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development, production  
and application of  
precision motors

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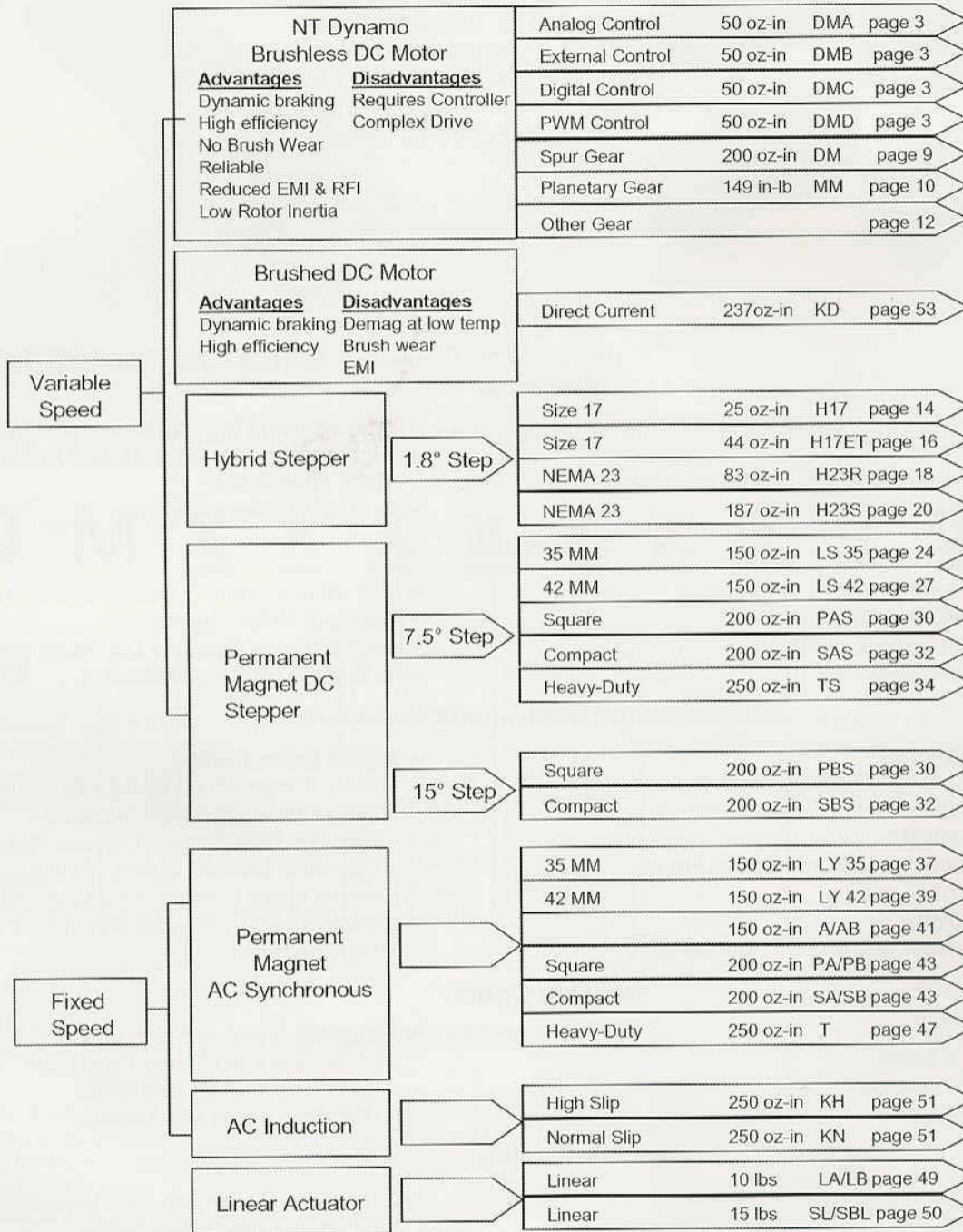


hurst motors and instrument motor controls

  
**hurst**  
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**EMERSON**  
Motor Technologies

	Model	Part Number Sequence	PAGE	BRUSHLESS DC STEPPER	SYNCHRONOUS	LINEAR	AC INDUCTION	BRUSHED DC	CONTROLLER	STEP ANGLE (degrees)	MAX. TORQUE (oz-in)	MAX. RPM
NT Dynamo Brushless DC Overview	DM	DM	2	X						50	6000	
NT Dynamo Brushless DC Selection Guide	DM	DM	3	X				X		50	6000	
NT Dynamo Brushless DC Speed Torque Curves	DM	DM	4	X				X		50	6000	
NT Dynamo Brushless DC Mechanical Features	DM	DM	5	X				X		50	6000	
NT Dynamo Brushless DC Motor Controls	DM	DM	6	X				X				
NT Dynamo Brushless DC Gear Options	DM	DM	8	X				X				
NT Dynamo Brushless DC Spur Gearmotor	DM	DM	9	X				X		200	280	
NT Dynamo Brushless DC Planetary Gearmotor	MM											
	JB											
	SE									149		
	EW	DM	10	X				X		lb-in	675	
Hybrid Stepper Application Notes			13		X							
H17 Series Hybrid Stepper	H17	H17	14		X				1.8	25		
H17ET Series Hybrid Stepper	H17ET	H17ET	16		X				1.8	44		
H23R Series Hybrid Stepper	H23R	H23R	18		X				1.8	83		
H23S Series Hybrid Stepper	H23S	H23S	20		X				1.8	187		
Stepper Motor Application Notes			22		X							
LS 35MM Series Stepper	LS 35	LS 35	24		X				7.5	150		
LS 42MM Series Stepper	LS 42	LS 42	27		X				7.5	150		
P Series Stepper	PAS	3205, 3206, 3229	30		X				7.5	15	200	
	PBS	3207, 3208, 3231										
S Series Stepper	SAS	4003, 4004, 4019	32		X				7.5	15	200	
	SBS	4007, 4008										
T Series Stepper	TS	2605, 2606, 2610	34		X				7.5	250		
Synchronous Motor Application Notes			36		X							
LY 35MM Series Stepper	LY 35	LY 35	37		X					150	300	
LY 42MM Series Stepper	LY 42	LY 42	39		X					150	300	
A Series Synchronous	A	3001, 3002, 3009, 3014	41		X					150	600	
	AB	3005, 3006, 3011, 3013										
P Series Synchronous	PA	3201, 3202, 3228, 3232	43		X					200	600	
	PB	3203, 3204, 3230, 3234										
S Series Synchronous	SA	4001, 4002, 4009, 4017, 4018, 4021	45		X					200	600	
	SB	4005, 4006, 4011										
T Series Synchronous	T	2601, 2602, 2609, 2611	47		X					250	300	
L Series Linear Actuator Stepper	LAS	3602	49			X			7.5	15	10 lb.	
	LBS	3604										
L Series Linear Actuator Synchronous	LA	3601	49			X				10 lb.	.625 in/sec	
	LB	3603										
SL Series Linear Actuator Stepper	SLS	4014	50			X			7.5	15	15 lb.	
	SBLS	4028										
SL Series Linear Actuator Synchronous	SL	4013	50			X				15 lb.	.48 in/sec	
	SBL	4027										
KH & KN AC Induction	KH	2403, 2423, 2433, 2443	51				X			250	1550	
	KN	2462, 2472, 2482, 2492										
KD Brushed DC Motor	KD	3402	53					X		237	500	





- Reliable Brushless DC Performance
- Smooth Precision Motion
- Adjustable Speed
- Integrated Electronic Controls
- Modular Motor & Control Approach
- Encoder Feedback Options
- Gearing Options Available

## Electrical

- Integral Motor Controls Matched to Motor Winding
- 2 or 4 Quadrant Operation
- 10Vdc - 48Vdc Range (depending on motor control)
- Up to 50 oz-in Torque (with no gearing)

- Ultra Smooth Precision Motion Quality
- UL Approved Class B Insulation System
- 100% Final Tested
- Custom Windings Available

## Mechanical

- Long Life Ball Bearing System
- Size 17 or NEMA 23 Mounting Flange
- Neodymium Ring Magnets (not arcs)
- Stainless Steel Shaft

- Over 20,000 Hours of Design Life @ Rated Torque
- Standard 'Molex' Connectors
- Small Package Size with Low Rotor Inertia
- Up to 6000 RPM Operation

## Integral Motor Control and Encoders

- **External Motor Module**
  - For Use with Customer Supplied Motor Control
  - Provides Hall Sensor and/or Encoder Outputs
- **Analog Motor Control**
  - Economical Control via a Simple Speed Pot or a 0 - 5Vdc Control Signal
- **PWM Motor Control**
  - Control via Customer Generated PWM Signal

- **Digital Motor Control**
  - Easily Programmed Using a Computer
  - Programming Software Available
  - Provides User with the Ultimate Flexibility
  - Operating Modes - Speed, Voltage, or Torque
- **External Motor Controls** are also Available
- **Encoders** - 100, 250, 256 with Index Pulse, 400, or 1000 Line Resolution

## Gearing Option

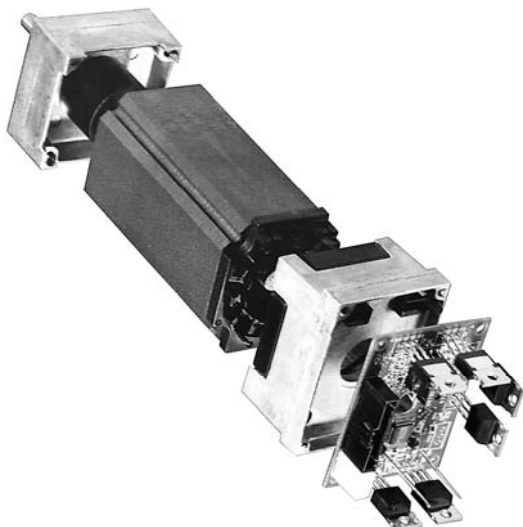
- **Spur**
  - Up to 600:1 Gear Ratio
  - Up to 200 oz-in of Torque
    - AGMA 7 Gear Quality

- **Planetary**
  - Wide Selection of Gear Ratios and Features
  - Inline, Right Angle, and Metric
  - High Torque and Low Backlash

## Reliability

- Over 1.5 Million Hours of Combined Life and Reliability Testing
- In Use at Major OEM's in Demanding Applications

- Our Proven Design can Help Reduce the Test Time Needed to Validate Your Design
- Contact Hurst for Detailed Life and Reliability Data



### Typical Applications

- Office Automation
- Instrumentation
- Medical Equipment
- Pumps
- Variable Speed Feeder Equipment

## Model Selection Guide (for gearmotors see page 8)

To construct a motor part number substitute the appropriate digits for the x's as shown below.

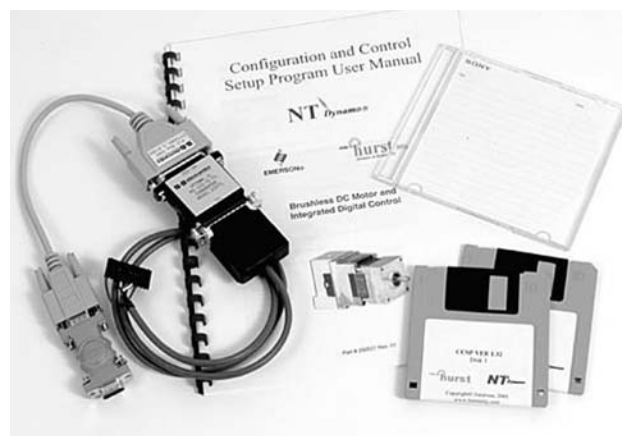
<b>D</b>	<b>M</b>	<b><u>x</u></b>	<b><u>x</u></b>	<b><u>x</u></b>	<b><u>x</u></b>	<b><u>x</u></b>	<b><u>x</u></b>	<b><u>x</u></b>	<b><u>0</u></b>	<b><u>0</u></b>	<b><u>0</u></b>	<b><u>x</u></b>
<b>Control</b> A = Analog* B = External C = Digital D = PWM  * no encoder available	<b>Encoder</b> 0 = None 1 = 100 Line 2 = 250 Line 3 = 400 Line 4 = 1000 Line 5 = 256 Line w/ index*  *use only w/ External Motor Control 'B'	<b>Model</b> Refer to Speed Torque Curves  1 = 5 oz-in 2 = 10 oz-in 3 = 20 oz-in 4 = 30 oz-in 5 = 40 oz-in 6 = 50 oz-in	<b>Voltage</b> 12 = 12V* 24 = 24V 36 = 36V 48 = 48V*  * Cannot use Analog or PWM Motor Control at this voltage	<b>Curve</b> Refer to Speed Torque Curves  A B C D E page 4	<b>Mechanical</b> 1 = Size 17 2 = NEMA 23	<b>Cables</b> 0 = None 1 = Analog 2 = External 3 = Digital 4 = PWM  All 24" long						

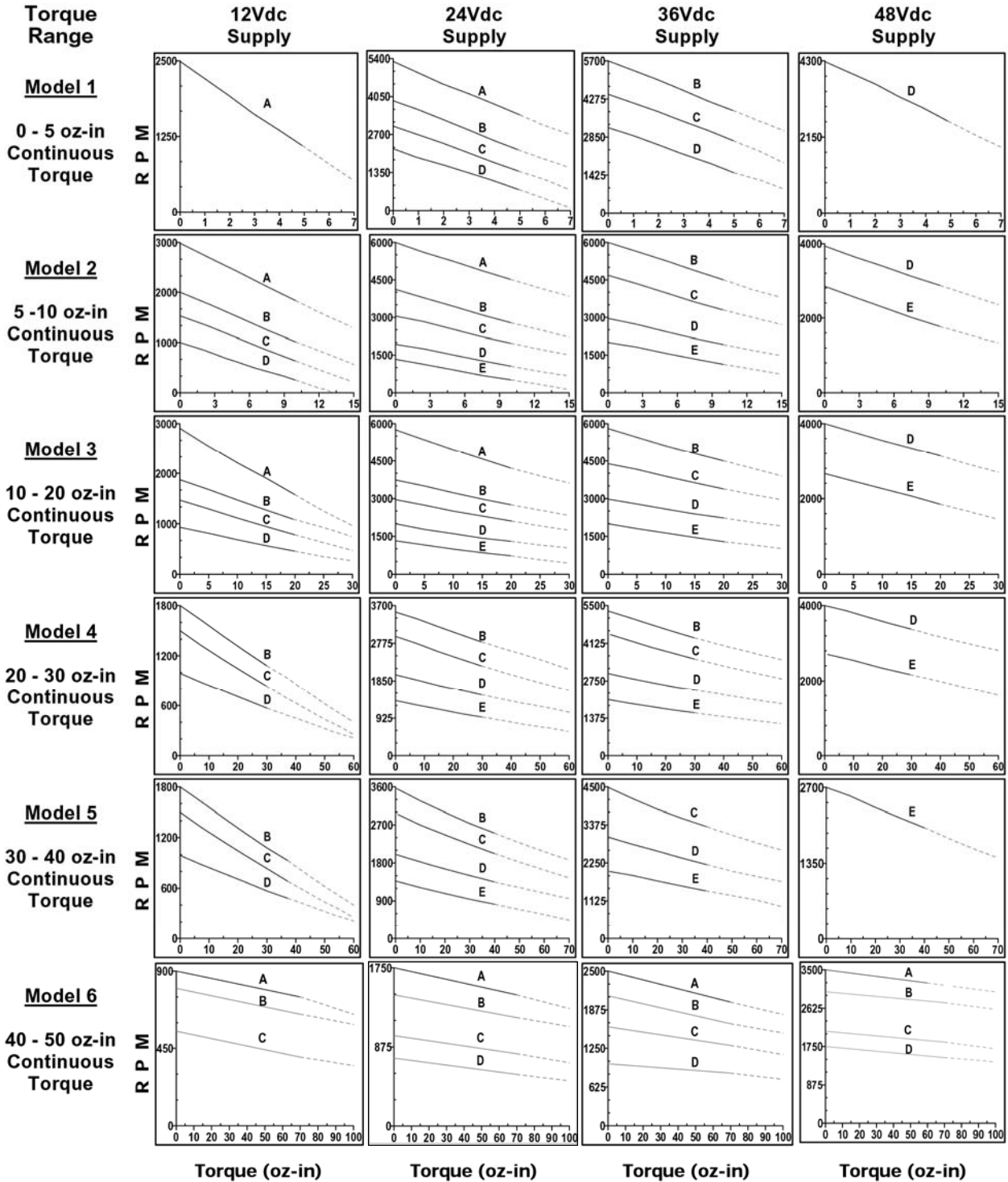
## RS232 Interface Kit and Software

The RS232 Interface Kit and Software package is required to change the factory program settings on the Digital Motor Control or to operate the Dynamo motor using your computer's RS232 port. The RS232 kit includes:

- RS232 to TTL converter
- Converter power supply
- Converter interface cable
- Programming software
- Installation instructions

Hurst Part Number: 120034





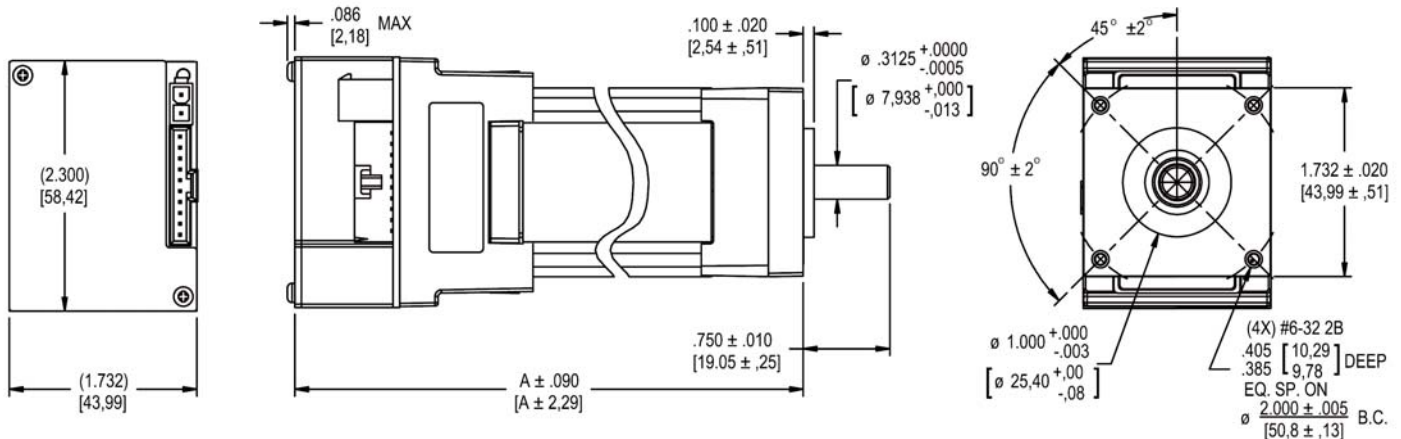
Note:

- Performance data shown is typical. More detailed data is available from Hurst for each of the above ratings. Ambient operating temperature range: 0 - 40°C.
- The solid portion of the diagonal line is continuous duty and the dotted line represents momentary operation.
- At 25°C ambient the max motor winding operating temperature rise is 65°C with motor mounted to a 2.50" x 2.50" x 0.25" aluminum plate.

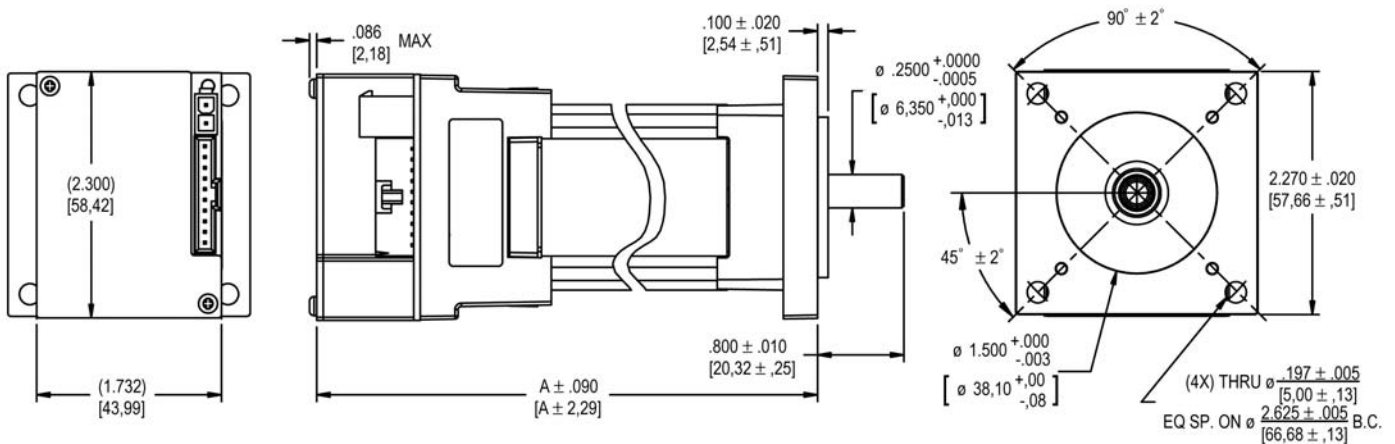
Size 17 and NEMA 23 Non-Geared Dynamo Motor

Model	A Inches [mm] External Control	A Inches [mm] Analog Control	A Inches [mm] PWM Control	A Inches [mm] Digital Control
1	3.18 [80.8]	3.79 [96.3]	3.79 [96.3]	4.13 [104.9]
2	3.43 [87.1]	4.04 [102.6]	4.04 [102.6]	4.38 [111.3]
3	4.18 [106.2]	4.79 [121.7]	4.79 [121.7]	5.13 [130.3]
4, 5, & 6	5.68 [144.3]	6.29 [159.7]	6.29 [159.7]	6.63 [168.4]

## Size 17



## NEMA 23



Note: Above views are shown with Analog control.

## Connection Cabling

- Refer to the Dynamo Model Number Chart for choosing the correct cable
- All standard cables are 24" long
- Flying leads are supplied on customer end
- Cabling includes Control, Power, and Encoder cables
- Custom cables are available upon request



**External** - The External Control Module (commutation board) simplifies the connection of an external motor drive to the Dynamo motor by providing the user with a standard set of hall signals, numerous encoder options, and a high current connector for the motor phase windings. The module is compatible with external motor drives using a 10 to 48Vdc power supply.

The External Control Module provides a standard system for rotor position sensing required by most brushless motor drives. Three hall devices spaced 120 electrical degrees apart, sense a magnetic disk which is synchronized to the rotor of the motor. The hall signals can be used to provide inexpensive speed feedback to the motor drive, or for more precise control a wide array of integral, two channel quadrature encoder options are available. The quadrature nature of an encoder allows the user to determine the direction of motor rotation as well as the speed.

**Analog** - The Analog Open Loop Motor Control converts DC input voltage into three phase waveforms. The control performs 2-quadrant commutation when an analog control signal is supplied. The control is compatible with 20Vdc to 36Vdc power supplies. The flexible customer interface allows for the following input signals:

- Analog (0-5Vdc)
- Contact Closure for Start/ Stop and Fwd/ Rev

Open loop speed control is accomplished by the user supplying a 0-5Vdc analog input or by using the controls 5Vdc output with a potentiometer. Contact closures (PLC's or relays) can be substituted for standard switches. For cost sensitive applications requiring minimal speed feedback a tachometer output can be accessed. The tachometer output is based on the signals from the hall devices used to commutate the motor. The tachometer signal is an open collector output with a 1K ohm resistor in series. The output is 30 pulses per revolution (ppr). The signal pulses low for 300ns minimum, 600ns typical.

**PWM** - The PWM Motor Control converts DC input voltage into three phase waveforms. The control performs 4-quadrant commutation when a PWM control signal is supplied. The control is compatible with 20Vdc to 36Vdc power supplies. The flexible customer interface allows for the following input signals:

- PWM
- Contact Closure for Start/ Stop

Open loop speed control is accomplished by the user supplying a logic level PWM input. Contact closures (PLC's or relays) can be substituted for standard switches. For cost sensitive applications requiring minimal speed feedback a tachometer output can be accessed. The tachometer output is based on the signals from the hall devices used to commutate the motor. The tachometer signal is an open collector output with a 1K ohm resistor in series. The output is 30 pulses per revolution (ppr). The signal pulses low for 300ns minimum, 600ns typical. For applications requiring more precise control a Hurst encoder can be added internally to the control for true closed loop operation.

**Digital** - The ASIC based Digital Motor Control converts DC input voltage into three phase waveforms. The control performs 4-quadrant commutation, thus allowing the motor to produce motoring and generating torque in both directions. Three types of motor operation can be performed with the Digital Control: Torque, Speed, and Voltage. The control is compatible with 10Vdc to 48Vdc power supplies. The flexible customer interface allows for the following control methods:

- PWM
- Analog (0-5Vdc or 0-10Vdc)
- Contact Closure for Start/ Stop and Fwd/ Rev
- Serial Communications via RS232

The control is easily programmed using a computer and the Hurst RS232 interface kit. The program is stored in non-volatile EEPROM. Once you program the control to your needs, Hurst can then provide your future motors with your program pre-installed in the EEPROM. You only program the motor once! Actual operation of the motor can be handled via the computer interface or by using standard switches and voltage signals. For applications requiring more precise control a Hurst encoder can be added internally to the control for true closed loop operation.

Flexible - Reliable - and Affordable.

If more detailed information on the motor controls is needed, please contact Hurst.



	Digital	Analog	PWM	External
<b>Power</b>				
Input Voltage (Vdc)	10 to 48	20 to 36	20 to 36	10 to 48
Hall Input Voltage (Vdc)	Not required	N/A	4.75 to 5.25	4.2 to 24
Encoder Input Voltage (Vdc)	Not required	N/A	Uses Hall Input Voltage	4.75 to 5.25
<b>Encoder Options (# Lines)</b>				
100, 250, 400, 1000	Y	N/A	Y	Y
256 w/index	N	N/A	N	Y
<b>Inputs</b>				
Analog (0-5Vdc)	Y	Y	N	N
Analog (0-10Vdc)	Y	N	N	N
PWM	Y	N	Y	N
Serial	Y	N	N	N
External Control Needed	N	N	N	Y
<b>Connectors &amp; Terminals (Mating)</b>				
Power (Molex brand)	39-01-2020, 39-00-0039	39-01-2020, 39-00-0039	39-01-2020, 39-00-0039	39-01-2040, 39-00-0039
Control/Hall (Molex brand)	50-57-9412, 16-02-0103	50-57-9410, 16-02-0103	50-57-9410, 16-02-0103	50-57-9408, 16-02-0103
Encoder (FCI brand)				65846-016, 48236-000
<b>Pin Configurations</b>				
	Connector/ Pin #	Function	Connector/ Pin #	Function
Power	1	Vs	1	Vs
	2	Vs <sub>(RTN)</sub>	2	Vs <sub>(RTN)</sub>
Control	1	+5V Output*	1	Tach Signal
	2	0-5V Input	2	0-5V Input
	3	0-10V Input	3	N/A
	4	Return	4	N/A
	5	Encoder B	5	N/A
	6	Encoder A	6	N/A
	7	Data Out**	7	Fwd/Rev
	8	Data In**	8	Run/Stop
	9	Run/Stop	9	+5V <sub>(RTN)</sub>
	10	Fwd/Rev	10	+5V Output*
	11	PWM Input		
	12	Fault Output		
	1	Vs	1	Vs
	2	Vs <sub>(RTN)</sub>	2	Vs <sub>(RTN)</sub>
	1	N/A	1	N/A
	2	N/A	2	N/A
	3	N/A	3	N/A
	4	Encoder B	4	Encoder B
	5	Encoder A	5	Encoder A
	6	N/A	6	N/A
	7	PWM Input	7	PWM Input
	8	Run/Stop	8	Run/Stop
	9	+5V <sub>(RTN)</sub>	9	+5V <sub>(RTN)</sub>
	10	+5Vs	10	+5Vs
Hall	1	Vs	1	Vs
	2	Vs <sub>(RTN)</sub>	2	Vs <sub>(RTN)</sub>
	3	Hall S2	3	Hall S2
	4	Hall S1	4	Hall S1
	5	Hall S3	5	Hall S3
	6	N/A	6	N/A
	7	N/A	7	N/A
	8	N/A	8	N/A
Encoder	1	+5Vs	1	+5Vs
	2	Encoder A	2	Encoder A
	3	Encoder B	3	Encoder B
	4	Encoder Index	4	Encoder Index
	5	+5V <sub>(RTN)</sub>	5	+5V <sub>(RTN)</sub>
	6	Encoder /A	6	Encoder /A
	7	Encoder /B	7	Encoder /B
	8	Encoder /Index	8	Encoder /Index

\*This output is not to be used for powering other circuitry.  
 It is intended for use with a potentiometer  
 (1k ohm minimum, 10k ohm recommended) for speed input only.  
 \*\* Used for RS232 serial communication

Hurst will assist you in the selection of the best gearhead solution for your application. Some factors to consider in maximizing your application system's performance:

Torque Multiplication  
Radial Loading

Speed Reduction  
Axial Loading

Inertia Matching  
Noise

**Spur** gearheads will suit most needs in relatively low-torque applications. However, spur configurations have higher backlash and are usually less efficient than planetary types of similar construction. For constant velocity and unidirectional applications where backlash is less of a concern, spur gearheads are ideal.

**Planetary** gearheads are generally specified for their high rated torque and high input speed. Planetary gearheads are more robust with higher accuracy, lower backlash and longer life than spur gearheads. They are well suited for higher load applications in small packages ranging from nut runners and nut setters to small medical tools, pumps, and other devices.

