

Motion Technology Catalog

Brushless & Brush Motors • Drive Electronics • Gearheads & Encoders



MOOG
COMPONENTS GROUP



***Your work demands
the right moves.***

Moog Components Group is a premier technology company with unique design and manufacturing capabilities in electromechanical and fiber optic products. Founded in 1953, the company's original vision was to become a research and development business offering new technologies for the then emerging inertial navigation marketplace for aircrafts. Quickly, it evolved into a manufacturing operation where its many innovative designs were crafted into products.

Moog Components Group has a legacy for providing high-quality products used in critical defense and space applications. Over the years, this foundation has expanded to a broad spectrum of commercial markets, including medical, industrial automation and communications. The company is ISO certified and utilizes world-class manufacturing strategies, including Six-Sigma and Lean Manufacturing, that allow the company to produce the highest quality products at competitive prices.

Today, Moog Components Group's core business is motion technology and fiber optics. Product lines include slip rings, motors, resolvers, actuators and fiber optic components. There are operations in Blacksburg, Va; Murphy, N.C.; Springfield, Pa; and Brno, Czech Republic. There are over 1,000 employees worldwide.

Moog Components Group offers standard and custom solutions for use in commercial, industrial, medical, aerospace and defense applications. More information about Moog Components Group and its products are available at www.moog.com.



"Our success is attributed to the ideas, skills and dedication of our employees. Over the past 50 years, these fine individuals have conquered new markets and built a company that today has a diverse portfolio of applications that range from slip rings used in medical imaging (CT Scan) applications to fiber optic switches used in shipboard communication systems. Our customers, our suppliers, our employees and our community - that's what it's all about at Moog Components Group."
- Larry Ball, vice president and general manager

We have the motion solutions.

Motion Technology Catalog Index



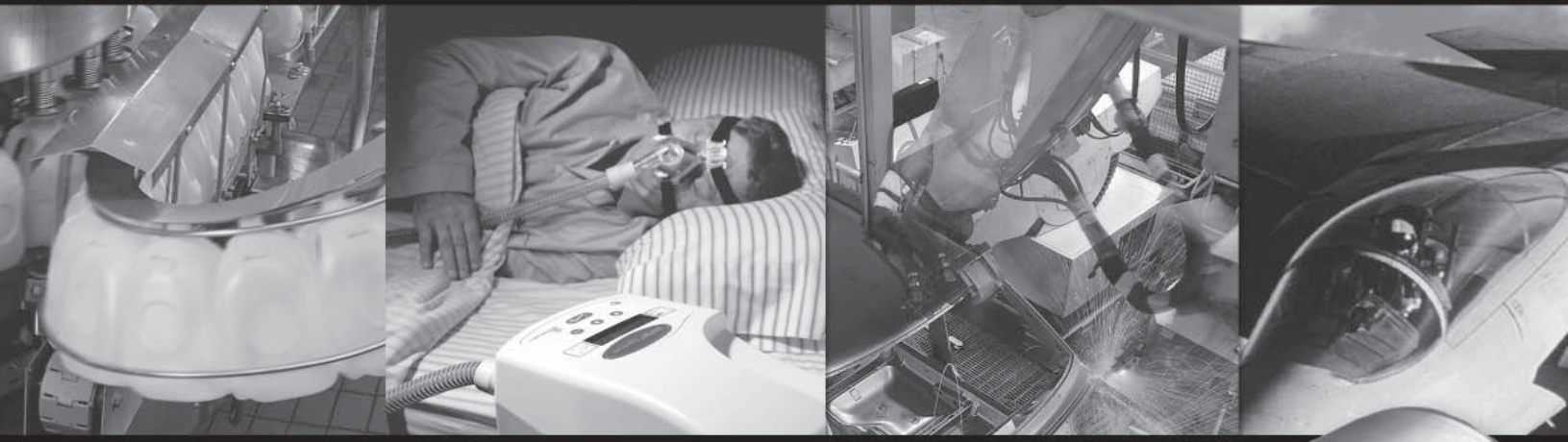
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Application Engineering Assistance
800-577-8685 ext. 256 • 828-837-5115

Sales Assistance
800-577-8685 ext. 239 • 828-837-5115

Literature Request
800-336-2112 ext. 279 • 540-552-3011 • mcg@moog.com

We have your motion application solutions.



Typical Applications

- Medical equipment
- Automatic door and window openers
- Textile machinery
- Scanners
- Packaging equipment
- HVAC equipment (air handling)
- Robotic storage and retrieval
- Semiconductor handling
- Actuator systems
- Industrial automation equipment
- Speed and rotation control systems
- Portable, battery-operated equipment



MOOG
COMPONENTS GROUP



Silencer[™] Series Brushless DC Motors

Commercial and Industrial

TYPICAL APPLICATIONS

- Medical equipment - pumps, blowers and electric scooters and wheelchairs
- Automatic door and window openers
- Computer-controlled embroidery machines
- Scanners
- Packaging equipment and printing products
- HVAC equipment (air handling)
- Robotic tape storage and retrieval
- Semiconductor handling and insertion machines
- Actuators

FEATURES

- Inside rotor construction for quick acceleration
- 8 pole motor standard, 4 pole motors optional for high speed applications
- Compact size – lengths from 1.3 to 5.5 inches
- Continuous torques from 2.4 to 519 oz-in
- High energy neodymium magnets
- Safe, arcless operation
- High speed capability – up to 20,000 rpm
- High torque per dollar ratio

BENEFITS

- Operation at any single speed - not limited to AC frequency
- Motor life is not limited to brush or commutator life
- An essentially linear speed/torque curve
- Efficient operation without losses associated with brushes and commutation or armature induction
- Precise, variable speed control
- Extremely quiet operation
- Long-life operation

ENCODERS

High resolution, high reliability, and state-of-the-art technology in a small package:

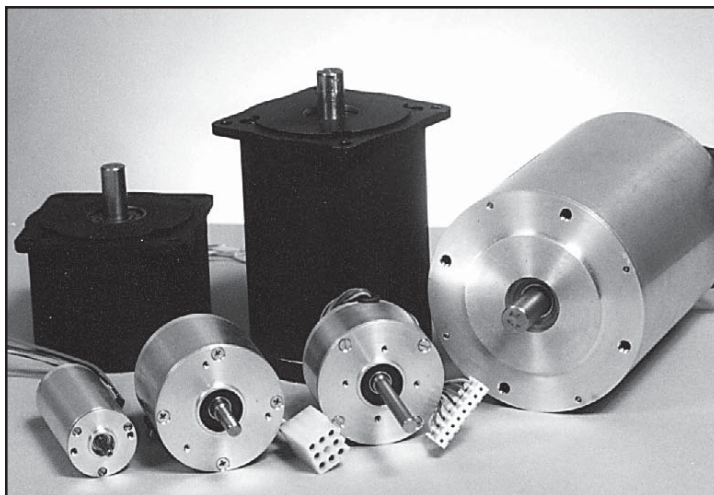
- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL / CMOS compatible
- Hewlett Packard HEDS-5500 encoder standard, other configurations and resolutions available

SILENCER BRUSHLESS MOTOR DRIVES

Optimized for use with Silencer Brushless DC motors, these drives provide:

- Multiple operating modes - commutation, velocity, torque, 2 and 4 quadrant
- Feedback using Hall effect sensor or encoder
- Efficient PWM speed control
- CE approved for European applications
- Low cost

BN12, 17, 23, 28, 34 and 42
1.2" to 4.15" Diameter



Quiet, Brushless Motors

Silencer Brushless motors provide smooth, efficient operation and increased speed ranges. Utilizing bonded neo magnets, our BN series motors provide excellent value with their low cost and high torque. Each frame of the BN motors is available in four different lengths with a variety of electrical options to meet a wide range of commercial and industrial operating specifications.

Reliable, Low-cost Operation

The compact BN motors are well-suited for applications demanding low audible noise and long life. An aluminum housing protects the unit in rugged applications and environments. Typical options include electronic drives, encoders and gearheads, as well as Hall effect, resolver and sensorless feedback.

Our engineering department is available for consultation to help you tailor a brushless motor for your specific application.

Note:

- IP65 versions available. Contact factory for information.
- UL Class F Insulation Systems for BN motors available upon request.

NOTES AND TERMS ON BRUSHLESS DC MOTORS

Application Assistance

There are a few typical questions our engineers will ask when discussing your specific application:

- ☐ What torque range is required?
- ☐ What speed range is required?
- ☐ What space is available?
- ☐ What voltage is available?
- ☐ What current is available?
- ☐ Are there any special shaft and/or mounting requirements?

Terms

Back EMF Constant: (Ke) (V / Krpm)

Also referred to as Voltage Constant. This is the voltage generated while the motor is operating which is proportional to speed, but opposing to the applied voltage.

Bearing Life:

The bearing life of an individual ball bearing is the number of revolutions (or hours at a given speed) which the bearing runs before the first evidence of fatigue develops in the material of either ring or of any of the rolling elements.

Bearing Rating Life:

The rating life, L10, of a group of apparently identical ball bearings is the life in millions of revolutions that 90% of the group will complete or exceed. For a single bearing, L10 also refers to the life associated with 90% reliability, L5 refers to 95% reliability and L1 refers to 99% reliability.

Brushless DC Motor:

A brushless DC motor is a motor which is electronically commutated and exhibits the linear speed-torque characteristics of the conventional DC motor. The motors typically use a permanent magnet to produce the rotor field.

Continuous Stall Torque: (Tcs) (oz-in)

The maximum torque at zero speed which a motor can continuously deliver without exceeding its thermal rating.

Encoder:

The encoder is a feedback device which

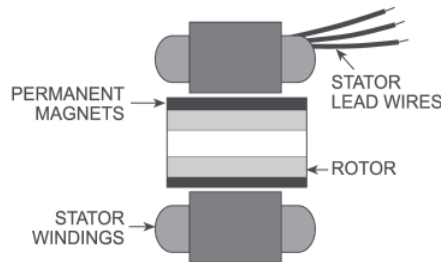
converts mechanical motion into a digital signal. The resolution of the encoder is defined in counts per revolutions as the number of electrical pulses provided in one mechanical revolution. The number of pulses is determined by a metal or glass code wheel and optical sensors.

Hall Effect Sensors:

Hall devices are magnetic sensing devices which produce an electronic signal. This signal provides information to the amplifier to electronically commutate the brushless motor.

Inside Rotor Motor:

This is the most common motor construction. The permanent magnet rotor is on the inside and is surrounded by the wound stator assembly. This is the typical construction of our BN motors.



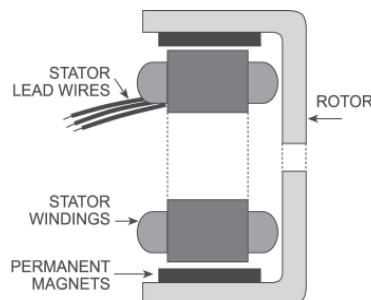
Motor Constant:

(Km) (oz-in / sq rt watts)

The motor constant is the ratio of motor torque to motor input power. It is a figure of merit typically used to compare motor capability.

Outside Rotor Motor:

The outside rotor motor is a special design used in applications where higher rotor inertia is desired. The wound stator field is stationary and located on the inside of the rotating magnetic field. The



rotor is typically a magnet inside of a housing. These motors are our BOH, BOF or BON series.

Peak Torque:

The peak torque of a motor is the maximum amount of torque the motor can produce for short periods of time. In a brushless PMDC motor, the current (and therefore the peak torque) is usually limited by the control electronics.

Permanent Magnet DC Motor:

A permanent magnet DC motor is a motor with a wound armature and a permanent magnetic field. Power is supplied to the armature through brushes and a commutator. This type of motor provides a linear speed / torque performance characteristic. The C-series is our line of PMDC motors in our C-series products.

Resolver:

The resolver is an electromechanical device which converts shaft position into analog signals. The resolver output is a sine and a cosine signal. There are several types of resolvers. The brushless motor typically uses the single speed transmitter type resolver. Position is determined by the ratio of the sine output amplitude to the cosine output amplitude. A single speed resolver produces one sine and cosine wave at the output for each mechanical revolution. We manufacture both single speed and multispeed resolvers.

Torque Sensitivity: (Kt) (oz-in / Amp)

The relationship of the output torque to the input current of the motor.

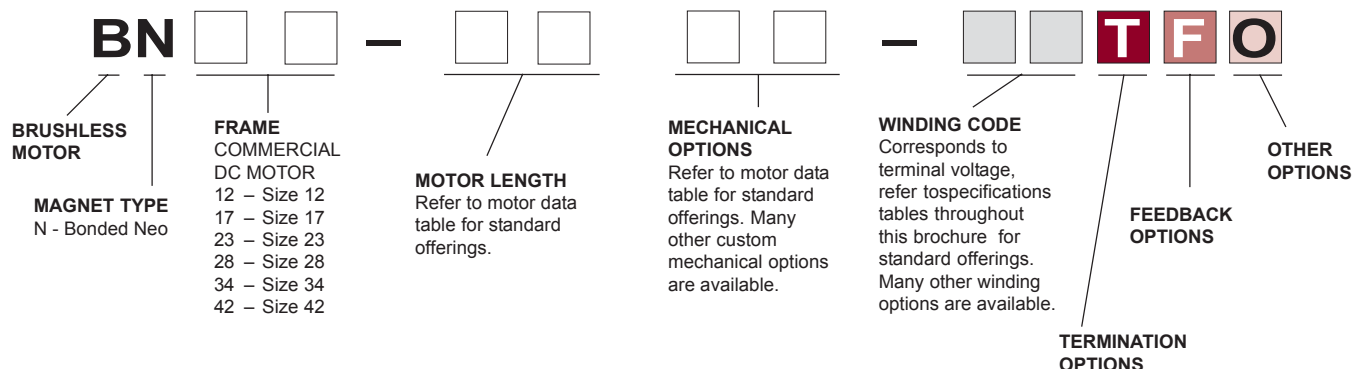
Terminal Resistance: (Rt) (ohms)

This is the line to line resistance at 25°C. The value of resistance in the motor is determined by the temperature of the windings in a particular application.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

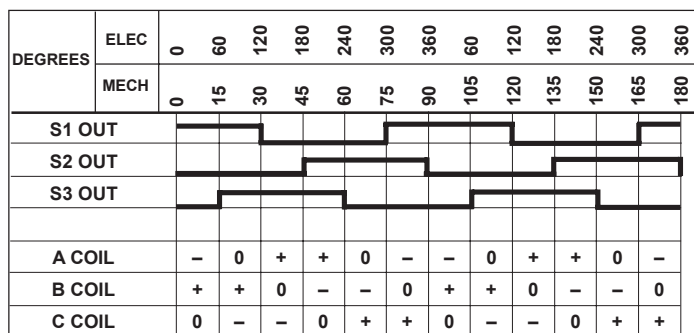
Part Numbering System Guide



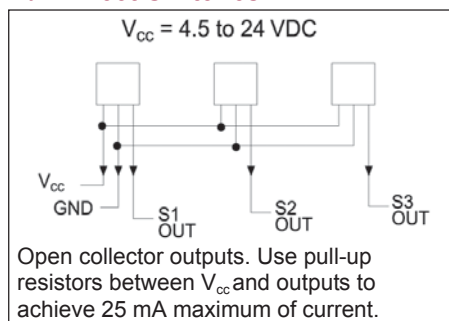
Conversion Table

FROM	TO	MULTIPLY BY
Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281×10^{-2}
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527×10^{-2}
lb	oz	16.0
g	lb	2.205×10^{-3}
oz	lb	6.250×10^{-2}
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383×10^4
g-cm	oz-in	1.389×10^{-2}
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233×10^{-5}
oz-in	lb-ft	5.208×10^{-3}
Rotation		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745×10^{-2}
rpm	rad/sec	.1047
Moment Of Inertia		
oz-in ²	g-cm ²	182.9
lb-ft ²	g-cm ²	4.214×10^5
g-cm ²	oz-in ²	5.467×10^{-3}
lb-ft ²	oz-in ²	2.304×10^3
g-cm ²	lb-ft ²	2.373×10^{-6}
oz-in ²	lb-ft ²	4.340×10^{-4}
oz-in-sec ²	g-cm ²	7.062×10^4

Timing Diagram for Hall Switches



Hall Effect Switches















IMPORTANT

The operational life and performance of any motor is dependent upon individual operating parameters, environment, temperature and other factors. Your specific application results may vary. Please consult the factory to discuss your requirements.

Bearing Load Rating (lbs)

Motor Size	Dynamic	Static
BN-12	295	110
BN-17	331	134
BN-23	743	304
BN-28	1022	422
BN-34	1532	683
BN-42	1340	725

BN12 SPECIFICATIONS - Continuous Stall Torque 2.4 - 8.6 oz-in (0.0170 - 0.0587 Nm) Peak Torque 13 - 72 oz-in (0.0918 - 0.509 Nm)

Part Number*		BN12-13AF-   			BN12-18AF-   			BN12-23AF-   			BN12-28AF-   		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	1.30			1.80"			2.30			2.80		
	millimeters	38.1			50.8			63.5			76.2		
Terminal Voltage	volts DC	12.0	24.0	36.0	12.0	24.0	36.0	12.0	24.0	36.0	12.0	24.0	36.0
Peak Torque	oz-in	13.0	13.0	14.0	37.0	37.0	39.0	58.0	58.0	61.0	77.0	77.0	72.0
	Nm	0.0918	0.0918	0.0989	0.2613	0.2613	0.2754	0.4096	0.4096	0.4308	0.5437	0.5437	0.5084
Continuous Stall Torque	oz-in	2.4	2.4	2.4	4.9	5.0	5.0	6.9	6.9	6.9	8.3	8.6	8.6
	Nm	0.0169	0.0169	0.0169	0.0346	0.0353	0.0353	0.0487	0.0487	0.0487	0.0586	0.0607	0.0607
Rated Speed	RPM	13027.0	12736.0	13753.0	11928.0	11448.0	12320.0	10604.0	10601.0	11489.0	11036.0	10253.0	9529.0
	rad/sec	1364	1334	1440	1249	1199	1290	1110	1110	1203	1156	1074	998
Rated Torque	oz-in	1.8	1.8	1.8	3.5	3.6	3.5	5.0	5.0	4.7	5.4	5.9	6.2
	Nm	0.0127	0.0127	0.0127	0.0247	0.0254	0.0247	0.0353	0.0353	0.0332	0.0381	0.0417	0.0438
Rated Current	Amps	2.26	1.13	0.77	3.49	1.76	1.20	4.32	2.16	1.46	4.81	2.46	1.61
Rated Power	watts	17.3	17.0	18.3	30.9	30.5	31.9	39.2	39.2	39.9	44.1	44.7	43.7
Torque Sensitivity	oz-in/amp	1.02	2.06	2.95	1.24	2.56	3.64	1.42	2.84	4.01	1.41	2.99	4.75
	Nm/amp	0.0072	0.0145	0.0208	0.0088	0.0181	0.0257	0.0100	0.0201	0.0283	0.0100	0.0211	0.0335
Back EMF	volts/KRPM	0.75	1.53	2.18	0.92	1.89	2.69	1.05	2.10	2.96	1.04	2.21	3.51
	volts/rad/sec	0.0072	0.0145	0.0208	0.0088	0.0181	0.0257	0.0100	0.0201	0.0283	0.0100	0.0211	0.0335
Terminal Resistance	ohms	0.953	3.89	7.85	0.403	1.67	3.36	0.294	1.18	2.36	0.219	0.934	2.36
Terminal Inductance	nH	0.254	1.100	2.210	0.181	0.742	1.460	0.172	0.692	1.374	0.128	0.447	1.220
Motor Constant	oz-in/sq.rt.watt	1.04	1.04	1.05	1.95	1.98	1.99	2.62	2.61	2.61	3.01	3.09	3.09
	Nm/sq.rt.watt	0.00738	0.00738	0.00744	0.01379	0.01399	0.01402	0.01849	0.01846	0.01843	0.02128	0.02185	0.02183
Rotor Inertia	oz-in-sec ² x10 ⁻³	0.040	0.040	0.040	0.080	0.080	0.080	0.120	0.120	0.120	0.16	0.16	0.16
	g-cm ²	2.82	2.82	2.82	5.65	5.65	5.65	8.47	8.47	8.47	11.3	11.3	11.3
Weight	oz	3.6	3.6	3.6	5.5	5.5	5.5	7.3	7.3	7.3	9.1	9.2	9.2
	g	102.2	102.2	102.2	156.2	156.2	156.2	207.3	207.3	207.3	258.4	261.3	261.3
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	5.2	5.2	5.1	3.0	2.9	2.9	2.5	2.5	2.5	2.5	2.4	2.4
Electrical Time Constant	ms	0.14	0.14	0.14	0.24	0.25	0.25	0.29	0.29	0.29	0.29	0.31	0.31
Thermal Resistivity	deg. C/watt	10.7	10.3	11.2	9.5	8.9	9.3	8.3	8.3	8.3	7.7	7.3	7.4
Speed/Torque Gradient	rpm/oz-in	1245.8	1234.2	1220.6	353.3	345.2	343.2	197.2	197.9	198.8	149.3	141.3	141.6

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

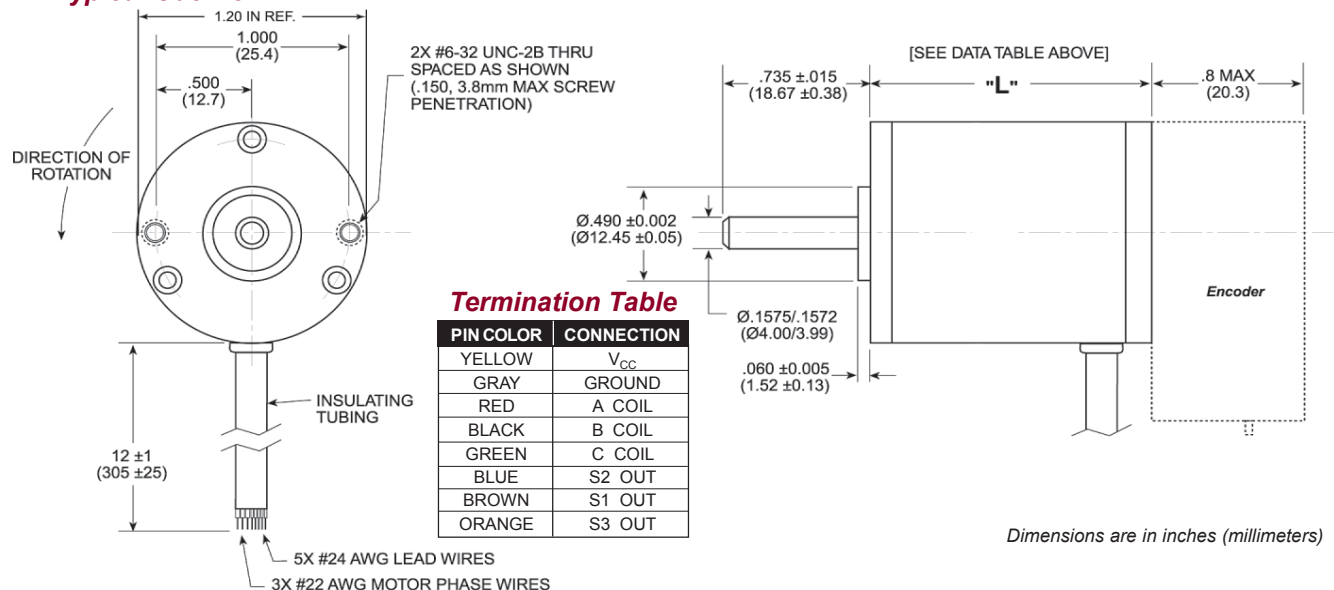
*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.













