawa	Sigma FSP, Sigma V* *contact Yaskawa for more information	NO

The following Servo Drives have been *tested by customers* and reported to work with the Linear Shaft Motor series of products.

<i>Manufacturer</i>	<i>Model(s)</i>	<i>Hall Required</i>
Allen-Bradley	Ultra 3000 servo drives	YES
Beckhoff	AX2003-B110-00z	NO
Baldor	Mint, Flex drives	
Delta Tau	P-MAC, U-MAC	NO
Kollmorgen	S200, S300, S600, CD drives	NO
Parker	Compax3	NO
Servoland	SVDM 40P, SVDM 2P, SVDM 5P	NO



## APPENDIX D CE DECLARATION



# CE DECLARATION OF CONFORMITY

We, GMC HILLSTONE CO., LTD., 4466-1, Daimyojin, Tomizawa, Mogami-machi, Mogami-gun, Yamagata 999-6105 Japan, declare in our sole responsibility that the following product conforms to all the relevant provisions.

Product Name : Shaft Motor

Models Covered : S080D followed by D, T or Q  
 S120D followed by D, T or Q  
 S160D followed by D, T or Q  
 S200D followed by T or Q  
 S250D followed by D, T, Q, H or X  
 S320D followed by D, T, Q or X  
 S427D followed by D, T or Q  
 S350P ~

Applicable Standards : EN60034-1 (1998)

Year to begin affixing CE Marking : 2005

Signature: Yoichi Ishiyama  
 Full Name: Yoichi Ishiyama  
 Position: President

Date: 28 December 2005

**APPENDIX E READER'S COMMENTS**



**Linear Shaft Motor Installation and Users Guide  
Item Number 24135 Rev C**

Please answer the questions below and add any suggestions for improving this document.

Is the information:	Yes	NO
Adequate?	_____	_____
Well organized?	_____	_____
Clearly presented?	_____	_____
Well illustrated?	_____	_____
Would you like to see more illustrations?	_____	_____
Would you like to see more text?	_____	_____

How do you use this document in your job? Does it meet your needs?  
What improvements, if any, would you like to see? Please be specific or cite examples.

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Your name : \_\_\_\_\_

Your title : \_\_\_\_\_

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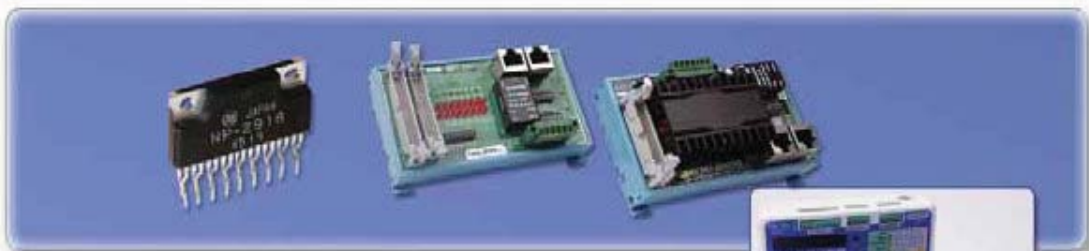
Remove this page from the document and fax or mail your comments to the technical writing department of Nippon Pulse.  
 Nippon Pulse America, Inc.  
 Technical Writing Department  
 4 Corporate Drive  
 Radford, VA 24141-5100 USA  
 Fax Number: 1-540-633-1674

## Nippon Pulse Product Overview

### Actuators



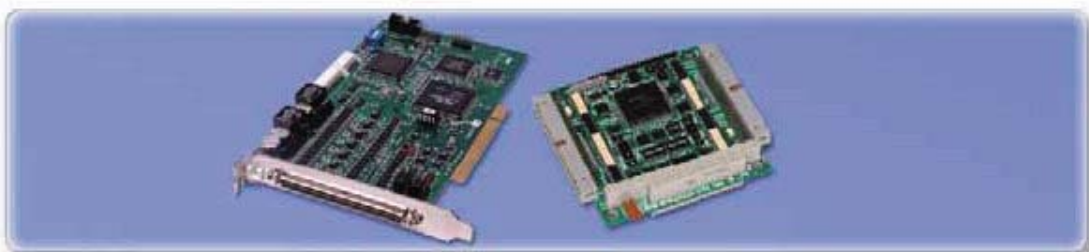
### Drivers



### Controller



### Network



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