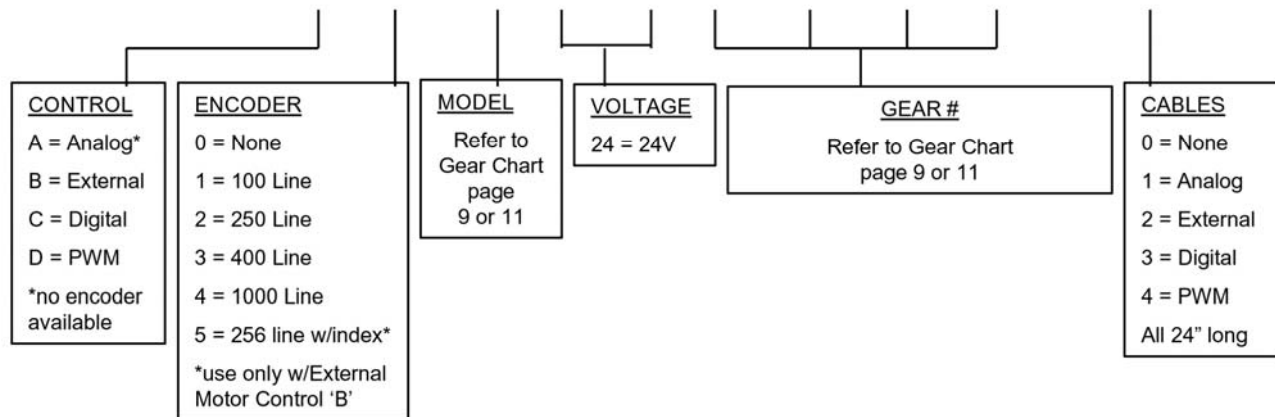
The gearhead solution (Spur Vs. Planetary) is primarily dependent upon the application. Some factors to be considered in making proper trade-offs between cost and performance are shown below.

DESIGN FACTORS	GEARHEAD TYPE	
	SPUR	PLANETARY
Torque Capacity	Lower	Higher
Power to Weight Ratio	Lower	Higher
Power to Size Ratio	Lower	Higher
Torsional Stiffness	Lower	Higher
Backlash	Higher	Lower
Available Number of Gear Ratios	Higher	Lower
Operating Speed	Lower	Higher
Size	Larger	Smaller
Cost	Lower	Higher

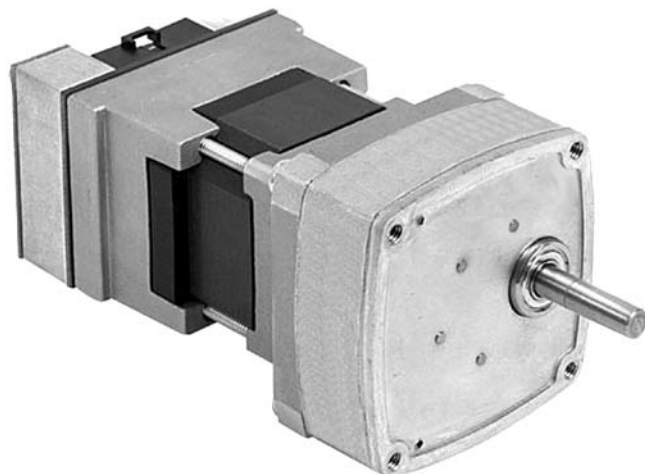
## Gearmotor Selection Guide (for non-gearmotors see previous sections)

To construct a gearmotor part number substitute the appropriate digits for the **x**'s as shown below.

**D M x x x 2 4 x x x x 0 x**

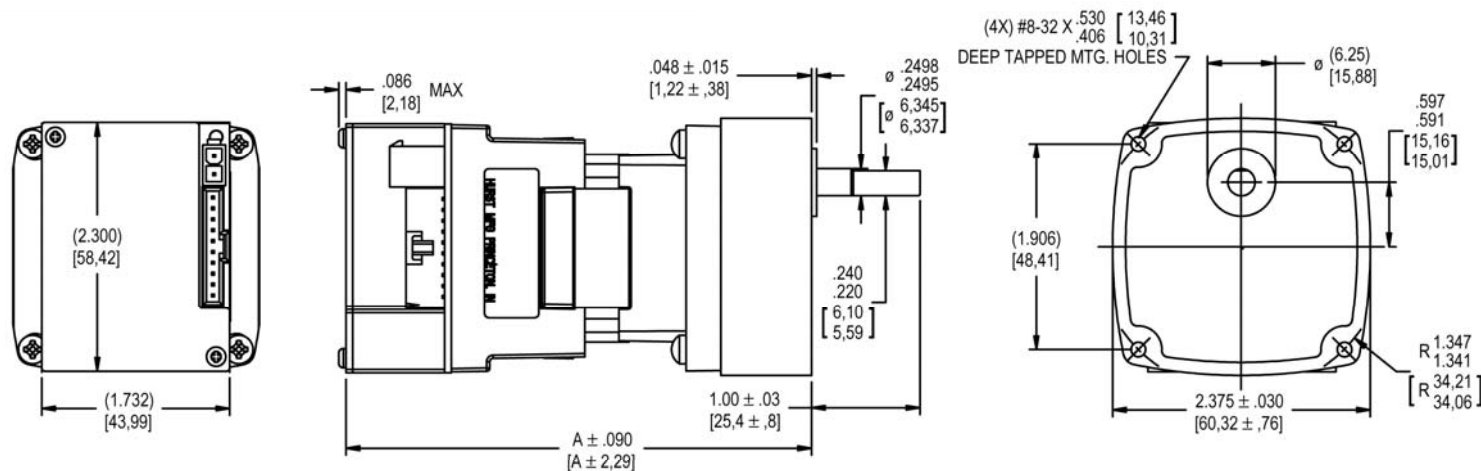


# Brushless DC with Spur Gear



## Features

- Torque Ratings up to 200 oz-in
- Gear Ratios to 600:1
- 24Vdc Standard - For Other Voltages Consult Factory
- Available with Integral 'External', PWM, Analog, and Digital Motor Controls
- Ball Bearing Design
- All Gears and Pinions are Hobbed to AGMA 7 Quality
- Pinions are Extruded from a Special Steel with a Modified Long Addendum Tooth Form to Provide Higher Strength
- Extremely Compact Design
- Both Pinion and Gear Teeth are Case Hardened for Wear Resistance and Rotate on Hardened and Ground Steel Studs



Note: Above views are shown with Analog control.

CONTROLLER TYPE		RATED TORQUE @ 24VDC	RATED CURRENT @ 24VDC	GEAR RATIO	GEAR STAGE	MAX. RADIAL LOAD (LB)	MAX. AXIAL LOAD (LB)	WT. (LB)	LENGTH "A" INCHES [mm]				PART NUMBER	
-DIGITAL -PWM -EXTERNAL (w/100 LINE ENCODER)	-DIGITAL -ANALOG -PWM -EXTERNAL (w/o ENCODER)								EXTERNAL CONTROL	ANALOG CONTROL	PWM CONTROL	DIGITAL CONTROL	MODEL #	GEAR #
5.6 to 280	93 to 280	15	0.35	2:1	2	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG00
		75	1.4						2.9	6.52 [165.6]	7.12 [180.8]	7.12 [180.8]	7.46 [189.5]	6
2.2 to 112	37 to 112	38	0.35	5:1	2	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG01
		188	1.4						2.9	6.52 [165.6]	7.12 [180.8]	7.12 [180.8]	7.46 [189.5]	6
1.1 to 56	18 to 56	75	0.35	10:1	2	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG02
		200 (1)	1.4						2.9	6.52 [165.6]	7.12 [180.8]	7.12 [180.8]	7.46 [189.5]	6
0.4 to 18	6.2 to 18	200 (1)	0.35	30:1	3	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG03
0.2 to 9.3	3.1 to 9.3	200 (1)	0.35	60:1	3	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG04
0.1 to 5.6	1.8 to 5.6	200 (1)	0.35	100:1	4	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG05
0.04 to 1.8	0.6 to 1.8	200 (1)	0.35	300:1	5	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG06
0.02 to 0.9	0.3 to 0.9	200 (1)	0.35	600:1	5	7	5	1.6	4.27 [108.4]	4.87 [123.7]	4.87 [123.7]	5.21 [132.3]	0	EG07

- Note:
- 1) Motor rated torque will exceed the 200 oz-in maximum geartrain rating. If this service is anticipated, a current limiting device should be used.
- All values are at nominal rated input voltage.
  - Ambient temperature range: 0 - 40°C.
  - At 25°C ambient, the max motor winding operating temperature rise is 65°C with gearmotor mounted to a 2.50" x 2.50" x 0.25" aluminum plate.
  - Performance data shown is typical. More detailed data is available from Hurst for each of the above ratings.

Contact Hurst for other gear ratios & voltages (10Vdc to 48Vdc).

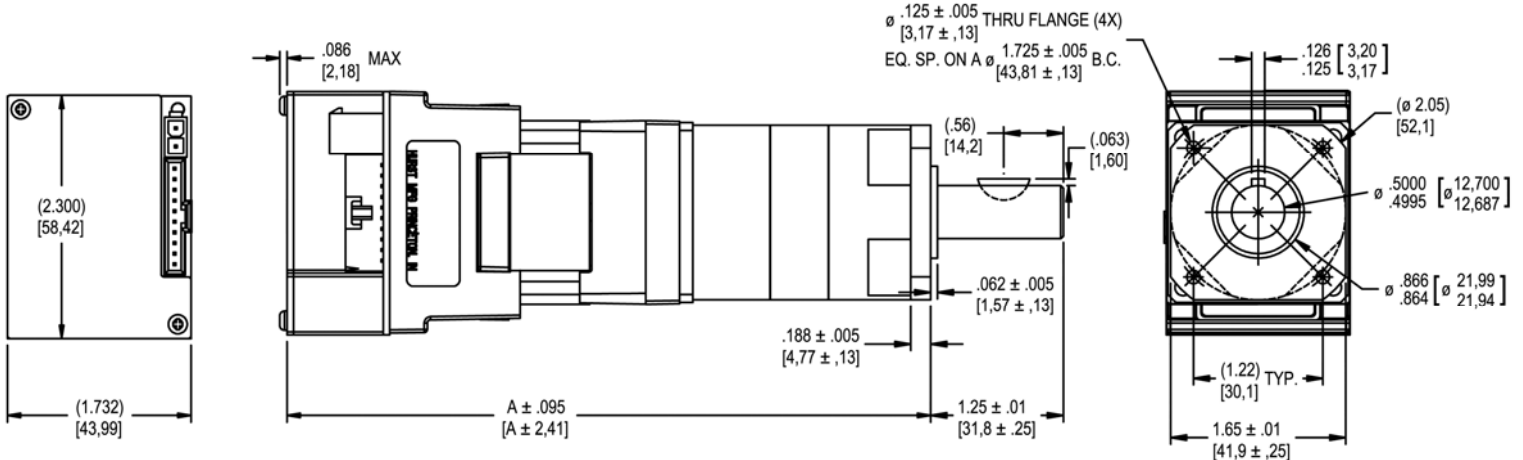
# Brushless DC Planetary Gearmotor

## MM Series – High Performance

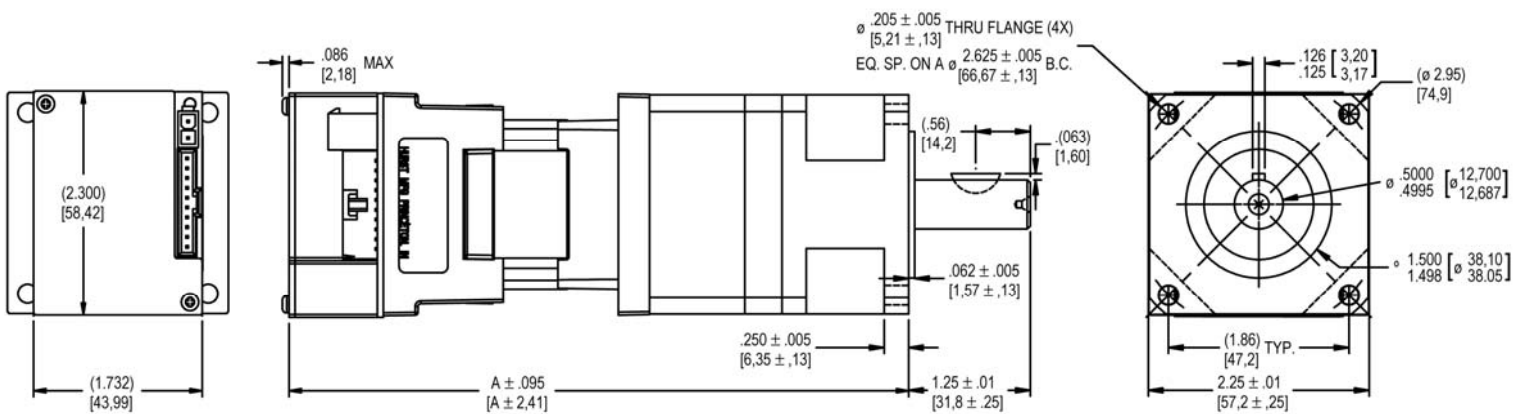
- True Planetary Design
- Integrated Design
  - Motor, Gearhead and Motor Control in One Compact Package
  - Eliminates Extra Parts
  - Improves Reliability and System Performance
- Lowest Backlash Design...Less than 10 Arc. Min.
- Strong, Caged Roller Bearings
- High Shaft Loading Capacity
- High Efficiency Over 90%
- High Torque
- Viton O-Ring Sealed at Each Joint
- Sealed Ball Bearings
- All Gears are Heat Treated
- NEMA Mounting Standards



### Size 17



### NEMA 23



Note: Above views are shown with Analog control.

# Brushless Planetary Gear Table



	CONTROLLER TYPE		RATED TORQUE @ 24Vdc	RATED AMPS @ 24Vdc	GEAR RATIO	GEAR STAGE	GEAR HEAD INERTIA (OZ-IN-SEC <sup>2</sup> )	GEARHEAD BACKLASH (STD/LOW)	WT. (LB)	LENGTH "A" INCHES [mm]				PART NUMBER	
	DIGITAL PWM EXTERNAL	DIGITAL ANALOG PWM EXTERNAL								EXTERNAL CONTROL	ANALOG CONTROL	PWM CONTROL	DIGITAL CONTROL	See instructions at beginning of gear section to establish Model number	
	W/ 100 LINE ENCODER	WITHOUT ENCODER	(LB-IN)	(AMPS)			(ARC-MIN)						MODEL #	GEAR #	
Size 17	13.5 to 675	225 to 675	1.7 6.8	1 3.6	3:1	Single	3.83E-04	6/3	2.1	5.89 [149.6]	6.49 [164.8]	6.49 [164.8]	6.83 [173.5]	0	BP10
						Single	3.83E-04	6/3	3.4	8.14 [206.7]	8.74 [222.0]	8.74 [222.0]	9.08 [230.6]	4	CP10
	10 to 506	168 to 506	2.3 9	1 3.6	4:1	Single	2.41E-04	6/3	2.1	5.89 [149.6]	6.49 [164.8]	6.49 [164.8]	6.83 [173.5]	0	BP11
						Single	2.41E-04	6/3	3.4	8.14 [206.7]	8.74 [222.0]	8.74 [222.0]	9.08 [230.6]	4	CP11
	7 to 368	122 to 368	3.1 12	1 3.6	5.5:1	Single	1.76E-04	6/3	2.1	5.89 [149.6]	6.49 [164.8]	6.49 [164.8]	6.83 [173.5]	0	BP12
						Single	1.76E-04	6/3	3.4	8.14 [206.7]	8.74 [222.0]	8.74 [222.0]	9.08 [230.6]	4	CP12
	6 to 289	96 to 289	3.9 16	1 3.6	7:1	Single	1.51E-04	6/3	2.1	5.89 [149.6]	6.49 [164.8]	6.49 [164.8]	6.83 [173.5]	0	BP13
						Single	1.51E-04	6/3	3.4	8.14 [206.7]	8.74 [222.0]	8.74 [222.0]	9.08 [230.6]	4	CP13
	4 to 202	67 to 202	5.6 23	1 3.6	10:1	Single	1.54E-04	6/3	2.1	5.89 [149.6]	6.49 [164.8]	6.49 [164.8]	6.83 [173.5]	0	BP14
						Single	1.54E-04	6/3	3.4	8.14 [206.7]	8.74 [222.0]	8.74 [222.0]	9.08 [230.6]	4	CP14
	2.5 to 127	42 to 127	8.5 34	1 3.6	16:1	Double	2.22E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP15
						Double	2.22E-04	10/5	4	8.63 [219.2]	9.23 [234.4]	9.23 [234.4]	9.57 [243.1]	4	CP15
	2 to 92	31 to 92	12 47	1 3.6	22:1	Double	1.73E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP16
					Double	1.73E-04	10/5	4	8.63 [219.2]	9.23 [234.4]	9.23 [234.4]	9.57 [243.1]	4	CP16	
1.4 to 72	24 to 72	15 60	1 3.6	28:1	Double	1.50E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP17	
					Double	1.50E-04	10/5	4	8.63 [219.2]	9.23 [234.4]	9.23 [234.4]	9.57 [243.1]	4	CP17	
1 to 51	17 to 51	21 85	1 3.6	40:1	Double	1.32E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP18	
					Double	1.32E-04	10/5	4	8.63 [219.2]	9.23 [234.4]	9.23 [234.4]	9.57 [243.1]	4	CP18	
0.7 to 37	12 to 37	29 117 (1)	1 3.6	55:1	Double	1.31E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP1A	
					Double	1.31E-04	10/5	4	8.63 [219.2]	9.23 [234.4]	9.23 [234.4]	9.57 [243.1]	4	CP1A	
0.6 to 29	10 to 29	37 128 (1)	1 3.6	70:1	Double	1.30E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP1B	
					Double	1.30E-04	10/5	4	8.63 [219.2]	9.23 [234.4]	9.23 [234.4]	9.57 [243.1]	4	CP1B	
0.4 to 20	6.7 to 20	52 (1)	1	100:1	Double	1.30E-04	10/5	2.7	6.38 [162.0]	6.98 [177.3]	6.98 [177.3]	7.32 [185.9]	0	BP1C	
NEMA 23	13.5 to 675	225 to 675	1.7 6.8	1 3.6	3:1	Single	1.68E-03	6/3	3.2	6.07 [154.2]	6.68 [169.7]	6.68 [169.7]	7.02 [178.3]	0	BP20
						Single	1.68E-03	6/3	4.5	8.32 [211.3]	8.93 [226.8]	8.93 [226.8]	9.27 [235.4]	4	CP20
	10 to 506	168 to 506	2.3 101	1 3.6	4:1	Single	1.27E-03	6/3	3.2	6.07 [154.2]	6.68 [169.7]	6.68 [169.7]	7.02 [178.3]	0	BP21
						Single	1.27E-03	6/3	4.5	8.32 [211.3]	8.93 [226.8]	8.93 [226.8]	9.27 [235.4]	4	CP21
	7 to 368	122 to 368	3.1 12	1 3.6	5.5:1	Single	1.08E-03	6/3	3.2	6.07 [154.2]	6.68 [169.7]	6.68 [169.7]	7.02 [178.3]	0	BP22
						Single	1.08E-03	6/3	4.5	8.32 [211.3]	8.93 [226.8]	8.93 [226.8]	9.27 [235.4]	4	CP22
	6 to 289	96 to 289	3.9 16	1 3.6	7:1	Single	1.01E-03	6/3	3.2	6.07 [154.2]	6.68 [169.7]	6.68 [169.7]	7.02 [178.3]	0	BP23
						Single	1.01E-03	6/3	4.5	8.32 [211.3]	8.93 [226.8]	8.93 [226.8]	9.27 [235.4]	4	CP23
	4 to 202	67 to 202	5.6 23	1 3.6	10:1	Single	9.50E-04	6/3	3.2	6.07 [154.2]	6.68 [169.7]	6.68 [169.7]	7.02 [178.3]	0	BP24
						Single	9.50E-04	6/3	4.5	8.32 [211.3]	8.93 [226.8]	8.93 [226.8]	9.27 [235.4]	4	CP24
	2.5 to 127	42 to 127	8.5 34	1 3.6	16:1	Double	1.28E-03	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP25
						Double	1.28E-03	10/5	5.5	9.14 [232.2]	9.75 [247.6]	9.75 [247.6]	10.1 [256.3]	4	CP25
	2 to 92	31 to 92	12 47	1 3.6	22:1	Double	1.09E-03	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP26
					Double	1.09E-03	10/5	5.5	9.14 [232.2]	9.75 [247.6]	9.75 [247.6]	10.1 [256.3]	4	CP26	
1.4 to 72	24 to 72	15 60	1 3.6	28:1	Double	1.01E-03	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP27	
					Double	1.01E-03	10/5	5.5	9.14 [232.2]	9.75 [247.6]	9.75 [247.6]	10.1 [256.3]	4	CP27	
1 to 51	17 to 51	21 85	1 3.6	40:1	Double	9.53E-04	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP28	
					Double	9.53E-04	10/5	5.5	9.14 [232.2]	9.75 [247.6]	9.75 [247.6]	10.1 [256.3]	4	CP28	
0.7 to 37	12 to 37	29 117	1 3.6	55:1	Double	9.51E-04	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP2A	
					Double	9.51E-04	10/5	5.5	9.14 [232.2]	9.75 [247.6]	9.75 [247.6]	10.1 [256.3]	4	CP2A	
0.6 to 29	10 to 29	37 149	1 3.6	70:1	Double	9.50E-04	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP2B	
					Double	9.50E-04	10/5	5.5	9.14 [232.2]	9.75 [247.6]	9.75 [247.6]	10.1 [256.3]	4	CP2B	
0.4 to 20	6.7 to 20	53	1	100:1	Double	9.49E-04	10/5	4.2	6.89 [175.0]	7.50 [190.5]	7.50 [190.5]	7.84 [199.1]	0	BP2C	

Note: 1) Motor rated torque can exceed indicated maximum gearhead rating. If this service is anticipated a current limiting device should be used.

- All values are at nominal rated input voltage.
- Ambient temperature range: 0 - 40°C.
- At 25°C ambient, the max motor winding operating temperature rise is 65°C with gearmotor mounted to a 2.50" x 2.50" x 0.25" aluminum plate.
- Performance data shown is typical. More detailed data is available from Hurst for each of the above ratings.

Contact Hurst for other gear ratios & voltages (10 to 48Vdc).



## JB Series - Moderate Performance Inline Planetary

- True planetary design
- Low backlash design
- Strong, caged roller bearings
- Sealed ball bearings
- All gears are heat treated
- NEMA mounting standards



## SE Series - High Performance Metric Inline Planetary

- Metric and NEMA mounting available
- True planetary design
- High radial and axial shaft loading capacity
- Low start-up torque
- High torque capability
- Popular metric output shaft and front bracket design
- Low backlash design



## EW Series - Precision Right Angle Planetary

- True planetary design
- Tapered roller bearings
- Low backlash design
- Strong, caged roller bearings
- High shaft loading capacity
- Case hardened spiral bevel gears
- Sealed ball bearings
- All gears are heat treated
- NEMA mounting standards

## Stepper Motor

The term, hybrid, is due to the motor being operated under the combined principles of permanent magnet and variable reluctance. The most popular step angle for the hybrid stepping motor is 1.8 degrees, or 200 steps per revolution.

The Hybrid Stepper is the motor solution for precision movements or higher speed applications in factory and office automation.

### Hybrid Stepping Motor Mechanical Construction

The construction of a hybrid stepper motor is characterized by having a coil, multi-toothed stator and rotor poles with a permanent magnet. This construction offers small step angle, sufficient torque and speed.

A 200 step per revolution (1.8°) step motor with 2 phases “on” (4 phase instant) has 50 rotor teeth on each rotor yoke. These are referred to as poles. The stator has 8 poles. A phase state in a motor with permanent magnets is considered a single polarity current or voltage. A cycle is considered a positive and negative current or voltage.

These motors are usually wound with a bifilar winding, this makes it possible to drive a motor from a single polarity voltage without using reversing switches or transistors to reverse the current to the motor windings. Each of the poles has 2 windings and is mistakenly called a 4 phase motor because of this. If the motor is driven from a bipolar drive or ac power source only 1 winding per pole is required.

### Advantages of Hybrid Stepper Motor

- Higher Torques than variable reluctance and permanent magnet step motors
- Allows for small step angles (higher rps)
- Highly Accurate - step angle error is small and non-cumulative

### Driving System of Hybrid Stepping Motor

The DC power supply is switched to each phase in sequence to operate a stepping motor. Ordinary DC or AC power supplies will not run a stepping motor unless the driving circuit includes a switching circuit. The signal circuit is used to generate pulses, change or stop frequencies and to generate reversing signals. The logic circuit distributes signal pulses to each wire according to the number of phases and the excitation method.

### Stepper Drives

#### Unipolar Drives

Motor phase winding current is switched in only one direction (typically to ground).

- Simple low cost drive circuit
- Requires a center tap winding
- Lower output Torque
- 6 & 8 lead motors

#### Bipolar Drives

Motor phase winding current is switched in both directions

- Higher cost drive circuit
- No center tap winding required
- Higher output torque
  - Approx 1.4 X Unipolar Drive
- 4, 6 & 8 lead motors
- 8 Lead motors are more efficient when used with a bi-polar drive

### Stepping Methods

#### Full/Half Stepping

Steps the motor by alternating phase windings in fully on or fully off mode

- Full Stepping (1 Phase)
  - Energize 1 phase at the same time
  - 1 Phase stepping uses half the power devices as 2 phase stepping
- Full Stepping
  - Energize 2 phases at the same time
  - Rotor step is function of motor pole count
- Half Stepping
  - Sequences 2 phases “on” and “off”
  - Rotor step 1/2 of full step value
  - 5-10% less torque than with full step control

#### Microstep Stepping

Gradually energizes a phase to create smaller subdivisions of each full-step.