T TERMINATION	F FEEDBACK OPTIONS	O OTHER OPTIONS
L – Leads (std)	H – Hall Effect (std)	D – Drive
C – Connector	R – Resolver	E – Encoder
M – MS connector	S – Sensorless	G – Gearhead

BN12 Typical Outline



Brushless Motors

BN12 EU SPECIFICATIONS - Continuous Stall Torque 2.4 - 8.6 oz-in (0.0170 - 0.0587 Nm) Peak Torque 13 - 72 oz-in (0.0918 - 0.509 Nm)

Part Number*		BN12-13EU-   			BN12-18EU-   			BN12-23EU-   			BN12-28EU-   		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	1.30			1.80			2.30			2.80		
	millimeters	38.1			50.8			63.5			76.2		
Terminal Voltage	volts DC	12	24	36	12	24	36	12	24	36	12	24	36
Peak Torque	oz-in	13	13	14	37	37	39	58	58	61	77	77	72
	Nm	0.0918	0.0918	0.0989	0.262	0.262	0.276	0.410	0.410	0.431	0.544	0.544	0.509
Continuous Stall Torque	oz-in	2.4	2.4	2.4	4.9	5.0	5.0	6.9	6.9	6.9	8.3	8.6	8.6
	Nm	0.0170	0.0170	0.0170	0.0346	0.0354	0.0354	0.0488	0.0488	0.0488	0.0587	0.0587	0.0587
Rated Speed	RPM	13027	12736	13753	11928	11448	12320	10604	10601	11489	11036	10253	9529
	rad/sec	1364	1333	1440	1249	1198	1290	1110	1110	1203	1155	1073	997
Rated Torque	oz-in	1.80	1.80	1.80	3.50	3.60	3.50	5.00	5.00	4.70	5.40	5.90	6.20
	Nm	0.0127	0.0127	0.0127	0.0248	0.0255	0.0248	0.0354	0.0354	0.0332	0.0382	0.0417	0.0438
Rated Current	Amps	2.26	1.13	0.77	3.49	1.76	1.20	4.32	2.16	1.46	4.81	2.46	1.61
Rated Power	watts	17.3	17.0	18.3	30.9	30.5	31.9	39.2	39.2	39.9	44.1	44.7	43.7
Torque Sensitivity	oz-in/amp	1.02	2.06	2.95	1.24	2.56	3.64	1.42	2.84	4.01	1.41	2.99	4.75
	Nm/amp	0.0072	0.0146	0.0209	0.0088	0.0180	0.0257	0.0101	0.0201	0.0284	0.0100	0.0212	0.0336
Back EMF	volts/KRPM	0.75	1.53	2.18	0.92	1.89	2.69	1.05	2.10	2.96	1.04	2.21	3.51
	volts/rad/sec	0.0072	0.0146	0.0209	0.0088	0.0180	0.0257	0.0101	0.0201	0.0284	0.0100	0.0212	0.0336
Terminal Resistance	ohms	0.953	3.89	7.85	0.403	1.67	3.36	0.294	1.18	2.36	0.219	0.934	2.36
Terminal Inductance	mH	0.254	1.100	2.210	0.181	0.742	1.460	0.172	0.692	1.374	0.128	0.447	1.220
Motor Constant	oz-in/sq.rt.watt	1.0	1.1	1.1	2.0	2.0	2.0	2.6	2.6	2.6	3.0	3.1	3.1
	Nm/sq.rt.watt	0.0071	0.0078	0.0078	0.0142	0.0142	0.0142	0.0184	0.0184	0.0184	0.0212	0.0219	0.0219
Rotor Inertia	oz-in-sec ²	4.0E-05	4.0E-05	4.0E-05	8.0E-05	8.0E-05	8.0E-05	1.2E-04	1.2E-04	1.2E-04	1.6E-04	1.6E-04	1.6E-04
	g-cm ²	2.83	2.83	2.83	5.65	5.65	5.65	8.48	8.48	8.48	11.3	11.3	11.3
Weight	oz	3.6	3.6	3.6	5.5	5.5	5.5	7.3	7.3	7.3	9.1	9.2	9.2
	g	102	102	102	156	156	156	207	207	207	258	261	261

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

T TERMINATION

L – Leads (std)
C – Connector
M – MS connector

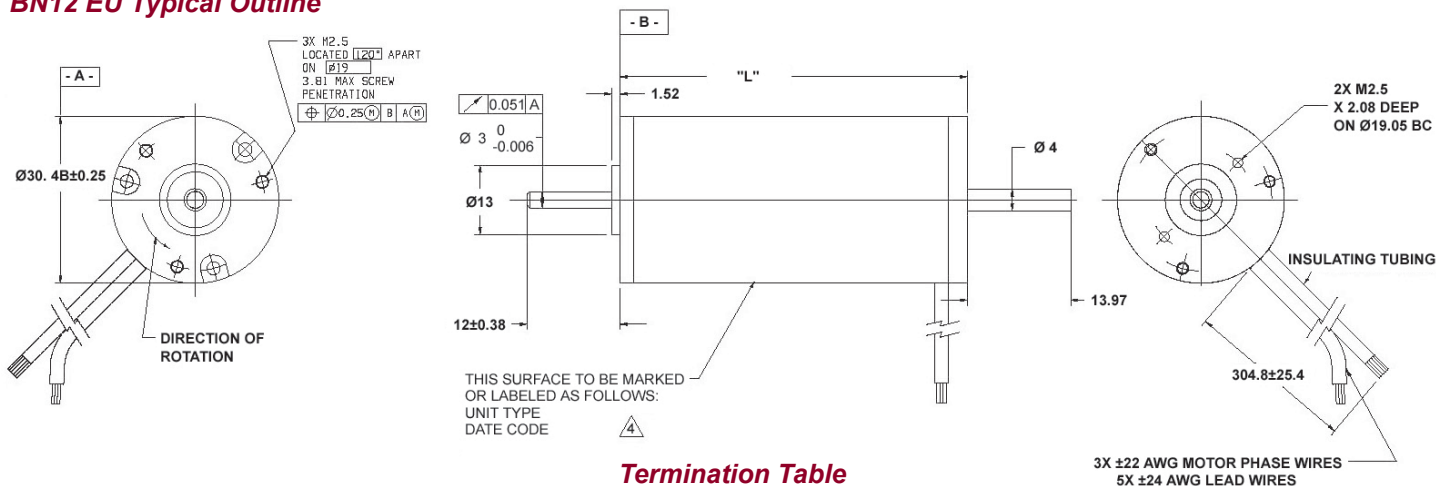
F FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

O OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

BN12 EU Typical Outline



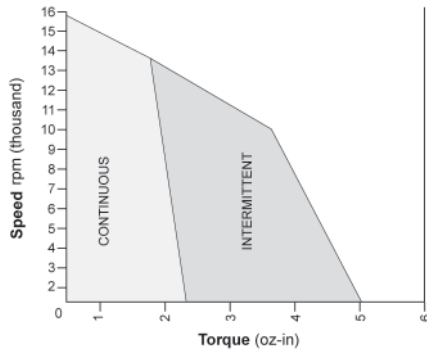
Termination Table

PIN COLOR	CONNECTION
YELLOW	V _{CC}
GRAY	GROUND
RED	A COIL
BLACK	B COIL
GREEN	C COIL
BLUE	S2 OUT
BROWN	S1 OUT
ORANGE	S3 OUT

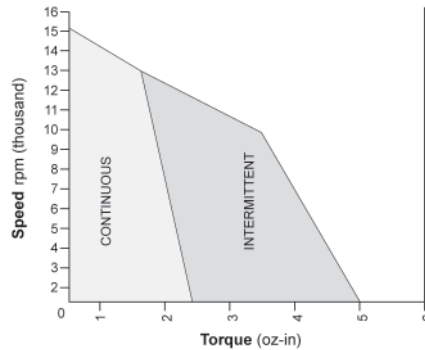
Dimensions are in inches (millimeters)

BN12 Performance Curves

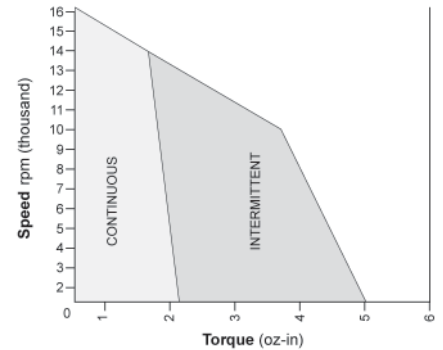
BN12-13AF-01: Continuous & Intermittent Operation at 12 Volt DC



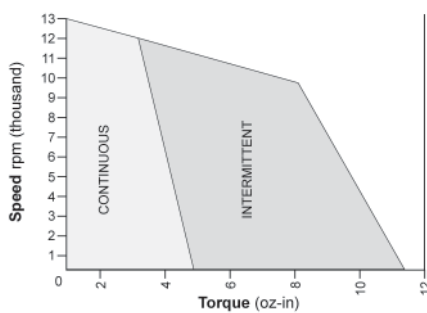
BN12-13AF-02: Continuous & Intermittent Operation at 24 Volt DC



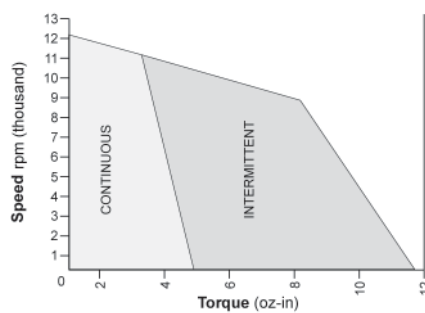
BN12-13AF-03: Continuous & Intermittent Operation at 36 Volt DC



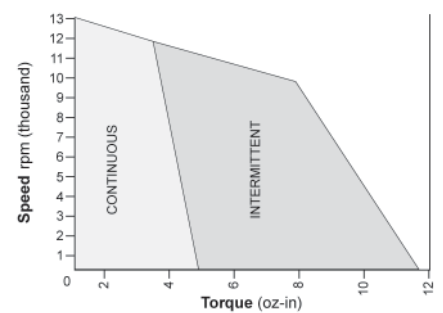
BN12-18AF-01: Continuous & Intermittent Operation at 12 Volt DC



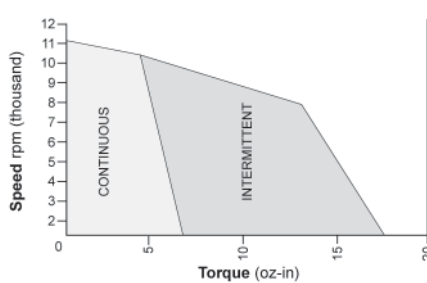
BN12-18AF-02: Continuous & Intermittent Operation at 24 Volt DC



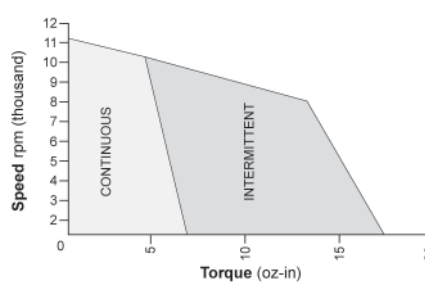
BN12-18AF-03: Continuous & Intermittent Operation at 36 Volt DC



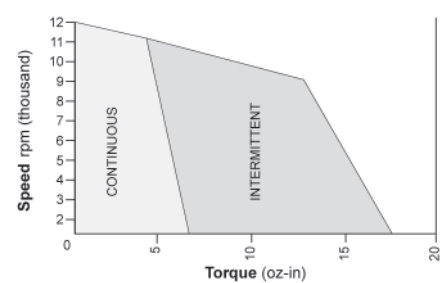
BN12-23AF-01: Continuous & Intermittent Operation at 12 Volt DC



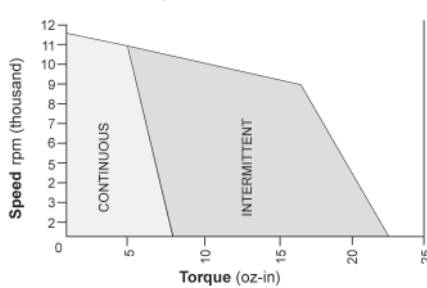
BN12-23AF-02: Continuous & Intermittent Operation at 24 Volt DC



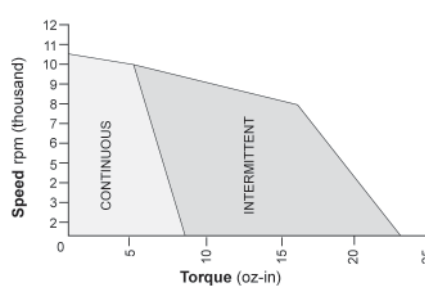
BN12-23AF-03: Continuous & Intermittent Operation at 36 Volt DC



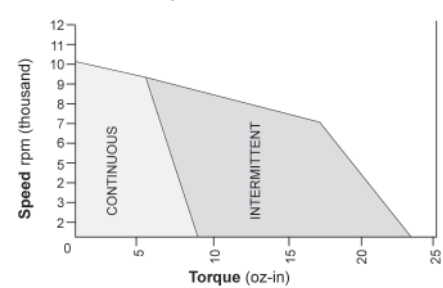
BN12-28AF-01: Continuous & Intermittent Operation at 12 Volt DC



BN12-28AF-02: Continuous & Intermittent Operation at 24 Volt DC



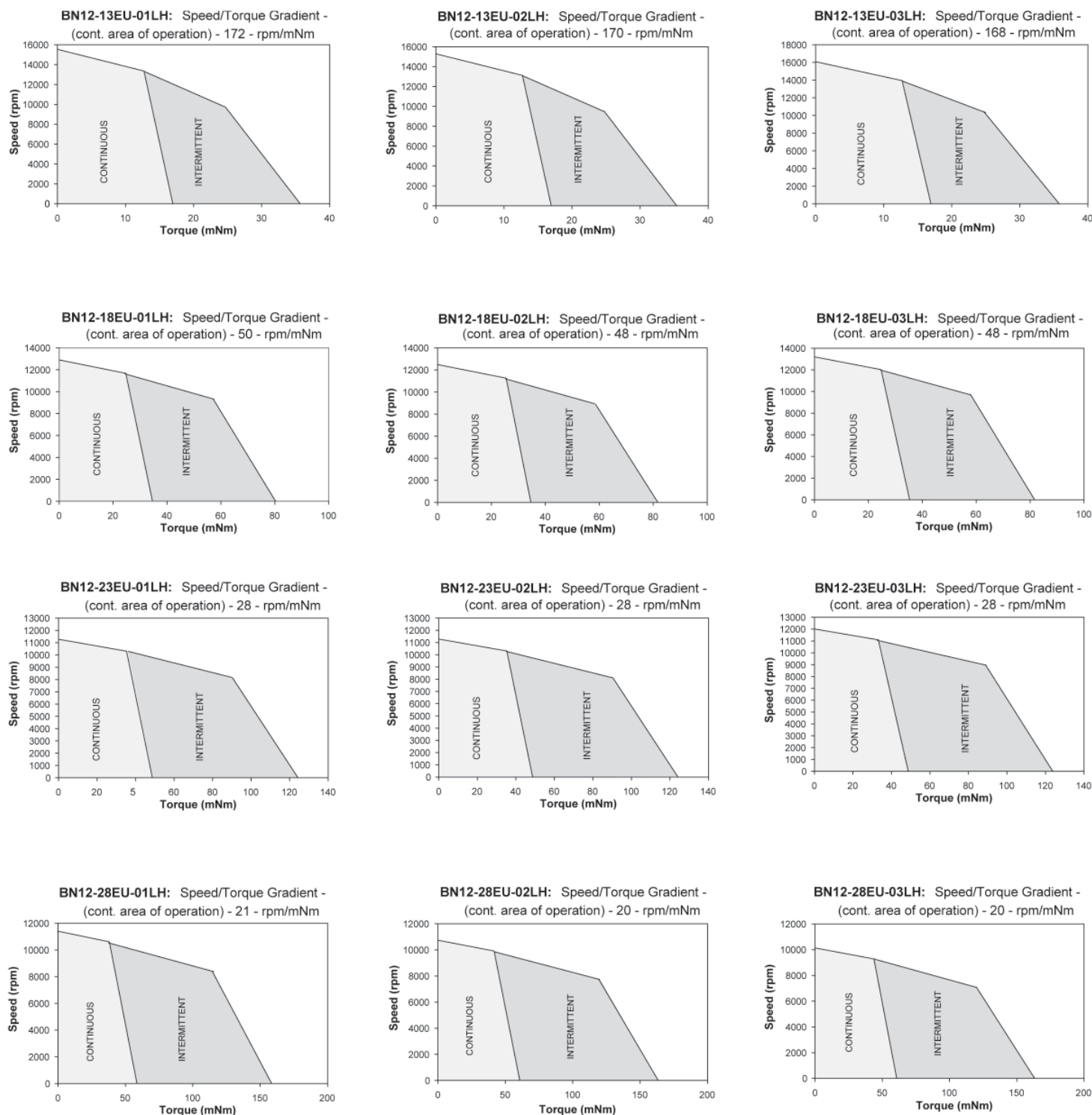
BN12-28AF-03: Continuous & Intermittent Operation at 36 Volt DC



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.










Brushless Motors

BN12 EU Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

BN17 SPECIFICATIONS - Continuous Stall Torque 7.0 to 16.0 oz-in (0.049 - 0.113 Nm) Peak Torque 64 - 149 oz-in (0.45 - 1.05 Nm)

Part Number*		BN17-15AA-   			BN17-20AA-   			BN17-25AA-   		
Winding Code**		01	02	03	01	02	03	01	02	03
L = Length	inches	1.50			2.00			2.50		
	millimeters	38.1			50.8			63.5		
Terminal Voltage	volts DC	12.0	24.0	36.0	12.0	24.0	36.0	12.0	24.0	36.0
Peak Torque	oz-in	64.0	83.0	88.00	116.0	116.0	124.0	140.0	149.0	142.0
	Nm	0.4519	0.5861	0.6214	0.8191	0.8191	0.8756	0.9886	1.0522	1.0027
Continuous Stall Torque	oz-in	7.0	7.0	8.0	12.0	12.0	12.0	15.0	15.0	16.0
	Nm	0.0494	0.0494	0.0565	0.0847	0.0847	0.0847	0.1059	0.1059	0.1130
Rated Speed	RPM	10623.0	15627.0	14644.0	8659.0	9172.0	9771.0	8414.0	8452.0	7834.0
	rad/sec	1112	1636	1534	907	960	1023	881	885	820
Rated Torque	oz-in	6.7	5.4	6.3	9.5	8.7	8.5	10.7	11.0	11.5
	Nm	0.0473	0.0381	0.0445	0.0671	0.0614	0.0600	0.0756	0.0777	0.0812
Rated Current	Amps	5.65	3.27	2.38	6.29	3.05	2.10	6.90	3.54	2.30
Rated Power	watts	52.2	62.4	68.8	60.8	59.0	61.4	66.6	68.7	66.6
Torque Sensitivity	oz-in/amp	1.28	1.86	2.95	1.64	3.13	4.45	1.70	3.40	5.44
	Nm/amp	0.0090	0.0131	0.0208	0.0116	0.0221	0.0314	0.0120	0.0240	0.0384
Back EMF	volts/KRPM	0.95	1.38	2.18	1.21	2.31	3.29	1.26	2.51	4.02
	volts/rad/sec	0.0090	0.0131	0.0208	0.0116	0.0221	0.0314	0.0120	0.0240	0.0384
Terminal Resistance	ohms	0.24	0.54	1.20	0.17	0.65	1.30	0.15	0.55	1.38
Terminal Inductance	mH	0.23	0.48	1.22	0.17	0.69	1.40	0.15	0.61	1.57
Motor Constant	oz-in/sq.rt.watts	2.69	2.56	2.71	4.13	3.92	3.93	4.67	4.64	4.65
	Nm/sq.rt.watts	0.01900	0.01808	0.01914	0.02916	0.02768	0.02775	0.03298	0.03277	0.03284
Rotor Inertia	oz-in-sec ² x10 ⁻³	0.23	0.23	0.23	0.39	0.39	0.39	0.54	0.54	0.54
	g-cm ²	16.2	16.2	16.2	27.5	27.5	27.5	38.1	38.1	38.1
Weight	oz	6.7	6.7	6.7	10.5	10.5	10.5	13.4	13.4	13.4
	g	190	190	190	298	298	298	380	380	380
# of Poles		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	4.8	5.1	4.5	3.5	3.7	3.6	4.0	3.6	3.6
Electrical Time Constant	ms	0.96	0.89	1.02	1.00	1.06	1.08	1.00	1.11	1.14
Thermal Resistivity	deg. C/watt	8.2	8.3	8.1	6.9	6.9	6.9	6.0	6.0	6.0
Speed/Torque Gradient	rpm/oz-in.	197.4	210.4	186.6	85.7	89.9	88.8	70.0	64.4	63.1




Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
 - Maximum winding temperature of 155°C.
 - Typical electrical specifications at 25°C.
 - Calculated (theoretical) speed/torque gradient.
 - Shaft options for encoder mounting available.
- * Many other custom mechanical options are available – consult factory.
** Many other winding options are available – consult factory.