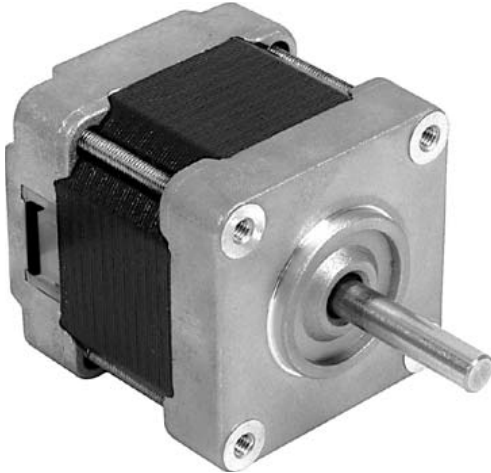
- Requires sophisticated control electronics
- Resonance speeds become an issue
- 20-30% less torque than with full step
- Motor design becomes significant

### Sequencing Charts

Full Step (1 Phase)				
CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On			
1		On		
2			On	
3				On
4	On			

Full Step (2 Phase)				
CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On	On		
1		On	On	
2			On	On
3	On			On
4	On	On		

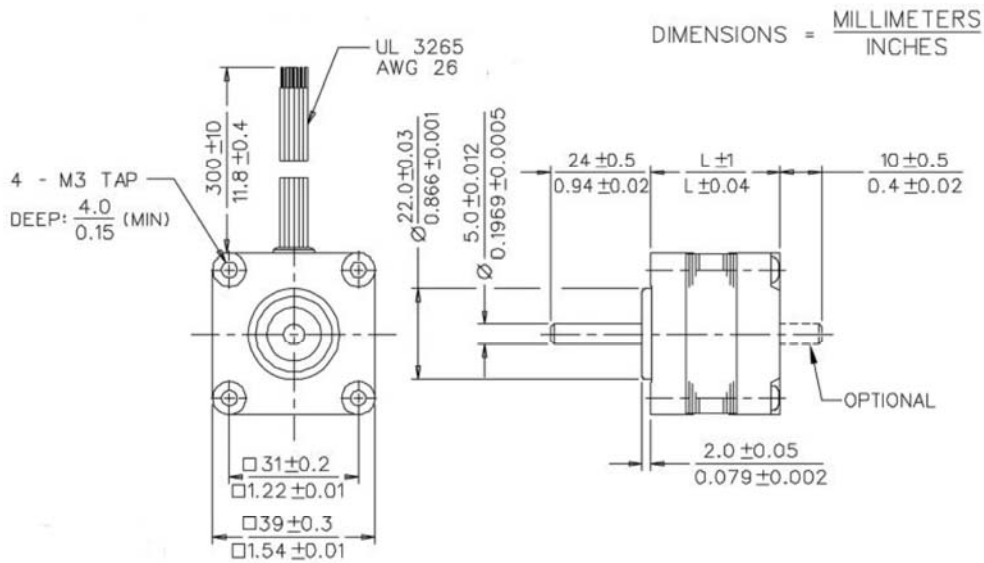
Half Step (2 Phase)				
CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On	On		
1		On		
2		On	On	
3			On	
4			On	On
5				On
6	On			On
7	On			
8	On	On		



## H17 Specifications

Mounting Flange:	NEMA17
Step angle:	1.8°
Positional Accuracy:	± 5% max.
Number of Phases:	2 or 4 (4 Phase standard)
Temperature Rise:	70 °C max
Insulation Resistance:	100M ohms at 500VDC for 1 minute
Dielectric Strength:	500VAC for 1 minute
Insulation Class:	Class B
Number of lead wires:	6 lead uni-polar, bi-polar upon request
Lead wire:	UL3265 AWG#26
Operation Ambient Temp:	-10°C ~ +50°C
Radial Play:	0.03 mm max at 0.4 kg load
Axial Play:	0.08 mm max at 0.5 kg load

## H17 Dimensions

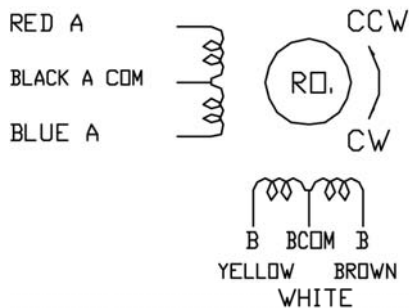


## H17 Hybrid Options

Example:            H                    17                    032                    4                    34

	Motor Family	Frame Size	Phase Voltage	Phase	Length
Options	Hybrid Stepper	17=17mm	032=3.2VDC	4=4 Phase Unipolar	31=31mm
			040=4.0VDC	2=2 Phase Bi-polar	34=34mm
			045=4.5VDC		40=40mm
			120=12.0VDC		

## H17 Wiring Diagram



Full Step (2 Phase)				
CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On	On		
1		On	On	
2			On	On
3	On			On
4	On	On		



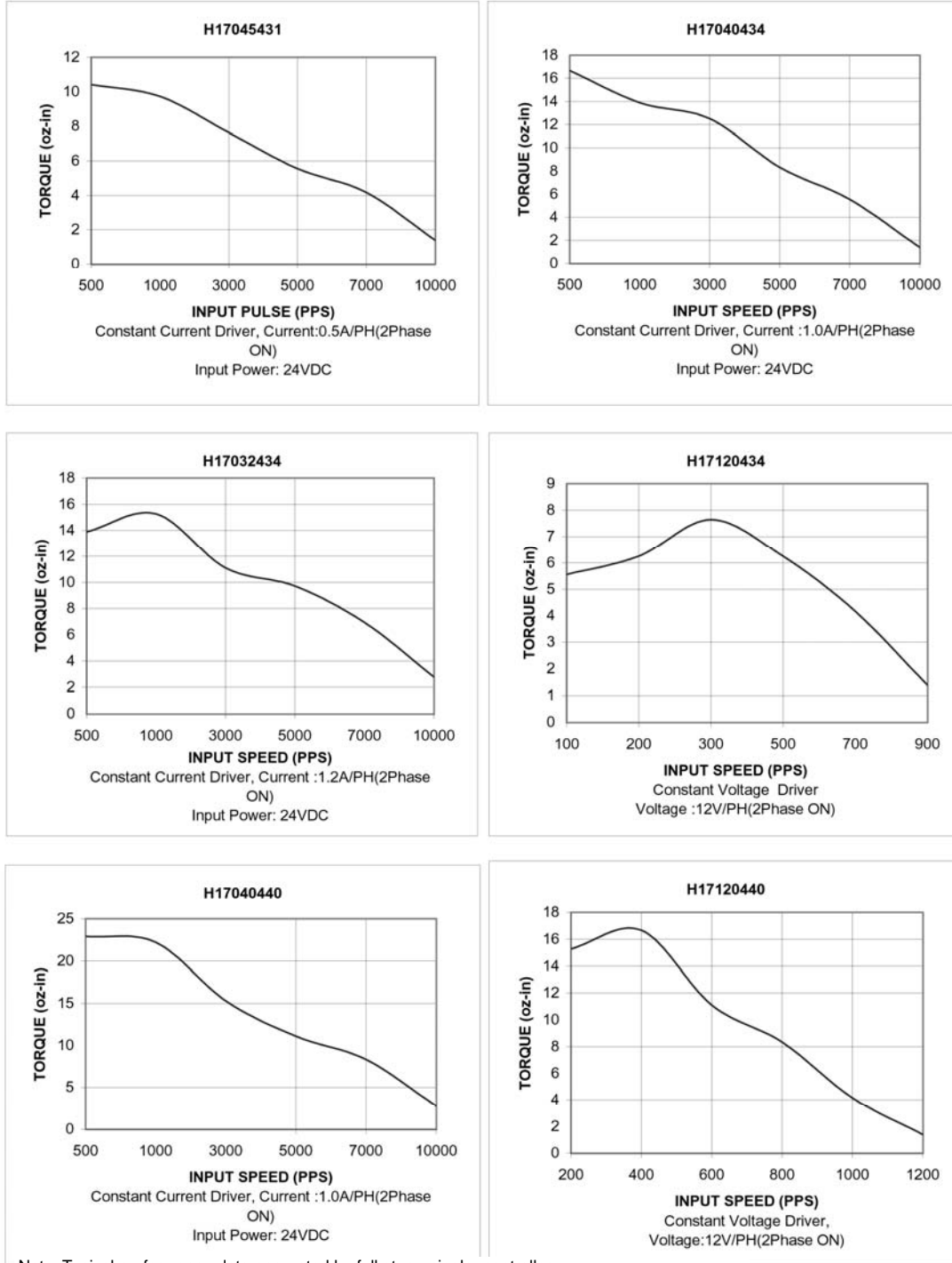
# Hybrid Stepper Series



## H17 Motor Specifications Table

Hurst Part-Number	Voltage DC	Resistance Ohms	Inductance mH/phase	Current A/Phase	Total Watts Input (W)	Detent Torque gf-cm (oz-in)	Holding Torque Kgf-cm (oz-in)	Rotor Inertia g-cm <sup>2</sup> (oz-in <sup>2</sup> )	Weight g (oz)	Length-L mm (in)
H17045431	4.5	9.0	6.0	0.50	4.5	70 (1.0)	1.0 (13.9)	16 (0.087)	180 (6.3)	31 (1.22)
H17120434	12	75.0	85.0	0.16	3.84	90 (1.25)	1.1 (15.3)	20 (0.109)	200 (7.0)	34 (1.34)
H17040434	4	4.0	4.2	1.00	8.0					
H17032434	3.2	2.7	2.3	1.20	7.68					
H17120440	12	30.0	33.0	0.40	9.6	100 (1.39)	1.8 (25.0)	30 (0.164)	250 (8.8)	40 (1.575)
H17040440	4	4.0	3.7	1.00	8.0					

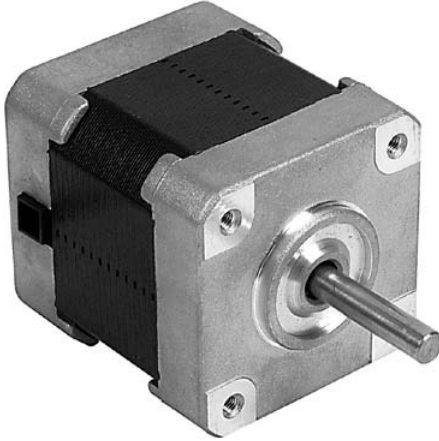
## H17 Typical Performance Curves



Note: Typical performance data generated by full step unipolar controller

Contact Hurst at 812-385-2564 or Fax: 812-386-7504 [www.hurstmfg.com](http://www.hurstmfg.com)

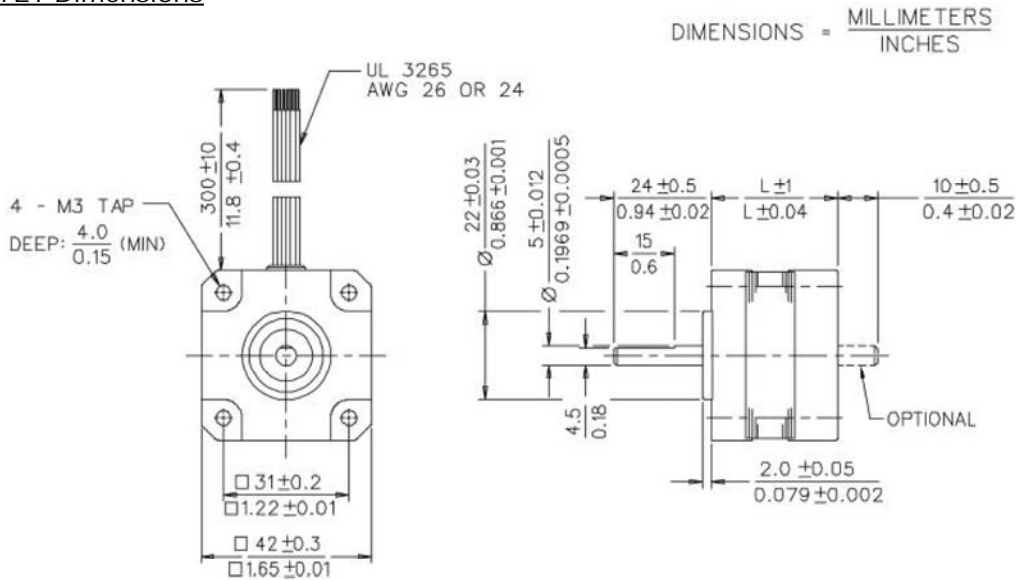




## H17ET Specifications

Mounting Flange:	NEMA17
Step angle:	1.8°
Positional Accuracy:	± 5% max.
Number of Phases:	2 or 4 (4 Phase standard)
Temperature Rise:	70°C max
Insulation Resistance:	100M ohms at 500VDC for 1 minute
Dielectric Strength:	500VAC for 1 minute
Insulation Class:	Class B
Number of lead wires:	6 lead uni-polar, bi-polar upon request
Lead wire:	UL3265 AWG#26
Operation Ambient Temp:	-10°C ~ +50°C
Radial Play:	0.03 mm max at 0.4 kg load
Axial Play:	0.08 mm max at 0.5 kg load

## H17ET Dimensions

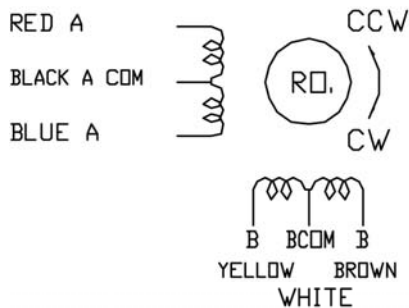


## H17ET Hybrid Options

Example:      H                      17                      032                      4                      34

	Motor Family	Frame Size	Phase Voltage	Phase	Length
Options	Hybrid Stepper	17=17mm	032=3.2VDC	4=4 Phase Unipolar	31=31mm
			040=4.0VDC	2=2 Phase Bi-polar	34=34mm
			045=4.5VDC		40=40mm
			120=12.0VDC		

## H17ET Wiring Diagram



Full Step (2 Phase) CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On	On		
1		On	On	
2			On	On
3	On			On
4	On	On		

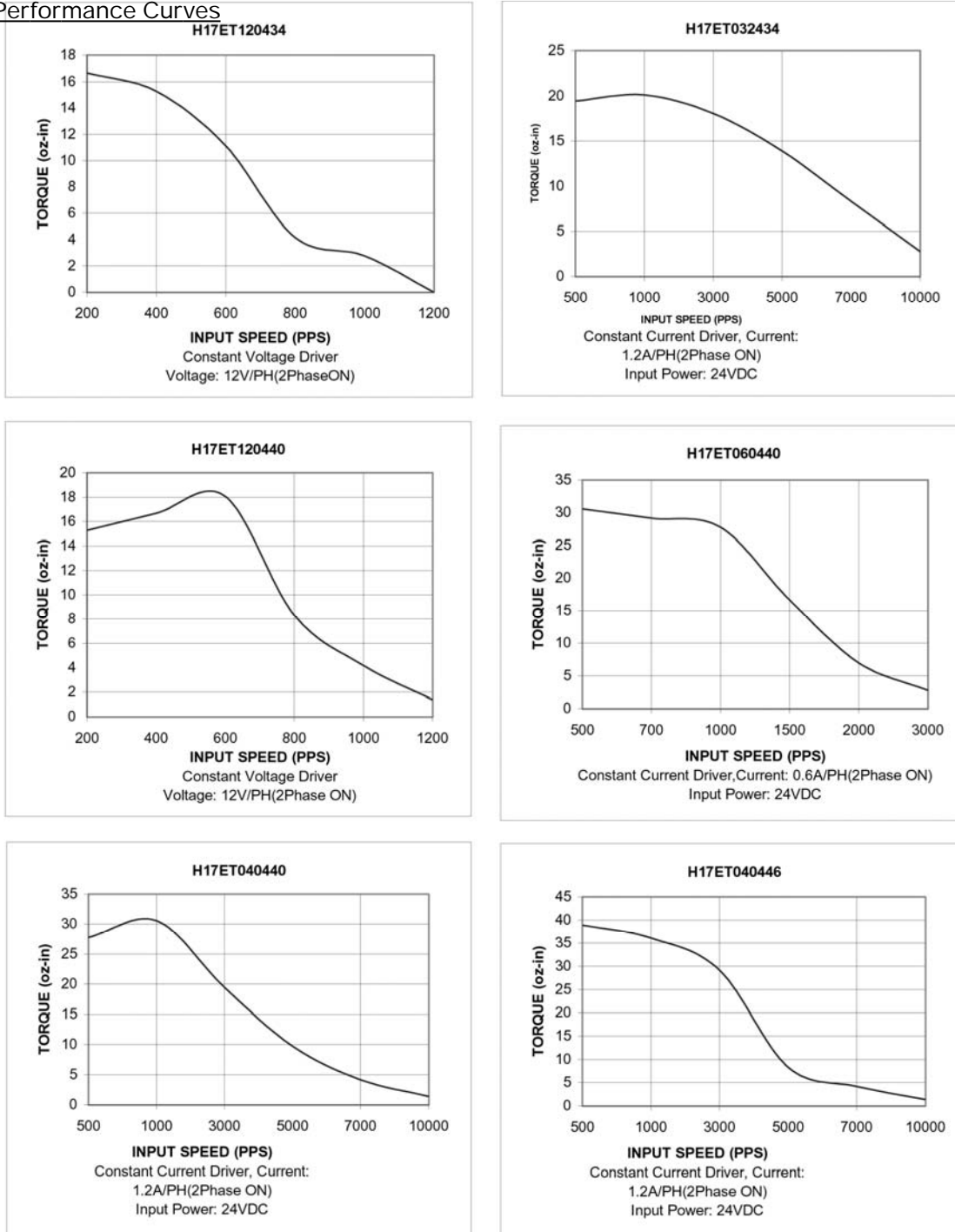
# Hybrid Stepper Series



## H17ET Motor Specifications Table

Hurst Part-Number	Voltage DC	Resistance Ohms	Inductance mH/phase	Current A/Phase	Total Watts Input (W)	Detent Torque gf-cm (oz-in)	Holding Torque Kgf-cm (oz-in)	Rotor Inertia g-cm <sup>2</sup> (oz-in <sup>2</sup> )	Weight g (oz)	Length-L mm (in)
H17ET120434	12	40	23	0.3	7.2	120	1.6	33	200	34
H17ET032434	3.2	2.7	1.8	1.2	7.7	(1.7)	(22.2)	(0.18)	(7.0)	(1.34)
H17ET120440	12	30	27	0.4	9.6	140	2.5	53	250	40
H17ET060440	6	10	9.5	0.6	7.2	(1.95)	(34.7)	(0.29)	(8.8)	(1.58)
H17ET040440	4	3.3	3.2	1.2	9.6					
H17ET040446	4	3.3	3	1.2	9.6	200	3.2	60	340	46
						(2.78)	(44.5)	(0.33)	(12.0)	(1.81)

## H17ET Typical Performance Curves



Note: Typical performance data generated by full step unipolar controller

Contact Hurst at 812-385-2564 or Fax: 812-386-7504 [www.hurstmfg.com](http://www.hurstmfg.com)

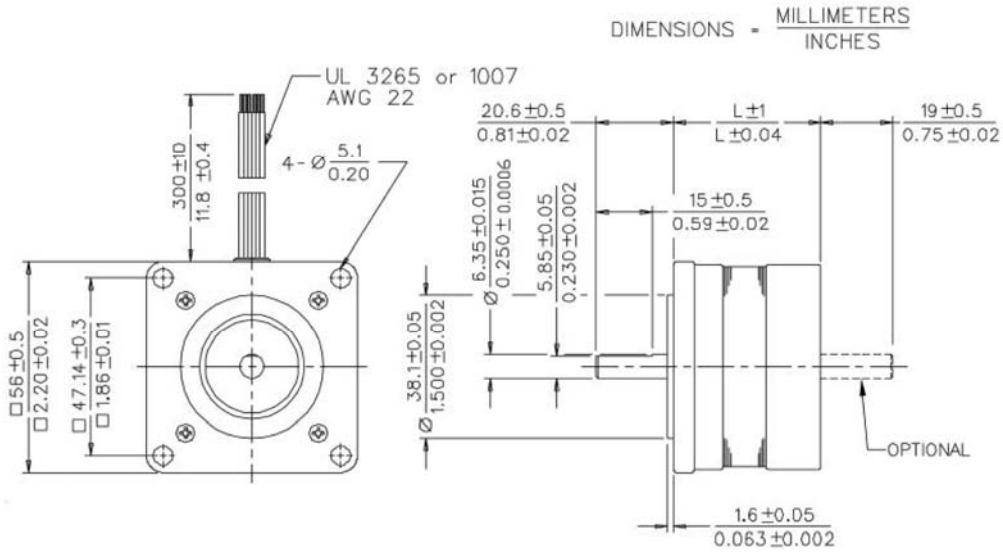




## H23R Specifications

Mounting Flange:	NEMA 23
Step angle:	1.8°
Positional Accuracy:	± 5% max.
Number of Phases:	2 or 4 (4 Phase standard)
Temperature Rise:	80°C max
Insulation Resistance:	100M ohms at 500VDC for 1 minute
Dielectric Strength:	800VAC for 1 minute
Insulation Class:	Class B
Number of lead wires:	6 lead uni-polar, bi-polar upon request
Lead wire:	UL3265 or UL 1007 AWG#22
Operation Ambient Temp:	-10°C ~ +50°C
Radial Play:	0.03 mm max at 0.5 kg load
Axial Play:	0.08 mm max at 0.7 kg load

## H23R Dimensions

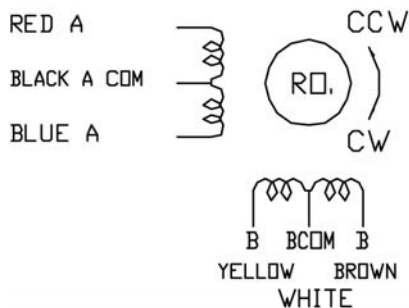


## H23R Hybrid Options

Example:      H                      23R                      028                      4                      51

	Motor Family	Frame Size	Phase Voltage	Phase	Length
Options	Hybrid Stepper	23R= 23mm (Round Motor)	028=2.8VDC 030=3.0VDC 060=6.0VDC 120=12.0VDC	4=4 Phase Unipolar 2=2 Phase Bi-polar	51=51mm 56=56mm

## H23R Wiring Diagram



Full Step (2 Phase)				
CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On	On		
1		On	On	
2			On	On
3	On			On
4	On	On		

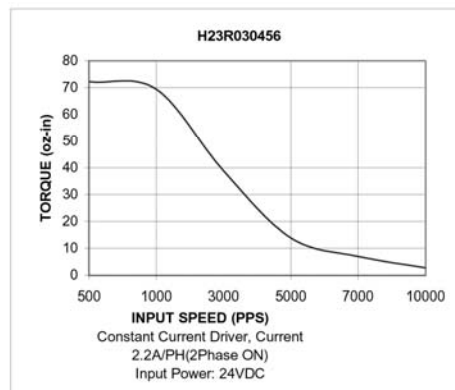
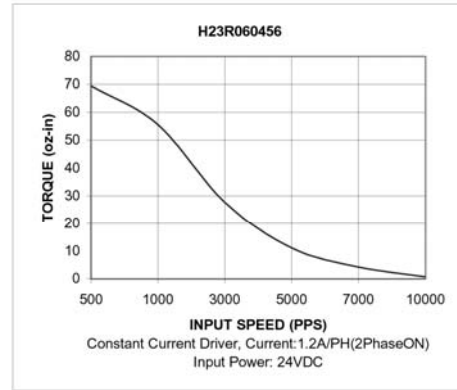
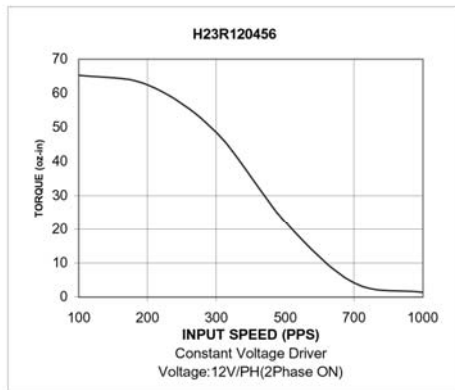
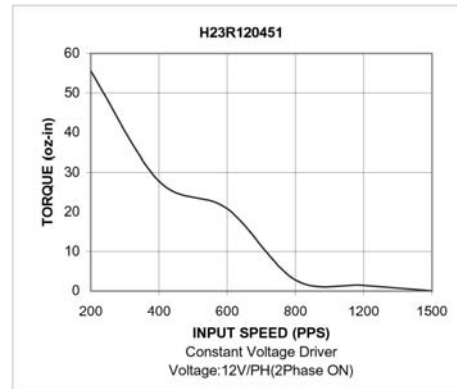
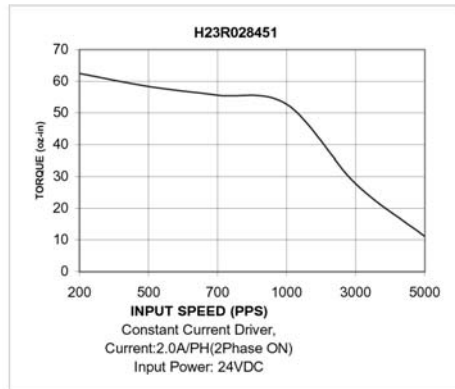
# Hybrid Stepper Series



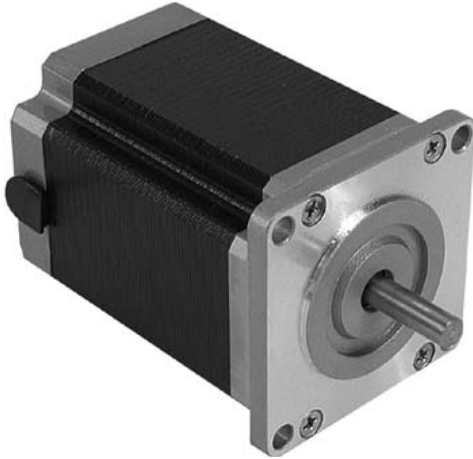
## H23R Motor Specifications Table

Hurst Part-Number	Voltage DC	Resistance Ohms	Inductance mH/phase	Current A/Phase	Total Watts Input (W)	Detent Torque gf-cm (oz-in)	Holding Torque Kgf-cm (oz-in)	Rotor Inertia g-cm <sup>2</sup> (oz-in <sup>2</sup> )	Weight g (oz)	Length L mm (in)
H23R120451	12	20.0	30.0	0.60	14.40	400	5.0	120	500	51
H23R028451	2.8	1.4	2.0	2.00	11.20	(5.6)	(69.5)	(0.656)	(17.6)	(2.01)
H23R120456	12	20.0	38.0	0.60	14.40	450	6.0	155	620	56
H23R060456	6	5.0	9.8	1.20	14.40	(6.3)	(83.4)	(0.847)	(21.9)	(2.205)
H23R030456	3	1.4	2.9	2.20	13.20					

## H23R Typical Performance Curves



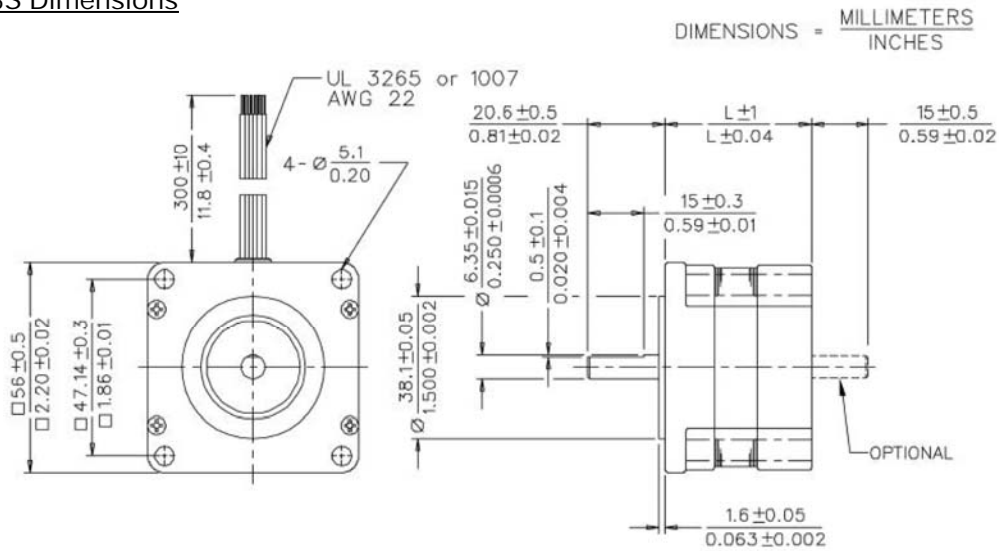
Note: Typical performance data generated using full step uni-polar controller



## H23S Specifications

Mounting Flange:	NEMA 23
Step angle:	1.8°
Positional Accuracy:	± 5% max.
Number of Phases:	2 or 4 (4 Phase standard)
Temperature Rise:	80°C max
Insulation Resistance:	100M ohms at 500VDC for 1 minute
Dielectric Strength:	800VAC for 1 minute
Insulation Class:	Class B
Number of lead wires:	6 lead uni-polar, bi-polar upon request
Lead wire:	UL3265 or UL1007 AWG#22
Operation Ambient Temp:	-10°C ~ +50°C
Radial Play:	0.03 mm max at 0.5 kg load
Axial Play:	0.08 mm max at 0.7 kg load

## H23S Dimensions

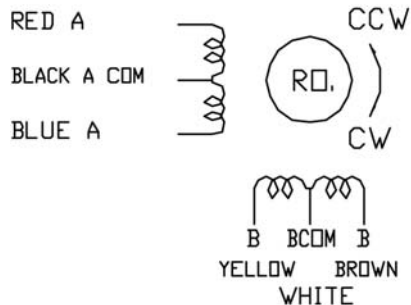


## H23S Hybrid Options

Example:      H                      23S                      050                      4                      42

Options	Motor Family	Frame Size	Phase Voltage	Phase	Length
	Hybrid Stepper	23S=23mm (Square Motor)	013=1.3VDC	4=4 Phase Unipolar	42=42mm
			021=2.1VDC	2=2 Phase Bi-polar	54=54mm
			025=2.5VDC		76=76mm
			030=3.0VDC		
			035=3.5VDC		
			045=4.5VDC		
			050=5.0VDC		
			073=7.3VDC		
			085=8.5VDC		

## H23S Wiring Diagram



Full Step (2 Phase)				
CW Rotation viewing Mounting End				
Step	A (Red)	B (Yellow)	/A (Blue)	/B (Brown)
0	On	On		
1		On	On	
2			On	On
3	On			On
4	On	On		

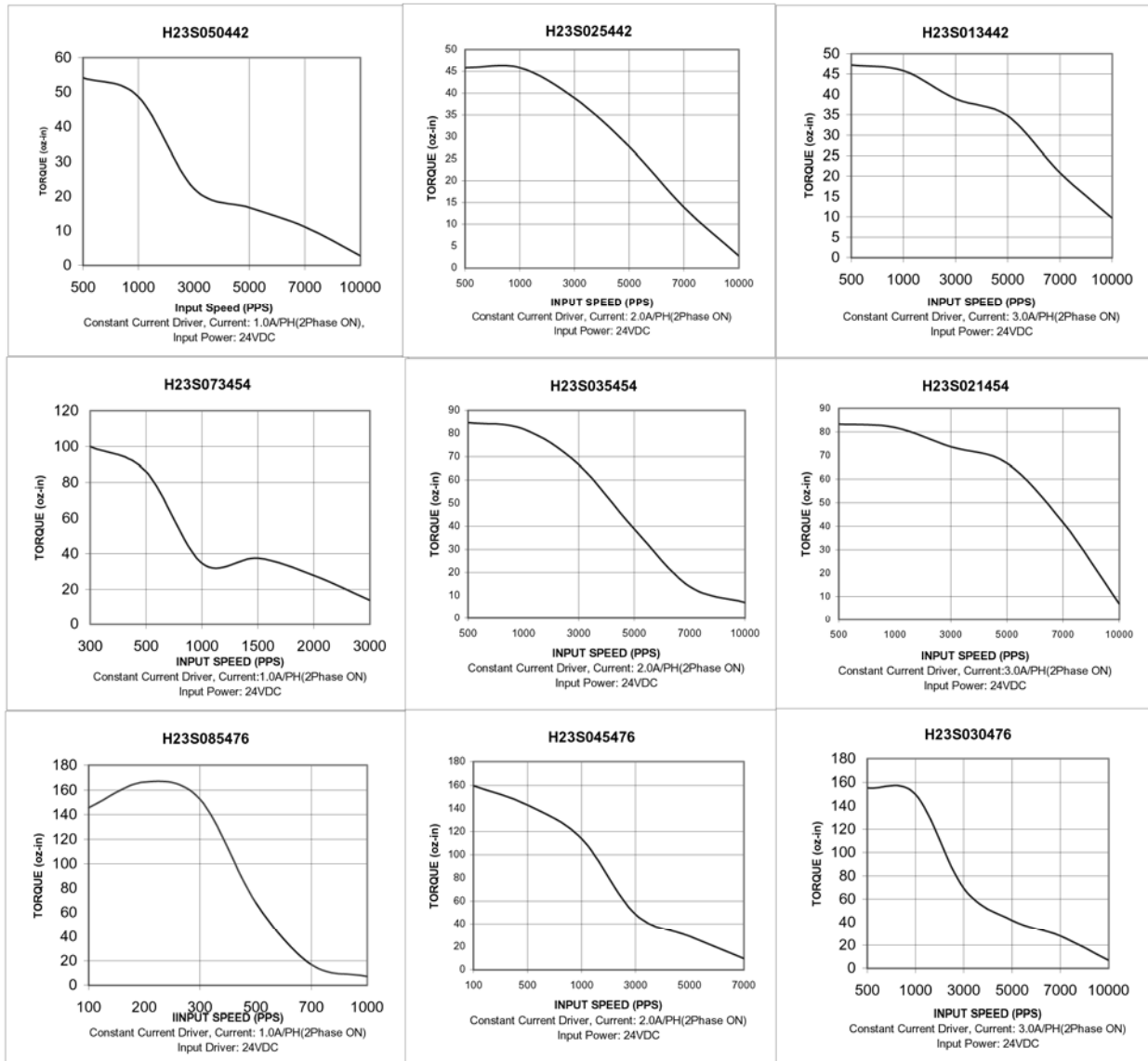
# Hybrid Stepper Series



## H23S Motor Specifications Table

Hurst Part-Number	Voltage DC	Resistance Ohms	Inductance mH/phase	Current A/Phase	Total Watts Input (W)	Detent Torque gf-cm (oz-in)	Holding Torque Kgf-cm (oz-in)	Rotor Inertia g-cm <sup>2</sup> (oz-in <sup>2</sup> )	Weight g (oz)	Length-L mm (in)
H23S050442	5.0	5.0	6.9	1	10	150	4.0	90	450	42
H23S025442	2.5	1.3	1.5	2	10	(2.1)	(55.55)	(0.492)	(16)	(1.654)
H23S013442	1.3	0.45	0.5	3	7.8					
H23S073454	7.3	7.3	14	1	14.6	250	8.0	230	650	54
H23S035454	3.5	1.75	2.6	2	14	(3.5)	(111.2)	(1.26)	(23)	(2.125)
H23S021454	2.1	0.7	1.3	3	12.6					
H23S085476	8.5	8.5	18	1	17	400	13.5	370	980	76
H23S045476	4.5	2.3	4.3	2	18	(5.6)	(187.6)	(2.02)	(35)	(2.992)
H23S030476	3.0	1.0	1.7	3	18					

## H23S Typical Performance Curves



Note: Typical performance data generated by full step unipolar controller

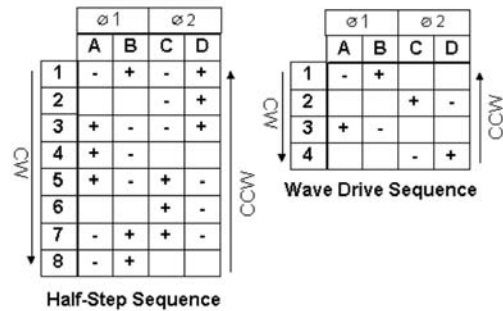
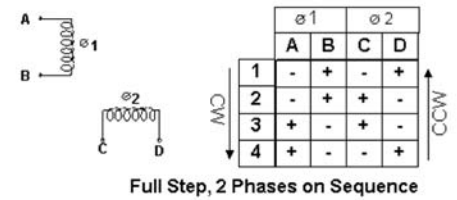
## Permanent Magnet Stepping Motor Application Notes

Hurst offers a broad line of permanent magnet stepping motors of the economical can-stack construction type with step angles in the range of 7.5 to 18° degrees. A complete line of high quality gearing is available for several of the models. Stepping is achieved by electronic commutation of the stator windings. Each pulse input to the commutation circuitry produces a fixed angular increment of rotation of the output shaft. The error in this increment is non-cumulative and is typically less than ±5% of the nominal step angle value. Up to a maximum pulse rate known as the pull-in rate, a stepping motor maintains an error free ratio rotational position to input pulses with the ability to start, stop or reverse direction. Above this rate, the motor must be accelerated and decelerated to maintain pulse to step integrity. Because of the precise incremental motion characteristics, stepping motors are well suited to positioning applications of all types. The permanent magnet rotor also provides inherent detent torque when the stator is not energized. The performance of a stepping motor in a given application is highly dependent upon its control circuitry.

### Stepping Motor Construction and Operation

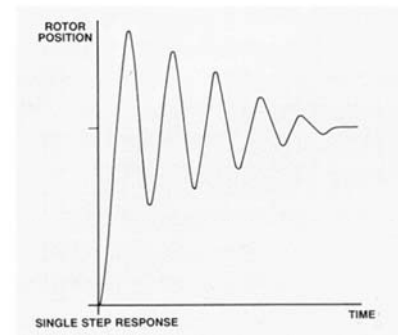
"Can-stack" stepping motors consist of two stacked sets of toothed stator poles, circular coils and a cylindrical ceramic permanent magnet rotor with radial alternating north and south poles. The number of rotor poles is equal to the number of stator teeth in each set of poles. When the stator pole coils are energized, the rotor will align itself between the two equal stator fields. Typically the number of poles are such that the motors have step angles in the range of 7.5 to 20 degrees.

A single step of the rotor corresponds to a change of magnetic polarity for one set of stator teeth. This change in polarity is brought about by reversing the direction of current flow in the coil associated with those teeth. The rotor motion for a single step with no load applied is that of a damped oscillation. The dampening characteristics are modified by frictional and inertial loading, the sequence in which windings are energized, and the electronic dampening in the drive circuitry.



### Stepping Motors Step Angle Accuracy

The average value of the measured step angles of an unloaded stepping motor over 360° will be equal to the nominal step angle. The maximum deviation of the individual steps from the nominal step angle is the error usually specified as a non-cumulative or incremental step angle error. The typical maximum value for this error in a can-stack motor with two phases energized is ±5%.



### Stepping Motor Stepping Sequences

For continuous rotation a repeating sequence of changing tooth polarity is required. Differences in motor performance characteristics result from different sequences.

A commonly used scheme for stepping is to energize both stator coils and to reverse the current in alternate coils with each successive step. This results in a four step sequence. Reversing the sequence reverses the direction of rotation. This is called a full step mode with two phases on.

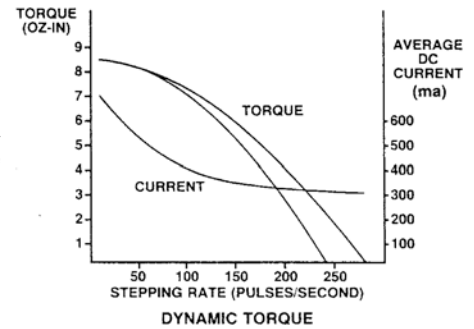
It is also possible to step the rotor with the same angular increment by energizing only one phase each step. This is also a four step sequence and is known as a wave drive. Since only half the copper volume is being used, the efficiency is lower and there is less damping with this scheme than with two phases on.

A third sequence alternates between one and two phases energized to produce 1/2 the step angle of the previous sequences. The half step sequence requires eight steps. Angular resolution is improved and the smaller step angle provides an improvement in damping. However, it should also be noted that this scheme produces alternate "weak" steps when only one phase is energized.



## Stepping Motor Resonance

All stepping motors exhibit resonance at certain pulse rates. In typical can-stack stepping motor applications resonances are most commonly encountered at low frequencies (less than 100 pulses per second). Although there is no loss of steps at these frequencies, there is an increase in vibration and noise. This becomes even more noticeable when a gear train is coupled to the motor. When operation at resonant frequencies cannot be avoided, some improvement in damping may be obtained with increased frictional damping, reduced input power, modified drive circuitry or half-stepping.



## Stepping Motor Torque Characteristics

The maximum torque developed by the motor is the static or holding torque. It is measured while displacing the rotor one step with one or two phases energized. During continuous stepping with a constant voltage supply the dynamic torque developed decreases with increasing stepping rate. This reflects the relatively large inductance to resistance ratio of the motor. In a typical dynamic torque curve (commonly called an L/R curve) the lower curve represents the maximum torque load which the motor will start and stop without losing steps (pull-in). The upper curve represents the maximum torque which the motor can develop at a given pulse rate or alternately, the maximum rate to which a given load can be accelerated (pull-out).

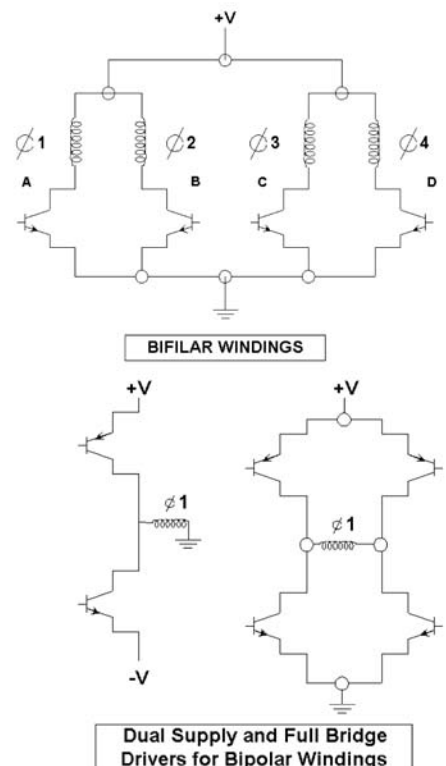
Motor torque at high pulse rates can be increased by increasing the input to the motor using a variety of drive techniques. These include simple schemes such as increasing the voltage directly or decreasing the time constant by adding external series resistance, and more elaborate techniques such as bi-level voltage drives in which winding current is controlled. When overdriving techniques are used to extend motor performance, consideration must be given to the maximum permissible temperature rise of the motor winding based on the insulation rating of the motor.

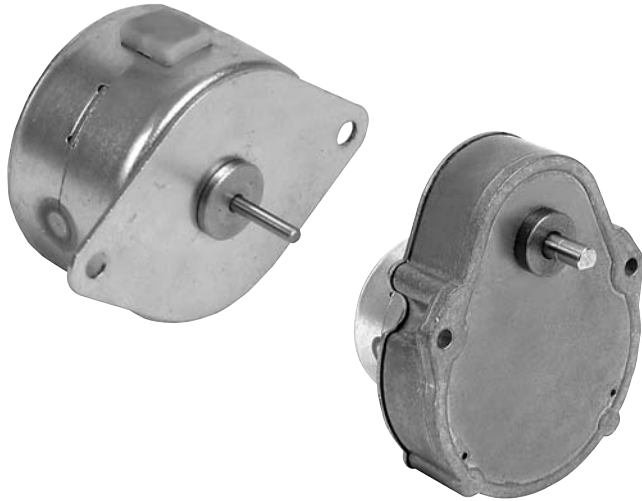
## Stepping Motor Bifilar and Bipolar Operation

The terms bifilar and bipolar refer to two different types of windings that may be used in the stator coils. Bipolar windings contain a single coil in each stator half. The switching circuitry used to reverse the direction of current flow with this coil is typically of the full bridge or dual supply type. Bifilar windings contain two coils in each stator half. When they are connected as shown in the figure, the magnetic polarity of the stator teeth can be reversed by switching from one coil to the other of each pair with a unipolar supply. Note that although a bifilar-wound motor does contain four coils or "phases," it is operated as a two phase motor. Bifilar-wound PM steppers are widely used because of the drive circuit simplicity. All stock Hurst stepping motors use this winding configuration.

Bifilar and bipolar-wound motors do exhibit some performance differences. Since the winding volume per phase of a bifilar-wound stepper is only half that of a bipolar-wound stepper, the attainable ampere-turns for a given input power will not necessarily be lower for the bifilar-wound motor. Therefore, the torque is lower. However, with an L/R drive the bipolar coil with its larger volume will have a larger time constant. At high stepping rates the bipolar-wound motor's torque will decrease to approximately the same level as that of the bifilar-wound motor.

The choice of winding type will depend upon the application. The holding torque for a bipolar version of a given motor will be 20-30% higher than the bifilar version. Dynamic torque differences will depend upon the drive circuitry. With the simplest drive circuits the bipolar performance exceeds the bifilar only at low frequencies. As drive circuit complexity increases the bipolar performance becomes superior.



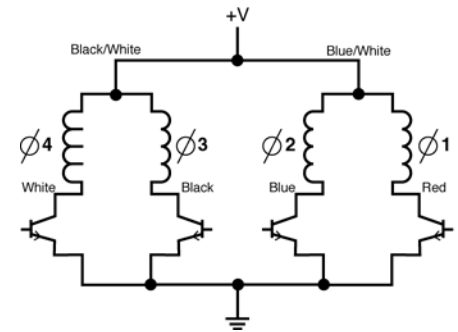
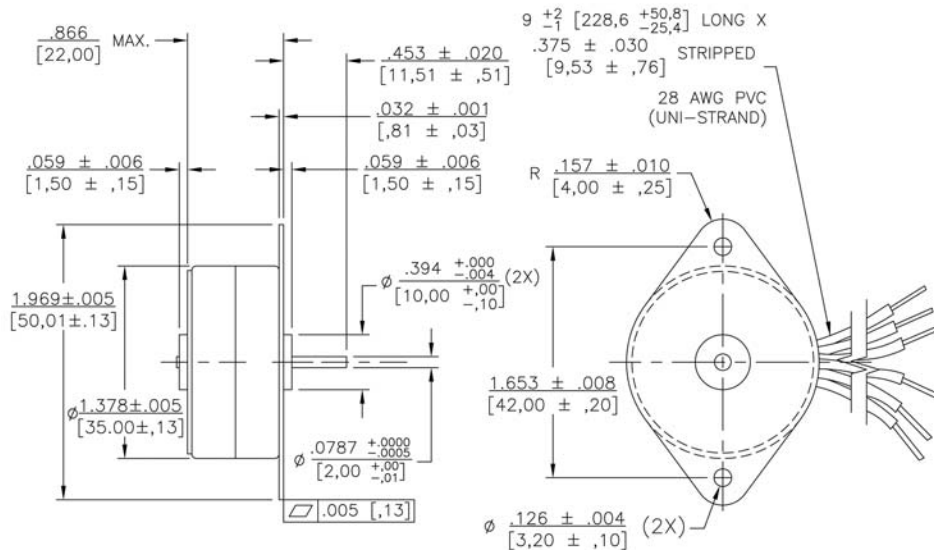


### LS 35MM Specifications

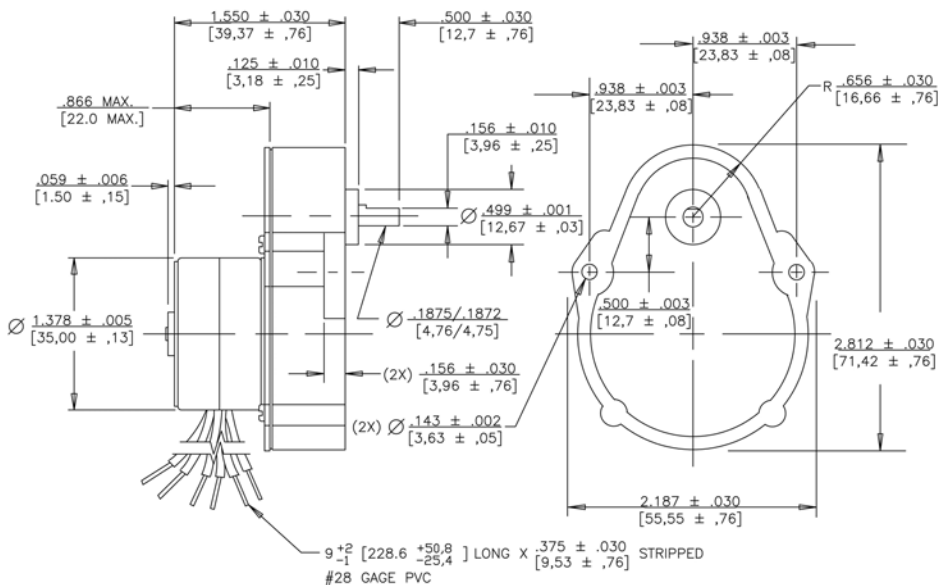
Frame Size:	35MM
Step Angle:	7.5°
Torque Ratings:	Up to 150 oz-in ± 5% max.
Positional Accuracy:	4 phase bifilar
Number of Phases:	Class A (105°C)
Insulation Class:	6 leads 28AWG (approx. 9 in.)
Lead wire:	-10° C ~ +40° C
Operation Ambient Temp:	60° C max.
Temperature Rise:	100 Meg ohms at 500 VDC
Insulation Resistance:	600 VAC/second
Dielectric Strength:	Gear Unit: Zinc Die Cast—AGMA 7 Standard with hardened steel gears

Note: Typical Data subject to change without notification.

### LS 35MM Direct Drive



### LS 35MM Geared



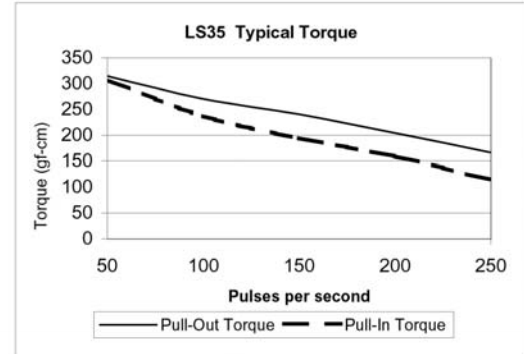
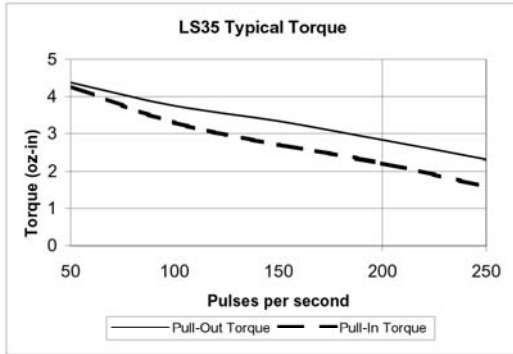
	∅4 White	∅3 Black	∅2 Blue	∅1 Red	
CCW ROTATION ↑	1	0	1	0	CW ROTATION ↓
	1	0	0	1	
	0	1	0	1	
	0	1	1	0	

**1 = ON, 0 = OFF**  
**SWITCHING SEQUENCE**

# LS 35MM Stepper Motor



## LS 35MM Speed-Torque



## LS 35 Options

Example: LS G 35 12 E02 P

	Motor Family	Gearing	Motor Size	Voltage	Gear Ratio	Gear Box
Options	LS	D=Direct Drive G=G geared	35=35MM 42=42MM	005=5VDC 006=6VDC 012=12VDC 024=24VDC	Gear Options	P=Pear-Shaped Gearbox

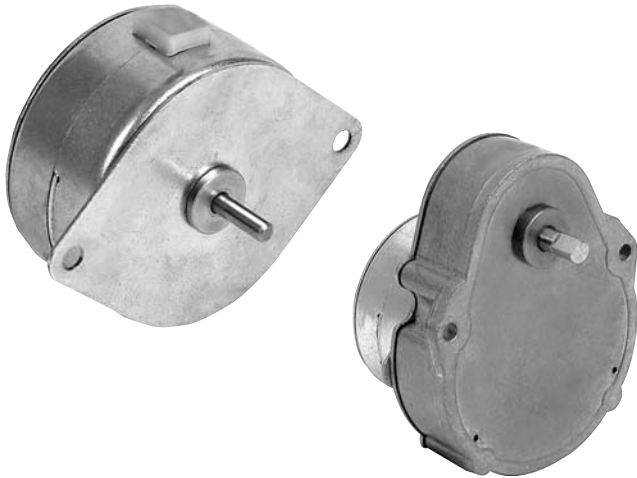
## LS 35MM Motor Specifications - Direct Drive

Model	Hurst Part-Number	Voltage VDC	Resistance Ohms/Phase	Inductance mH/Phase	Hold Current A	Total Watts Input W	Minimum Holding Torque oz-in (gf-cm)	Pull-Out Torque @ 175 P/S oz-in (gf-cm)	Detent Torque oz-in (gf-cm)	Rotor Inertia oz-in <sup>2</sup> (g-cm <sup>2</sup> )	Weight oz (g)	Length (L) in (mm)
LS35	LSD35005D	5	16.0	6.9	0.625	3.2	5.8 (420)	2.1 (151)	1.8 (130)	0.0372 (6.8)	2.9 (82)	.866 (22)
LS35	LSD35006D	6	17.5	9.0	0.686	4.2	6.0 (430)	2.1 (151)	1.8 (130)	0.0372 (6.8)	2.9 (82)	.866 (22)
LS35	LSD35012D	12	65.0	27.0	0.369	4.5	6.3 (450)	2.1 (151)	1.8 (130)	0.0372 (6.8)	2.9 (82)	.866 (22)
LS35	LSD35024D	24	280.0	130.0	0.172	4.2	6.0 (430)	2.1 (151)	1.8 (130)	0.0372 (6.8)	2.9 (82)	.866 (22)

## LS 35MM Motor Specifications - Geared

Model	Part-Number	Step Angle (degrees)	Steps per Rev.	Reduction	Nominal Voltage (VDC)	Minimum Holding Torque (oz-in)	Pull-Out Torque @ 175 p/s (oz-in)	Detent Torque (oz-in)	Rotor Inertia (oz-in <sup>2</sup> )	Weight (oz)	Length (L) (in)
LSG35	LSG35012E02P	4.500	80	1 2/3	12	15	2	4.3	0.0372	8.6	1.55
LSG35	LSG35012E04P	3.750	96	2	12	18	3	5.1	0.0372	8.6	1.55
LSG35	LSG35012E06P	3.600	100	2 1/12	12	19	3	5.4	0.0372	8.6	1.55
LSG35	LSG35012E08P	3.000	120	2 1/2	12	22	4	6.4	0.0372	8.6	1.55
LSG35	LSG35012E10P	2.500	144	3	12	27	4	7.7	0.0372	8.6	1.55
LSG35	LSG35012E12P	2.250	160	3 1/3	12	30	5	8.6	0.0372	8.6	1.55
LSG35	LSG35012E16P	1.875	192	4	12	36	6	10.3	0.0372	8.6	1.55
LSG35	LSG35012E18P	1.800	200	4 1/6	12	37	6	10.7	0.0372	8.6	1.55
LSG35	LSG35012E20P	1.500	240	5	12	45	7	12.9	0.0372	8.6	1.55
LSG35	LSG35012E22P	1.200	300	6 1/4	12	56	9	16.1	0.0372	8.6	1.55
LSG35	LSG35012E24P	1.000	360	7 1/2	12	67	11	19.3	0.0372	8.6	1.55
LSG35	LSG35012E28P	0.900	400	8 1/3	12	74	12	21.4	0.0372	8.6	1.55
LSG35	LSG35012E30P	0.750	480	10	12	89	15	25.7	0.0372	8.6	1.55
LSG35	LSG35012E34P	0.625	576	12	12	107	18	30.9	0.0372	8.6	1.55
LSG35	LSG35012E36P	0.600	600	12 1/2	12	112	18	32.1	0.0372	8.6	1.55
LSG35	LSG35012E38P	0.563	640	13 1/3	12	119	20	34.3	0.0372	8.6	1.55
LSG35	LSG35012E40P	0.500	720	15	12	134	22	38.6	0.0372	8.6	1.55
LSG35	LSG35012E42P	0.469	768	16	12	143	24	41.1	0.0372	8.6	1.55
LSG35	LSG35012E44P	0.450	800	16 2/3	12	149	25	42.9	0.0372	8.6	1.55
LSG35	LSG35012F46P	0.375	960	20	12	150	27	56.3	0.0372	8.6	1.55
LSG35	LSG35012F48P	0.360	1000	20 5/6	12	150	28	58.6	0.0372	8.6	1.55
LSG35	LSG35012F50P	0.300	1200	25	12	150	34	70.3	0.0372	8.6	1.55
LSG35	LSG35012F52P	0.250	1440	30	12	150	40	84.4	0.0372	8.6	1.55
LSG35	LSG35012F54P	0.240	1500	31 1/4	12	150	42	87.9	0.0372	8.6	1.55
LSG35	LSG35012F56P	0.225	1600	33 1/3	12	150	45	93.8	0.0372	8.6	1.55
LSG35	LSG35012F58P	0.200	1800	37 1/2	12	150	50	105.5	0.0372	8.6	1.55
LSG35	LSG35012F60P	0.188	1920	40	12	150	54	112.5	0.0372	8.6	1.55
LSG35	LSG35012F62P	0.180	2000	41 2/3	12	150	56	117.2	0.0372	8.6	1.55
LSG35	LSG35012F64P	0.150	2400	50	12	150	67	140.6	0.0372	8.6	1.55
LSG35	LSG35012F66P	0.139	2592	54	12	150	73	150.0	0.0372	8.6	1.55
LSG35	LSG35012F68P	0.133	2700	56 1/4	12	150	76	150.0	0.0372	8.6	1.55
LSG35	LSG35012F70P	0.125	2880	60	12	150	81	150.0	0.0372	8.6	1.55
LSG35	LSG35012F72P	0.120	3000	62 1/2	12	150	84	150.0	0.0372	8.6	1.55
LSG35	LSG35012F74P	0.113	3200	66 2/3	12	150	90	150.0	0.0372	8.6	1.55
LSG35	LSG35012F76P	0.100	3600	75	12	150	101	150.0	0.0372	8.6	1.55
LSG35	LSG35012F78P	0.094	3840	80	12	150	108	150.0	0.0372	8.6	1.55
LSG35	LSG35012F80P	0.090	4000	83 1/3	12	150	112	150.0	0.0372	8.6	1.55
LSG35	LSG35012E82P	0.075	4800	100	12	150	109	150.0	0.0372	8.6	1.55
LSG35	LSG35012E84P	0.067	5400	112 1/2	12	150	123	150.0	0.0372	8.6	1.55
LSG35	LSG35012E86P	0.063	5760	120	12	150	131	150.0	0.0372	8.6	1.55
LSG35	LSG35012E88P	0.060	6000	125	12	150	137	150.0	0.0372	8.6	1.55
LSG35	LSG35012E90P	0.050	7200	150	12	150	150	150.0	0.0372	8.6	1.55
LSG35	LSG35012E96P	0.030	12000	250	12	150	150	150.0	0.0372	8.6	1.55
LSG35	LSG35012E98P	0.025	14400	300	12	150	150	150.0	0.0372	8.6	1.55

# LS 42MM Stepper Motor

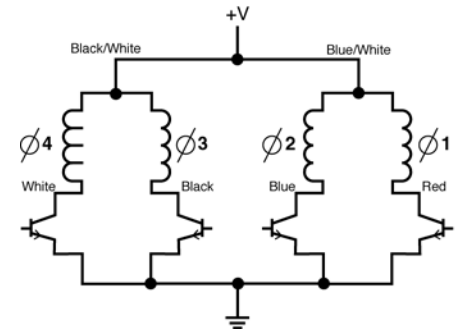
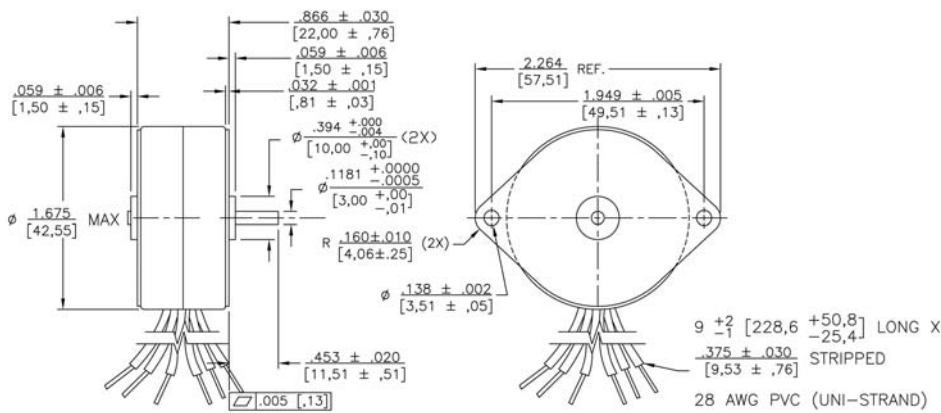


## LS 42MM Specifications

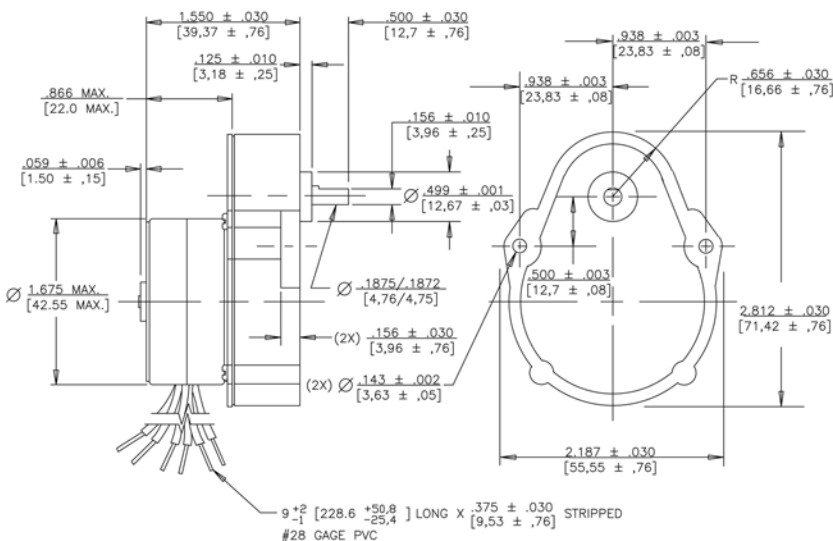
Frame Size:	42MM
Step Angle:	7.5°
Torque Ratings:	Up to 150 oz-in
Positional Accuracy:	± 5% max.
Number of Phases:	4 phase bifilar
Insulation Class:	Class A (105°C)
Lead wire:	6 leads 28AWG (approx. 9 in.)
Operation Ambient Temp:	-10° C ~ +40° C
Temperature Rise:	60° C max.
Insulation Resistance:	100 Meg ohms at 500 VDC
Dielectric Strength:	600 VAC/second
Gear Unit:	Zinc Die Cast—AGMA 7 Standard with hardened steel gears

Note: Typical Data subject to change without notification.