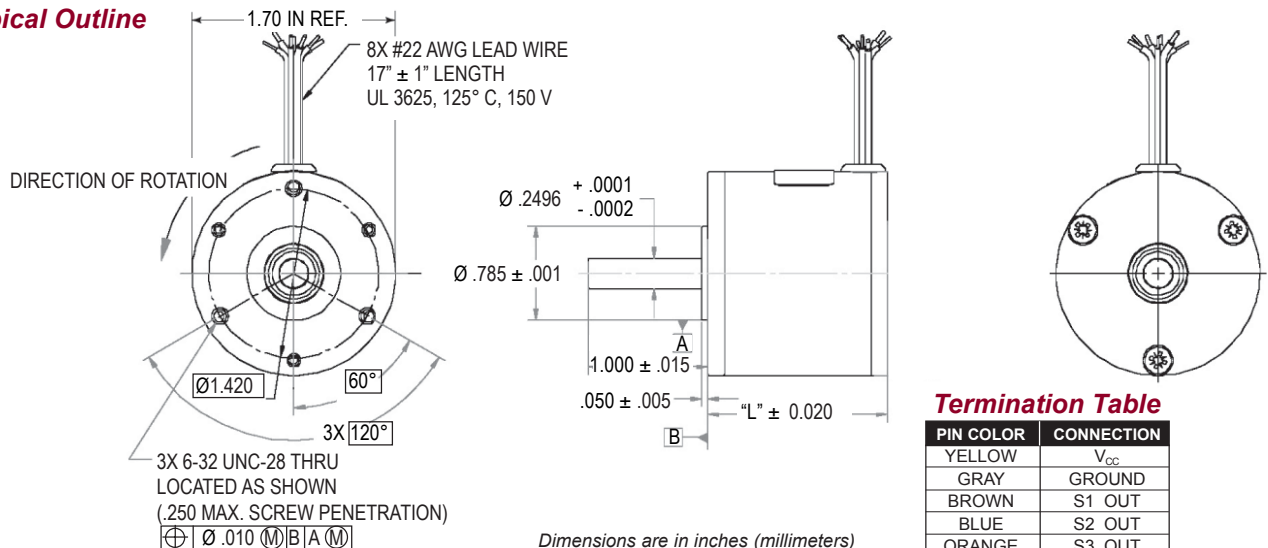
*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

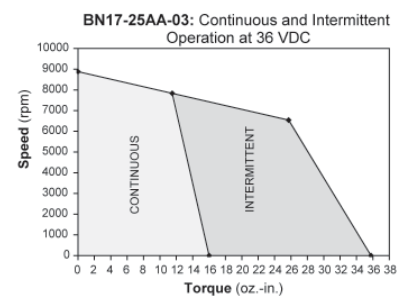
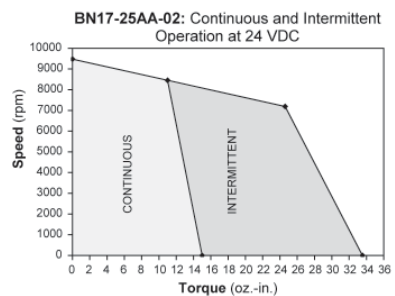
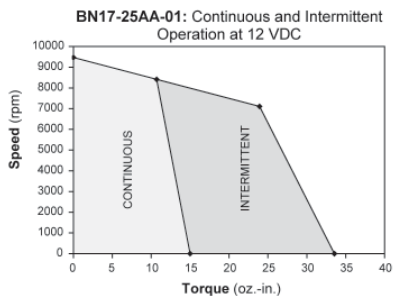
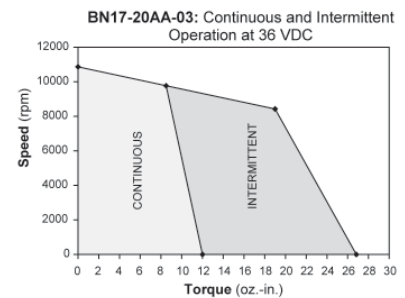
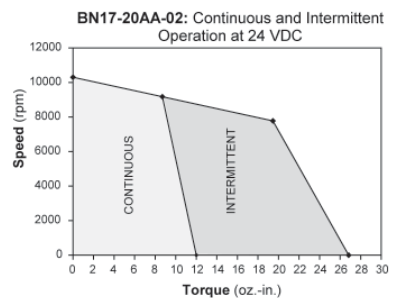
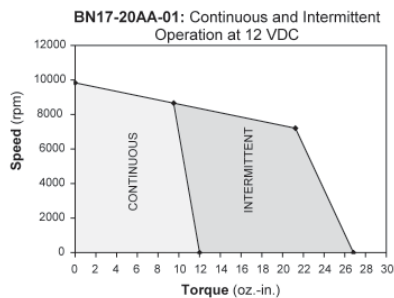
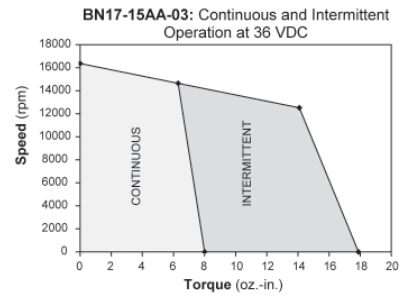
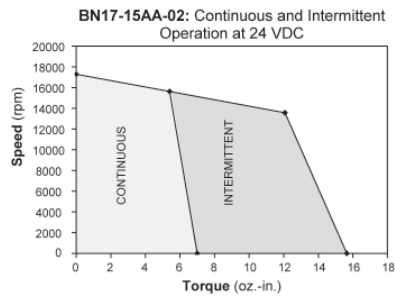
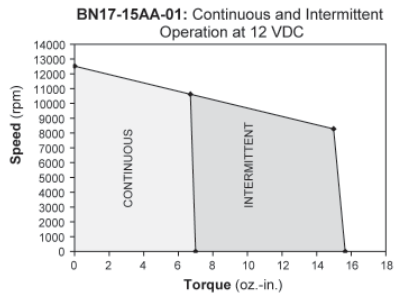
 TERMINATION	 FEEDBACK OPTIONS	 OTHER OPTIONS
L – Leads (std)	H – Hall Effect (std)	D – Drive
C – Connector	R – Resolver	E – Encoder
M – MS connector	S – Sensorless	G – Gearhead

BN17 Typical Outline



Brushless Motors

BN17 Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

BN23 SPECIFICATIONS -

Continuous Stall Torque 12.6 - 41 oz-in (0.0890 - 0.290 Nm)
Peak Torque 35 - 186 oz-in (0.248 - 1.32 Nm)

Part Number*		BN23-13PM- <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23-18PM- <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23-23PM- <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23-28PM- <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	1.41			1.91			2.41			2.91		
	millimeters	35.8			48.5			61.2			73.9		
Terminal Voltage	volts DC	24.0	36.0	48.0	24.0	36.0	48.0	24.0	36.0	48.0	24.0	36.0	48.0
Peak Torque	oz-in	35.0	35.0	35.0	88.0	88.0	88.0	143.0	143.0	143.0	186.0	186.0	186.0
	Nm	0.2472	0.2472	0.2472	0.6214	0.6214	0.6214	1.0098	1.0098	1.0098	1.3134	1.3134	1.3134
Continuous Stall Torque	oz-in	12.6	12.6	12.6	24.2	24.2	24.2	34.5	34.5	34.5	41.0	41.0	41.0
	Nm	0.0890	0.0890	0.0890	0.1709	0.1709	0.1709	0.2436	0.2436	0.2436	0.2895	0.2895	0.2895
Rated Speed	RPM	12235.0	13040.0	12060.0	9810.0	10185.0	10985.0	8585.0	9490.0	8587.0	7640.0	8090.0	8720.0
	rad/sec	1281	1366	1263	1027	1067	1150	899	994	899	800	847	913
Rated Torque	oz-in	8.7	8.2	8.8	16.6	16.3	14.9	23.9	21.2	23.9	28.5	27.2	24.9
	Nm	0.0614	0.0579	0.0621	0.1172	0.1151	0.1052	0.1688	0.1497	0.1688	0.2013	0.1921	0.1758
Rated Current	Amps	4.10	2.75	2.10	6.00	4.10	3.00	7.40	4.90	3.70	8.00	5.40	4.00
Rated Power	watts	78.3	79.1	79.1	120.8	123.1	120.8	152.2	148.5	151.4	161.1	163.4	160.4
Torque Sensitivity	oz-in/amp	2.58	3.67	5.22	3.31	4.81	6.02	3.82	5.25	7.63	4.26	6.08	7.61
	Nm/amp	0.0182	0.0259	0.0369	0.0234	0.0340	0.0425	0.0270	0.0371	0.0539	0.0301	0.0429	0.0537
Back EMF	volts/KRPM	1.91	2.72	3.86	2.45	3.56	4.45	2.82	3.88	5.65	3.15	4.50	5.62
	volts/rad/sec	0.0182	0.0259	0.0369	0.0234	0.0340	0.0425	0.0270	0.0371	0.0539	0.0301	0.0429	0.0537
Terminal Resistance	ohms	0.465	0.939	1.89	0.246	0.507	0.800	0.178	0.347	0.715	0.181	0.366	0.576
Terminal Inductance	mH	0.374	0.758	1.53	0.251	0.531	0.829	0.217	0.410	0.867	0.242	0.493	0.770
Motor Constant	oz-in/sq.rt.watt	3.78	3.79	3.80	6.67	6.76	6.73	9.05	8.91	9.02	10.01	10.05	10.03
	Nm/sq.rt.watt	0.02672	0.02674	0.02681	0.04713	0.04770	0.04753	0.06394	0.06294	0.06372	0.07071	0.07097	0.07081
Rotor Inertia	oz-in-sec ² ×10 ⁻³	0.51	0.51	0.51	0.99	0.99	0.99	1.50	1.50	1.50	1.90	1.90	1.90
	g-cm ²	36.0	36.0	36.0	69.9	69.9	69.9	105.9	105.9	105.9	134.1	134.1	134.1
Weight	oz	10.0	10.0	10.0	15.0	15.0	15.0	21.0	21.0	21.0	26.0	26.0	26.0
	g	284.0	284.0	284.0	426.0	426.0	426.0	596.4	596.4	596.4	738.4	738.4	738.4
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	5.0	5.0	5.0	3.1	3.1	3.1	2.6	2.7	2.6	2.7	2.7	2.7
Electrical Time Constant	ms	0.80	0.81	0.81	1.02	1.05	1.04	1.22	1.18	1.21	1.34	1.35	1.34
Thermal Resistivity	deg. C/watt	5.3	5.3	4.7	4.5	4.2	4.6	4.1	3.8	4.1	3.4	3.3	3.3
Speed/Torque Gradient	rpm/oz-in	94.4	94.1	93.8	30.3	29.6	29.9	16.5	17.0	16.6	13.5	13.4	13.5

Notes:

- Motor mounted to a 6" x 6" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Data shown for 8 pole motors. Please consult factory for 4 pole specifications.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

TERMINATION

L – Leads (std)
C – Connector
M – MS connector

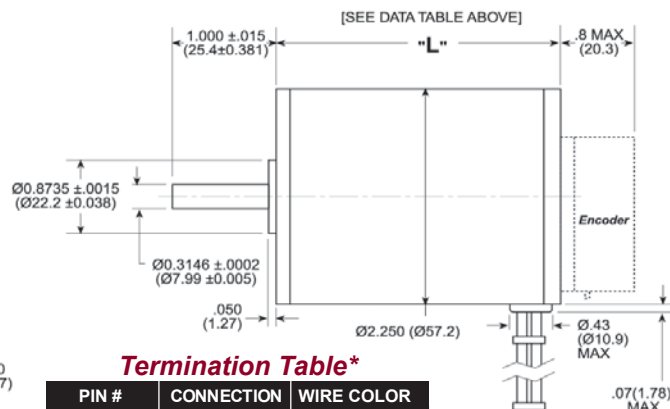
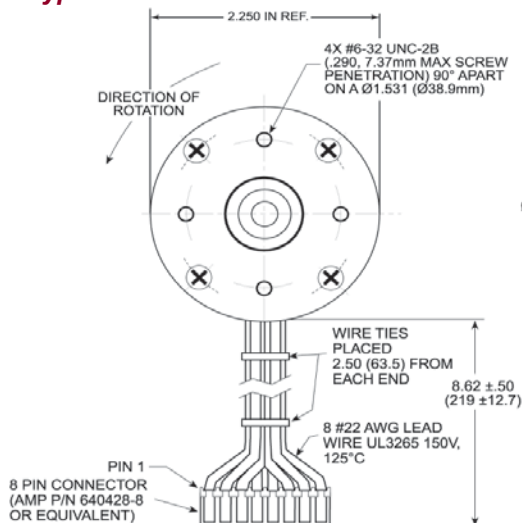
FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

BN23 Typical Outline



Termination Table*

PIN #	CONNECTION	WIRE COLOR
1	V _{CC}	White/Yellow
2	GROUND	White/Gray
3	A COIL	White/Violet
4	B COIL	White/Black
5	C COIL	Green
6	S2 OUT	White/Blue
7	S1 OUT	White/Brown
8	S3 OUT	White

*We reserve the right to use solid color wires or white wires with color trace.

Dimensions are in inches (millimeters)

Brushless Motors

BN23 EU SPECIFICATIONS - Continuous Stall Torque 12.6 - 41 oz-in (0.0890 - 0.290 Nm) Peak Torque 35 - 186 oz-in (0.248 - 1.32 Nm)

Part Number*		BN23-13EU- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23-18EU- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23-23EU- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23-28EU- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	1.41			1.91			2.41			2.91		
	millimeters	35.8			48.5			61.2			73.9		
Terminal Voltage	volts DC	24	36	48	24	36	48	24	36	48	24	36	48
Peak Torque	oz-in	35	35	35	88	88	88	143	143	143	186	186	186
	Nm	0.248	0.248	0.248	0.622	0.622	0.622	1.01	1.01	1.01	1.32	1.32	1.32
Continuous Stall Torque	oz-in	12.6	12.6	12.6	24.2	24.2	24.2	34.5	34.5	34.5	41.0	41.0	41.0
	Nm	0.0890	0.0890	0.0890	0.171	0.171	0.171	0.244	0.244	0.244	0.290	0.290	0.290
Rated Speed	RPM	12235	13040	12060	9810	10185	10985	8585	9490	8587	7640	8090	8720
	rad/sec	1281	1366	1263	1028	1067	1151	899	994	899	800	848	914
Rated Torque	oz-in	8.70	8.20	8.80	16.6	16.3	14.9	23.9	21.2	23.9	28.5	27.2	24.9
	Nm	0.0615	0.0579	0.0622	0.118	0.116	0.106	0.169	0.150	0.169	0.202	0.192	0.176
Rated Current	Amps	4.10	2.75	2.10	6.00	4.10	3.0	7.40	4.90	3.70	8.00	5.40	4.00
Rated Power	watts	78.3	79.1	79.1	120.8	123.1	120.8	152.2	148.5	151.4	161.1	163.4	160.4
Torque Sensitivity	oz-in/amp	2.58	3.67	5.22	3.31	4.81	6.02	3.82	5.25	7.63	4.26	6.08	7.61
	Nm/amp	0.0183	0.0260	0.0369	0.0234	0.0340	0.0425	0.0270	0.0371	0.0540	0.0301	0.0430	0.0537
Back EMF	volts/KRPM	1.91	2.72	3.86	2.45	3.56	4.45	2.82	3.88	5.65	3.15	4.50	5.62
	volts/rad/sec	0.0183	0.0260	0.0369	0.0234	0.0340	0.0425	0.0270	0.0371	0.0540	0.0301	0.0430	0.0537
Terminal Resistance	ohms	0.465	0.939	1.89	0.246	0.507	0.800	0.178	0.347	0.715	0.181	0.366	0.576
Terminal Inductance	mH	0.374	0.758	1.53	0.251	0.531	0.829	0.217	0.410	0.867	0.242	0.493	0.770
Motor Constant	oz-in/sq.rt.watt	3.8	3.8	3.8	6.7	6.7	6.7	9.0	9.0	9.0	10.0	10.0	10.0
	Nm/sq.rt.watt	0.0269	0.0269	0.0269	0.0474	0.0474	0.0474	0.0636	0.0636	0.0636	0.0707	0.0707	0.0707
Rotor Inertia	oz-in-sec ²	.51E-03	.51E-03	.51E-03	.99E-03	.99E-03	.99E-03	1.5E-03	1.5E-03	1.5E-03	1.9E-03	1.9E-03	1.9E-03
	g-cm ²	36.1	36.1	36.1	69.9	69.9	69.9	106	106	106	135	135	135
Weight	oz	10.0	10.0	10.0	15.0	15.0	15.0	21.0	21.0	21.0	26.0	26.0	26.0
	g	284	284	284	426	426	426	596	596	596	738	738	738

Notes:

- Motor mounted to a 6" x 6" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Data shown for 8 pole motors. Please consult factory for 4 pole specifications.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

☒ TERMINATION

L – Leads
C – Connector (std)
M – MS connector

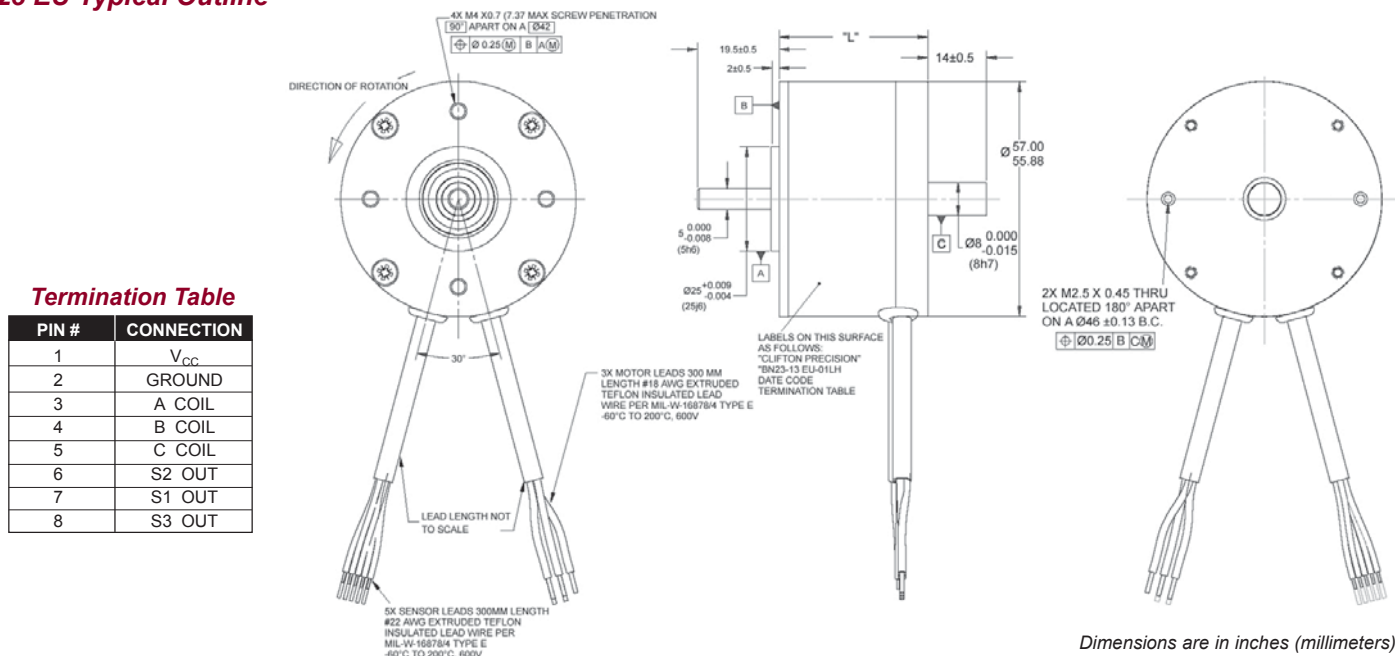
☐ FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