## LS 42MM Direct Drive



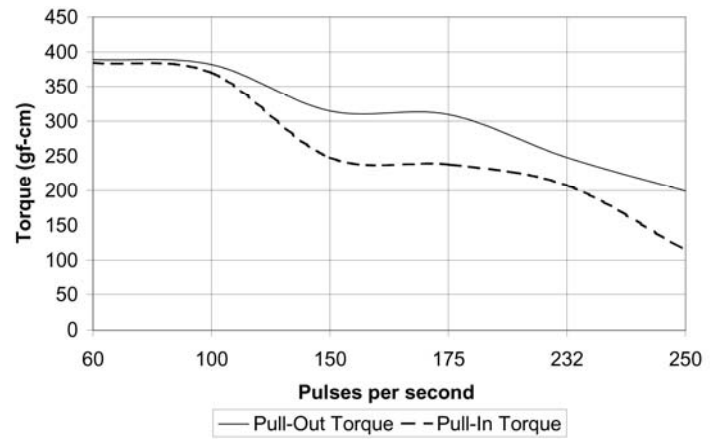
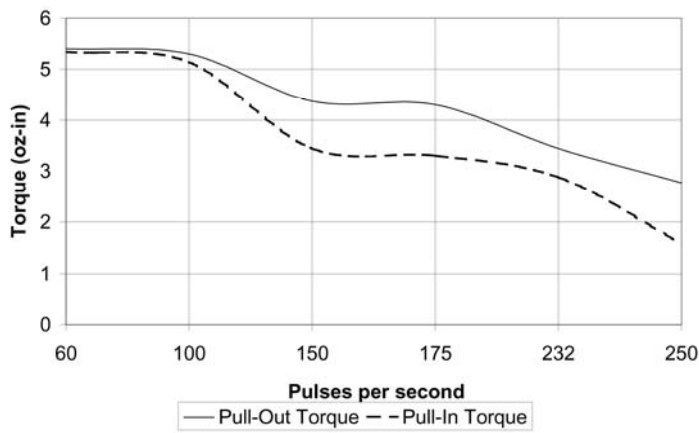
## LS 42MM Geared



	Ø4 White	Ø3 Black	Ø2 Blue	Ø1 Red	
↑ CCW ROTATION	1	0	1	0	↓ CW ROTATION
	1	0	0	1	
↓ CW ROTATION	0	1	0	1	↑ CCW ROTATION
	0	1	1	0	

**1 = ON, 0 = OFF**  
**SWITCHING SEQUENCE**

## LS 42MM Speed-Torque



## LS 42MM Options

Example: LS G 42 12 E02 P

	Motor Family	Gearing	Motor Size	Voltage	Gear Ratio	Gear Box
Options	LS	D=Direct Drive G=Geared	35=35MM 42=42MM	005=5VDC 006=6VDC 012=12VDC 024=24VDC	Gear Options	P=Pear-Shaped Gearbox

## LS 42MM Motor Specifications - Direct Drive

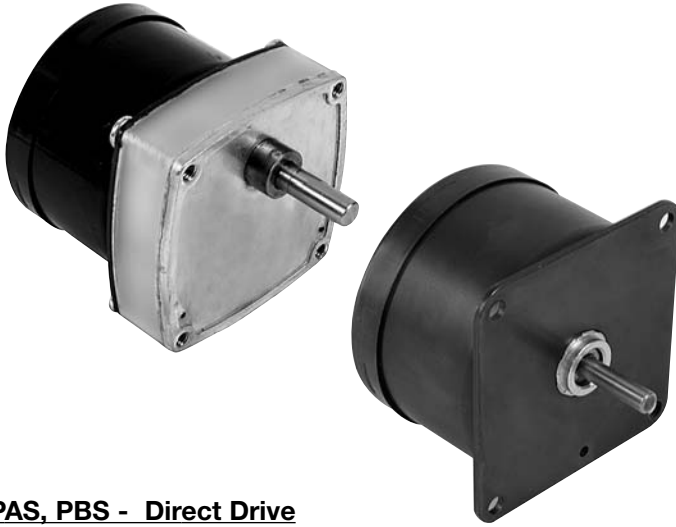
Model	Hurst Part-Number	Voltage VDC	Resistance Ohms/Phase	Inductance mH/Phase	Hold Current A	Total Watts Input W	Minimum Holding Torque oz-in (gf-cm)	Pull-Out Torque @ 175 P/S oz-in (gf-cm)	Detent Torque oz-in (gf-cm)	Rotor Inertia oz-in <sup>2</sup> (g-cm <sup>2</sup> )	Weight oz (g)	Length (L) in (mm)
LS42	LSD42005D	5	9	5.8	1.110	5.5						
LS42	LSD42006D	6	12	9.5	1.000	6	8.0	3.6 (259)	1.8 (130)	0.0394 (7.2)	4.8 (135)	.866 (22)
LS42	LSD42012D	12	50	33	0.483	5.8						
LS42	LSD42024D	24	190	140	0.253	6.1						

# LS 42MM Stepper Motor



## LS 42MM Motor Specifications - Geared

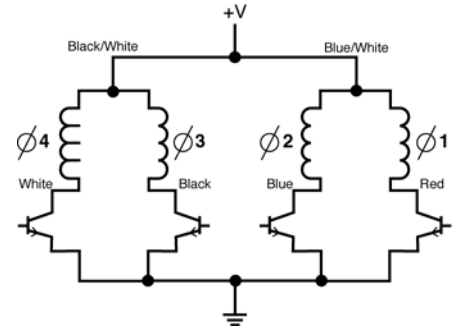
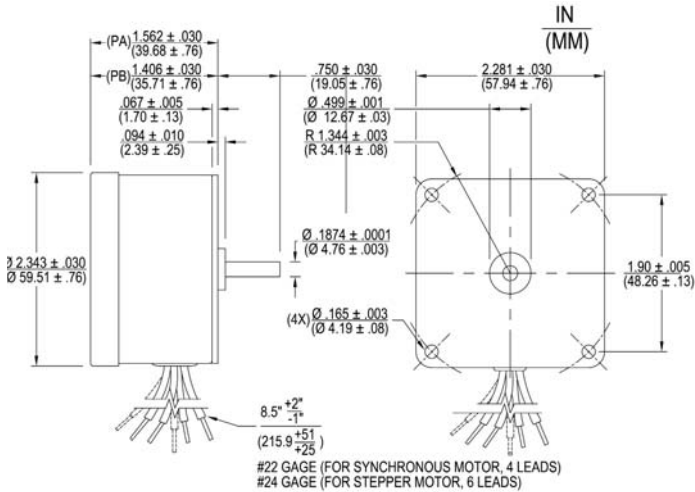
Model	Part-Number	Step Angle (degrees)	Steps per Rev.	Reduction	Nominal Voltage (VDC)	Minimum Holding Torque (oz-in)	Pull-Out Torque @ 175 p/s (oz-in)	Detent Torque (oz-in)	Rotor Inertia (oz-in <sup>2</sup> )	Weight (oz)	Length (L) (in)
LSG42	LSG42012E02P	4.500	80	1 2/3	12	19	4	4.3	0.0394	10.2	1.55
LSG42	LSG42012E04P	3.750	96	2	12	23	5	5.1	0.0394	10.2	1.55
LSG42	LSG42012E06P	3.600	100	2 1/12	12	24	5	5.4	0.0394	10.2	1.55
LSG42	LSG42012E08P	3.000	120	2 1/2	12	29	6	6.4	0.0394	10.2	1.55
LSG42	LSG42012E10P	2.500	144	3	12	34	8	7.7	0.0394	10.2	1.55
LSG42	LSG42012E12P	2.250	160	3 1/3	12	38	8	8.6	0.0394	10.2	1.55
LSG42	LSG42012E16P	1.875	192	4	12	46	10	10.3	0.0394	10.2	1.55
LSG42	LSG42012E18P	1.800	200	4 1/6	12	48	11	10.7	0.0394	10.2	1.55
LSG42	LSG42012E20P	1.500	240	5	12	57	13	12.9	0.0394	10.2	1.55
LSG42	LSG42012E22P	1.200	300	6 1/4	12	71	16	16.1	0.0394	10.2	1.55
LSG42	LSG42012E24P	1.000	360	7 1/2	12	86	19	19.3	0.0394	10.2	1.55
LSG42	LSG42012E28P	0.900	400	8 1/3	12	95	21	21.4	0.0394	10.2	1.55
LSG42	LSG42012E30P	0.750	480	10	12	114	25	25.7	0.0394	10.2	1.55
LSG42	LSG42012E34P	0.625	576	12	12	137	30	30.9	0.0394	10.2	1.55
LSG42	LSG42012E36P	0.600	600	12 1/2	12	143	32	32.1	0.0394	10.2	1.55
LSG42	LSG42012E38P	0.563	640	13 1/3	12	150	34	34.3	0.0394	10.2	1.55
LSG42	LSG42012E40P	0.500	720	15	12	150	38	38.6	0.0394	10.2	1.55
LSG42	LSG42012E42P	0.469	768	16	12	150	40	41.1	0.0394	10.2	1.55
LSG42	LSG42012E44P	0.450	800	16 2/3	12	150	42	42.9	0.0394	10.2	1.55
LSG42	LSG42012F46P	0.375	960	20	12	150	46	56.3	0.0394	10.2	1.55
LSG42	LSG42012F48P	0.360	1000	20 5/6	12	150	48	58.6	0.0394	10.2	1.55
LSG42	LSG42012F50P	0.300	1200	25	12	150	58	70.3	0.0394	10.2	1.55
LSG42	LSG42012F52P	0.250	1440	30	12	150	69	84.4	0.0394	10.2	1.55
LSG42	LSG42012F54P	0.240	1500	31 1/4	12	150	72	87.9	0.0394	10.2	1.55
LSG42	LSG42012F56P	0.225	1600	33 1/3	12	150	77	93.8	0.0394	10.2	1.55
LSG42	LSG42012F58P	0.200	1800	37 1/2	12	150	86	105.5	0.0394	10.2	1.55
LSG42	LSG42012F60P	0.188	1920	40	12	150	92	112.5	0.0394	10.2	1.55
LSG42	LSG42012F62P	0.180	2000	41 2/3	12	150	96	117.2	0.0394	10.2	1.55
LSG42	LSG42012F64P	0.150	2400	50	12	150	115	140.6	0.0394	10.2	1.55
LSG42	LSG42012F66P	0.139	2592	54	12	150	124	150.0	0.0394	10.2	1.55
LSG42	LSG42012F68P	0.133	2700	56 1/4	12	150	130	150.0	0.0394	10.2	1.55
LSG42	LSG42012F70P	0.125	2880	60	12	150	138	150.0	0.0394	10.2	1.55
LSG42	LSG42012F72P	0.120	3000	62 1/2	12	150	144	150.0	0.0394	10.2	1.55
LSG42	LSG42012F74P	0.113	3200	66 2/3	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012F76P	0.100	3600	75	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012F78P	0.094	3840	80	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012F80P	0.090	4000	83 1/3	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E82P	0.075	4800	100	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E84P	0.067	5400	112 1/2	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E86P	0.063	5760	120	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E88P	0.060	6000	125	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E90P	0.050	7200	150	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E96P	0.030	12000	250	12	150	150	150.0	0.0394	10.2	1.55
LSG42	LSG42012E98P	0.025	14400	300	12	150	150	150.0	0.0394	10.2	1.55



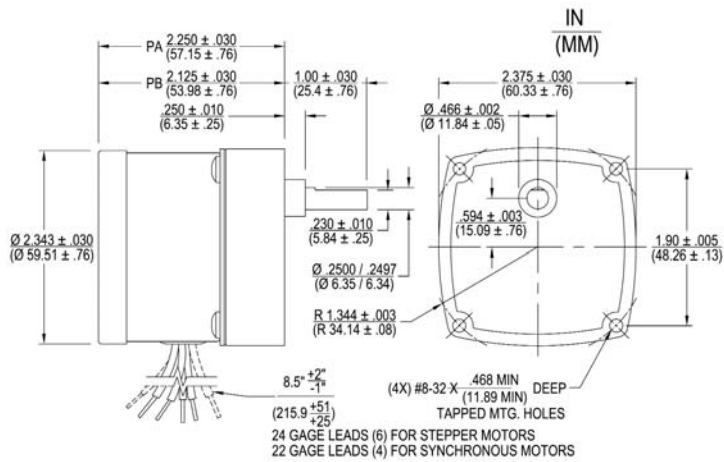
### PAS, PBS Specifications

Step angle:	7.5° & 15°
Torque Range:	Up to 200 oz-in
Positional Accuracy:	± 5% max.
Number of Phases:	4 phase bifilar
Insulation Class:	Class A (105°C)
Lead wire:	6 leads 24 AWG (approx. 8.5 in.)
Operation Ambient Temp:	-10°C ~ +40°C
Shaft Bearing:	Sleeve bearing
Gear Unit:	Zinc Die Cast—AGMA 7 Standards with hardened steel gears
Note:	Typical data subject to change without notification.

### PAS, PBS - Direct Drive



### PAS, PBS - Geared Drive

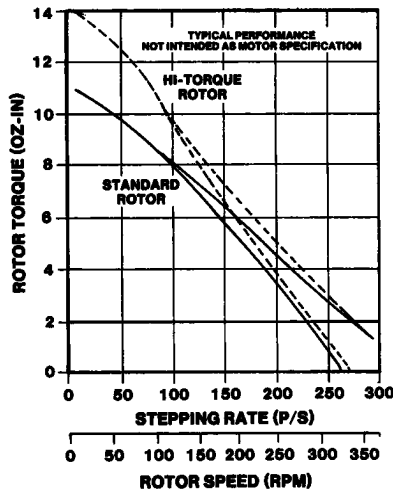


	Ø4 White	Ø3 Black	Ø2 Blue	Ø1 Red	
↑ CCW ROTATION	1	0	1	0	↓ CW ROTATION
	1	0	0	1	
↑ CCW ROTATION	0	1	0	1	↓ CW ROTATION
	0	1	1	0	

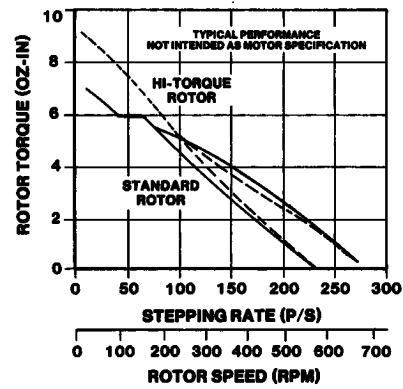
**1 = ON, 0 = OFF**  
**SWITCHING SEQUENCE**



**MODELS PAS 3205-001 AND PAS 3229-002  
UNIPOLAR L/R DRIVE**



**MODELS PBS 3207-001 AND PBS 3231-002  
UNIPOLAR L/R DRIVE**



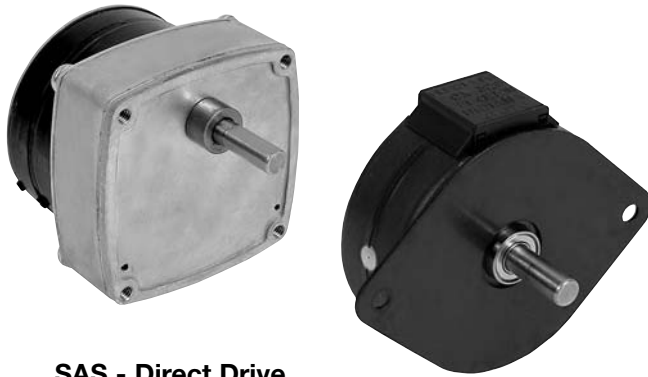
### Motor Specification - Direct Drive

Model	Part Number	Step Angle (degrees)	Steps per Rev.	Rated Torque @ 175 p/s (oz-in)	Torque @ 4-5 p/s (oz-in)	Holding Torque (2 Phase Energized) (oz-in)	Output Speed @ 200 p/s (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Rotor Inertia (oz-in <sup>2</sup> )	Full Load Temp. Rise (°C)	Weight (oz)
PAS	3205-001	7.5	48	4.8	8.5	14	250	8	12	35	0.34	50	13
PAS	3205-003	7.5	48	4.8	8.5	14	250	8	24	135	0.34	50	13
PAS-ET	3229-002	7.5	48	5.1	11.5	16.5	250	8	12	35	0.34	50	13
PBS	3207-001	15	24	3.2	5.8	11	500	8.5	12	32	0.19	52	13
PBS-ET	3231-001	15	24	3.2	5.8	11	500	8.5	6	7.4	0.19	52	13
PBS-ET	3231-002	15	24	3.2	7.3	12.3	500	8.5	12	32	0.19	52	13

### Motor Specification - Geared

Model	Part Number	Step Angle (degrees)	Steps per Rev.	Reduction	Rated Torque @ 175 p/s (oz-in)	Output Speed @ 200 p/s (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Weight (oz)
PAS	3206-044	2.5	144	3	11	83.33	8	5	6	18
PAS	3206-020	0.25	1440	30	101	8.33	8	6	8	18
PAS	3206-042	0.06	6000	125	200	2	8	6	8	18
PAS	3206-024	0.025	14400	300	200	0.83	8	6	8	18
PAS	3206-010	3.75	96	2	7	125	8	12	35	18
PAS	3206-041	1.8	200	4.17	15	60	8	12	35	18
PAS	3206-009	1.5	240	5	18	50	8	12	35	18
PAS	3206-043	0.9	400	8.33	30	30	8	12	35	18
PAS	3206-008	0.75	480	10	36	25	8	12	35	18
PAS	3206-012	0.375	960	20	67	12.5	8	12	35	18
PAS	3206-011	0.25	1440	30	101	8.33	8	12	35	18
PAS	3206-004	0.15	2400	50	168	5	8	12	35	18
PAS	3206-003	0.1	3600	75	200	3.33	8	12	35	18
PAS	3206-002	0.05	7200	150	200	1.67	8	12	35	18
PAS	3206-001	0.025	14400	300	200	0.83	8	12	35	18
PAS	3206-013	0.3	1200	25	84	10	8	24	135	18
PAS	3206-030	0.25	1440	30	101	8.33	8	24	135	18
PAS	3206-031	0.15	2400	50	168	5	8	24	135	18
PAS	3206-034	0.025	14400	300	200	0.83	8	24	135	18
PBS	3208-016	0.75	480	20	45	25	8.5	6	7.4	18
PBS	3208-009	0.75	480	20	45	25	8.5	12	32	18
PBS	3208-004	0.5	720	30	67	16.67	8.5	12	32	18
PBS	3235-005	0.5	720	30	67	16.67	8.5	12	32	18
PBS	3208-036	0.5	720	40	89	12.5	8.5	12	32	18
PBS	3208-005	0.3	1200	50	112	10	8.5	12	32	18
PBS	3208-003	0.2	1800	75	155	6.67	8.5	12	32	18
PBS	3208-002	0.1	3600	150	200	3.33	8.5	12	32	18
PBS	3208-001	0.05	7200	300	200	1.67	8.5	12	32	18
PBS	3208-024	0.75	480	20	45	25	8.5	24	130	18
PBS	3208-028	0.1	3600	150	200	3.33	8.5	24	130	18
PBS-ET	3235-004	0.3	1200	50	112	10	8.5	12	32	18

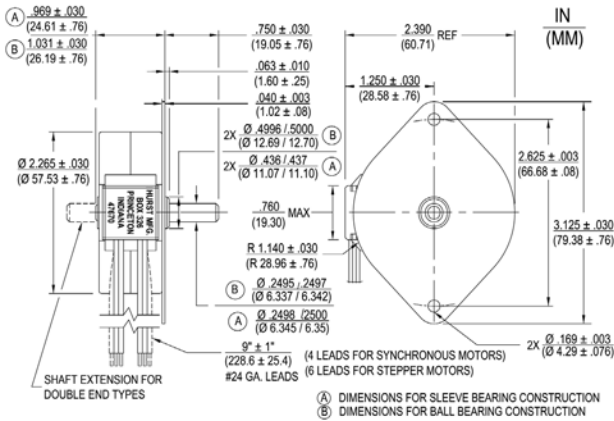
Note: Contact Hurst Mfg for additional voltages and reductions.



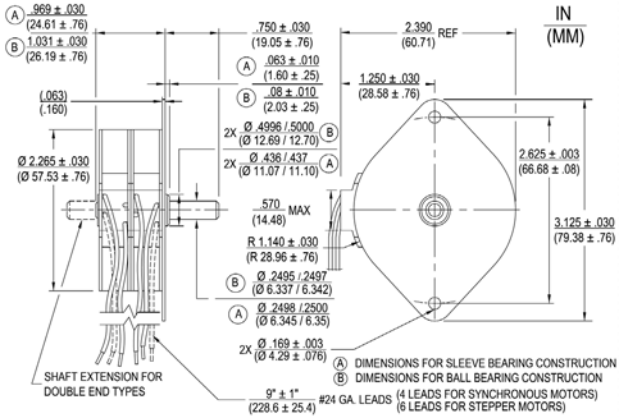
## SAS Specifications

Step angle: 7.5° & 15°  
 Torque Ratings: Up to 200 oz-in.  
 Positional Accuracy: ± 5% max.  
 Number of Phases: 4 phase bifilar  
 Insulation Class: Class A (105°C)  
 Lead wire: 6 leads 24 AWG (approx. 9 in.)  
 Operation: Ambient Temp: -10°C ~ +40°C  
 Shaft Bearing: Sleeve bearing  
 Gear Unit: Zinc Die Cast—AGMA 7 Standards with hardened steel gears  
 Note: Typical data subject to change without notification.

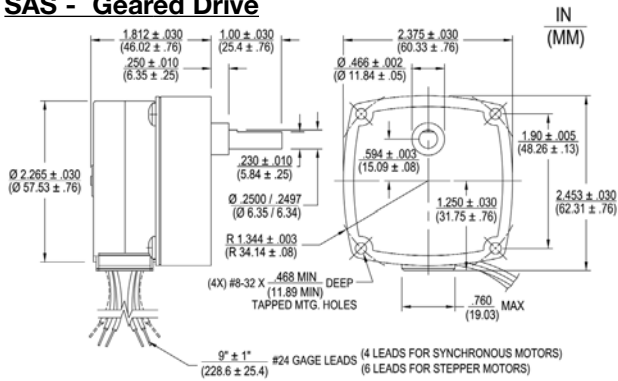
### SAS - Direct Drive



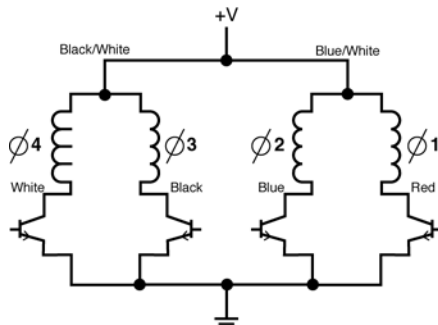
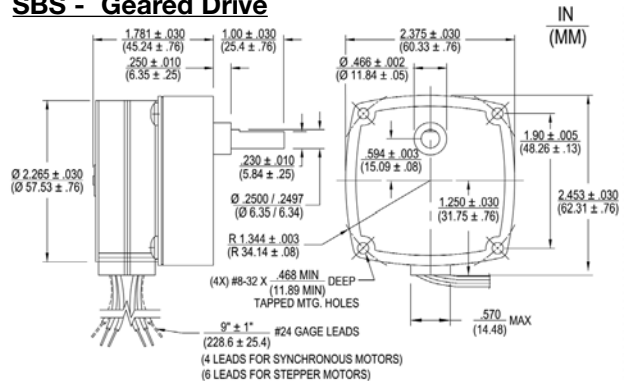
### SBS - Direct Drive



### SAS - Geared Drive



### SBS - Geared Drive



	Ø4 White	Ø3 Black	Ø2 Blue	Ø1 Red	
↑ CCW ROTATION	1	0	1	0	↓ CW ROTATION
	1	0	0	1	
	0	1	0	1	
	0	1	1	0	

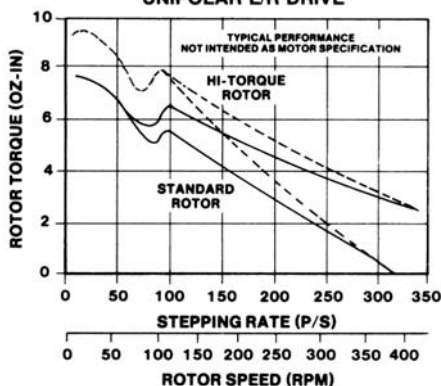
1 = ON, 0 = OFF

SWITCHING SEQUENCE

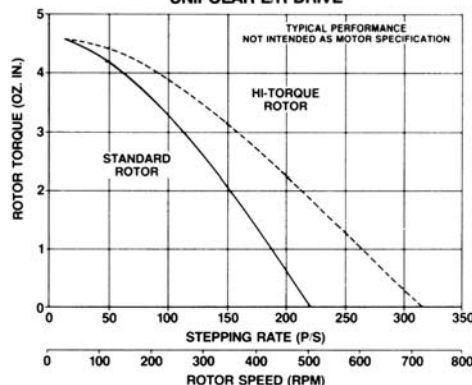
# SAS & SBS Stepper Motor



MODELS SAS 4003-002 and SAS 4019-001  
UNIPOLAR L/R DRIVE



MODEL SBS 4007-002  
UNIPOLAR L/R DRIVE



## Motor Specification - Direct Drive

Model	Part Number	Step Angle (degrees)	Steps per Rev	Rated Torque @ 175 p/s (oz-in)	Torque @ 4-5 p/s (oz-in)	Holding Torque (2 Phase Energized) (oz-in)	Output Speed @ 200 p/s (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Rotor Inertia (oz-in <sup>2</sup> )	Full Load Temp. Rise (°C)	Weight (oz)
SAS	4003-004	7.5	48	4.8	7.5	10.5	250	8	5	6.25	0.17	65	8
SAS	4003-001	7.5	48	4.8	7.5	10.5	250	8	6	9	0.17	65	8
SAS	4003-002	7.5	48	4.8	7.5	10.5	250	8	12	36	0.17	65	8
SAS	4003-003	7.5	48	4.8	7.5	10.5	250	8	24	144	0.17	65	8
SAS-ET	4019-004	7.5	48	4.9	9	11.9	250	8	5	6.25	0.17	65	8
SAS-ET	4019-001	7.5	48	4.9	9	11.9	250	8	12	36	0.17	65	8
SAS-ET	4020-002	7.5	48	4.9	9	11.9	250	8	12	36	0.17	65	8
SBS	4007-002	15	24	2.2	4.6	8	500	8	12	36	0.17	65	8
SBS	4007-003	15	24	2.2	4.6	8	500	8	24	144	0.17	65	8

## Motor Specification - Geared

Model	Part Number	Step Angle (degrees)	Steps per Rev	Reduction	Rated Torque @ 175 p/s (oz-in)	Output Speed @ 200 p/s (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Weight (oz)
SAS	4004-026	0.25	1440	30	101	8.33	8	6	9	16
SAS	4004-021	0.025	14400	300	200	0.83	8	6	9	16
SAS	4004-019	3.75	96	2	7	125	8	12	36	16
SAS	4004-014	0.75	480	10	36	25	8	12	36	16
SAS	4004-012	0.5	720	15	54	16.67	8	12	36	16
SAS	4004-010	0.25	1440	30	101	8.33	8	12	36	16
SAS	4004-009	0.2	1800	37.5	126	6.67	8	12	36	16
SAS	4004-006	0.1	3600	75	162	3.33	8	12	36	16
SAS	4004-004	0.05	7200	150	185	1.67	8	12	36	16
SAS	4004-002	0.025	14400	300	200	0.83	8	12	36	16
SAS	4004-001	0.0125	28800	600	200	0.42	8	12	36	16
SAS	4004-025	0.75	480	10	36	25	8	24	144	16
SAS	4004-027	0.1	3600	75	162	3.33	8	24	144	16
SAS-ET	4024-003	0.2	1800	37.5	126	6.67	8	12	36	16
SBS	4008-020	0.2	1800	75	107	6.67	8	6	9	16
SBS	4008-019	7.5	48	2	3	250	8	12	36	16
SBS	4008-012	1	360	15	23	33.33	8	12	36	16
SBS	4008-010	0.5	720	30	46	16.67	8	12	36	16
SBS	4008-006	0.2	1800	75	107	6.67	8	12	36	16
SBS	4008-002	0.05	7200	300	200	1.67	8	12	36	16

Note: Contact Hurst Mfg for additional voltages and reductions.