☐ OTHER OPTIONS

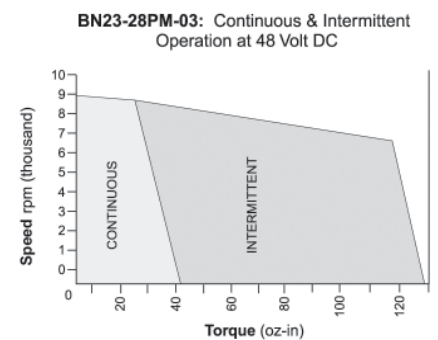
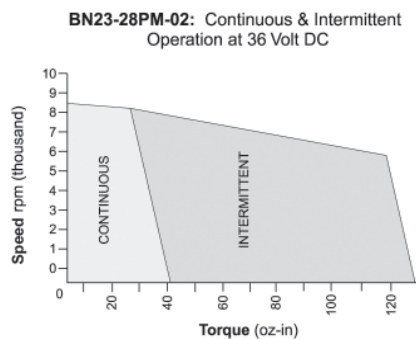
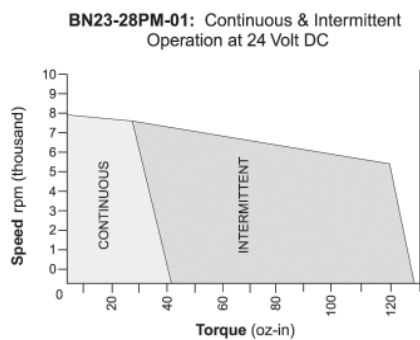
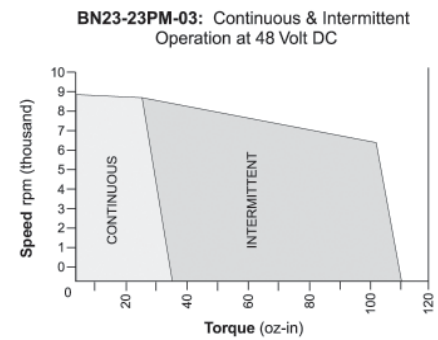
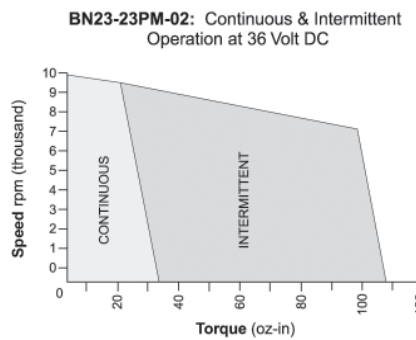
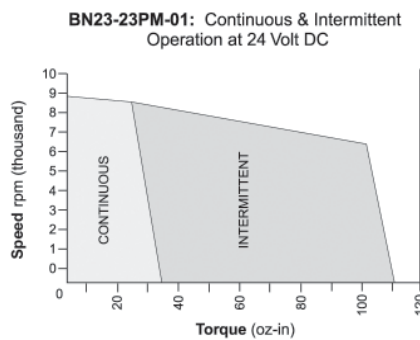
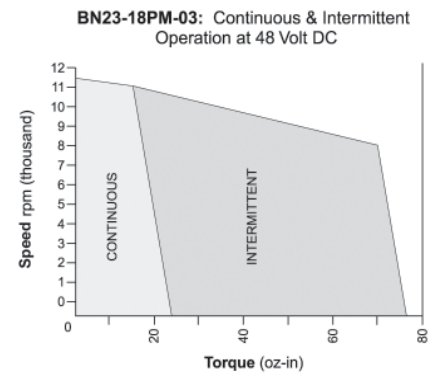
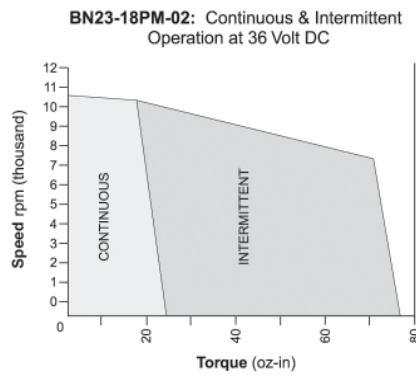
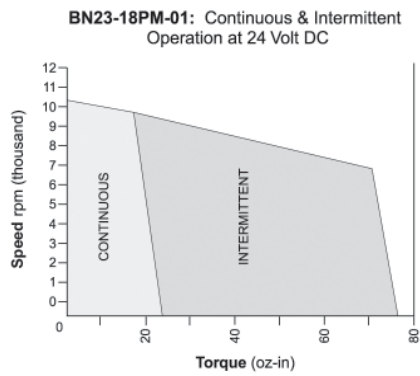
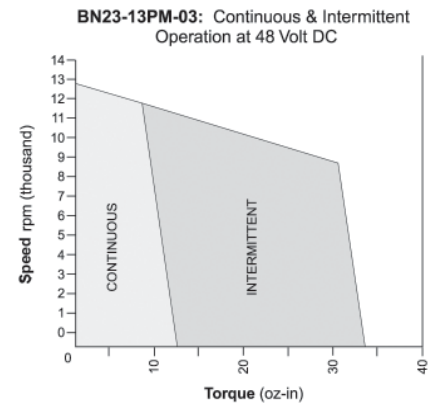
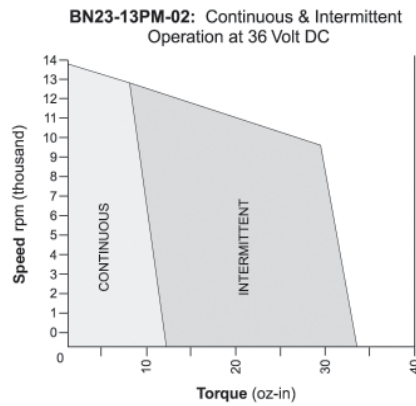
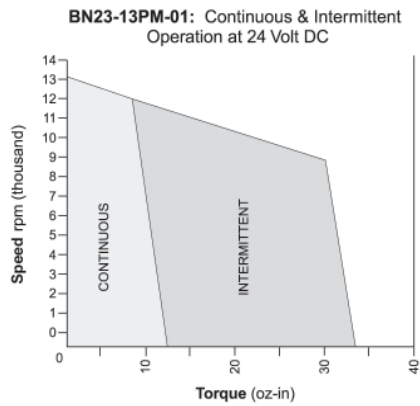
D – Drive
E – Encoder
G – Gearhead

BN23 EU Typical Outline



Dimensions are in inches (millimeters)

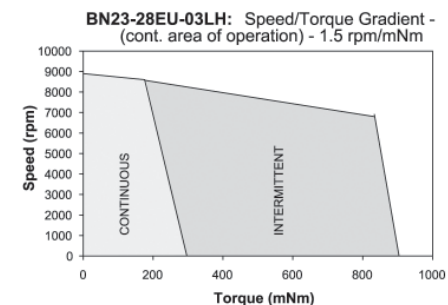
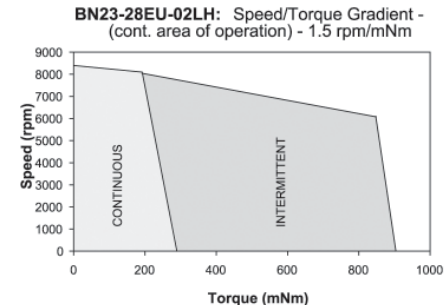
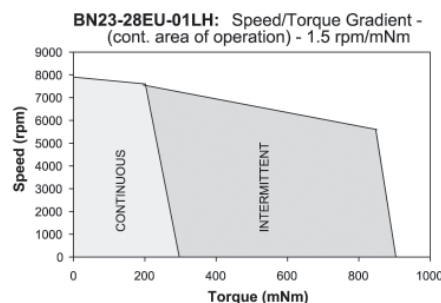
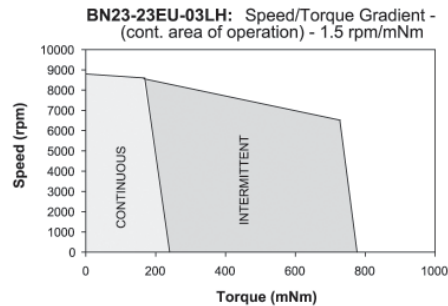
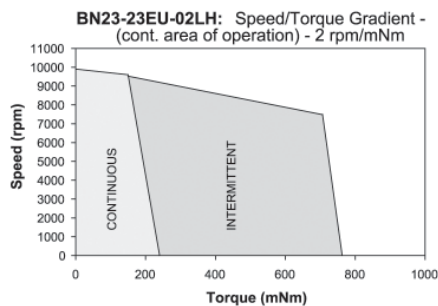
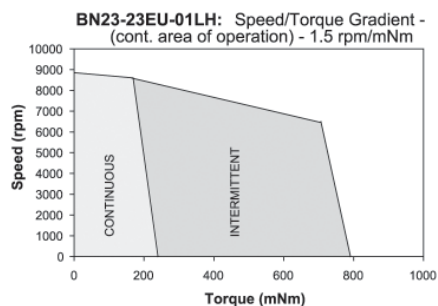
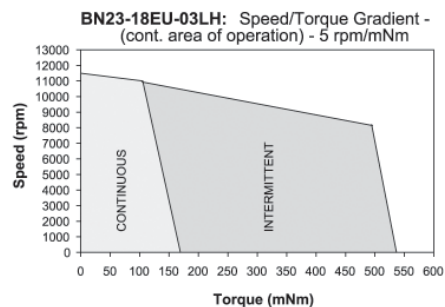
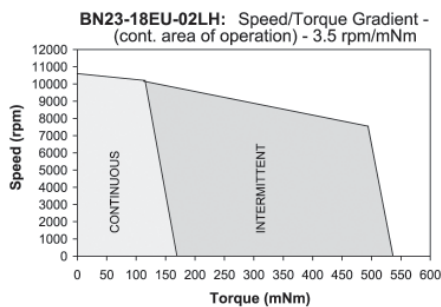
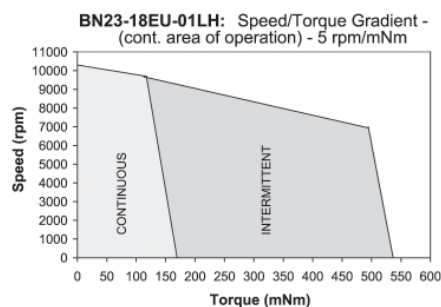
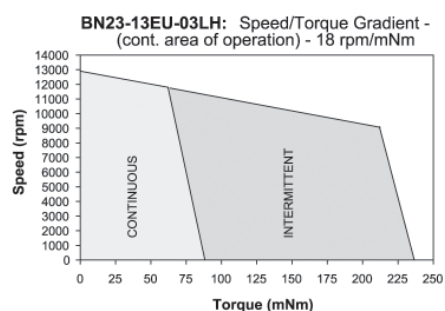
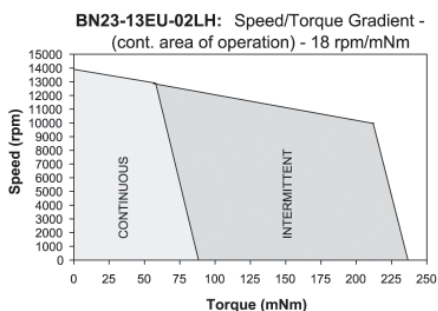
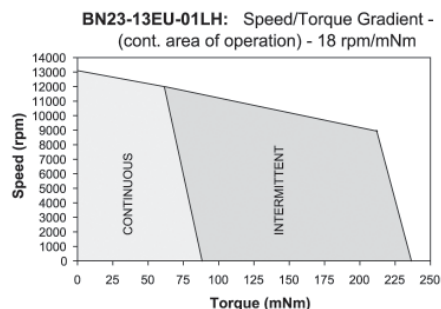
BN23 Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

Brushless Motors

BN23 EU Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

BN28 SPECIFICATIONS - Continuous Stall Torque 43 - 108 oz-in (.30 - .76 Nm) Peak Torque 188 - 737 oz-in (1.33 - 5.2 Nm)

Part Number*		BN28-21AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN28-29AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN28-36AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN28-44AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	2.10			2.90			3.60			4.40		
	millimeters	53.3			73.7			91.4			111.8		
Terminal Voltage	volts DC	24.0	48.0	72.0	24.0	48.0	72.0	24.0	48.0	72.0	24.0	48.0	72.0
Peak Torque	oz-in	188.0	188.0	188.0	407.0	407.0	407.0	596.0	596.0	596.0	737.0	737.0	737.0
	Nm	1.3276	1.3276	1.3276	2.8740	2.8740	2.8740	4.2087	4.2087	4.2087	5.2043	5.2043	5.2043
Continuous Stall Torque	oz-in	43.0	44.0	46.0	71.0	74.0	72.0	93.0	95.0	93.0	106.0	108.0	105.0
	Nm	0.3036	0.3107	0.3248	0.5014	0.5226	0.5084	0.6567	0.6708	0.6567	0.7485	0.7626	0.7415
Rated Speed	RPM	9170	9230	9240	8870	8900	7890	5890	5910	5230	4660	4680	4120
	rad/sec	960	967	968	929	932	826	617	619	548	488	490	431
Rated Torque	oz-in	31	31	33	40	40	46	68	70	72	84	84	86
	Nm	0.2189	0.2189	0.2330	0.2825	0.2825	0.3248	0.4802	0.4943	0.5084	0.5932	0.5932	0.6073
Rated Current	Amps	10.26	5.13	3.63	12.67	6.33	4.29	14.31	7.35	4.51	14.25	7.13	4.35
Rated Power	watts	210.3	211.6	225.5	262.4	263.3	268.4	296.2	306.0	278.5	289.5	290.8	262.1
Torque Sensitivity	oz-in/amp	3.24	6.49	9.73	3.48	6.95	11.59	5.07	10.13	16.89	6.25	12.50	20.84
	Nm/amp	0.0229	0.0458	0.0687	0.0246	0.0491	0.0818	0.0358	0.0715	0.1193	0.0441	0.0883	0.1472
Back EMF	volts/KRPM	2.40	4.80	7.20	2.57	5.14	8.57	3.75	7.49	12.49	4.62	9.24	15.41
	volts/rad/sec	0.0229	0.0458	0.0687	0.0246	0.0491	0.0818	0.0358	0.0715	0.1193	0.0441	0.0883	0.1472
Terminal Resistance	ohms	0.14	0.51	1.08	0.07	0.25	0.72	0.10	0.36	1.05	0.12	0.47	1.38
Terminal Inductance	mH	0.18	0.72	1.62	0.11	0.43	1.19	0.17	0.69	1.92	0.24	0.97	2.69
Motor Constant	oz-in/sq.rt.watt	8.72	9.06	9.38	13.44	13.93	13.69	16.45	16.86	16.49	17.82	18.18	17.73
	Nm/sq.rt.watt	0.062	0.064	0.066	0.095	0.098	0.097	0.116	0.119	0.11645	0.12584	0.12835	0.12518
Rotor Inertia	oz-in-sec ² x10 ⁻³	2.30	2.30	2.30	4.40	4.40	4.40	6.60	6.60	6.60	8.80	8.80	8.80
	g-cm ²	162.3	162.3	162.3	310.5	310.5	310.5	465.8	465.8	465.8	621.0	621.0	621.0
Weight	oz	23.0	23.0	23.0	35.0	35.0	35.0	48.0	48.0	48.0	61.0	61.0	61.0
	g	653.2	653.2	653.2	994.0	994.0	994.0	1363.2	1363.2	1363.2	1732.4	1732.4	1732.4
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	4.3	4.0	3.7	3.4	3.2	3.3	3.5	3.3	3.4	3.9	3.8	4.0
Electrical Time Constant	ms	1.30	1.40	1.51	1.64	1.73	1.66	1.79	1.91	1.83	1.95	2.05	1.95
Thermal Resistivity	deg. C/watt	2.9	3.0	2.9	2.5	2.6	2.6	2.2	2.2	2.3	2.0	2.0	2.1
Speed/Torque Gradient	rpm/oz-in	17.7	16.5	15.4	7.5	7.0	7.2	5.0	4.8	5.0	4.3	4.1	4.3

Notes:

- Motor mounted to a 10" x 10" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

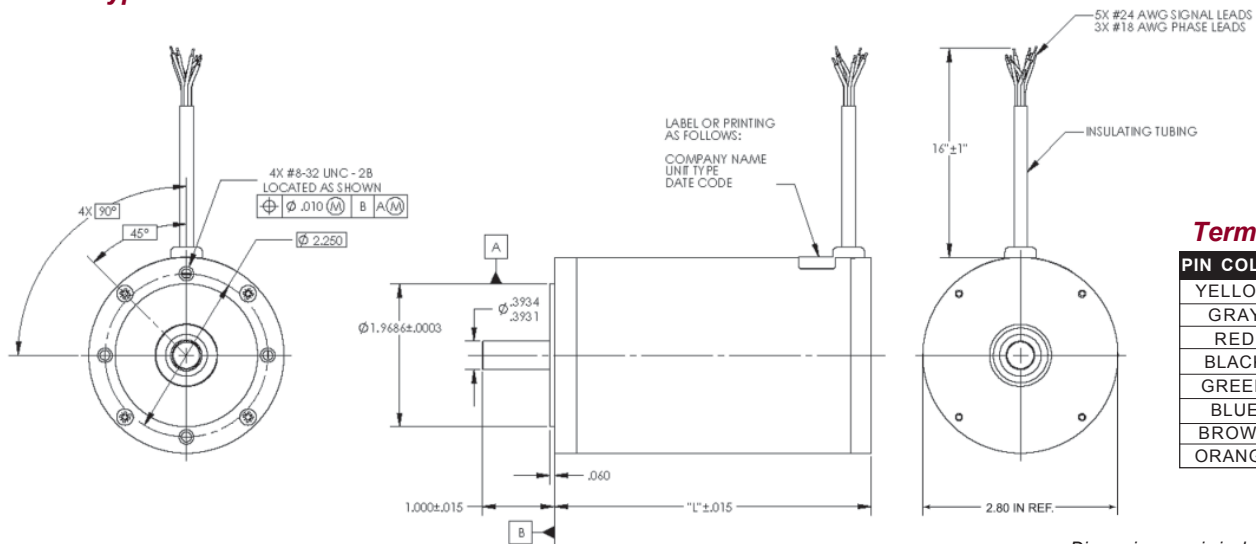
*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

T TERMINATION	F FEEDBACK OPTIONS	O OTHER OPTIONS
L – Leads (std)	H – Hall Effect (std)	D – Drive
C – Connector	R – Resolver	E – Encoder
M – MS connector	S – Sensorless	G – Gearhead

BN28 Typical Outline



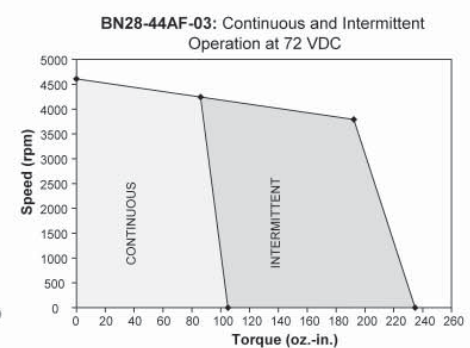
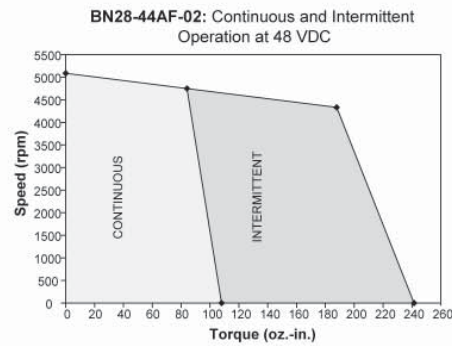
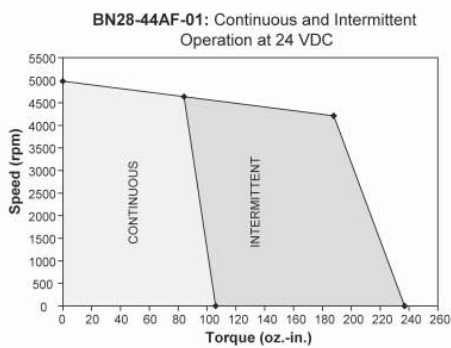
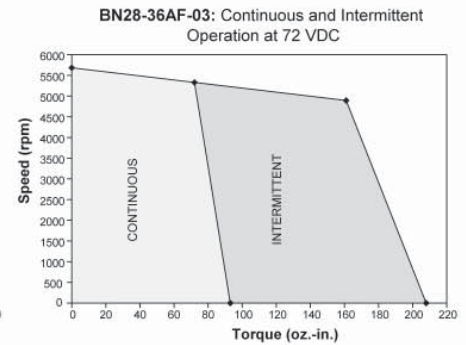
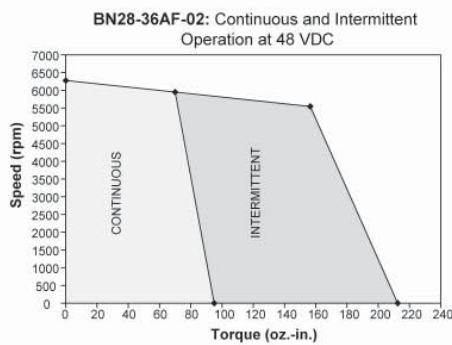
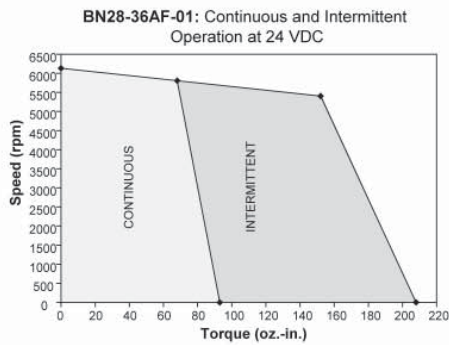
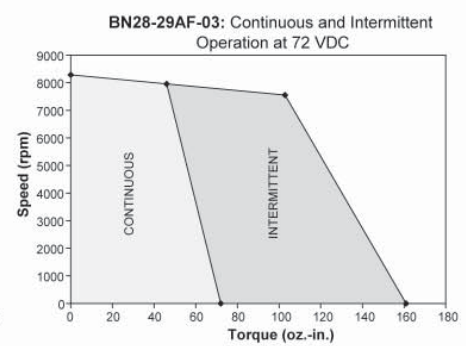
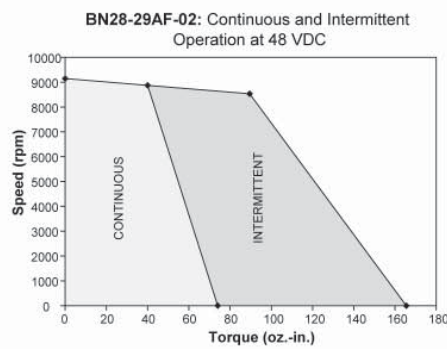
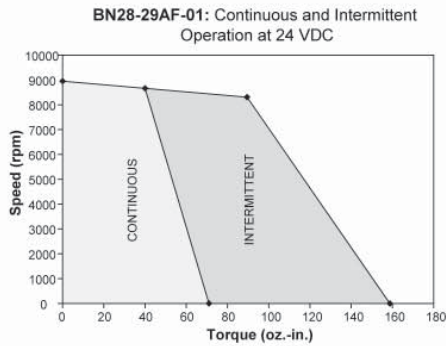
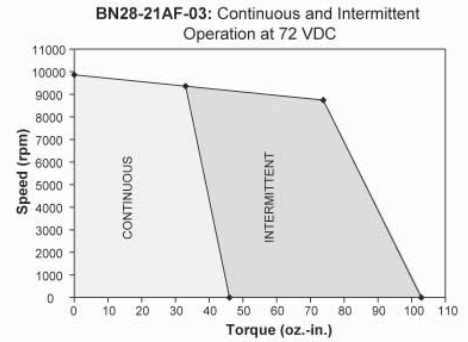
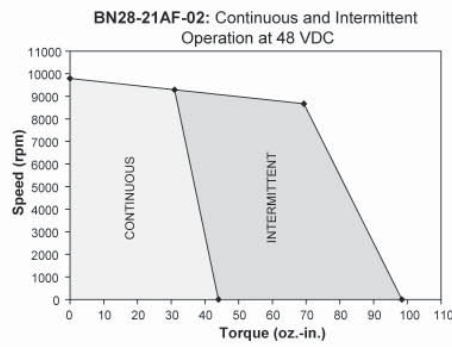
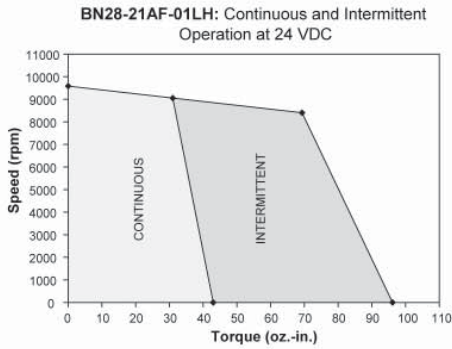
Termination Table

PIN	COLOR	CONNECTION
	YELLOW	V _{CC}
	GRAY	GROUND
	RED	A COIL
	BLACK	B COIL
	GREEN	C COIL
	BLUE	S2 OUT
	BROWN	S1 OUT
	ORANGE	S3 OUT

Dimensions are in inches (millimeters)

Brushless Motors

BN28 Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

BN34 SPECIFICATIONS - Continuous Stall Torque 83 - 309 oz-in (0.587 - 2.19 Nm) Peak Torque 326 - 1445 oz-in (2.31 - 10.21 Nm)

Part Number*		BN34-25AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN34-35AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN34-45AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN34-55AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	2.50			3.50			4.50			5.50		
	millimeters	63.5			88.9			114.3			139.7		
Terminal Voltage	volts DC	24.0	50.0	100.0	24.0	50.0	100.0	24.0	50.0	100.0	24.0	50.0	100.0
Peak Torque	oz-in	326.0	326.0	326.0	566.0	697.0	697.0	1070.0	1070.0	1070.0	1445.0	1445.0	1445.0
	Nm	2.3020	2.3020	2.3020	3.9968	4.9219	4.9219	7.5558	7.5558	7.5558	10.2039	10.2039	10.2039
Continuous Stall Torque	oz-in	83.0	93.0	93.0	133.0	159.0	159.0	220.0	224.0	231.0	287.0	306.0	309.0
	Nm	0.5861	0.6567	0.6567	0.9392	1.1228	1.1228	1.5535	1.5818	1.6312	2.0267	2.1608	2.1820
Rated Speed	RPM	7400.0	7330.0	7550.0	5916.0	5930.0	6240.0	3300.0	4710.0	4710.0	2410.0	3910.0	3920.0
	rad/sec	775	768	791	620	621	653	346	493	493	252	409	411
Rated Torque	oz-in	60.0	67.0	66.0	93.0	110.0	106.0	188.0	165.0	170.0	258.0	240.0	240.0
	Nm	0.4237	0.4731	0.4661	0.6567	0.7768	0.7485	1.3276	1.1651	1.2005	1.8219	1.6948	1.6948
Rated Current	Amps	16.40	8.70	4.40	18.74	11.50	5.80	23.0	13.70	7.00	23.30	16.50	8.20
Rated Power	watts	328.0	363.0	368.0	407.0	482.0	489.0	459.0	575.0	592.0	460.0	694.0	696.0
Torque Sensitivity	oz-in/amp	4.19	8.90	17.20	5.24	11.00	21.0	9.20	13.80	27.70	12.40	16.60	33.20
	Nm/amp	0.0296	0.0628	0.1215	0.0370	0.0777	0.1483	0.0650	0.0974	0.1956	0.0876	0.1172	0.2344
Back EMF	volts/KRPM	3.10	6.50	12.80	3.88	8.10	15.50	6.83	10.20	20.50	9.20	12.30	24.50
	volts/rad/sec	0.0296	0.0628	0.1215	0.0370	0.0777	0.1483	0.0650	0.0974	0.1956	0.0876	0.1172	0.2344
Terminal Resistance	ohms	0.069	0.251	0.941	0.057	0.160	0.575	0.069	0.147	0.552	0.086	0.135	0.504
Terminal Inductance	mH	0.129	0.575	2.180	0.143	0.432	1.570	0.200	0.450	1.800	0.271	0.482	1.930
Motor Constant	oz-in/sq.rt.watt	15.95	17.76	17.73	21.95	27.50	27.69	35.02	35.99	37.28	42.28	45.18	46.77
	Nm/sq.rt.watt	0.11264	0.12544	0.12521	0.15499	0.19419	0.19556	0.24732	0.25417	0.26328	0.29859	0.31904	0.33023
Rotor Inertia	oz-in-sec ² x10 ⁻³	6.00	6.00	6.00	12.00	12.00	12.00	18.00	18.00	18.00	24.00	24.00	24.00
	g-cm ²	423.4	423.4	423.4	846.8	846.8	846.8	1270.3	1270.3	1270.3	1693.7	1693.7	1693.7
Weight	oz	37.0	37.0	37.0	62.0	62.0	62.0	88.0	88.0	88.0	115.0	115.0	115.0
	g	1050.8	1050.8	1050.8	1760.8	1760.8	1760.8	2499.2	2499.2	2499.2	3266.0	3266.0	3266.0
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	3.3	2.7	2.7	3.5	2.2	2.2	2.1	2.0	1.8	1.9	1.7	1.6
Electrical Time Constant	ms	1.87	2.29	2.32	2.51	2.70	2.73	2.90	3.06	3.26	3.15	3.57	3.83
Thermal Resistivity	deg. C/watt	1.6	1.5	1.5	2.5	1.1	1.2	1.1	1.0	1.0	1.1	0.8	0.8
Speed/Torque Gradient	rpm/oz-in	5.3	4.3	4.3	2.8	1.8	1.8	1.1	1.0	1.0	0.8	0.7	0.6

Notes:

- Motor mounted to a 10" x 10" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

T TERMINATION

- L – Leads (std)
- C – Connector
- M – MS connector

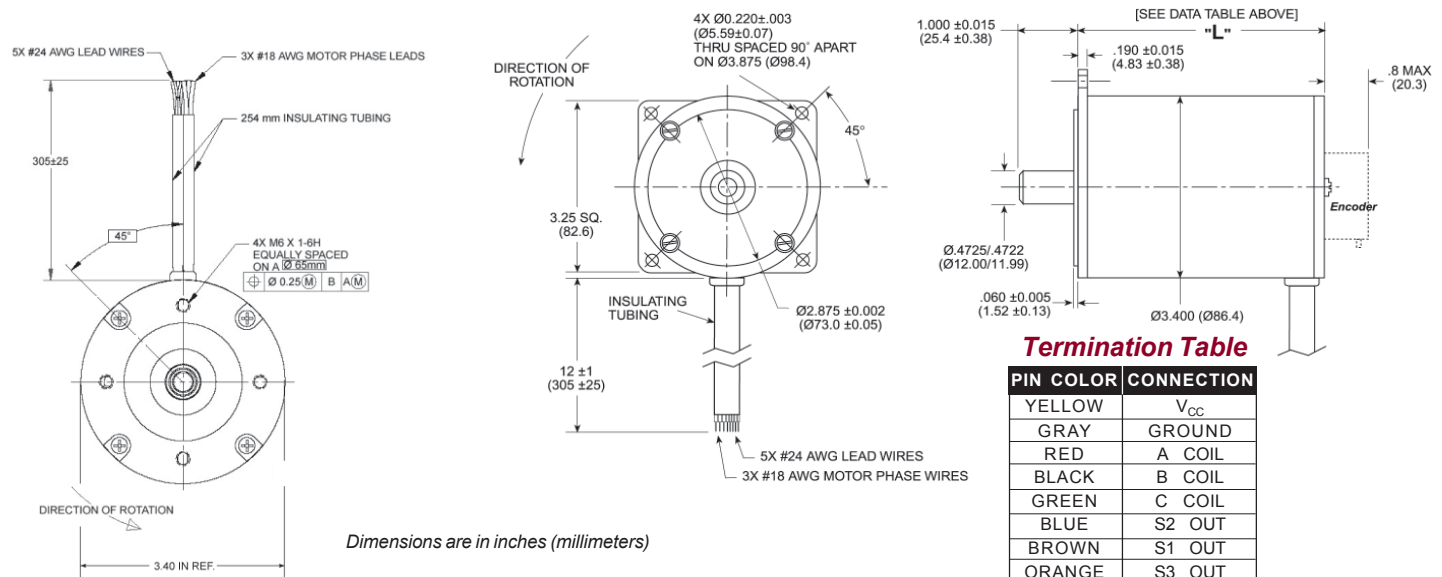
F FEEDBACK OPTIONS

- H – Hall Effect (std)
- R – Resolver
- S – Sensorless

O OTHER OPTIONS

- D – Drive
- E – Encoder
- G – Gearhead













BN34 Typical Outline



Brushless Motors

BN34 EU SPECIFICATIONS -

Continuous Stall Torque 83 - 309 oz-in (0.587 - 2.19 Nm)
Peak Torque 326 - 1445 oz-in (2.31 - 10.21 Nm)

Part Number*		BN34-25EU-   			BN34-35EU-   			BN34-45EU-   			BN34-55EU-   		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	2.50			3.50			4.50			5.50		
	millimeters	63.5			88.9			114.3			139.7		
Terminal Voltage	volts DC	24	50	100	24	50	100	24	50	100	24	50	100
Peak Torque	oz-in	326	326	326	697	697	697	1070	1070	1070	1445	1445	1445
	Nm	2.31	2.31	2.31	4.93	4.93	4.93	7.56	7.56	7.56	10.21	10.21	10.21
Continuous Stall Torque	oz-in	83	93	93	152	159	159	220	224	231	287	306	309
	Nm	0.587	0.657	0.657	1.074	1.13	1.13	1.54	1.59	1.64	2.03	2.17	2.19
Rated Speed	RPM	7400	7330	7550	5160	5930	6240	3300	4710	4710	2410	3910	3920
	rad/sec	775	768	791	541	621	654	346	494	494	253	410	411
Rated Torque	oz-in	60	67	66	117	110	106	188	165	170	258	240	240
	Nm	0.424	0.474	0.467	0.827	0.777	0.749	1.33	1.17	1.20	1.83	1.70	1.70
Rated Current	Amps	16.4	8.7	4.4	22.3	11.5	5.8	23.0	13.7	7.0	23.3	16.5	8.2
Rated Power	watts	328	363	368	446	482	489	459	575	592	460	694	696
Torque Sensitivity	oz-in/amp	4.19	8.90	17.2	6.01	11.0	21.0	9.20	13.8	27.7	12.40	16.6	33.2
	Nm/amp	0.0296	0.0621	0.123	0.0424	0.0774	0.148	0.0653	0.0974	0.196	0.0879	0.118	0.234
Back EMF	volts/KRPM	3.10	6.50	12.8	4.44	8.10	15.5	6.83	10.2	20.5	9.20	12.3	24.5
	volts/rad/sec	0.0296	0.0621	0.123	0.0424	0.0774	0.148	0.0653	0.0974	0.196	0.0879	0.118	0.234
Terminal Resistance	ohms	0.069	0.251	0.941	0.053	0.160	0.575	0.069	0.147	0.552	0.086	0.135	0.504
Terminal Inductance	mH	0.129	0.575	2.18	0.129	0.432	1.57	0.200	0.450	1.80	0.271	0.482	1.93
Motor Constant	oz-in/sq.rt.watt	17.7	18.2	17.9	30.1	28.7	28.0	38.9	37.8	37.7	46.1	47.4	47.4
	Nm/sq.rt.watt	0.125	0.129	0.127	0.213	0.203	0.198	0.275	0.267	0.267	0.326	0.335	0.335
Rotor Inertia	oz-in-sec ²	0.006	0.006	0.006	0.012	0.012	0.012	0.018	0.018	0.018	0.024	0.024	0.024
	g-cm ²	424	424	424	848	848	848	1271	1271	1271	1695	1695	1695
Weight	oz	37	37	37	62	62	62	88	88	88	115	115	115
	g	1049	1049	1049	1758	1758	1758	2495	2495	2495	3261	3261	3261

Notes:

- Motor mounted to a 10" x 10" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 8.

TERMINATION

L – Leads (std)
C – Connector
M – MS connector

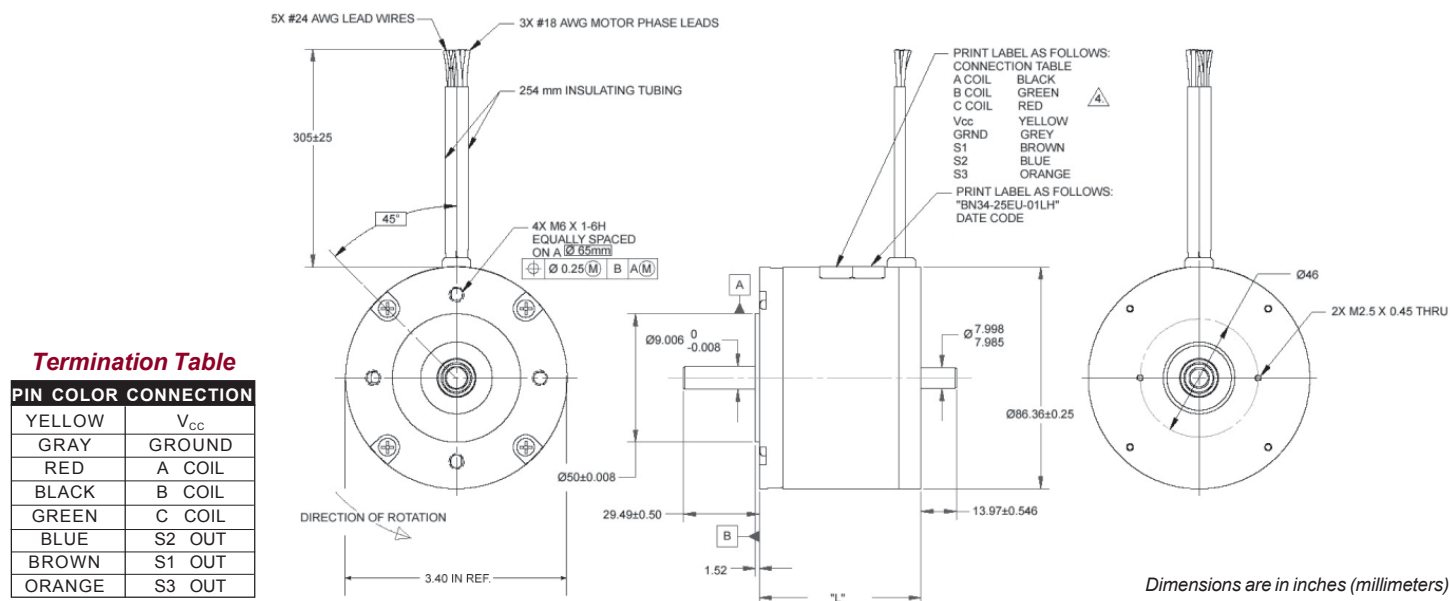
FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

OTHER OPTIONS

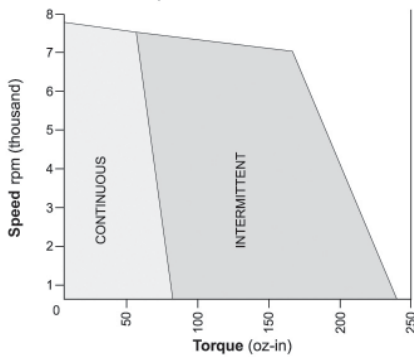
D – Drive
E – Encoder
G – Gearhead

BN34 EU Typical Outline

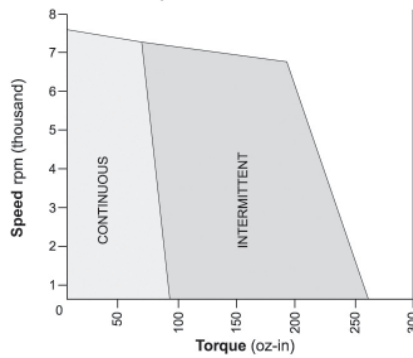


BN34 Performance Curves

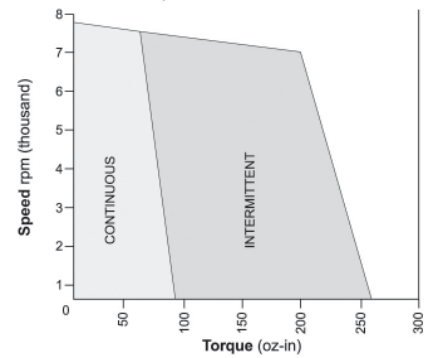
BN34-25AF-01: Continuous & Intermittent Operation at 24 Volt DC



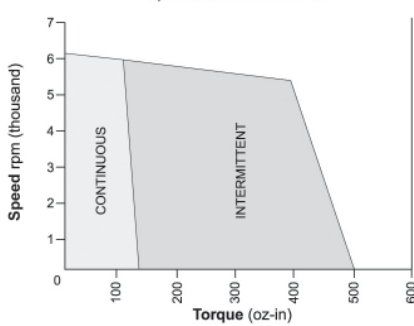
BN34-25AF-02: Continuous & Intermittent Operation at 50 Volt DC



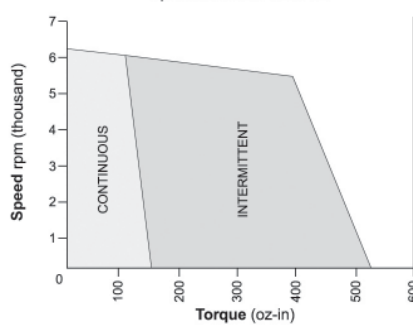
BN34-25AF-03: Continuous & Intermittent Operation at 100 Volt DC



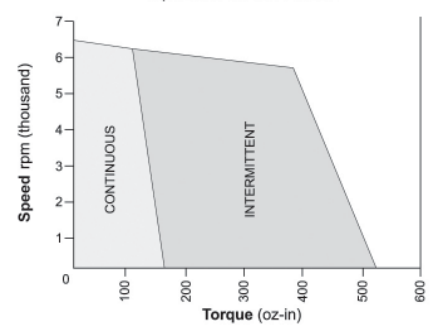
BN34-35AF-01: Continuous & Intermittent Operation at 24 Volt DC



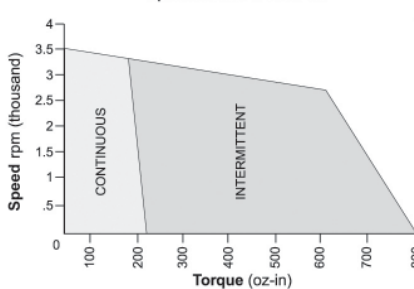
BN34-35AF-02: Continuous & Intermittent Operation at 50 Volt DC



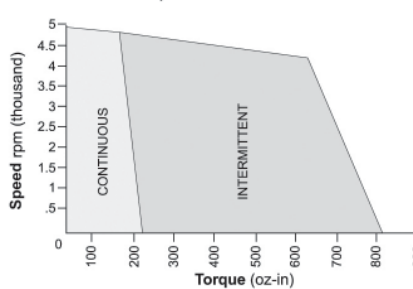
BN34-35AF-03: Continuous & Intermittent Operation at 100 Volt DC



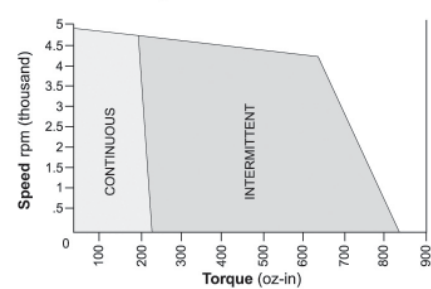
BN34-45AF-01: Continuous & Intermittent Operation at 24 Volt DC



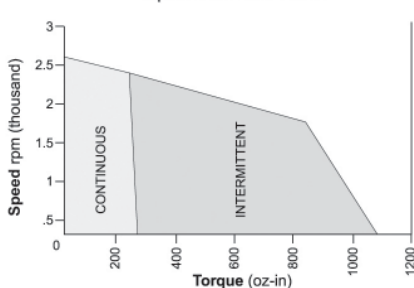
BN34-45AF-02: Continuous & Intermittent Operation at 50 Volt DC



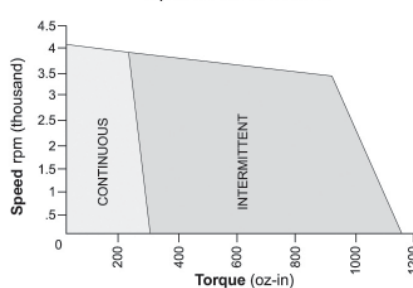
BN34-45AF-03: Continuous & Intermittent Operation at 100 Volt DC