# TS Stepper Motor

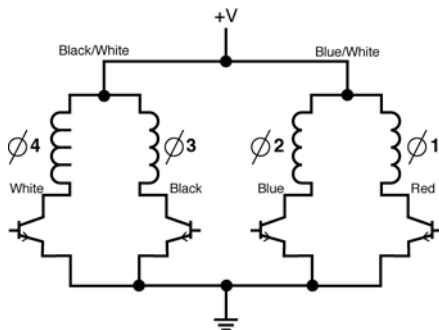
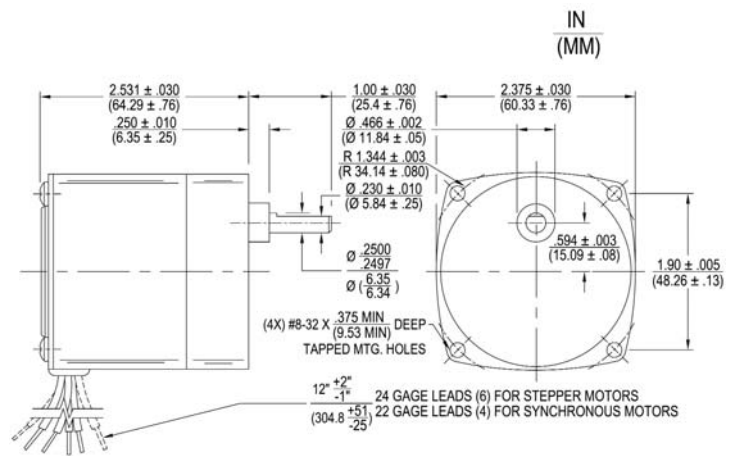
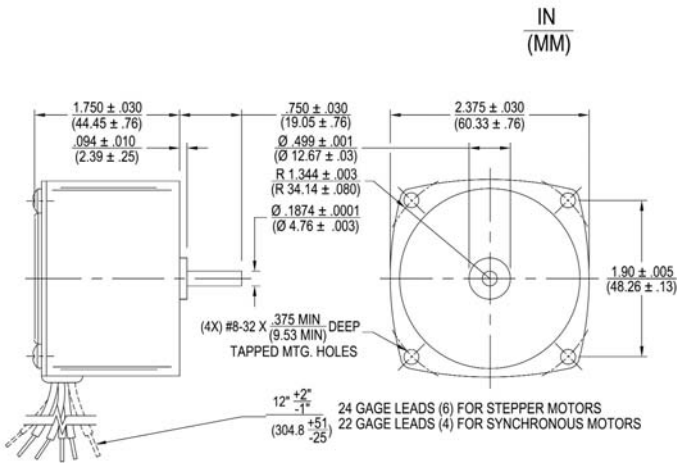


## TS Specifications

Step Angle: 7.5°  
 Torque Ratings: Up to 250 oz-in  
 Positional Accuracy: ± 5% max.  
 Number of Phases: 4 phase bifilar  
 Insulation Class: Class A (105°C)  
 Lead wire: 6 leads 24AWG (approx. 12 in.)  
 Operation Ambient Temp: -10° C ~ +40° C  
 Shaft bearing: Sleeve bearing  
 Gear Unit: Zinc Die Cast—AGMA 7 Standard with hardened steel gears  
 Note: Typical Data subject to change without notification.

## TS - Direct Drive

## TS - Geared Drive

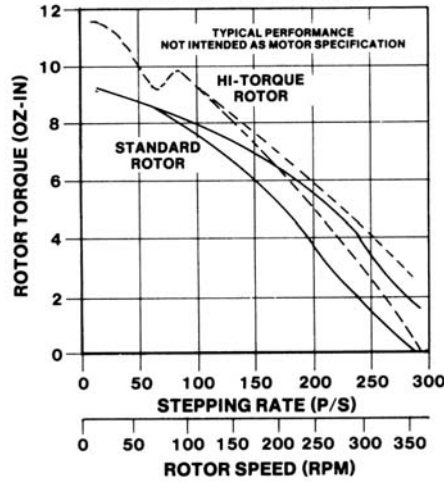


	Ø4 White	Ø3 Black	Ø2 Blue	Ø1 Red	
↑ CCW ROTATION	1	0	1	0	↓ CW ROTATION
	1	0	0	1	
	0	1	0	1	
	0	1	1	0	

1 = ON, 0 = OFF

SWITCHING SEQUENCE

MODELS TS 2605-001 AND TS 2610-002  
UNIPOLAR L/R DRIVE



## Motor Specification - Direct Drive

Model	Part Number	Step Angle (degrees)	Steps per Rev.	Rated Torque @ 175 p/s (oz-in)	Torque @ 4-5 p/s (oz-in)	Holding Torque (2 Phase Energized) (oz-in)	Output Speed @ 200 p/s (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Rotor Inertia (oz-in <sup>2</sup> )	Full Load Temp. Rise (°C)	Weight (oz)
TS	2605-002	7.5	48	3.6	8.5	14	250	8.5	6	9.8	0.34	52	20
TS-ET	2610-002	7.5	48	5.4	10.4	15.5	250	8.5	12	31	0.34	40	20

## Motor Specification - Geared

Model	Part Number	Step Angle (degrees)	Steps per Rev.	Reduction	Rated Torque @ 175 p/s (oz-in)	Output Speed @ 200 p/s (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Weight (oz)
TS	2606-013	0.1	3600	30	76	8.3	8.5	6	9.8	27
TS	2606-012	0.1	3600	75	176	3.3	8.5	6	9.8	27
TS	2606-010	0.025	14400	300	250	0.83	8.5	6	9.8	27
TS	2606-009	3.75	96	2	7	125	8.5	12	31	27
TS	2606-008	1.8	200	4.17	14	60	8.5	12	31	27
TS	2606-007	0.75	480	10	35	25	8.5	12	31	27
TS	2606-006	0.6	600	12.5	40	20	8.5	12	31	27
TS	2606-005	0.375	960	20	64	12.5	8.5	12	31	27
TS	2608-001	0.25	1440	30	78	8.3	8.5	12	31	27
TS	2606-004	0.25	1440	30	97	8.3	8.5	12	31	27
TS	2606-003	0.1	3600	75	218	3.1	8.5	12	31	27
TS	2606-042	0.075	4800	100	233	2.5	8.5	12	31	27
TS	2606-002	0.05	7200	150	240	1.67	8.5	12	31	27
TS	2606-001	0.025	14400	300	250	0.83	8.5	12	31	27
TS	2606-045	1.8	200	4.17	14	60	8.5	24	135	27
TS	2606-033	0.25	1440	30	76	8.3	8.5	24	135	27
TS	2606-044	0.025	14400	300	250	0.83	8.5	24	135	27

Note: Contact Hurst Mfg for additional voltages and reductions.

## Permanent Magnet Synchronous Motor Application Notes

The Hurst permanent magnet synchronous motors are reversible permanent-split capacitor motors identical in construction to the Hurst stepping motors. In operation the permanent magnet rotor poles lock-in with the effectively rotating stator field and the motor runs at synchronous speed. The 60 Hz can-stack motors operate at synchronous speeds of 300 and 600 RPM. High quality gearing is available for the can-stack motors.

The ceramic rotor magnet material provides a relatively high flux resulting in a good torque to size ratio at moderate cost. In addition the permanent magnet construction provides inherent dynamic braking and low rotor speed for quiet operation and rapid acceleration.

The disadvantages of permanent magnet motors are a limited ability to accelerate inertial loads and a high sensitivity to the parameters of voltage and phasing capacitor. The first of these problems may be minimized by gearing or in some cases flexible couplings. The sensitivity to voltage and phasing capacitor directly affects the directional reliability of both starting and running under load. In Hurst motor designs directional reliability is a primary consideration and is assured when motors are operated with the recommended capacitor within a voltage range of  $\pm 10\%$  of nominal.

### Variable Frequency Operation of AC Motor

Sometimes a single motor is specified for both 50 and 60 Hz operation. Since inductive reactance and capacitive reactance vary dissimilarly with frequency, optimum performance must usually be compromised when a single winding/capacitor combination is operated at different frequencies. Some types of motors are more sensitive than others to frequency changes. As a general rule synchronous motors and especially permanent magnet motors are more sensitive than induction motors. The factory should be consulted before 50/60Hz operation of a motor is planned. Operation over a wider frequency range is extremely difficult to accomplish with capacitor phased motors and is not recommended. Reliable operation requires a two phase power supply with applied voltage a function of frequency.

### Applying 50Hz to synchronous motors design

Permanent magnet synchronous motors designed for optimum performance at 60Hz will be directionally un-reliable when operated at 50Hz. Rated torque will be 20% to 25% lower at 50Hz. Additionally, the output speed will be 5/6 the speed while applying 50Hz to the motor.

By increasing the capacitor value of the recommended capacitor by 30%, 50Hz may be applied to 60Hz motors without sacrificing reliability. 50Hz torque will be approximately 5% less than rated 60Hz torque.

### Why Capacitor Start AC Synchronous Motors?

All Permanent Magnet AC Synchronous motors manufactured at Hurst are of the capacitor start variation. These motors, which are classified in the sub-fractional group, find various applications in situations requiring frequent and prolonged starting periods. As the name suggest these motors run at synchronous speed. The speed of a single phase AC synchronous motor can be determined using the formula Synchronous speed (in RPM) =  $120f/p$  where  $f$  is the frequency of the power supply &  $p$  is the # of poles For the same starting torque, the capacitor motor when compared to the split-phase motor requires half of the current for starting. The auxiliary winding of the capacitor motor has twice the number of turns of the split-phase AC motor. A split phase AC motor basically has an inductive auxiliary winding. The lesser current in the auxiliary winding of the capacitor motor results in less copper loss and subsequently less heat generated by that motor. Because of the capacitor in the winding, the capacitor motor has the advantage of a greater phase shift between the current of the stator winding and that of the auxiliary winding. Phase shift is typically about 80% compared to 20% for the split-phase motor. The increased phase shift translates into easier starting for the capacitor start motor.

### Starting & Stopping Characteristics

Virtually instant starting and stopping characteristics are among the principal advantages of an AC Synchronous motor. Generally, the motor will start within 1 1/2 cycles of the applied frequency and will stop within 5 mechanical degrees. The motor will start and reach its full synchronous speed within 5 to 25 milliseconds. The unusually short stopping distance of an AC Synchronous motor is obtained by simply de-energizing the motor. No mechanical or electrical braking is necessary. The quick stopping is the result of the slow rotor speed and the presence of a no-load reluctance torque produced by the permanent magnet and the tooth construction of the stator and rotor.

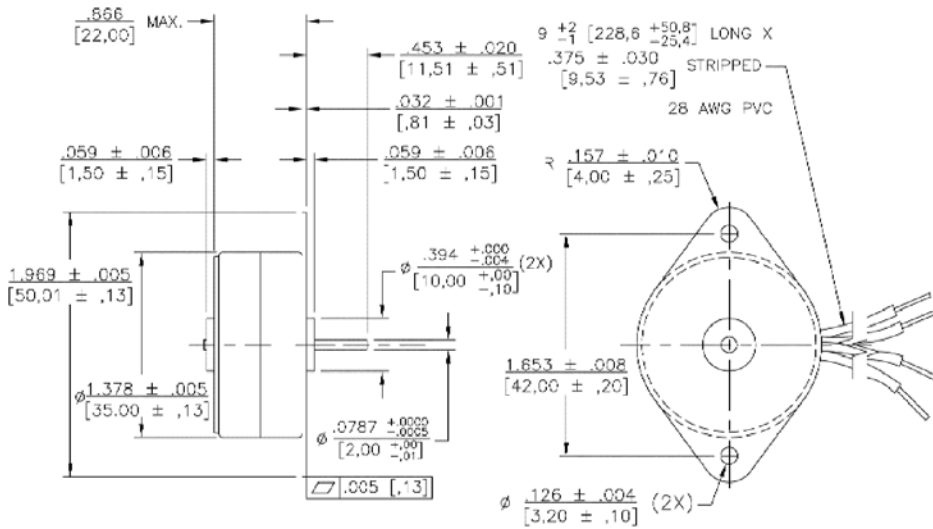


## LY35MM Specifications

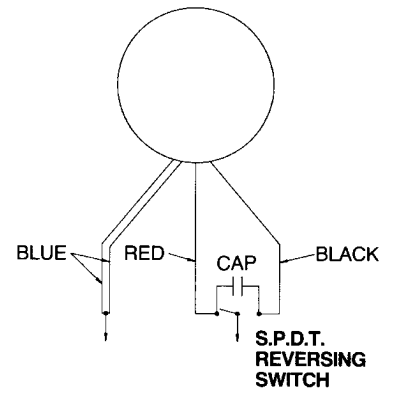
Torque Range:	Up to 150 oz-in
Output Speed:	1 to 300 RPM
Standard Voltages:	115VAC & 24VAC 50/60Hz
Insulation Class:	UL Class A (105°C)
Dielectric Strength:	1200 VAC/Sec.
Lead wire:	4 leads 28AWG (approx. 9 in.)
Operation Ambient Temp:	-10°C ~ +40°C
Gear Unit:	Zinc Die Cast—AGMA7 Standard with hardened steel gears
Shaft Bearings:	Sleeve bearings
C-UL Recognized:	E174872, Component-Impedance Protected Motors
	115V Standard Rotor

Capacitor is required for operation. Capacitor supplied with 115VAC motors  
 Note: Typical data subject to change without notification.

## LY35MM Direct Drive

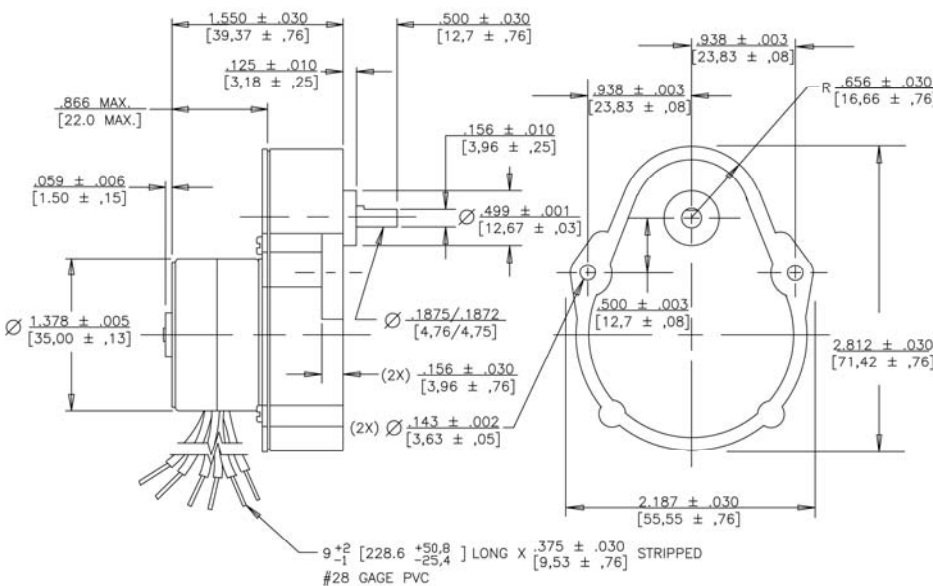


## WIRING DIAGRAM



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

## LY35MM Geared Drive



# LY 35MM Synchronous Motors



## LY35MM Options

Example: LY G 35 115 E02 P

	Motor Family	Gearing	Motor Size	Voltage	Gear Ratio	Gear Box
Options	LY	D=Direct Drive G=Geared	35=35MM 42=42MM	024=24VAC 50/60Hz 115=115VAC 50/60Hz	Gear Options	P=Peer-Shaped Gearbox

## Motor Specification - Direct Drive

Model	Hurst Part-Number	Minimum Torque oz-in (gf-cm)	Output Speed (RPM)	Input Power (watts)	Nominal Voltage (VAC) 50/60 HZ	Winding Resistance (ohms)	Inductance mH/Phase	Capacitor Value MFD	Capacitor not supplied	Weight oz (g)	Length (L) in (mm)
LY35	LYD35024D	2.3 (100)	250/300	2	24	316	0.368	4.0, 100VDC +/-5%	X	3.5 (100)	0.866 (22)
LY35	LYD35115D	2.3 (100)	250/300	2.5	115	6115	5.4	0.25, 400VDC +/-5%		3.5 (100)	0.866 (22)

## Motor Specification - Geared

Model	Part Number	Reduction	Minimum Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Nominal Voltage (VAC) 60 Hz	Winding Resistance (ohms)	Inductance mH/Phase	Capacitor Value MFD	Weight (oz)	Length (L) (in)
LYG35	LYG35115E02P	1 2/3	3	180.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E04P	2	3	150.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E06P	2 1/12	3	144.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E08P	2 1/2	4	120.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E10P	3	5	100.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E12P	3 1/3	5	90.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E16P	4	6	75.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E18P	4 1/6	7	72.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E20P	5	8	60.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E22P	6 1/4	10	48.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E24P	7 1/2	12	40.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E28P	8 1/3	13	36.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E30P	10	16	30.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E34P	12	19	25.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E36P	12 1/2	20	24.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E38P	13 1/3	21	22.5	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E40P	15	24	20.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E42P	16	26	18.8	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E44P	16 2/3	27	18.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F46P	20	29	15.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F48P	20 5/6	31	14.4	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F50P	25	37	12.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F52P	30	44	10.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F54P	31 1/4	46	9.6	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F56P	33 1/3	49	9.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F58P	37 1/2	55	8.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F60P	40	59	7.5	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F62P	41 2/3	61	7.2	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F64P	50	74	6.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F66P	54	79	5.6	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F68P	56 1/4	83	5.3	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F70P	60	88	5.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F72P	62 1/2	92	4.8	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F74P	66 2/3	98	4.5	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F76P	75	110	4.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F78P	80	118	3.8	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F80P	83 1/3	123	3.6	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E82P	100	120	3.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E84P	112 1/2	135	2.7	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E86P	120	144	2.5	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E88P	125	150	2.4	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E90P	150	150	2.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E96P	250	150	1.2	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115E98P	300	150	1.0	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55
LYG35	LYG35115F99P	900	150	0.3	2.5	115	6115	5.4	0.25, 400VDC +/-5%	9.2	1.55

Note 1: Contact Hurst Mfg for additional voltages and reductions.  
 Note 2: Motors will also operate at 50Hz but will run at a slower speed.  
 Note 3: DC Capacitors must be non-polarized. Electrolytic types are not suitable.



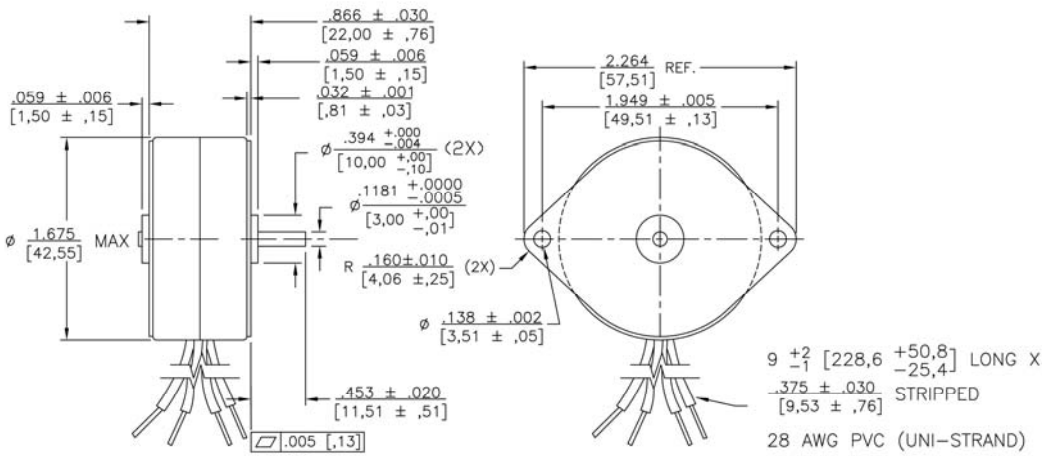




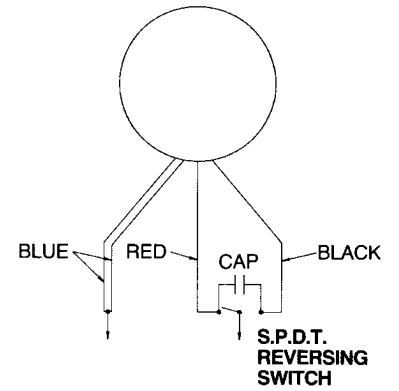
## LY42MM Specifications

Torque Range:	Up to 150 oz-in
Output Speed:	1 to 300 RPM
Standard Voltages:	115VAC & 24VAC 50/60Hz
Insulation Class:	ULClass A (105°C)
Dielectric Strength:	1200 VAC/Sec.
Lead wire:	4 leads 28AWG (approx. 9 in.)
Operation Ambient Temp:	-10°C ~ +40°C
Gear Unit: Zinc Die Cast—AGMA7	Standard with hardened steel gears
Shaft Bearings:	Sleeve bearings
C-UL Recognized:	E174872, Component-Impedance Protected Motors
	115V Standard Rotor
Capacitor is required for operation. Capacitor supplied with 115VAC motors	
Note: Typical data subject to change without notification.	

### LY42MM Direct Drive

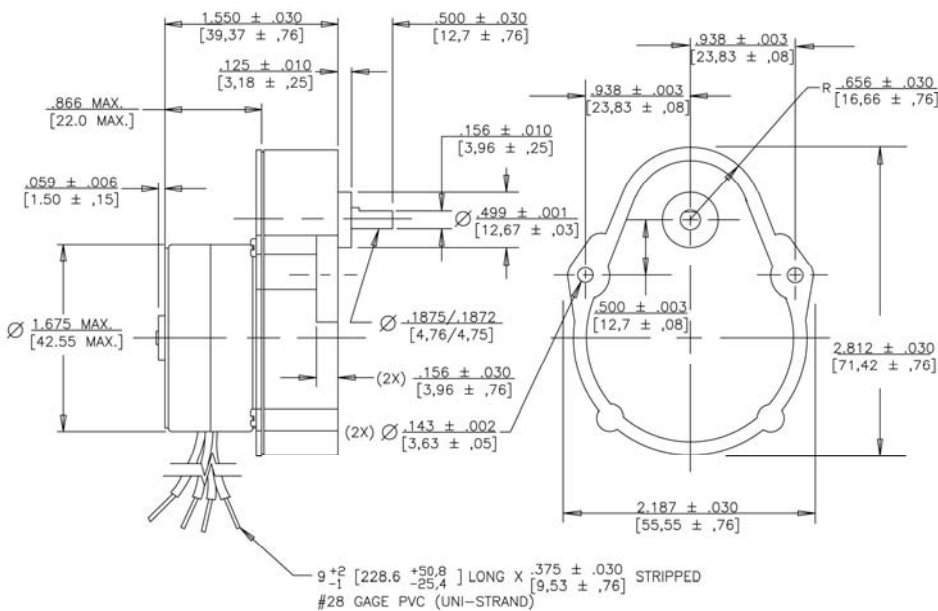


### WIRING DIAGRAM



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

### LY42MM Geared Drive



# LY 42MM Synchronous Motors



## LY 42 Options

Example: LY G 42 115 E02 P

	Motor Family	Gearing	Motor Size	Voltage	Gear Ratio	Gear Box
Options	LY	D=Direct Drive G=G geared	35=35MM 42=42MM	024=24VAC 50/60Hz 115=115VAC 50/60Hz	Gear Options	P=Pear-Shaped Gearbox

## Motor Specification - Direct Drive

Model	Hurst Part-Number	Minimum Torque oz-in (af-cm)	Output Speed (RPM)	Input Power (watts)	Nominal Voltage (VAC) 50/60 HZ	Winding Resistance (ohms)	Inductance mH/Phase	Capacitor Value MFD	Capacitor not supplied	Weight oz (g)	Length (L) in (mm)
LY42	LYD42024D	4 (288)	250/300	4	24	160	0.211	10, 100VDC +/-5%	X	4.8 (135)	0.866 (22)
LY42	LYD42115D	4 (288)	250/300	4	115	3700	4.7	0.39, 400VDC +/-5%		4.8 (135)	0.866 (22)

## Motor Specification - Geared

Model	Part Number	Reduction	Minimum Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Nominal Voltage (VAC) 60Hz	Winding Resistance (ohms)	Inductance mH/Phase	Capacitor Value MFD	Weight (oz)	Length (L) (in)
LYG42	LYG42115E02P	1 2/3	5	180.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E04P	2	6	150.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E06P	2 1/12	6	144.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E08P	2 1/2	7	120.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E10P	3	8	100.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E12P	3 1/3	9	90.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E16P	4	11	75.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E18P	4 1/6	12	72.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E20P	5	14	60.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E22P	6 1/4	18	48.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E24P	7 1/2	21	40.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E28P	8 1/3	23	36.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E30P	10	28	30.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E34P	12	34	25.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E36P	12 1/2	35	24.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E38P	13 1/3	37	22.5	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E40P	15	42	20.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E42P	16	45	18.8	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E44P	16 2/3	47	18.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F46P	20	51	15.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F48P	20 5/6	53	14.4	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F50P	25	64	12.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F52P	30	77	10.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F54P	31 1/4	80	9.6	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F56P	33 1/3	85	9.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F58P	37 1/2	96	8.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F60P	40	102	7.5	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F62P	41 2/3	107	7.2	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F64P	50	128	6.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F66P	54	138	5.6	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F68P	56 1/4	144	5.3	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F70P	60	150	5.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F72P	62 1/2	150	4.8	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F74P	66 2/3	150	4.5	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F76P	75	150	4.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F78P	80	150	3.8	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F80P	83 1/3	150	3.6	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E82P	100	150	3.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E84P	112 1/2	150	2.7	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E86P	120	150	2.5	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E88P	125	150	2.4	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E90P	150	150	2.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E96P	250	150	1.2	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115E98P	300	150	1.0	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55
LYG42	LYG42115F99P	900	150	0.3	4	115	3700	4.7	0.39, 400VDC +/-5%	10.2	1.55

Note 1: Contact Hurst Mfg for additional voltages and reductions.

Note 2: Motors will also operate at 50Hz but will run at a slower speed.

Note 3: DC Capacitors must be non-polarized. Electrolytic types are not suitable.

Contact Hurst at 812-385-2564 or Fax: 812-386-7504 [www.hurstmfg.com](http://www.hurstmfg.com)

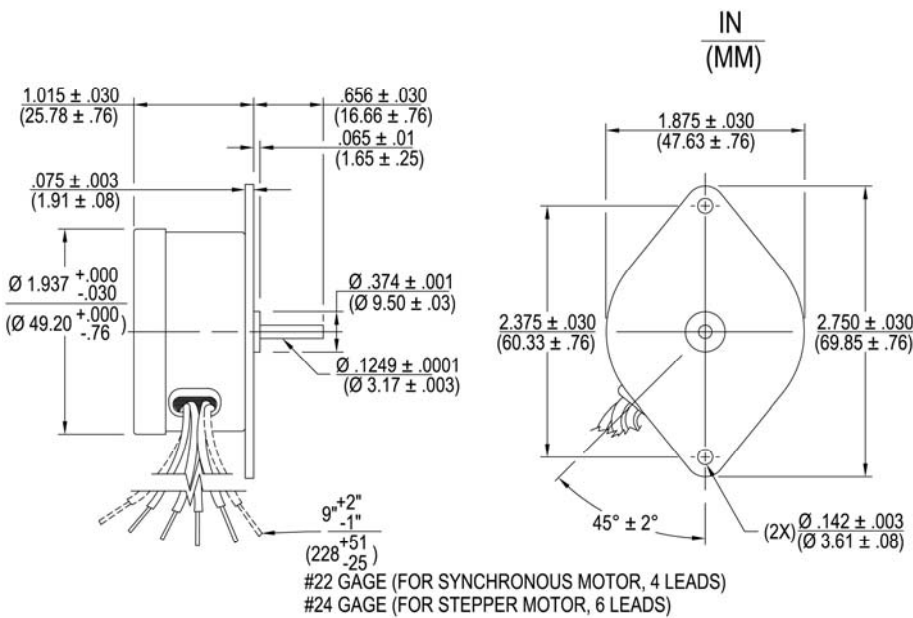




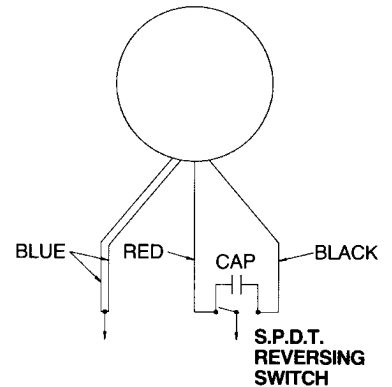
## A,AB Specifications

Torque Range: Up to 150 oz-in  
 Output Speed: 1 to 600 RPM  
 Insulation Class: UL Class A (105°C)  
 Lead wire: 4 leads 22AWG (approx. 9 in.)  
 Operation Ambient Temp: -10°C ~ +40°C  
 Shaft Bearings: Sleeve bearings  
 Gear Unit: Zinc Die Cast—AGMA7 Standard with hardened steel gears  
 UL Recognized: E37163, Component-Time- Indicating and Recording Appliances  
 115V, 60 Hz Standard Rotor  
 CSA Certified: Card No. 42576, Motors and Generators  
 115V, 60 Hz, Standard Rotor, 3 watts max.  
 Capacitor is required for operation. Capacitor supplied with 115VAC motors.  
 Note: Typical data subject to change without notification