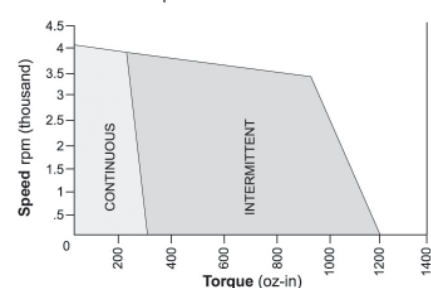
BN34-55AF-01: Continuous & Intermittent Operation at 24 Volt DC



BN34-55AF-02: Continuous & Intermittent Operation at 50 Volt DC



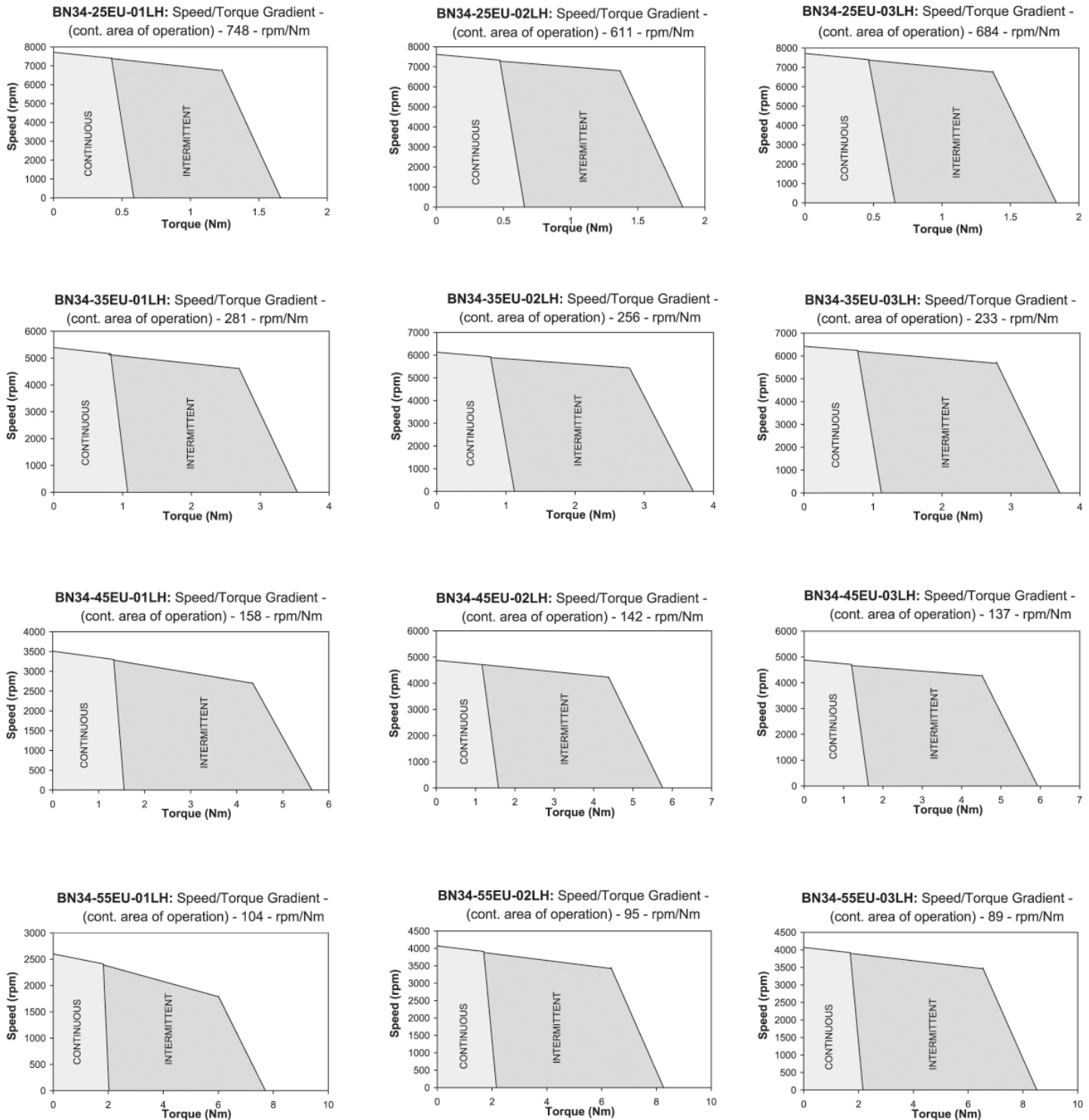
BN34-55AF-03: Continuous & Intermittent Operation at 100 Volt DC



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

Brushless Motors

BN34 EU Performance Curves

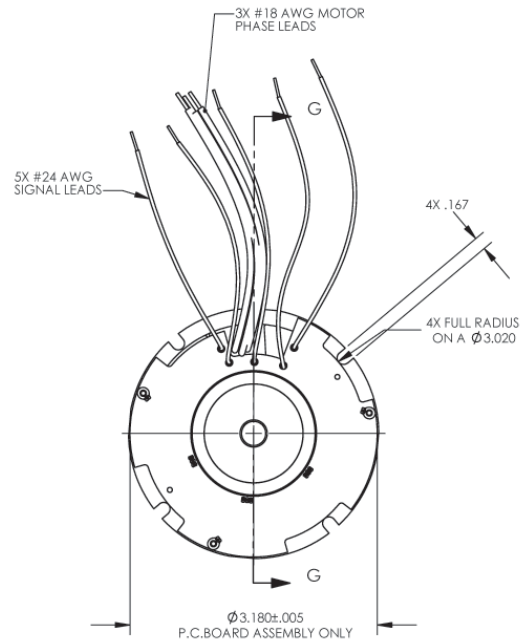
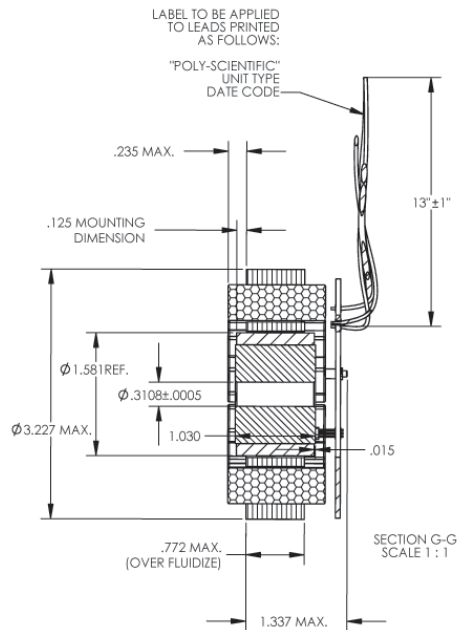


Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

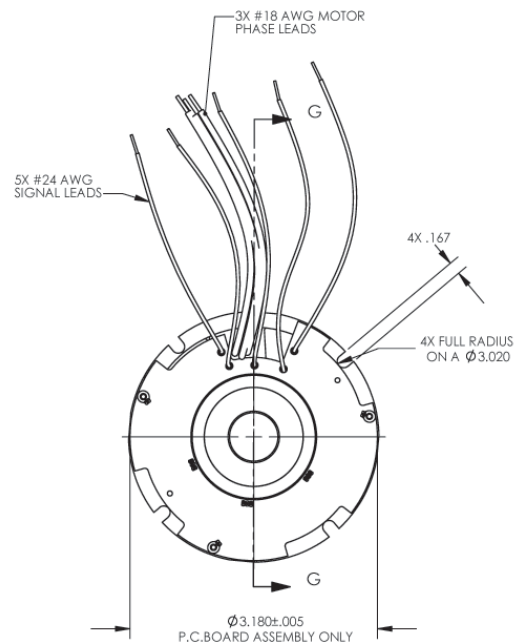
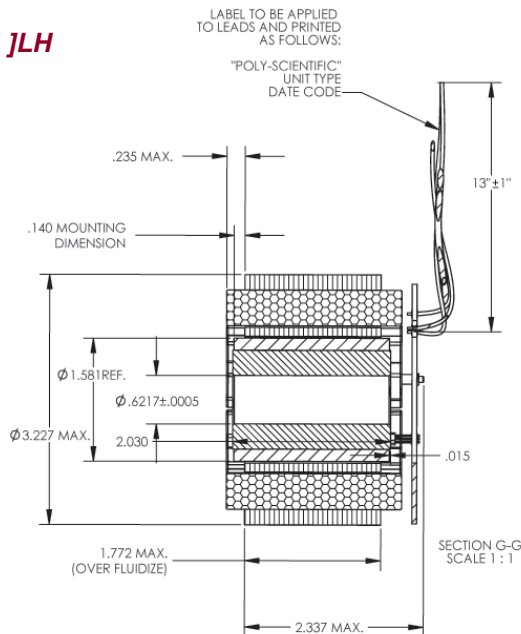
BN34 Part-Set

In addition to the housed motors, the BN34 is also available as a rotor-stator part-set. Part-sets are often used when the application or apparatus involves a higher-level assembly where the motor's rotor and stator can be integrated into existing housings or casting. Part-sets are more economical than the housed motor due to the elimination of the motor housing, end caps, bearings and shafts. Another economic advantage is that the rotor and stator assembly may be purchased separately for either spare or replacement parts. Part-sets are available in all standard lengths and winding codes. The following drawings depict our standard BN34 part-sets. For application assistance call 800-577-8685, ext. 256.

BN34-25ZP[][]LH

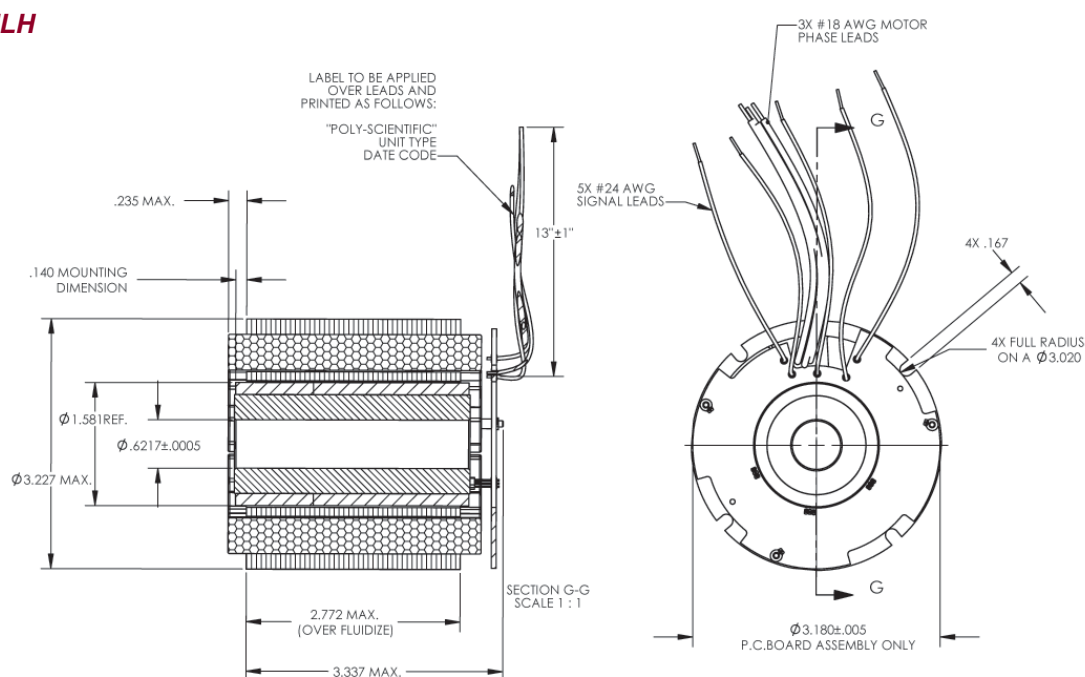


BN34-35ZP[][]LH

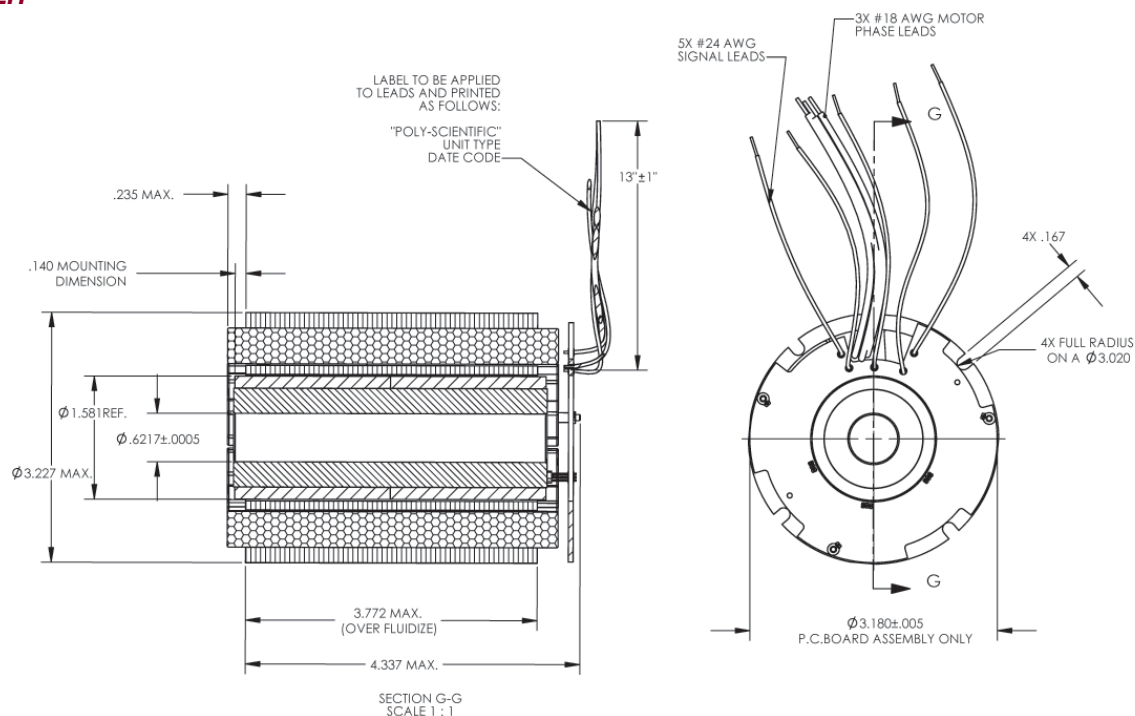


Brushless Motors

BN34-45ZP[][]LH



BN34-55ZP[][]LH



Notes:

1. The basic part-set consists of a wound stator, rotor core and magnet, and Hall-effect printed circuit board. Shafts and bearings can be furnished if necessary. Contact the factory for assistance.
2. The performance table shows the basic electrical parameters. For a frame-of-reference, refer to the same length and winding code for the housed motor.

BN42 SPECIFICATIONS - *Continuous Stall Torque 144 - 519 oz-in (1.02 - 3.67 Nm)*
Peak Torque 609 - 2560 oz-in (4.30 - 18.1 Nm)

Part Number*		BN42-23AF- <div><div></div><div></div><div>T</div><div>F</div><div>O</div></div>			BN42-33AF- <div><div></div><div></div><div>T</div><div>F</div><div>O</div></div>			BN42-43AF- <div><div></div><div></div><div>T</div><div>F</div><div>O</div></div>			BN42-53AF- <div><div></div><div></div><div>T</div><div>F</div><div>O</div></div>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	2.30			3.30			4.30			5.30		
	millimeters	58.4			83.8			109.2			134.6		
Terminal Voltage	volts DC	24.0	50.0	100.0	24.0	50.0	100.0	24.0	50.0	100.0	24.0	50.0	100.0
Peak Torque	oz-in	609.0	609.0	609.0	1248.0	1248.0	1248.0	1906.0	1906.0	1906.0	2560.0	2560.0	2560.0
	Nm	4.3005	4.3005	4.3005	8.8128	8.8128	8.8128	13.4592	13.4592	13.4592	18.0774	18.0774	18.0774
Continuous Stall Torque	oz-in	144.0	156.0	155.0	266.0	281.0	287.0	387.0	398.0	407.0	496.0	510.0	519.0
	Nm	1.0169	1.1016	1.0945	1.8784	1.9843	2.0267	2.7328	2.8105	2.8740	3.5025	3.6014	3.6649
Rated Speed	RPM	6050.0	5950.0	6140.0	3710.0	4710.0	4710.0	2380.0	3840.0	3840.0	1740.0	2820.0	2820.0
	rad/sec	634	623	643	389	493	493	249	402	402	182	295	295
Rated Torque	oz-in	102.0	113.0	110.0	213.0	198.0	200.0	340.0	290.0	296.0	451.0	413.0	419.0
	Nm	0.7203	0.7979	0.7768	1.5041	1.3982	1.4123	2.4009	2.0478	2.0902	3.1847	2.9164	2.9588
Rated Current	Amps	22.60	11.70	5.90	28.90	16.20	8.20	29.70	19.20	9.80	29.20	20.20	10.20
Rated Power	watts	456.0	497.0	499.0	584.0	690.0	697.0	598.0	824.0	841.0	580.0	861.0	874.0
Torque Sensitivity	oz-in/amp	5.20	11.00	21.40	8.41	14.00	28.00	12.90	17.20	34.30	17.40	23.10	46.30
	Nm/amp	0.0367	0.0777	0.1511	0.0594	0.0989	0.1977	0.0911	0.1215	0.2422	0.1229	0.1631	0.3269
Back EMF	volts/KRPM	3.80	8.20	15.80	6.22	10.40	20.70	9.52	12.70	25.40	12.80	17.10	34.20
	volts/rad/sec	0.0367	0.0777	0.1511	0.0594	0.0989	0.1977	0.0911	0.1215	0.2422	0.1229	0.1631	0.3269
Terminal Resistance	ohms	0.040	0.154	0.584	0.039	0.095	0.364	0.052	0.084	0.320	0.065	0.106	0.408
Terminal Inductance	mH	0.090	0.408	1.540	0.115	0.318	1.270	0.178	0.316	1.260	0.241	0.428	1.710
Motor Constant	oz-in/sq.rt.watt	26.00	28.03	28.00	42.59	45.42	46.41	56.57	59.35	60.63	68.25	70.95	72.49
	Nm/sq.rt.watt	0.18360	0.19794	0.19775	0.30072	0.32075	0.32772	0.39947	0.41907	0.42817	0.48194	0.50102	0.51186
Rotor Inertia	oz-in-sec²x10 ⁻³	18.00	18.00	18.00	35.00	35.00	35.00	52.00	52.00	52.00	70.00	70.00	70.00
	g-cm²	1270.3	1270.3	1270.3	2470.0	2470.0	2470.0	3669.6	3669.6	3669.6	4939.9	4939.9	4939.9
Weight	oz	65.0	65.0	65.0	104.0	104.0	104.0	143.0	143.0	143.0	182.0	182.0	182.0
	g	1846.0	1846.0	1846.0	2953.6	2953.6	2953.6	4061.2	4061.2	4061.2	5168.8	5168.8	5168.8
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	3.8	3.2	3.2	2.7	2.4	2.3	2.3	2.1	2.0	2.1	2.0	1.9
Electrical Time Constant	ms	2.25	2.65	2.64	2.95	3.35	3.49	3.42	3.76	3.94	3.71	4.04	4.19
Thermal Resistivity	deg. C/watt	1.2	1.2	1.2	1.0	0.9	0.9	0.9	0.8	0.8	0.9	0.7	0.7
Speed/Torque Gradient	rpm/oz-in	2.0	1.7	1.7	0.7	0.7	0.6	0.4	0.4	0.4	0.3	0.3	0.3

Notes:

1. Motor mounted to a 10" x 10" x 1/4" aluminum plate, still air.
2. Maximum winding temperature of 155°C.
3. Typical electrical specifications at 25°C.
4. Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

****Many other winding options are available – consult factory.**

Select your options below and place their code in its corresponding block as shown on page 8.