## A,AB - Direct Drive

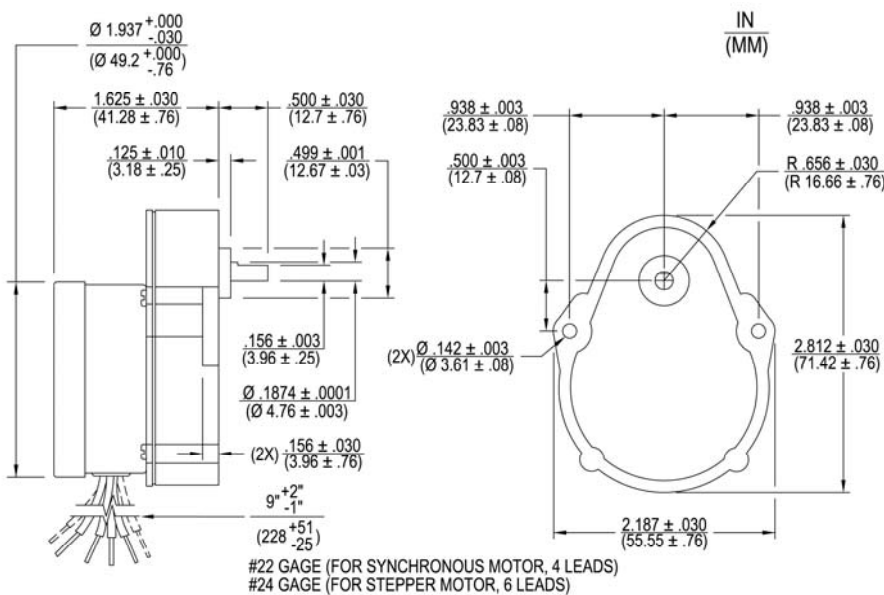


## WIRING DIAGRAM



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

## A,AB - Geared Drive



# A & AB Synchronous Motors



## Motor Specification - Direct Drive

Model	Part Number	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 50HZ	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Capacitor not supplied	Weight (oz)
A	3001-003	2	300	3		24	21	5.7, 100VDC, +/- 10%	X	6.8
A	3001-001	2	300	3		115	21	0.25, 400VDC, +/-10%		6.8
A	3001-005	2	300	3		230	21	0.062, 440VAC, +/-	X	6.8
A-ET	3009-002	2.7	300	3		24	21	5.7, 100VDC, +/- 10%	X	6.8
A-ET	3009-001	2.7	300	3		115	21	0.25, 400VDC, +/-10%		6.8
AB	3005-003	2.3	600	5		24	36	10, 100VDC, +/- 10%	X	6.8
AB	3005-001	2.3	600	5		115	36	0.50, 400VDC, +/-		6.8
AB	3005-004	2.8	500	4	220		36	0.15, 440VAC, +/-	X	6.8
AB-ET	3011-001	3.75	600	6.5		115	43	0.62, 400VDC +/-10%		6.8

## Motor Specification - Geared

Model	Part Number	Reduction	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 60HZ	Capacitor Value (mfd)	Weight (oz)
A	3002-020	2.5	4	120	3	115	0.25, 400VDC, +/-10%	11
A	3002-016	5	8	60	3	115	0.25, 400VDC, +/-10%	11
A	3002-027	7.5	12	40	3	115	0.25, 400VDC, +/-10%	11
A	3002-015	10	16	30	3	115	0.25, 400VDC, +/-10%	11
A	3002-013	15	24	20	3	115	0.25, 400VDC, +/-10%	11
A	3002-010	25	37	12	3	115	0.25, 400VDC, +/-10%	11
A	3002-009	30	44	10	3	115	0.25, 400VDC, +/-10%	11
A	3002-008	37.5	55	8	3	115	0.25, 400VDC, +/-10%	11
A	3002-007	50	74	6	3	115	0.25, 400VDC, +/-10%	11
A	3002-006	60	88	5	3	115	0.25, 400VDC, +/-10%	11
A	3002-005	75	110	4	3	115	0.25, 400VDC, +/-10%	11
A	3002-004	100	120	3	3	115	0.25, 400VDC, +/-10%	11
A	3002-003	150	131	2	3	115	0.25, 400VDC, +/-10%	11
A	3002-002	200	138	1.5	3	115	0.25, 400VDC, +/-10%	11
A	3002-001	300	150	1	3	115	0.25, 400VDC, +/-10%	11
A	3002-025	600	150	0.5	3	115	0.25, 400VDC, +/-10%	11
A	3002-023	900	150	0.33	3	115	0.25, 400VDC, +/-10%	11
A-ET	3014-012	5	10	60	3	115	0.25, 400VDC, +/-10%	11
A-ET	3014-010	10	19	30	3	115	0.25, 400VDC, +/-10%	11
A-ET	3014-008	15	29	20	3	115	0.25, 400VDC, +/-10%	11
A-ET	3014-005	25	44	12	3	115	0.25, 400VDC, +/-10%	11
AB	3006-019	2	3	300	5	115	0.50, 400VDC, +/-10%	11
AB	3006-017	3	5	200	5	115	0.50, 400VDC, +/-10%	11
AB	3006-016	3.5	5	180	5	115	0.50, 400VDC, +/-10%	11
AB	3006-014	5	8	120	5	115	0.50, 400VDC, +/-10%	11
AB	3006-013	10	16	60	5	115	0.50, 400VDC, +/-10%	11
AB	3006-012	12	19	50	5	115	0.50, 400VDC, +/-10%	11
AB	3006-011	15	24	40	5	115	0.50, 400VDC, +/-10%	11
AB	3006-010	16.67	27	36	5	115	0.50, 400VDC, +/-10%	11
AB	3006-009	20	29	30	5	115	0.50, 400VDC, +/-10%	11
AB	3006-007	30	44	20	5	115	0.50, 400VDC, +/-10%	11
AB	3006-061	40	59	15	5	115	0.50, 400VDC, +/-10%	11
AB	3006-005	50	73	12	5	115	0.50, 400VDC, +/-10%	11
AB	3006-004	60	88	10	5	115	0.50, 400VDC, +/-10%	11
AB	3006-002	100	105	6	5	115	0.50, 400VDC, +/-10%	11
AB-ET	3013-019	2	5	300	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-017	3	8	200	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-016	3.33	9	180	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-014	5	13	120	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-001	10	26	60	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-012	12	32	50	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-009	20	48	30	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-008	25	60	24	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-007	30	72	20	6.5	115	0.62, 400VDC +/-10%	11
AB-ET	3013-002	60	95	10	6.5	115	0.62, 400VDC +/-10%	11

Note: Contact Hurst Mfg for additional voltages and reductions.

## Capacitor Table

VOLTAGE FREQUENCY	115 V. 60 Hz.	115 V. 50 Hz.	24 V. 60 Hz.	24 V. 50 Hz.	220 V. 60 Hz.	220 V. 50 Hz.	230 V. 60 Hz.	230 V. 50 Hz.	240 V. 60 Hz.	240 V. 50 Hz.
Model A	.25 MFD 400 VDC ±10%	.25 MFD 400 VDC +10%	5.6 MFD 100 VDC +10%	5.6 MFD 100 VDC +10%	.068 MFD 440 VAC +10%	.068 MFD 440 VAC +10%	.062 MFD 440 VAC +10%	.062 MFD 440 VAC +10%	.056 MFD 440 VAC +10%	.056 MFD 440 VAC +10%
Model A High Torque	.25 MFD 400 VDC ±10%		5.6 MFD 100 VDC ±5%		.068 MFD 440 VAC ±5%		.062 MFD 440 VAC ±5%		.056 MFD 440 VAC ±5%	
Model AB	.50 MFD 400 VDC ±10%	.50 MFD 400 VDC ±10%	10 MFD 100 VDC ±10%	10 MFD 100 VDC ±10%	.15 MFD 440 VAC ±10%	.15 MFD 440 VAC ±10%	.12 MFD 440 VAC ±5%	.12 MFD 440 VAC ±5%	.12 MFD 440 VAC ±5%	.12 MFD 440 VAC ±5%
Model AB High Torque	.62 MFD 400 VDC ±10%		15 MFD 100 VDC ±5%		.18 MFD 440 VAC ±5%		.15 MFD 440 VAC ±5%		.15 MFD 440 VAC ±5%	

Capacitors are furnished with 115V 60Hz motors

Note: DC Capacitors must be non-polarized. Electrolytic types are not suitable.

Contact Hurst at 812-385-2564 or Fax: 812-386-7504 [www.hurstmfg.com](http://www.hurstmfg.com)

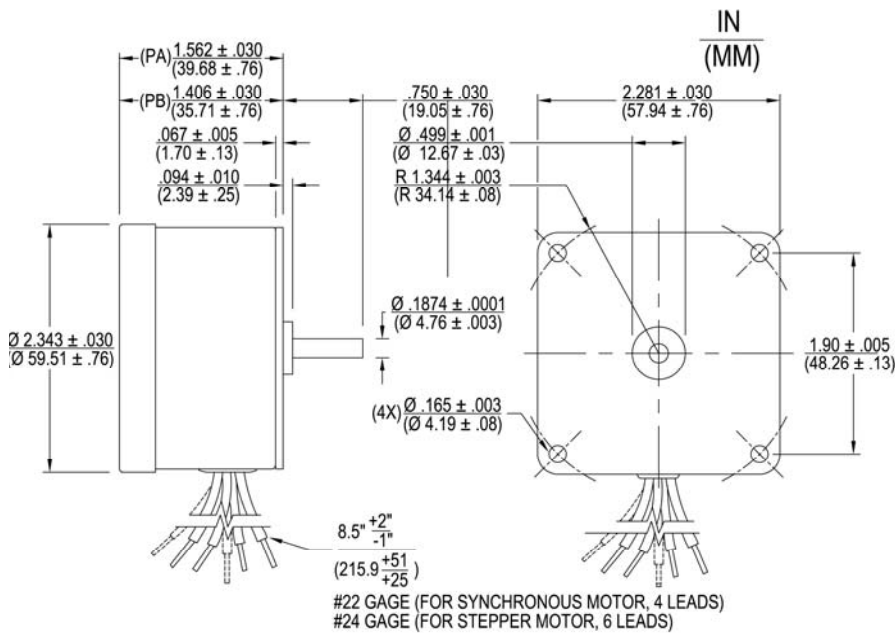




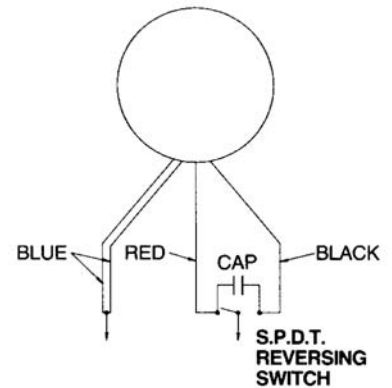
## PA,PB - Specifications

Torque Range: Up to 200 oz-in  
 Output Speed: 1 to 600 RPM  
 Insulation Class: UL Class A (105°C)  
 Lead wire: 4 leads 22AWG (approx 8 1/2 in.)  
 Operation Ambient Temp: -10°C ~ +40°C  
 Gear Unit: Zinc Die Cast—AGMA7 Standard with hardened steel gears  
 Shaft Bearings: Sleeve bearings  
 UL Recognized: E53578(N), Component-Impedance Protected Motors  
 115V, 60Hz Standard Rotor  
 CSA Certified: Card No. 42576, Motors and Generators  
 115V, 60 Hz, Standard Rotor, 7.5 watts max. PA, 10 watts max PB  
 Capacitor is required for operation. Capacitor supplied with 115VAC motors  
 Note: Typical data subject to change without notification.

## PA,PB - Direct Drive

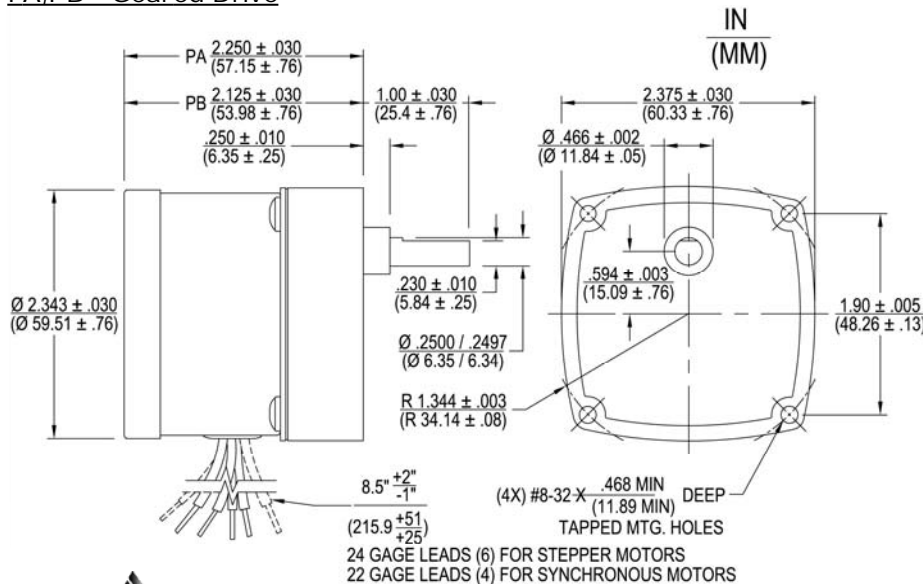


## WIRING DIAGRAM



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation. For dual speed versions switching the current produces a change in speed but not in direction of rotation. Direction of rotation must be specified separately.

## PA,PB - Geared Drive



# PA & PB Synchronous Motors



## Motor Specification - Direct Drive

Model	Part Number	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 50HZ	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Capacitor not supplied	Weight (oz)
PA	3201-004	8.5	300	7.5		24	31	15, 100VDC +/-10%	X	13
PA	3201-001	8.5	300	7.5		115	31	0.68, 400VDC +/-10%		13
PA	3228-001	11	300	9.5		115	42	0.85, 250VAC +/- 5%		13
PA	3236-001	11	300	9.5		115	42	0.85, 250VAC +/- 5%		13
PA	3228-004	12.25	250	11	115		42	0.85, 250VAC +/- 5%		13
PA	3201-003	8.5	250	6	220		31	0.18, 440VAC +/-10%	X	13
PA	3228-003	12.25	250	11	220		42	0.22, 440VAC +/-10%	X	13
PB	3203-001	5.5	600	10		115	44	0.82, 400VDC +/-10%		13
PB	3230-001	7.5	600	11		115	45	1.0, 250VAC +/-10%		13
PB	3203-007	6.6	500	10	230		44	0.25, 440VAC +/-10%	X	13
PB	3203-006	6.6	500	10	240		44	0.22, 440VAC +/-10%	X	13

## Motor Specification - Geared

Model	Part Number	Reduction	Rated Torque (oz-in)	Output Speed (RPM)	Maximum gear train loading	Input Power (watts)	Voltage (VAC) 50HZ	Voltage (VAC) 60HZ	Capacitor Value (mfd)	Weight (oz)
PA	3232-007	2.5	20.5	120		9.5		115	0.85, 250VAC +/- 5%	18
PA	3202-026	5	32	60		7.5		115	0.68, 400VDC +/-10%	18
PA	3232-004	5	41	60		9.5		115	0.85, 250VAC +/- 5%	18
PA	3202-024	10	64	30		7.5		115	0.68, 400VDC +/-10%	18
PA	3232-003	10	82.5	30		9.5		115	0.85, 250VAC +/- 5%	18
PA	3202-070	15	89	20		7.5		115	0.68, 400VDC +/-10%	18
PA	3202-020	16.67	99	18		7.5		115	0.68, 400VDC +/-10%	18
PA	3202-019	20	116	15		7.5		115	0.68, 400VDC +/-10%	18
PA	3202-017	30	126	10	X	7.5		115	0.68, 400VDC +/-10%	18
PA	3202-014	50	140	6	X	7.5		115	0.68, 400VDC +/-10%	18
PA	3202-011	75	152	4	X	7.5		115	0.68, 400VDC +/-10%	18
PA	3202-007	150	174	2	X	7.5		115	0.68, 400VDC +/-10%	18
PA	3202-003	300	200	1	X	7.5		115	0.68, 400VDC +/-10%	18
PA	3202-001	600	200	0.5		7.5		115	0.68, 400VDC +/-10%	18
PB	3204-033	1.67	6	360		10		115	0.82, 400VDC +/-10%	18
PB	3234-009	1.67	9.5	360		11		115	1.0, 250VAC +/-10%	18
PB	3234-008	2	11.25	300		11		115	1.0, 250VAC +/-10%	18
PB	3234-016	2.5	12	240		11		115	1.0, 250VAC +/-10%	18
PB	3204-029	3	12	200		10		115	0.82, 400VDC +/-10%	18
PB	3234-007	3	17	200		11		115	1.0, 250VAC +/-10%	18
PB	3204-026	5	20	120		10		115	0.82, 400VDC +/-10%	18
PB	3234-006	5	28	120		11		115	1.0, 250VAC +/-10%	18
PB	3234-004	8.5	47	72		11		115	1.0, 250VAC +/-10%	18
PB	3204-024	10	41	60		10		115	0.82, 400VDC +/-10%	18
PB	3234-003	10	56	60		11		115	1.0, 250VAC +/-10%	18
PB	3234-001	11	101	30	X	11		115	1.0, 250VAC +/-10%	18
PB	3204-022	12	49	50		10		115	0.82, 400VDC +/-10%	18
PB	3234-002	12	67	50		11		115	1.0, 250VAC +/-10%	18
PB	3204-019	20	77	30		10		115	0.82, 400VDC +/-10%	18
PB	3234-014	25	106	24		11		115	1.0, 250VAC +/-10%	18
PB	3204-017	30	110	20		10		115	0.82, 400VDC +/-10%	18
PB	3234-027	30	110	20		11		115	1.0, 250VAC +/-10%	18
PB	3204-050	40	116	15		10		115	0.82, 400VDC +/-10%	18
PB	3204-013	60	126	10		10		115	0.82, 400VDC +/-10%	18
PB	3204-009	100	140	6		10		115	0.82, 400VDC +/-10%	18
PB	3204-007	150	152	4		10		115	0.82, 400VDC +/-10%	18
PB	3204-003	300	174	2		10		115	0.82, 400VDC +/-10%	18
PB	3204-001	600	200	1		10		115	0.82, 400VDC +/-10%	18
PB	3204-046	8.33	41	60		10	115		1.0, 480VAC +/-10%	18
PB	3234-025	25	20	20		11	115		1.0, 250VAC +/-10%	18
PB	3204-041	50	126	10		10	115		1.0, 480VAC +/-10%	18

Note: Contact Hurst Mfg for additional voltages and reductions.

## Capacitor Table

VOLTAGE FREQUENCY	115 V. 60 Hz.	115 V. 50 Hz.	24 V. 60 Hz.	24 V. 50 Hz.	220 V. 60 Hz.	220 V. 50 Hz.	230 V. 60 Hz.	230 V. 50 Hz.	240 V. 60 Hz.	240 V. 50 Hz.
<b>Models</b>	.68 MFD	.68 MFD	15.0 MFD	15.0 MFD	.18 MFD	.18 MFD	.18 MFD	.18 MFD	.15 MFD	.15 MFD
<b>PA, LA, T</b>	400 VDC ±10%	400 VDC +10%	100 VDC +10%	100 VDC +10%	440 VAC +10%	440 VAC +10%	440 VAC +5%	440 VAC +5%	440 VAC +5%	440 VAC +5%
<b>Models</b>	.85 MFD		20 MFD		.22 MFD		.22 MFD		.20 MFD	
<b>PA, LA, T</b>	250 VAC ±5%		100 VDC ±5%		440 VAC ±5%		440 VAC ±5%		440 VAC ±5%	
<b>Models</b>	.82 MFD	1.0 MFD	18 MFD	22 MFD	.22 MFD	.27 MFD	.20 MFD	.25 MFD	.18 MFD	.22 MFD
<b>PB, LB</b>	400 VDC ±10%	480 VAC ±10%	100 VDC ±10%	100 VDC ±10%	440 VAC ±10%	440 VAC ±10%	440 VAC ±10%	440 VAC ±10%	440 VAC ±10%	440 VAC ±10%
<b>Models</b>	1.0 MFD		22 MFD		.27 MFD		.25 MFD		.22 MFD	
<b>PB, LB</b>	250 VAC ±10%		100 VDC ±10%		440 VAC ±10%		440 VAC ±5%		440 VAC ±10%	

Capacitors are furnished with 115V 60Hz motors

Note: DC Capacitors must be non-polarized. Electrolytic types are not suitable.

Contact Hurst at 812-385-2564 or Fax: 812-386-7504 www.hurstmfg.com

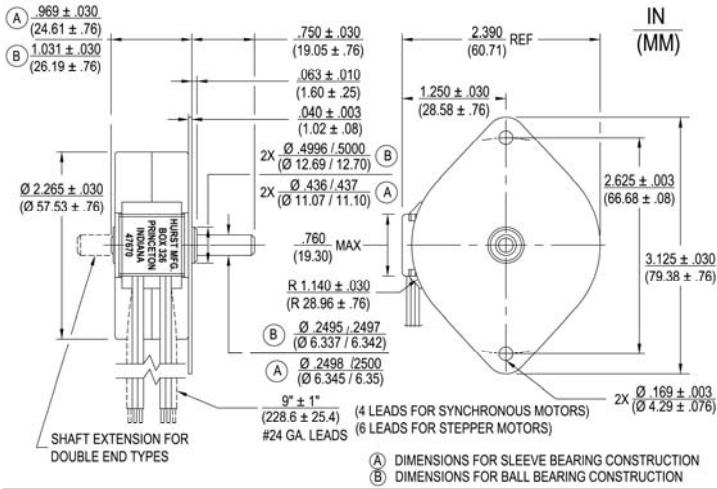




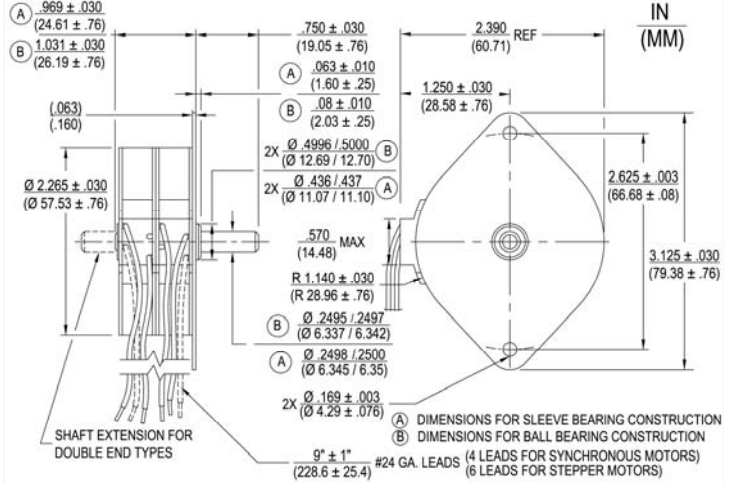
## SA,SB Specifications

Torque Range: Up to 200 oz-in  
 Output Speed: 1 to 600 RPM  
 Insulation Class: ULClass A (105°C)  
 Lead wire: 4 leads 24AWG (approx. 9 in.)  
 Operation Ambient Temp: -10°C ~ +40°C  
 Gear Unit: Zinc Die Cast—AGMA7 Standard with hardened steel gears  
 Shaft Bearings: Sleeve bearings  
 ULRecognized: E53578(N), Component-Impedance Protected Motors  
 115V, 60Hz Standard Rotor  
 CSACertified: Card No. 42576, Motors and Generators  
 115V, 60 Hz, 8.4 watts max. SA, 8.4 watts max SB  
 Capacitor is required for operation. Capacitor supplied with 115VAC motors  
 Note: Typical data subject to change without notification.

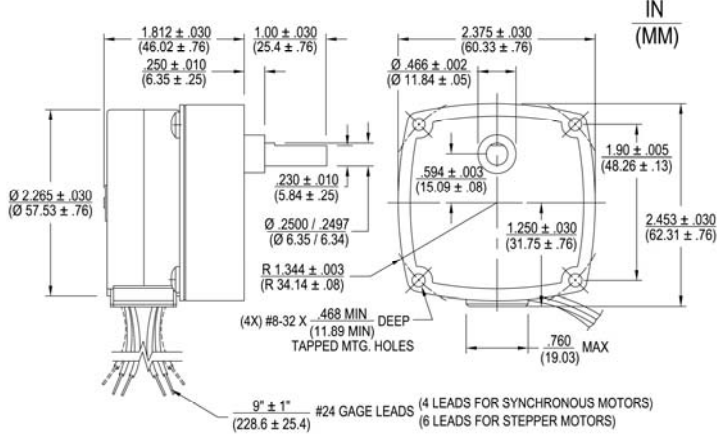
### SA - Direct Drive



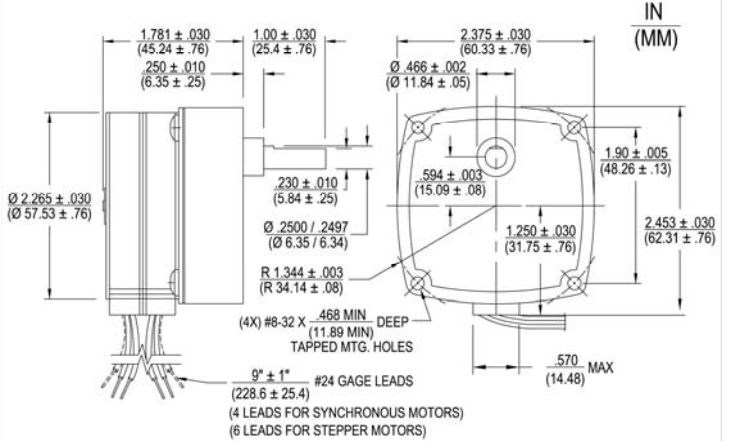
### SB - Direct Drive



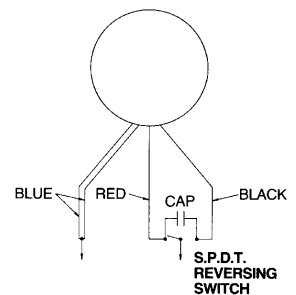
### SA - Geared Drive



### SB - Geared Drive



### WIRING DIAGRAM



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

# SA & SB Synchronous Motors



## Motor Specification - Direct Drive

Model	Part Number	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Capacitor not supplied	Shaft bearing	Weight (oz)
SA	4001-003	6	300	5.5	24	28	10, 100VDC +/-10%	X	sleeve	8
SA	4018-003	8.5	300	7	24	37	15, 100VDC +/-10%	X	ball	8
SA	4001-001	6	300	5.5	115	28	0.5, 400VDC +/-10%		sleeve	8
SA	4009-001	7	300	5.5	115	28	0.5, 400VDC +/-10%		ball	8
SA	4017-001	8.5	300	7	115	37	0.62, 400VDC +/-10%		sleeve	8
SA	4018-001	8.5	300	7	115	37	0.62, 400VDC +/-10%		ball	8
SB	4005-001	5.5	600	7	115	30	0.68, 400VDC +/-10%		sleeve	8
SB	4011-001	5.5	600	7	115	36	0.68, 400VDC +/-10%		ball	8

## Motor Specification - Geared

Model	Part Number	Reduction	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 50HZ	Voltage (VAC) 60HZ	Capacitor Value (mfd)	Weight (oz)
SA	4002-018	2.5	11	120	5.5		115	0.5, 400VDC +/-10%	16
SA	4021-018	2.5	16	120	7		115	0.62, 400VDC +/-10%	16
SA	4002-015	5	22.5	60	5.5		115	0.5, 400VDC +/-10%	16
SA	4021-015	5	32	60	7		115	0.62, 400VDC +/-10%	16
SA	4002-014	10	45	30	5.5		115	0.5, 400VDC +/-10%	16
SA	4021-014	10	64	30	7		115	0.62, 400VDC +/-10%	16
SA	4002-010	30	126	10	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-008	50	140	6	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-007	60	145	5	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-006	75	152	4	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-005	100	161	3	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-004	150	174	2	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-002	300	200	1	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-001	600	200	5	5.5		115	0.5, 400VDC +/-10%	16
SA	4002-040	4.17	17.5	60	5.5	115		0.5, 400VDC +/-10%	16
SA	4002-039	8.33	28	30	5.5	115		0.5, 400VDC +/-10%	16
SA	4002-038	25	84	10	5.5	115		0.5, 400VDC +/-10%	16
SA	4002-034	41.67	140	6	5.5	115		0.5, 400VDC +/-10%	16
SB	4006-011	1.67	7	360	7		115	0.68, 400VDC +/-10%	16
SB	4006-009	3	12	200	7		115	0.68, 400VDC +/-10%	16
SB	4006-008	5	20	120	7		115	0.68, 400VDC +/-10%	16
SB	4006-006	10	41	60	7		115	0.68, 400VDC +/-10%	16
SB	4006-004	20	77	30	7		115	0.68, 400VDC +/-10%	16
SB	4006-003	30	115	20	7		115	0.68, 400VDC +/-10%	16
SB	4006-016	100	140	6	7		115	0.68, 400VDC +/-10%	16

Note: Contact Hurst Mfg for additional voltages and reductions.

## Capacitor Table

VOLTAGE	115 V.	115 V.	24 V.	24 V.	220 V.	220 V.	230 V.	230 V.	240 V.	240 V.
FREQUENCY	60 Hz.	50 Hz.	60 Hz.	50 Hz.	60 Hz.	50 Hz.	60 Hz.	50 Hz.	60 Hz.	50 Hz.
<b>Models</b>	.50 MFD	.50 MFD	10 MFD	10 MFD	.15 MFD	.15 MFD	.12 MFD	.12 MFD	.12 MFD	.12 MFD
<b>SA, SL</b>	400 VDC	400 VDC	100 VDC	100 VDC	440 VAC	440 VAC	440 VAC	440 VAC	440 VAC	440 VAC
	±10%	+10%	+10%	+10%	+10%	+10%	+10%	+10%	+10%	+10%
<b>Models</b>	.62 MFD		15 MFD		.18 MFD		.15 MFD		.15 MFD	
<b>SA, SL</b>	440 VAC		100 VDC		440 VAC		440 VAC		440 VAC	
<b>High Torque</b>	±10%		±10%		±10%		±10%		±10%	

Capacitors are furnished with 115V 60Hz motors

Note: DC Capacitors must be non-polarized. Electrolytic types are not suitable.