T TERMINATION

L – Leads (std)

C – Connector

M – MS connector

F FEEDBACK OPTIONS

H – Hall Effect (std)

R – Resolver

S – Sensorless

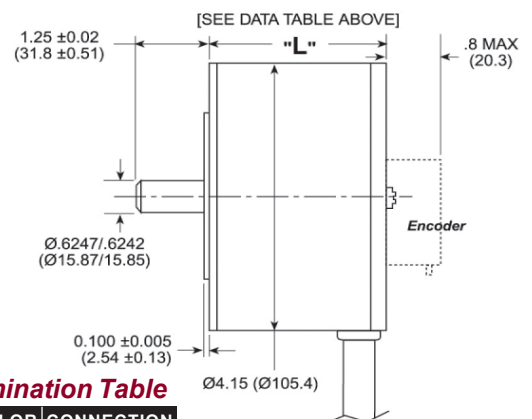
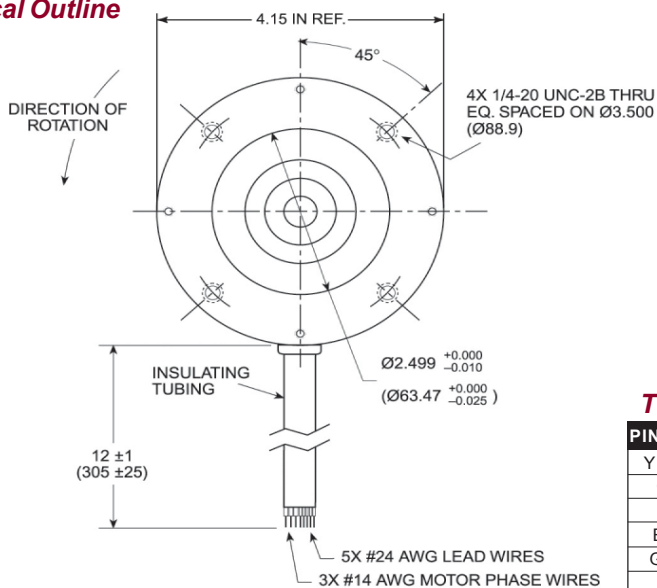
OTHER OPTIONS

D – Drive

E – Encoder

G – Gearhead

BN42 Typical Outline



Termination Table





PIN	COLOR	CONNECTION
	YELLOW	V _{CC}
	GRAY	GROUND
	RED	A COIL
	BLACK	B COIL
	GREEN	C COIL
	BLUE	S2 OUT
	BROWN	S1 OUT
	ORANGE	S3 OUT

Dimensions are in inches (millimeters)

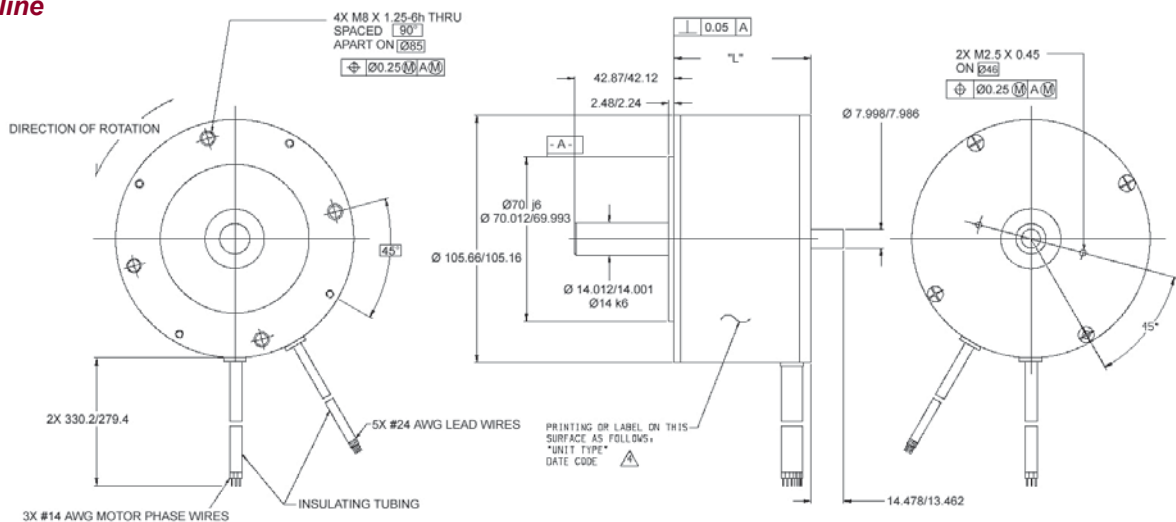
Note: An optional 4.15 (105.4) square front end cap is available.

Brushless Motors

BN42 EU SPECIFICATIONS -

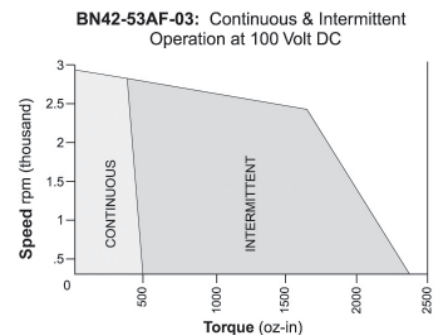
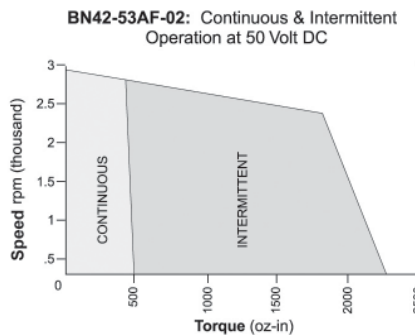
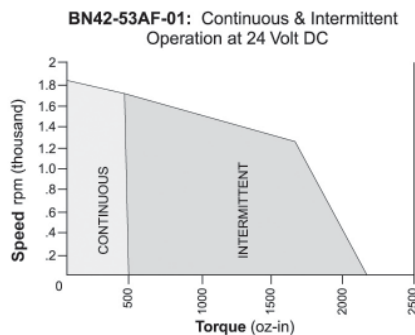
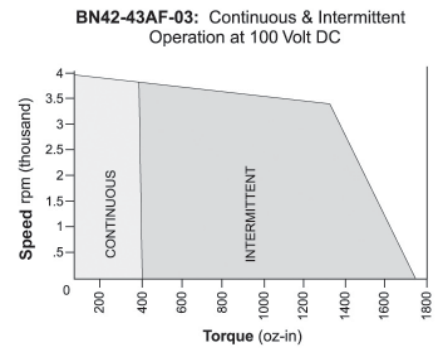
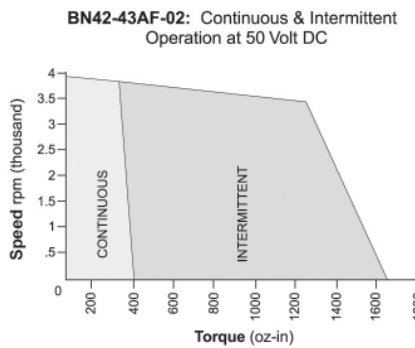
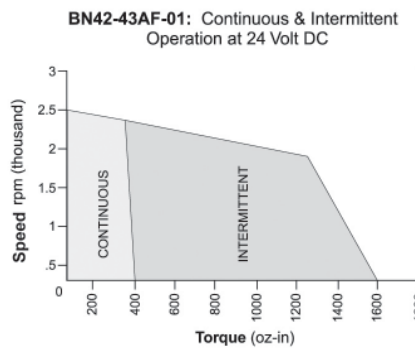
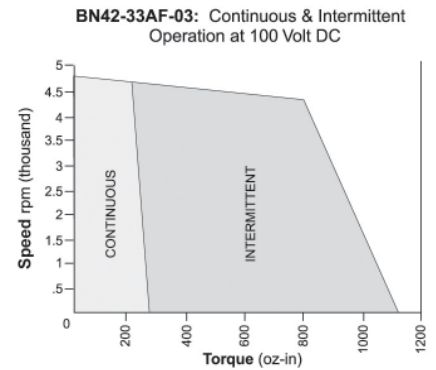
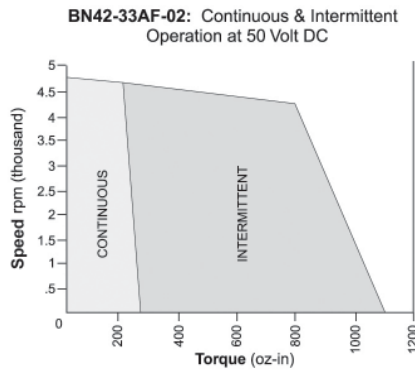
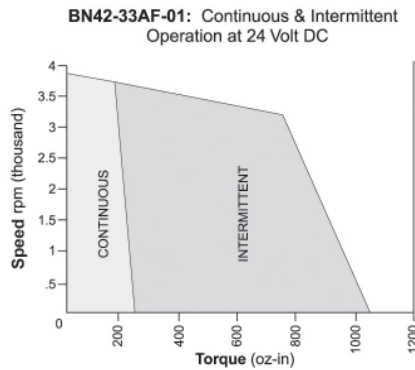
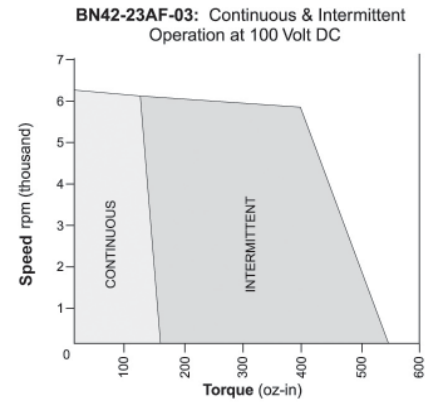
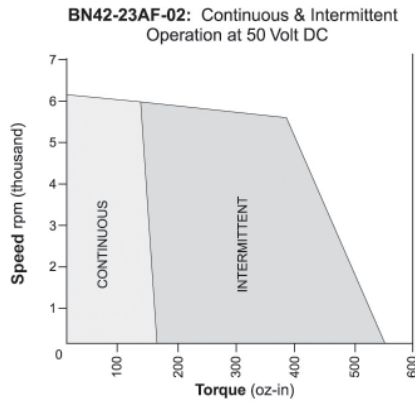
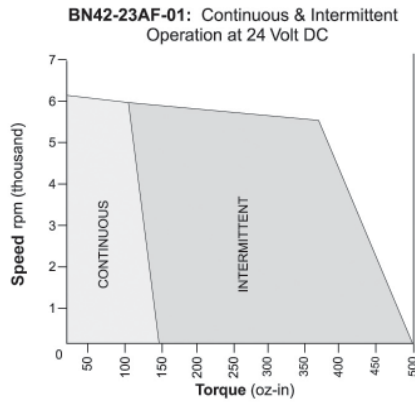
Part Number*		BN42-23EU-  T F O			BN42-33EU-  T F O			BN42-43EU-  T F O			BN42-53EU-  T F O		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	2.30			3.30			4.30			5.30		
	millimeters	58.5			83.9			109.3			134.7		
Terminal Voltage	volts DC	24	50	100	24	50	100	24	50	100	24	50	100
Peak Torque	oz-in	609	609	609	1248	1248	1248	1906	1906	1906	2560	2560	2560
	N m	4.30	4.30	4.30	8.82	8.82	8.82	13.5	13.5	13.5	18.1	18.1	18.1
Continuous Stall Torque	oz-in	144	156	155	266	281	287	387	398	407	496	510	519
	N m	1.02	1.11	1.10	1.88	1.99	2.03	2.74	2.81	2.88	3.51	3.61	3.67
Rated Speed	RPM	6050	5950	6140	3710	4710	4710	2380	3840	3840	1740	2820	2820
	rad/sec	634	623	643	389	494	494	250	403	403	183	296	296
Rated Torque	oz-in	102	113	110	213	198	200	340	290	296	451	413	419
	N m	0.721	0.798	0.777	1.51	1.40	1.42	2.41	2.05	2.09	3.19	2.92	2.96
Rated Current	Amps	22.6	11.7	5.9	28.9	16.2	8.2	29.7	19.2	9.8	29.2	20.2	10.2
Rated Power	watts	456	497	499	584	690	697	598	824	841	580	861	874
Torque Sensitivity	oz-in/amp	5.20	11.0	21.4	8.41	14.0	28.0	12.9	17.2	34.3	17.4	23.1	46.3
	Nm/amp	0.0363	0.0783	0.151	0.0594	0.0992	0.198	0.0909	0.122	0.243	0.123	0.164	0.327
Back EMF	volts/KRPM	3.80	8.20	15.8	6.22	10.4	20.7	9.52	12.7	25.4	12.8	17.1	34.2
	volts/rad/sec	0.0363	0.0783	0.151	0.0594	0.0992	0.198	0.0909	0.122	0.243	0.123	0.164	0.327
Terminal Resistance	ohms	0.040	0.154	0.584	0.039	0.095	0.364	0.052	0.084	0.320	0.065	0.106	0.408
Terminal Inductance	m H	0.090	0.408	1.54	0.115	0.318	1.27	0.178	0.316	1.26	0.241	0.428	1.71
Motor Constant	oz-in/sq.rt.watt	27.8	28.6	28.2	45.7	46.8	46.8	59.5	61.2	61.1	71.0	73.0	72.9
	Nm/sq.rt.watt	0.197	0.202	0.199	0.323	0.331	0.331	0.421	0.433	0.432	0.502	0.516	0.515
Rotor Inertia	oz-in-sec ²	0.018	0.018	0.018	0.035	0.035	0.035	0.052	0.052	0.052	0.070	0.070	0.070
	g-cm ²	1271	1271	1271	2472	2472	2472	3672	3672	3672	4943	4943	4943
Weight	oz	65	65	65	104	104	104	143	143	143	182	182	182
	g	1843	1843	1843	2949	2949	2949	4054	4054	4054	5160	5160	5160

BN42 EU Typical Outline



Dimensions are in inches (millimeters)

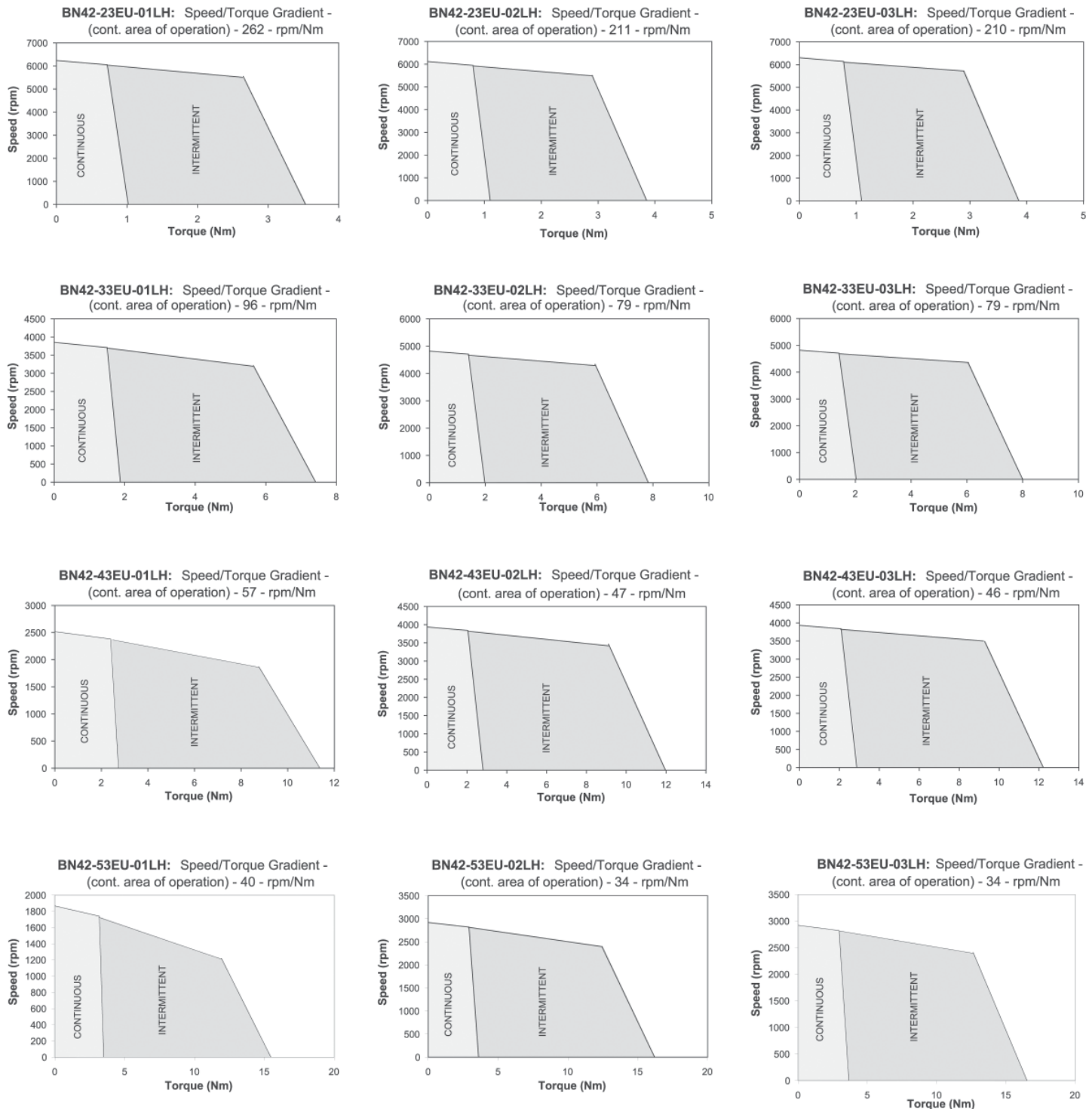
BN42 Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

Brushless Motors

BN42 EU Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

Silencer[™] Series

Brushless DC Motors

TYPICAL APPLICATIONS

- Medical equipment - pumps, blowers, centrifuges, saws and drills
- Scanners
- Packaging equipment and printing products
- HVAC equipment (air handling)

FEATURES

- Inside rotor construction for quick acceleration
- 4 pole motors for high speed applications
- Compact size
- Continuous torques to 78.0 oz-in
- High energy neodymium magnets
- Safe, arcless operation
- High speed capability – up to 35,000 rpm
- High torque per dollar ratio

BENEFITS

- Operation at any single speed - not limited to AC frequency
- Motor life is not limited to brush or commutator life
- An essentially linear speed/torque curve
- Efficient operation without losses associated with brushes and commutation or armature induction
- Precise, variable speed control
- Extremely quiet operation
- Long-life operation

ENCODERS

High resolution, high reliability, and state-of-the-art technology in a small package:

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL/CMOS compatible
- Hewlett Packard HEDS-5500 encoder standard, other configurations and resolutions available

SILENCER BRUSHLESS MOTOR DRIVES

Optimized for use with Silencer Brushless DC motors, these drives provide:

- Multiple operating modes - commutation, velocity, torque, 2 and 4 quadrant
- Feedback using Hall effect sensor or encoder
- Efficient PWM speed control
- CE approved for European applications
- Low cost
- Operating temperatures from -10° to 45°C

BN12, 23 and 34 High Speed



High Speed Brushless Motors

BN high speed brushless motors offer relatively high speeds in the same BN package size. Ideal for applications involving higher speeds at higher power levels, such as medical centrifuge, pumps, blowers and medical drills and saws. Utilizing high energy rare-earth magnets, these motors provide excellent value in a high speed, high power motor.

Reliable, Low-Cost Operation

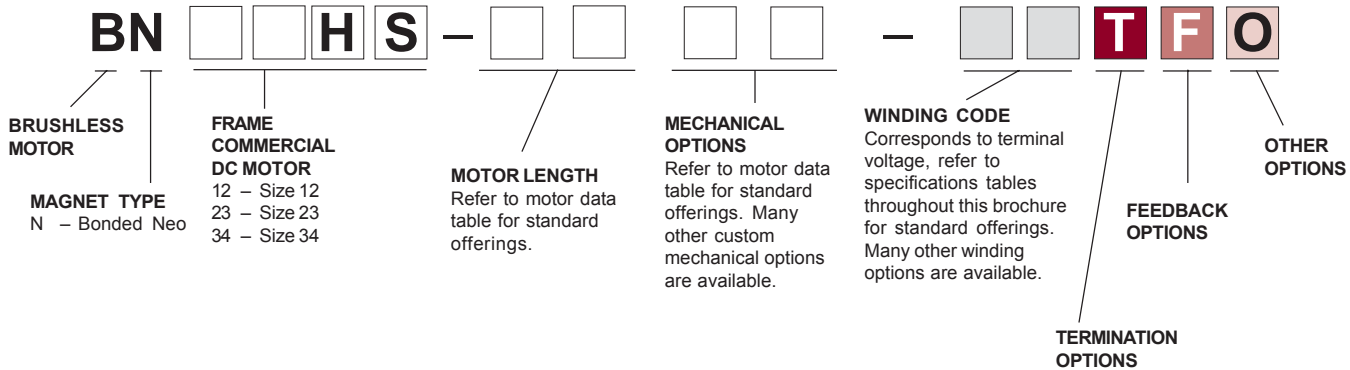
The compact BN motors are well-suited for applications demanding low audible noise and long life. An aluminum housing protects the unit in rugged applications and environments. Typical options include electronic drives, encoders and gearheads, as well as Hall effect, resolver and sensorless feedback.