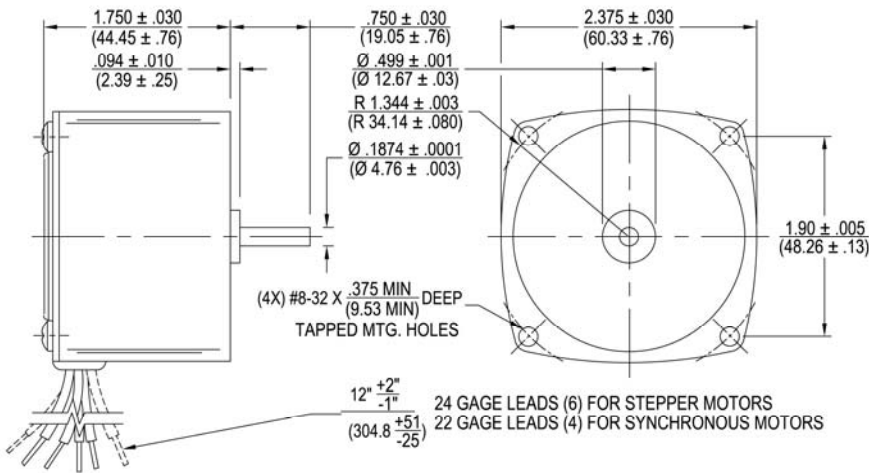


## T Specifications

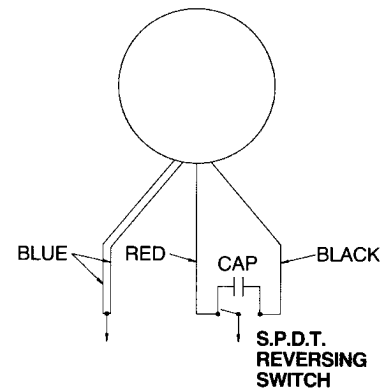
Torque Range:	Up to 250 oz-in
Output Speed:	.25 to 300 RPM
Poles:	T series 24 poles; TA series 20 poles
Insulation Class:	UL Class A (105°C)
Lead wire:	4 leads 22AWG (approx. 12 in.)
Operation Ambient Temp:	-10°C ~ +40°C
Shaft Bearings:	Sleeve bearings
Gear Unit:	Zinc Die Cast—AGMA7 Standard with hardened steel gears
UL Recognized:	E53578(N), Component-Impedance Protected Motors
115V Standard Rotor	
CSA Certified:	Card No. 42576, Motors and Generators
115V, 60 Hz, Standard Rotor,	7 watts max.
Capacitor is required for operation.	Capacitor supplied with 115VAC motors
Note:	Typical data subject to change without notification.

## T - Direct Drive

IN  
(MM)



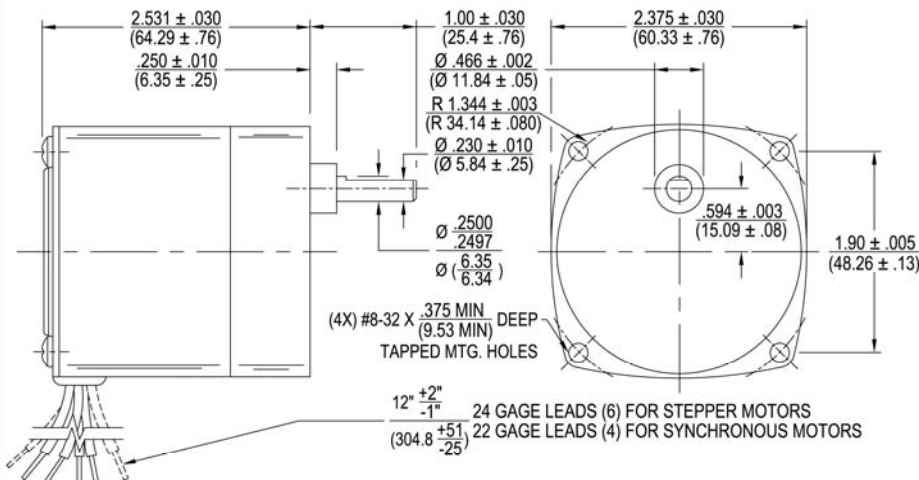
## WIRING DIAGRAM



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

## T - Geared Drive

IN  
(MM)



# T Synchronous Motors



## Motor Specification - Direct Drive

Model	Part Number	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 50HZ	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Capacitor not supplied	Weight (oz)
T	2601-001	8.5	300	7		115	27	0.68, 400VDC, +/-10%		20
T	2601-005	8.5	250	6	220		27	0.18, 440VAC, +/- 10%	X	20
T-ET	2609-001	10.25	300	9.5		115	38	0.85, 250VAC, +/-5%		20

## Motor Specification - Geared

Model	Part Number	Reduction	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 60HZ	Capacitor Value (mfd)	Weight (oz)
T	2602-011	2	13	150	7	115	0.68, 400VDC, +/-10%	27
T	2602-015	2.5	16	120	7	115	0.68, 400VDC, +/-10%	27
T	2602-010	3	19	100	7	115	0.68, 400VDC, +/-10%	27
T	2602-081	4.17	27	72	7	115	0.68, 400VDC, +/-10%	27
T	2602-009	5	32	60	7	115	0.68, 400VDC, +/-10%	27
T	2602-014	10	64	30	7	115	0.68, 400VDC, +/-10%	27
T	2602-008	12	77	25	7	115	0.68, 400VDC, +/-10%	27
T	2602-040	15	96	20	7	115	0.68, 400VDC, +/-10%	27
T	2602-082	16.67	99	18	7	115	0.68, 400VDC, +/-10%	27
T	2602-007	20	120	15	7	115	0.68, 400VDC, +/-10%	27
T	2602-037	25	149	12	7	115	0.68, 400VDC, +/-10%	27
T	2602-006	30	180	10	7	115	0.68, 400VDC, +/-10%	27
T	2602-013	50	210	6	7	115	0.68, 400VDC, +/-10%	27
T	2602-017	60	215	5	7	115	0.68, 400VDC, +/-10%	27
T	2602-012	75	218	4	7	115	0.68, 400VDC, +/-10%	27
T	2602-005	100	224	3	7	115	0.68, 400VDC, +/-10%	27
T	2602-004	150	233	2	7	115	0.68, 400VDC, +/-10%	27
T	2602-002	200	240	1.5	7	115	0.68, 400VDC, +/-10%	27
T	2602-001	300	250	1	7	115	0.68, 400VDC, +/-10%	27
T	2602-034	600	250	0.5	7	115	0.68, 400VDC, +/-10%	27
T	2602-039	1200	250	0.25	7	115	0.68, 400VDC, +/-10%	27
T-ET	2611-010	2.5	20	120	9.5	115	0.85, 250VAC, +/-5%	27
T-ET	2611-007	5	40	60	9.5	115	0.85, 250VAC, +/-5%	27
T-ET	2611-005	10	79	30	9.5	115	0.85, 250VAC, +/-5%	27

Note: Contact Hurst Mfg for additional voltages and reductions.

## Capacitor Table

VOLTAGE	115 V.	115 V.	24 V.	24 V.	220 V.	220 V.	230 V.	230 V.	240 V.	240 V.
FREQUENCY	60 Hz.	50 Hz.	60 Hz.	50 Hz.	60 Hz.	50 Hz.	60 Hz.	50 Hz.	60 Hz.	50 Hz.
<b>Models</b> PA, LA, T	.68 MFD 400 VDC ±10%	.68 MFD 400 VDC +10%	15.0 MFD 100 VDC +10%	15.0 MFD 100 VDC +10%	.18 MFD 440 VAC +10%	.18 MFD 440 VAC +10%	.18 MFD 440 VAC +5%	.18 MFD 440 VAC +5%	.15 MFD 440 VAC +5%	.15 MFD 440 VAC +5%
<b>Models</b> PA, LA, T High Torque	.85 MFD 250 VAC ±5%	1.1 MFD 250 VAC ±5%	20 MFD 100 VDC ±5%	25 MFD 100 VDC ±5%	.22 MFD 440 VAC ±5%	.30 MFD 440 VAC ±5%	.22 MFD 440 VAC ±5%	.27 MFD 440 VAC ±5%	.20 MFD 440 VAC ±5%	.25 MFD 440 VAC ±5%
<b>Models</b> PB, LB	.82 MFD 400 VDC ±10%	1.0 MFD 480 VAC ±10%	18 MFD 100 VDC ±10%	22 MFD 100 VDC ±10%	.22 MFD 440 VAC ±10%	.27 MFD 440 VAC ±10%	.20 MFD 440 VAC ±10%	.25 MFD 440 VAC ±10%	.18 MFD 440 VAC ±10%	.22 MFD 440 VAC ±10%

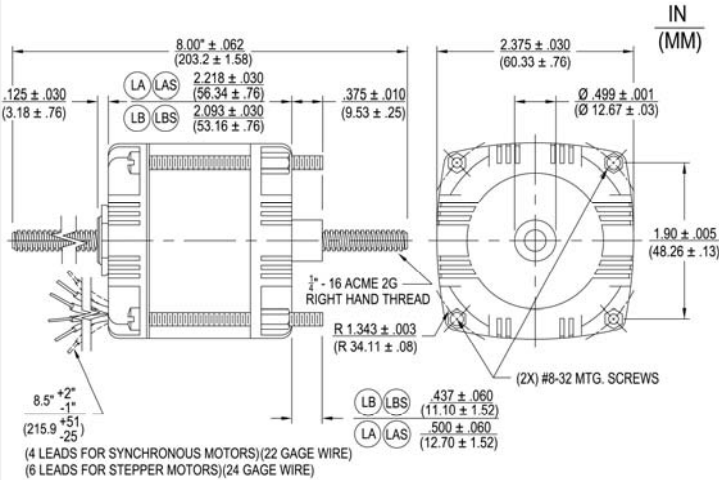
Capacitors are furnished with 115V 60Hz motors

Note: DC Capacitors must be non-polarized. Electrolytic types are not suitable.

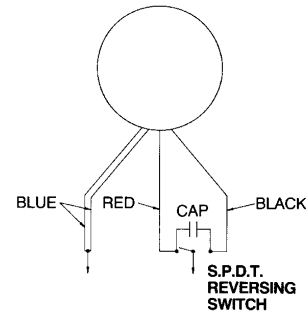


## LA/LB & LAS/LBS Specifications

**Maximum Load:** LA/LAS 10 lbs., LB/LBS 6.5 lbs  
**Rotor Assembly:** Threaded to accept a std. 1/4"-16 ACME 2G right-hand screw (Class 2G RH)  
**Insulation Class:** ULClass A (105°C)  
**Lead wire:** LA/LB 4 leads 22AWG (approx. 8 1/2 in.)  
 LAS/LBS 6 leads 24AWG (approx. 8 1/2 in.)  
**Operation Ambient Temp:** -10°C ~ +40°C  
**Motor Construction:** Die cast end bells and ball bearing construction  
**Shaft Length:** 8 inches with max travel of 5.25 inches  
**Applications:** Pushing, Pulling, Lifting and Positioning  
 LA/LB - ULRecognized: E53578(N), Component-Impedance Protected Motors  
 115V, 60Hz Standard Rotor  
 LA/LB - Capacitor is required for operation. Capacitor supplied with 115VAC motors  
 Note: Typical data subject to change without notification.

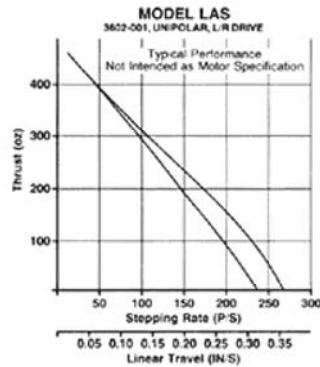
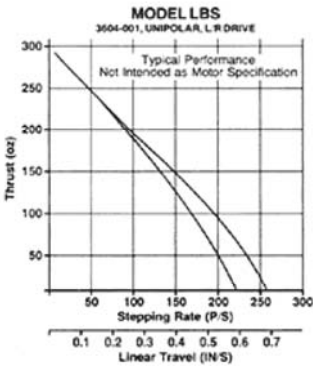
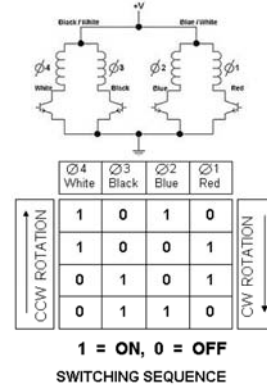


## LA/LB Wiring



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

## LAS/LBS Wiring



## Motor Specification

### Synchronous Linear Actuators

Model	Part Number	in/sec	Maximum Load (lbs)	Input Power (watts)	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Shaft Length (in)	Weight (oz)
LA	3601-001	0.3125	10	7.5	115	34	0.68, 400VDC +/-10%	8	22
LB	3603-001	0.625	6.5	8	115	44	0.82, 400VDC +/-10%	8	22

### Stepping Linear Actuators

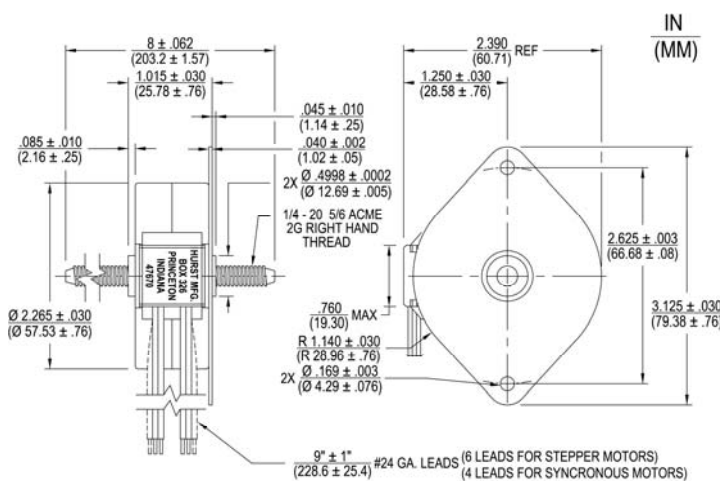
Model	Part Number	Step Angle (degrees)	Steps Inch	Maximum Load (lbs)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Full Load Temp. Rise (°C)	Shaft Length (in)	Weight (oz)
LAS	3602-003	7.5	768	10	8	6	8	51	8	22
LAS	3602-001	7.5	768	10	8	12	35.2	51	8	22
LAS	3602-002	7.5	768	10	8	24	135	51	8	22
LBS	3604-003	15	384	6.5	8.5	6	7.4	52	8	22
LBS	3604-001	15	384	6.5	8.5	12	32.2	52	8	22
LBS	3604-007	15	384	6.5	8.5	12	32.2	52	12	24
LBS	3604-002	15	384	6.5	8.5	24	122	52	8	22

# SL/SBL/SLS/SBLS Linear Actuators

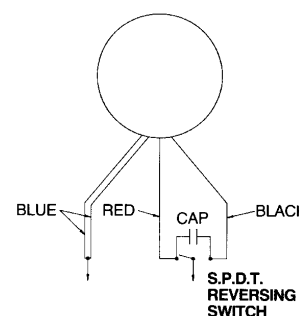


## SL/SBL/SLS/SBLS Specifications

Maximum Load: SL/SLS 15 lbs., SBL/SBLS 10 lbs.  
 Rotor Assembly: Threaded to accept a std. 1/4"-20 5/6 ACME 2G right hand screw (Class 2G RH)  
 Insulation Class: ULClass A (105°C)  
 Lead wire: SL/SBL 4 leads 24AWG (approx. 9 in.)  
 SLS/SBLS 6 leads 24AWG (approx. 9 in.)  
 Operation Ambient Temp: -10°C ~ +40°C  
 Rotor bearings: Ball bearings are standard  
 Shaft Length: 8 inches with max travel 6.75 inches  
 SL/SBL - ULRecognized: E53578(N), Component-Impedance Protected Motors 115V, 60Hz Standard Rotor  
 SL/SBL - Capacitor is required for operation. Capacitor supplied with 115VAC motors  
 Note: Typical data subject to change without notification.

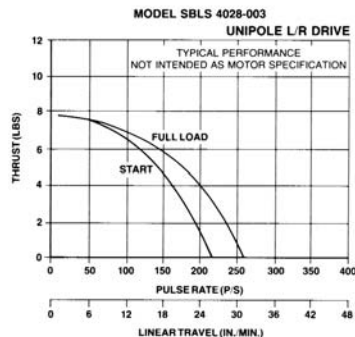
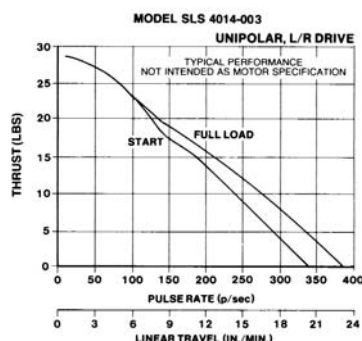
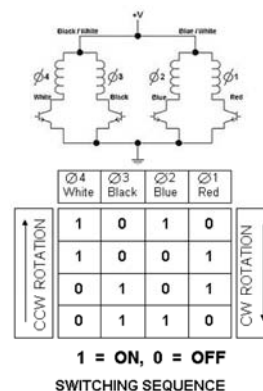


## SL/SBL Wiring



Current applied to the blue and red leads produces CW rotation. Switching the current to the blue and black leads produces CCW rotation.

## SLS/SBLS Wiring



## Motor Specification

### Synchronous Linear Actuator

Model	Part Number	in/sec	Maximum Load (lbs)	Input Power (watts)	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Shaft Length (in)	Weight (oz)
SL	4013-001	0.24	15	6.5	115	37	0.62, 400VAC +/-10%	8	10.5
SBL	4027-002	0.48	10	7	115	37	0.68, 400VDC +/-10%	8	10.5

Note: DC Capacitors must be non-polarized. Electrolytic types are not suitable.

### Stepping Linear Actuators

Model	Part Number	Steps/Inch	Maximum Load (lbs)	Input Power (watts)	Nominal Voltage (VDC)	Winding Resistance (ohms)	Full Load Temp. Rise (°C)	Shaft Length (in)	Weight (oz)
SLS	4014-001	1000	15	11.5	6	6.3	70	8	10.5
SLS	4014-002	1000	15	11.5	12	25	70	8	10.5
SLS	4014-003	1000	15	11.5	24	100	70	8	10.5
SLS	4014-016	1000	15	11.5	12	25	70	12	12.5
SBLS	4028-003	500	10	8	12	36	65	8	10.5
SBLS	4028-004	500	10	8	24	144	65	8	10.5

Note: Contact Hurst Mfg for additional voltages and reductions.

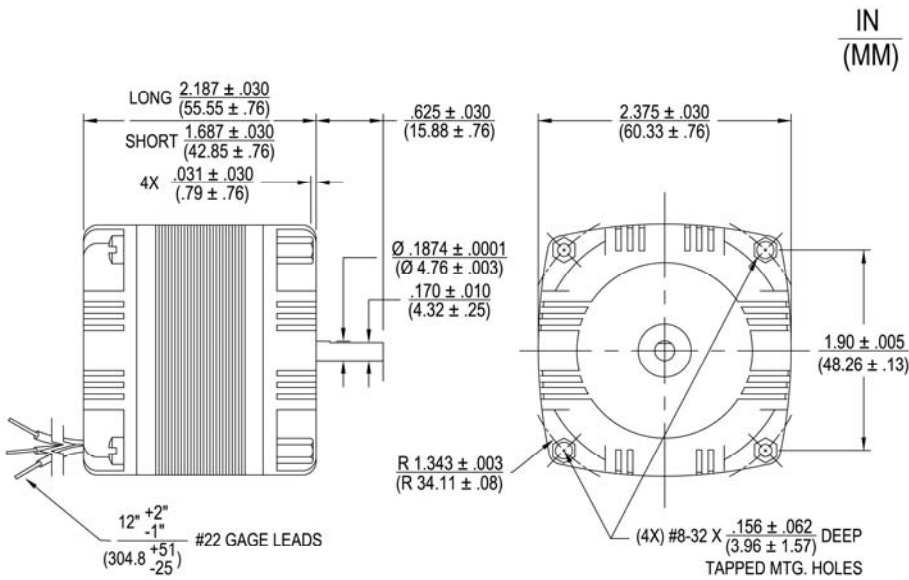
Contact Hurst at 812-385-2564 or Fax: 812-386-7504 www.hurstmfg.com



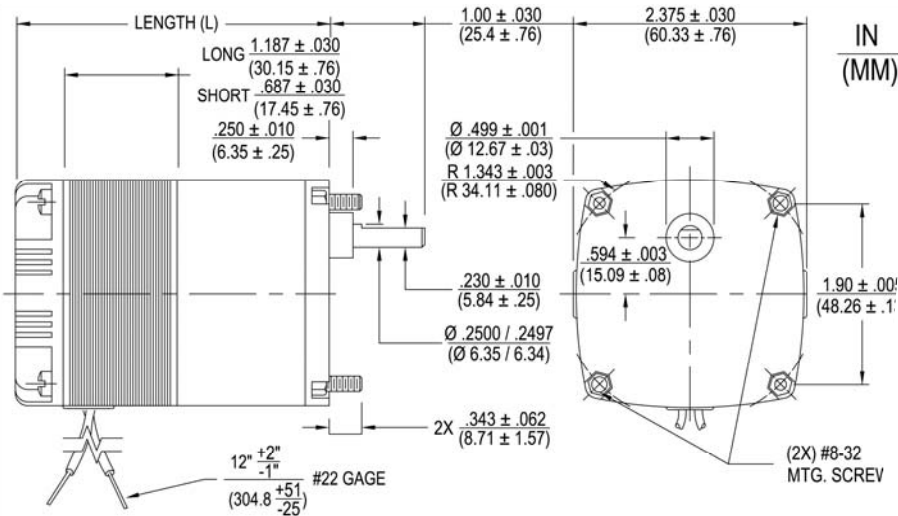
## KH & KN Specifications

Mounting: NEMA2-11  
 KH Series: High Slip—high starting torque, rapid reversal and/or dynamic braking is required  
 Normal Slip—greater output torque, maintain relatively uniform speed but do not have synchronous timing characteristics  
 KN Series:  
 Output Speed: .8 to 1550 RPM  
 Insulation Class: UL Class A (105°C)  
 Lead wire: 3 leads 22AWG (approx. 12 in.)  
 Operation Ambient Temp: -10°C ~ +40°C  
 Gearing: Heli-Spur, permanent lubrication  
 Capacitor is required for operation. Capacitor supplied with 115VAC 60Hz motors.  
 Note: Typical data subject to change without notification.

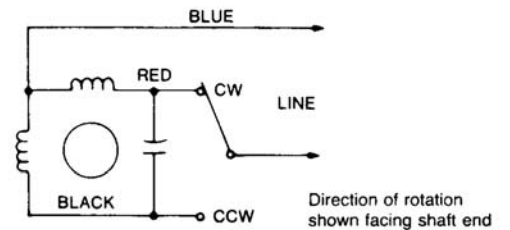
### KH



### KN



### KH and KN SERIES WIRING DIAGRAM



FRAME (STACK/GEAR)	LENGTH (L) in/(mm)
SHORT / LONG	2.531/(64.29)
LONG / LONG	3.031/(76.99)
LONG / SHORT	2.875/(73.03)

## Motor Specification - KH

High Slip, Reversible, Non-Synchronous

Model	Part Number	Reduction	Full-Load Torque (oz-in)	Stall Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Case Length (in)	Weight (oz)
KH	2423-003	1800	250	*	0.8	8.5	115	29	0.85	2.53	34
KH	2423-009	300	175	*	4.5	8.5	115	29	0.85	2.53	34
KH	2423-010	180	105	200	7.5	8.5	115	29	0.85	2.53	34
KH	2433-012	120	164	312	10	12	115	35	1.3	3.03	42
KH	2433-022	30	44	84	40	12	115	35	1.3	3.03	42
KH	2443-024	18	28	53	67	12	115	35	1.3	2.88	40
KH	2443-027	6	9.5	18	200	12	115	35	1.3	2.88	40
KH	2403-001		0.9	1.8	1200	8.5	115	35	0.85	1.69	25

Note 1: Contact Hurst Mfg for additional voltages and reductions.

Note 2: \*Can not be stalled.

## Motor Specification - KN

Normal slip, Reversible, Non-Synchronous

Model	Part Number	Reduction	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Voltage (VAC) 60HZ	Full Load Temp. Rise (°C)	Capacitor Value (mfd)	Case Length (in)	Weight (oz)
KN	2472-591	1800	250	0.9	8.5	115	29	0.85	2.53	34
KN	2472-592	900	220	1.9	8.5	115	29	0.85	2.53	34
KN	2472-593	600	205	2.8	8.5	115	29	0.85	2.53	34
KN	2472-596	300	178	5.5	8.5	115	29	0.85	2.53	34
KN	2482-599	180	160	8.8	11	115	32	1.3	3.03	42
KN	2482-603	120	150	13	11	115	32	1.3	3.03	42
KN	2482-609	72	125	22	11	115	32	1.3	3.03	42
KN	2482-611	60	105	26	11	115	32	1.3	3.03	42
KN	2482-613	30	54	52	11	115	32	1.3	3.03	42
KN	2492-615	18	35	86	11	115	32	1.3	2.88	40
KN	2492-616	12	24	130	11	115	32	1.3	2.88	40
KN	2492-618	6	12	260	11	115	32	1.3	2.88	40
KN	2462-590		2.4	1550	11	115	32	1.3	3.03	34

Note: Contact Hurst Mfg for additional voltages and reductions.

## Capacitor Table

VOLTAGE	115 V.	115 V.	24 V.	24 V.
FREQUENCY	60 Hz.	50 Hz.	60 Hz.	50 Hz.
Models	0.85 MFD	1.00 MFD	20 MFD	25MFD
KS, KN, KH	250 VAC	250 VAC	100 VDC	100 VDC
Short Stack	±10%	±10%	±10%	±10%
Models	1.3 MFD	1.6 MFD	30 MFD	36 MFD
KS, KN, KH	250 VAC	250 VAC	100 VDC	100 VDC
Long Stack	±10%	±10%	±10%	±10%

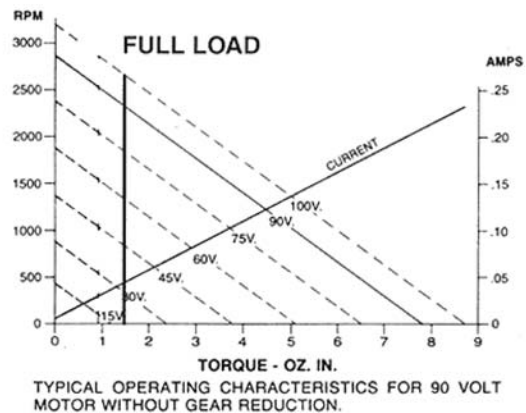
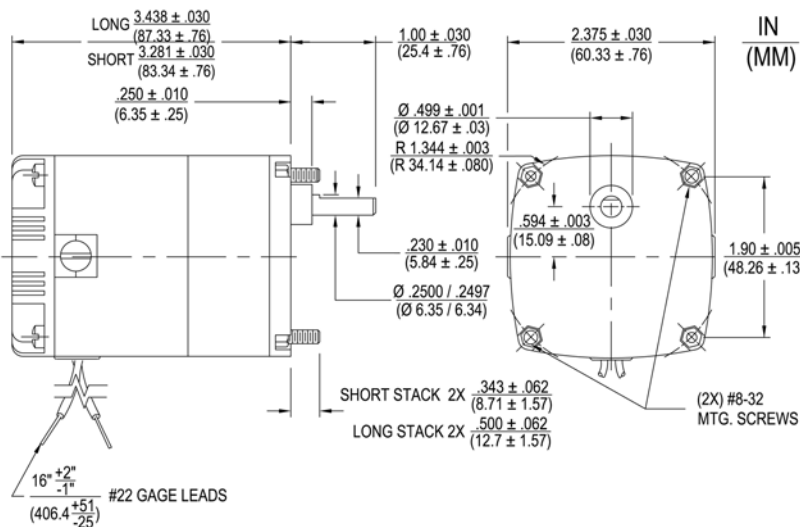
Capacitors are furnished with 115V 60Hz motors

Note: DC Capacitors must be non-polarized. Electrolytic types are not suitable.



## KD Specifications

Mounting: NEMA 2-11 Standard.  
 Torque Rating: 5.8 to 237 oz-in  
 Nominal Voltage: 90 Volt DC  
 Operation Ambient Temp: < 50°C  
 Gearing: Heli-Spur design  
 Leads: 2 leads 22AWG (approx. 16 inches)  
 Note: Typical data subject to change without notification.



## Motor Specification

Model	Part Number	Ratio	Track Speed Range Full Load RPM	Track Speed Range No Load RPM	Rated Torque (oz-in)	Output Speed (RPM)	Input Power (watts)	Nominal Voltage (VDC)	Typical Full Load Current (amp) Low	Typical Full Load Current (amp) High	Weight (oz)
KD	3402-001	1800:01:00	.95-1.2	1.1-1.5	237	1.2	2.25	90	0.018	0.028	37
KD	3402-002	900:01:00	2.3-2.5	2.6-3.2	206	2.5	2.25	90	0.022	0.03	37
KD	3402-003	600:01:00	3.1-3.7	3.9-4.5	190	3.7	2.25	90	0.025	0.03	37
KD	3402-004	300:01:00	6.3-7.4	7.7-90	166	7.4	2.25	90	0.032	0.04	37
KD	3402-005	180:01:00	11.5-12.2	14-15	150	12.2	2.25	90	0.039	0.046	37
KD	3402-006	60:01:00	30-35	40-45	69	35	2.25	90	0.048	0.06	37
KD	3402-007	30:01:00	65-75	80-90	35	75	2.25	90	0.048	0.06	37
KD	3402-008	18:01	120-135	145-170	22.5	135	2.25	90	0.048	0.06	37
KD	3402-009	9:01	220-245	270-305	10	245	2.25	90	0.048	0.058	37
KD	3402-010	6:01	345-385	430-475	7	385	2.25	90	0.05	0.058	37

Note: Contact Hurst Mfg for additional voltages and reductions.  
 Note: All performance data are based upon operation with uniform direct current.  
 Rectified and non-filtered A.C. will give different performance values.