For more information about how this product can be tailored to fit your specific application, contact our applications engineers.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



BN12HS SPECIFICATIONS -

Continuous Stall Torque 1.2 - 4.5 oz-in (0.0088 - 0.0318 Nm)
Peak Torque 5 - 27 oz-in (0.0353 - 0.1907 Nm)

Part Number*		BN12HS-13AF- <input type="text"/> <input type="text"/> <input type="text"/>			BN12HS-18AF- <input type="text"/> <input type="text"/> <input type="text"/>			BN12HS-23AF- <input type="text"/> <input type="text"/> <input type="text"/>			BN12HS-28AF- <input type="text"/> <input type="text"/> <input type="text"/>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	1.30			1.80			2.30			2.80		
	millimeters	33.0			45.7			58.4			71.1		
Terminal Voltage	volts DC	12.0	24.0	36.0	12.0	24.0	36.0	12.0	24.0	36.0	12.0	24.0	36.0
Peak Torque	oz-in	5.0	5.0	5.0	11.0	11.0	12.0	18.0	20.0	20.0	27.0	27.0	27.0
	Nm	0.0353	0.0353	0.0353	0.0777	0.0777	0.0847	0.1271	0.1412	0.1412	0.1907	0.1907	0.1907
Continuous Stall Torque	oz-in	1.2	1.3	1.3	2.0	2.0	2.0	3.2	3.6	3.6	4.3	4.4	4.5
	Nm	0.0088	0.0092	0.0092	0.0141	0.0141	0.0141	0.0229	0.0254	0.0254	0.0304	0.0311	0.0318
Rated Speed	RPM	26000.00	35670.0	27570.0	23520.0	22800.0	24520.0	19650.0	20500.0	22740.0	20050.0	20270.0	18450.0
	rad/sec	2723	3735	2887	2463	2388	2568	2058	2147	2381	2100	2123	1932
Rated Torque	oz-in	1.2	1.2	1.2	2.0	2.0	2.0	3.0	3.3	3.3	3.9	4.0	4.2
	Nm	0.0085	0.0083	0.0083	0.0138	0.0141	0.0141	0.0212	0.0233	0.0233	0.0275	0.0282	0.0297
Rated Current	Amps	2.50	1.40	1.00	3.90	2.00	1.40	5.00	2.70	2.00	6.30	3.20	2.10
Rated Power	watts	21.00	22.0	24.00	34.0	34.0	37.0	44.0	50.0	55.0	58.0	60.0	57.0
Torque Sensitivity	oz-in/amp	0.44	0.89	1.27	0.51	1.05	1.50	0.62	1.25	1.72	0.64	1.28	2.07
	Nm/amp	0.0031	0.0063	0.0090	0.0036	0.0074	0.0106	0.0044	0.0088	0.0121	0.0045	0.0090	0.0146
Back EMF	volts/KRPM	0.32	0.66	0.94	0.38	0.78	1.11	0.46	0.92	1.27	0.48	0.95	1.53
	volts/rad/sec	0.0031	0.0063	0.0090	0.0036	0.0074	0.0106	0.0044	0.0088	0.0121	0.0045	0.0090	0.0146
Terminal Resistance	ohms	0.92	3.69	7.45	0.56	2.25	4.52	0.42	1.32	2.54	0.28	1.04	2.63
Terminal Inductance	mH	0.27	1.11	2.28	0.17	0.70	1.43	0.14	0.54	1.01	0.10	0.42	1.08
Motor Constant	oz-in/sq.rt.watt	0.46	0.46	0.47	0.68	0.70	0.71	0.96	1.09	1.08	1.21	1.26	1.28
	Nm/sq.rt.watt	0.00324	0.00327	0.00329	0.00481	0.00494	0.00498	0.00676	0.00768	0.00762	0.00854	0.00886	0.00901
Rotor Inertia	oz-in-sec ² x10 ⁻³	0.02	0.02	0.02	0.04	0.04	0.04	0.06	0.06	0.06	0.08	0.08	0.08
	g-cm ²	1.4	1.4	1.4	2.8	2.8	2.8	4.0	4.2	4.2	5.4	5.6	5.6
Weight	oz	5.0	5.0	5.0	6.0	6.0	6.0	7.0	7.0	7.0	9.0	9.0	9.0
	g	142.0	142.0	142.0	170.4	170.4	170.4	198.8	198.8	198.8	255.6	255.6	255.6
# of Poles		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	13.5	13.2	13.1	12.2	11.6	11.4	8.8	7.2	7.3	7.4	7.2	6.9
Electrical Time Constant	ms	0.29	0.30	0.31	0.30	0.31	0.32	0.33	0.41	0.40	0.36	0.40	0.41
Thermal Resistivity	deg. C/watt	15.2	42.5	8.8	8.2	7.4	7.4	6.4	7.1	6.4	5.9	6.2	5.7
Speed/Torque Gradient	rpm/oz-in	6534.1	6281.9	6240.6	2889.6	2747.3	2714.7	1472.7	1147.8	1162.8	911.5	855.3	830.4

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact an applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

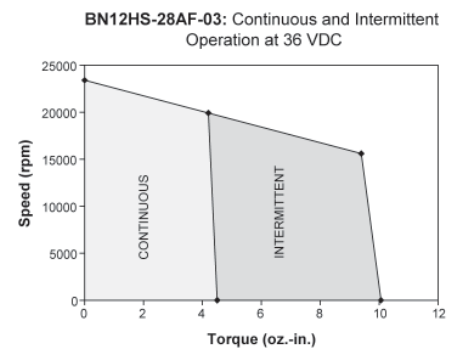
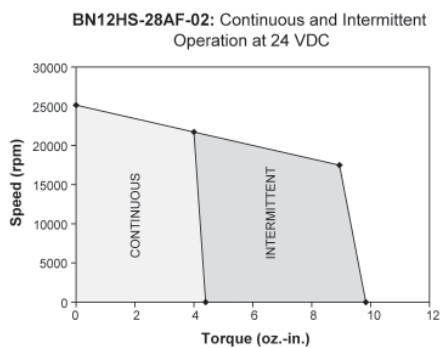
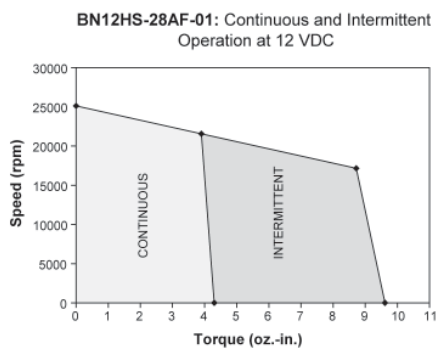
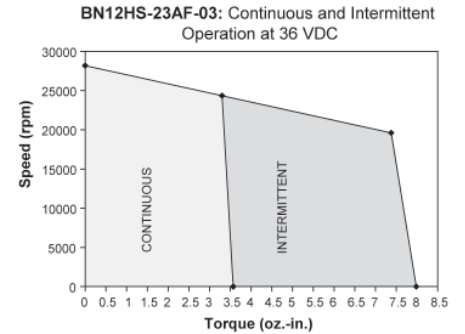
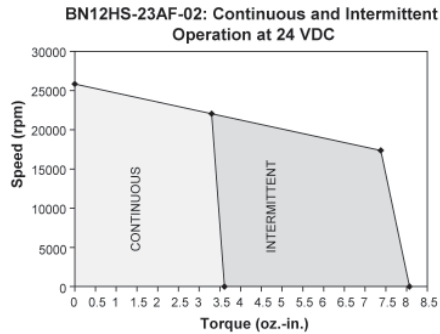
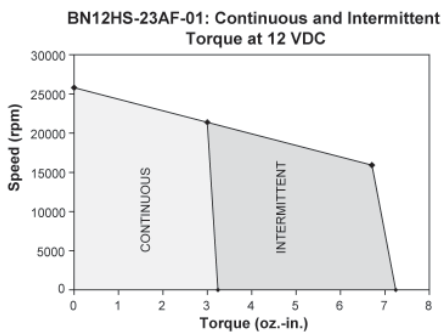
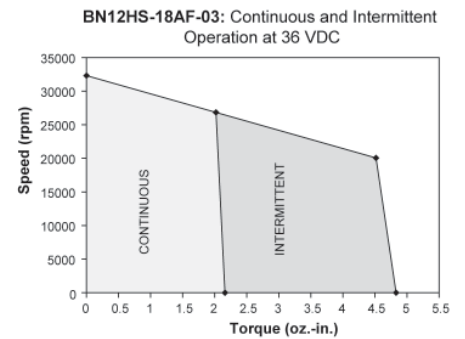
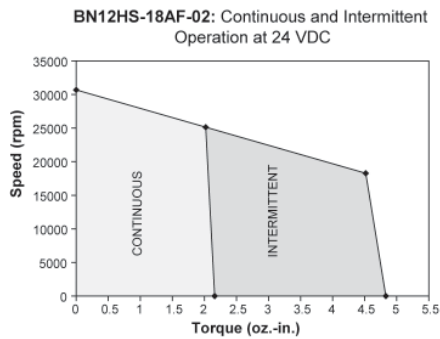
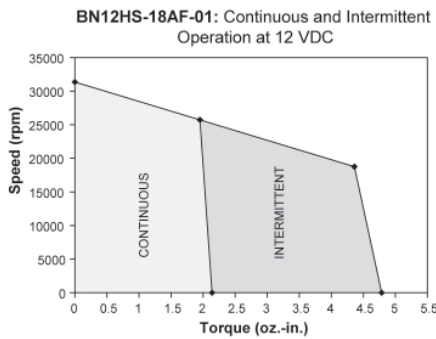
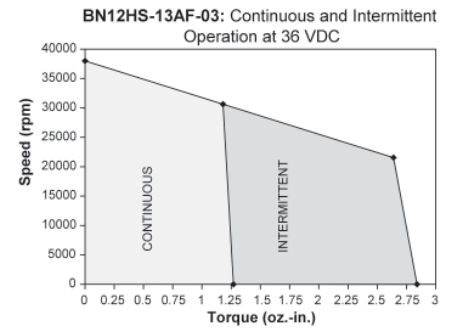
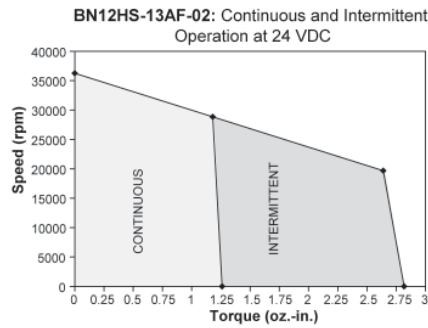
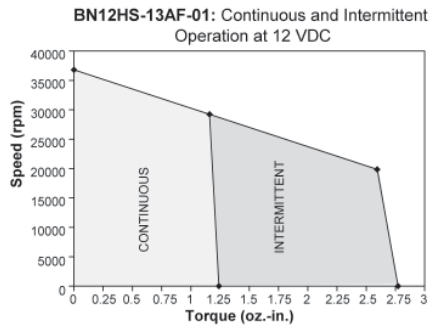
Select your options below and place their code in its corresponding block as shown above.

T **TERMINATION**
L – Leads (std)
C – Connector
M – MS Connector

F **FEEDBACK OPTIONS**
H – Hall Effect (std)
R – Resolver
S – Sensorless

O **OTHER OPTIONS**
D – Drive
E – Encoder
G – Gearhead

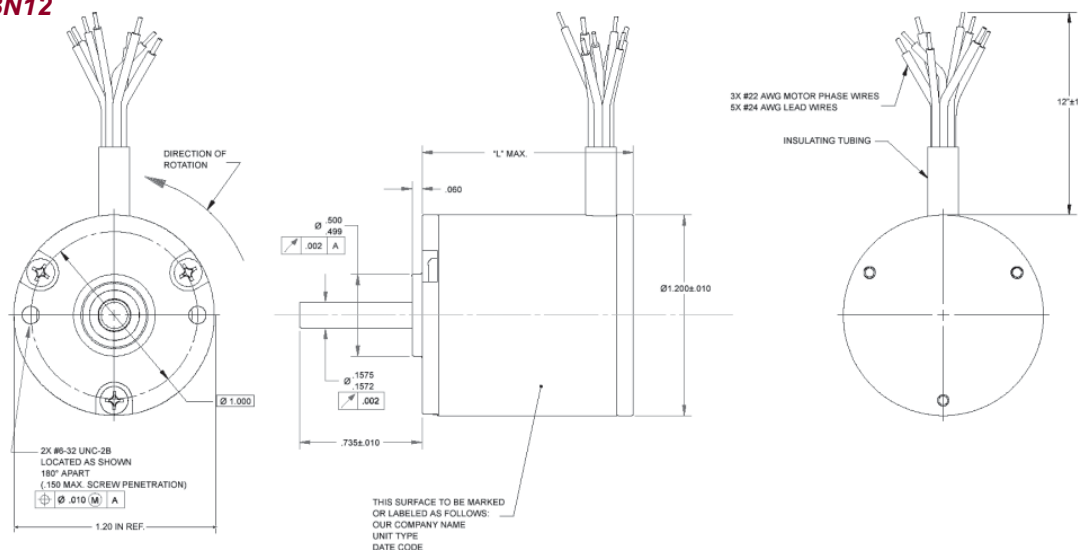
BN12 Performance Curves



Note: Intermittent operation is based on a 20% duty cycle of one minute on, four minutes off.
Please contact the factory regarding the duty cycle of your application.

Brushless Motors

Typical Outline Drawing - BN12



Dimensions are in millimeters

BN23HS SPECIFICATIONS -

Continuous Stall Torque 6 - 32 oz-in (0.042 - 0.226 Nm)
Peak Torque 41 - 222 oz-in (0.2895 - 1.5677 Nm)

Part Number*		BN23HS-13HS <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23HS-18HS <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23HS-23HS <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN23HS-28HS <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Winding Code**		01	02	03	01	02	03	01	02	03	01	02	03
L = Length	inches	1.41			1.91			2.41			2.91		
	millimeters	35.8			48.5			61.2			73.9		
Terminal Voltage	volts DC	24	36	48	24	36	48	24	36	48	24	36	48
Peak Torque	oz-in	41	41	41	101	101	101	162	162	162	222	222	222
	Nm	0.2895	0.2895	0.2895	0.7132	0.7132	0.7132	1.1440	1.1440	1.1440	1.5677	1.5677	1.5677
Continuous Stall Torque	oz-in	6	6	6	16	16	16	23	25	24	27	32	32
	Nm	0.042	0.042	0.042	0.113	0.113	0.113	0.162	0.177	0.169	0.191	0.226	0.226
Rated Speed	RPM	18991	19048	19531	19644	19818	19225	14702	14875	14908	13285	14917	14629
	rad/sec	1989	1995	2045	2057	2075	2013	1540	1558	1561	1391	1562	1532
Rated Torque	oz-in	3.5	3.5	3.5	8.0	8.0	8.0	16.0	16.0	16.0	21.0	21.0	21.0
	Nm	0.025	0.025	0.025	0.056	0.056	0.056	0.113	0.113	0.113	0.148	0.148	0.148
Rated Current	Amps	2.7	1.8	1.4	5.8	3.9	2.9	8.3	5.6	4.2	9.9	7.3	5.3
Rated Power	watts	49	49	51	116	117	114	174	176	176	206	232	227
Torque Sensitivity	oz-in/amp	1.54	2.31	3.03	1.56	2.34	3.13	2.06	3.09	4.12	2.25	3.10	4.22
	Nm/amp	0.0109	0.0163	0.0214	0.0110	0.0165	0.0221	0.0145	0.0218	0.0291	0.0159	0.0219	0.0298
Back EMF	volts/KRPM	1.14	1.71	2.24	1.15	1.73	2.31	1.52	2.28	3.04	1.66	2.29	3.12
	volts/rad/sec	0.011	0.016	0.021	0.011	0.017	0.022	0.015	0.022	0.029	0.016	0.022	0.030
Terminal Resistance	ohms	0.70	1.65	2.72	0.14	0.30	0.50	0.14	0.28	0.51	0.14	0.19	0.35
Terminal Inductance	mH	0.48	1.08	1.86	0.23	0.52	0.93	0.26	0.59	1.04	0.23	0.44	0.81
Motor Constant	oz-in/sq.rt.watt	1.84	1.80	1.84	4.17	4.27	4.43	5.51	5.84	5.77	6.01	7.11	7.13
	Nm/sq.rt.watt	0.13	0.13	0.013	0.029	0.030	0.031	0.039	0.041	0.041	0.042	0.050	0.050
Rotor Inertia	oz-in-sec ² x10 ⁻³	0.51	0.51	0.51	0.99	0.99	0.99	1.50	1.50	1.50	1.90	1.90	1.90
	g-cm ²	36.0	36.0	36.0	69.9	69.9	69.9	105.9	105.9	105.9	134.1	134.1	134.1
Weight	oz	10.0	10.0	10.0	15.0	15.0	15.0	21.0	21.0	21.0	26.0	26.0	26.0
	g	284.0	284.0	284.0	426.0	426.0	426.0	596.4	596.4	596.4	738.4	738.4	738.4
# of Poles		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	21.3	22.3	21.4	8.1	7.7	7.2	7.0	6.2	6.4	7.4	5.3	5.3
Electrical Time Constant	ms	0.69	0.65	0.68	1.64	1.73	1.86	1.86	2.11	2.04	1.64	2.32	2.31
Thermal Resistivity	deg. C/watt	6.7	6.8	6.3	4.6	4.5	4.1	4.2	4.1	4.2	3.4	3.4	3.9
Speed/Torque Gradient	rpm/oz-in	398.7	417.7	400.8	78.0	74.1	69.2	44.7	39.7	40.7	37.5	26.8	26.6

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact an applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 32.

T TERMINATION

L – Leads (std)
C – Connector
M – MS Connector

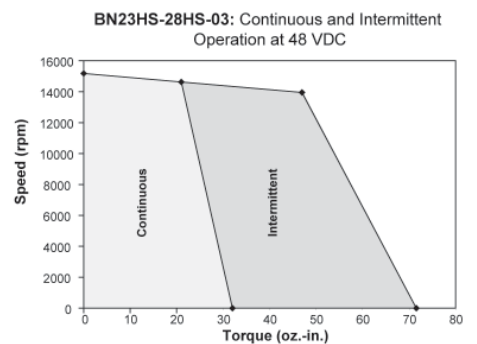
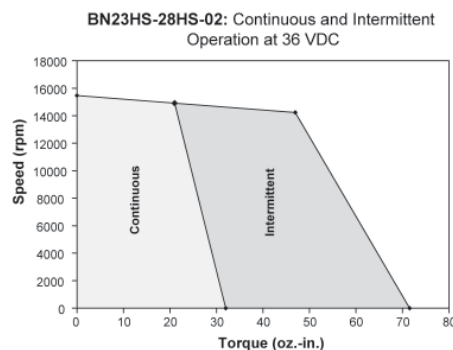
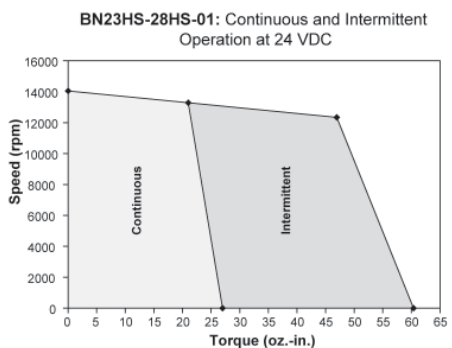
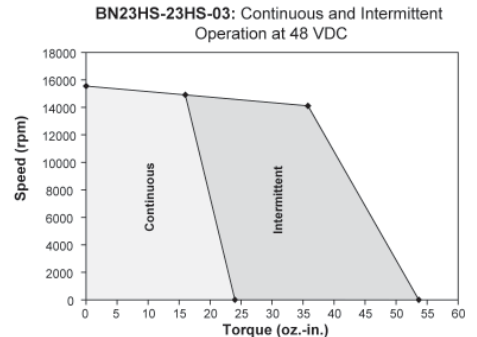
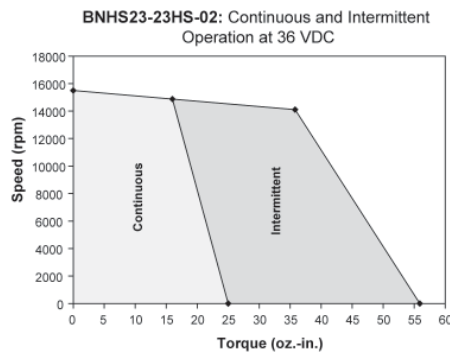
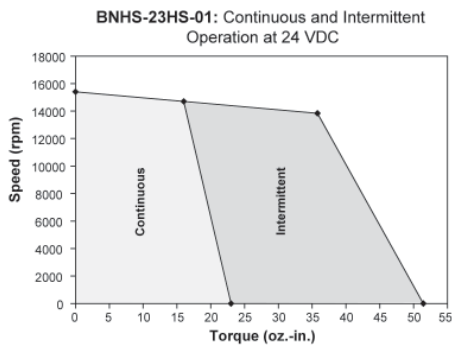
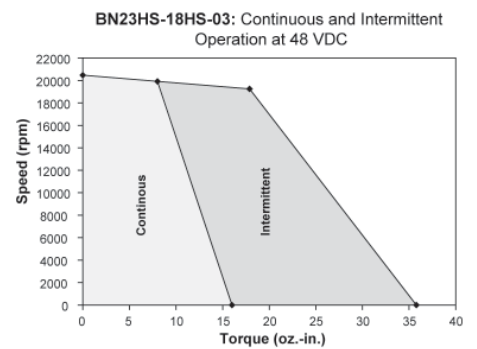
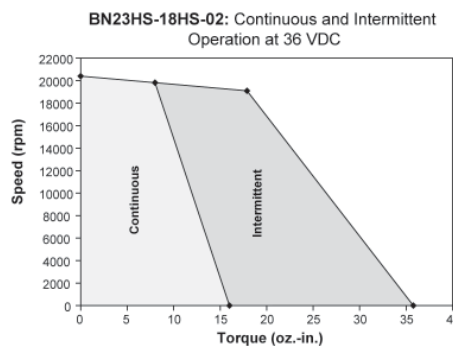
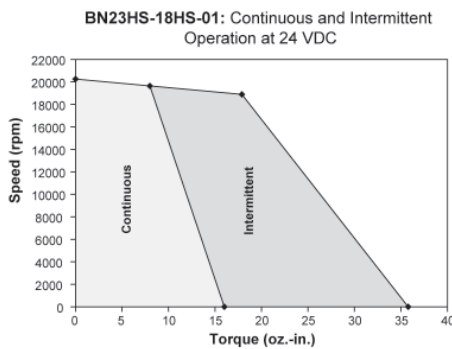
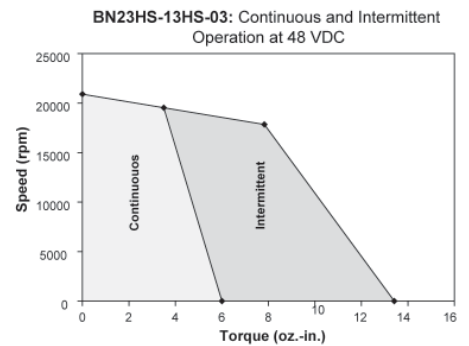
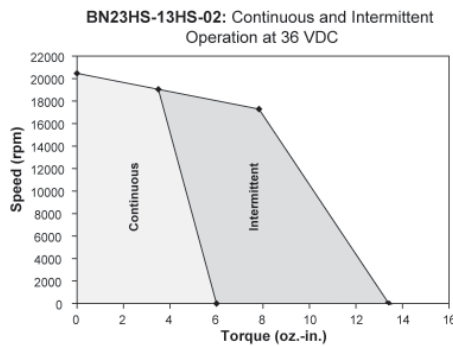
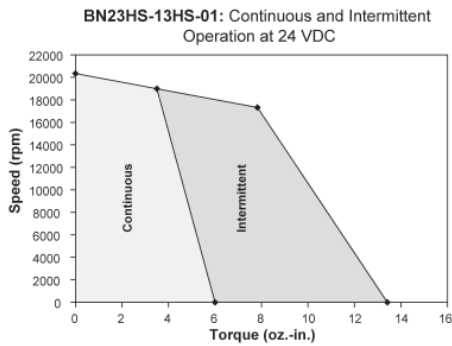
F FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

O OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

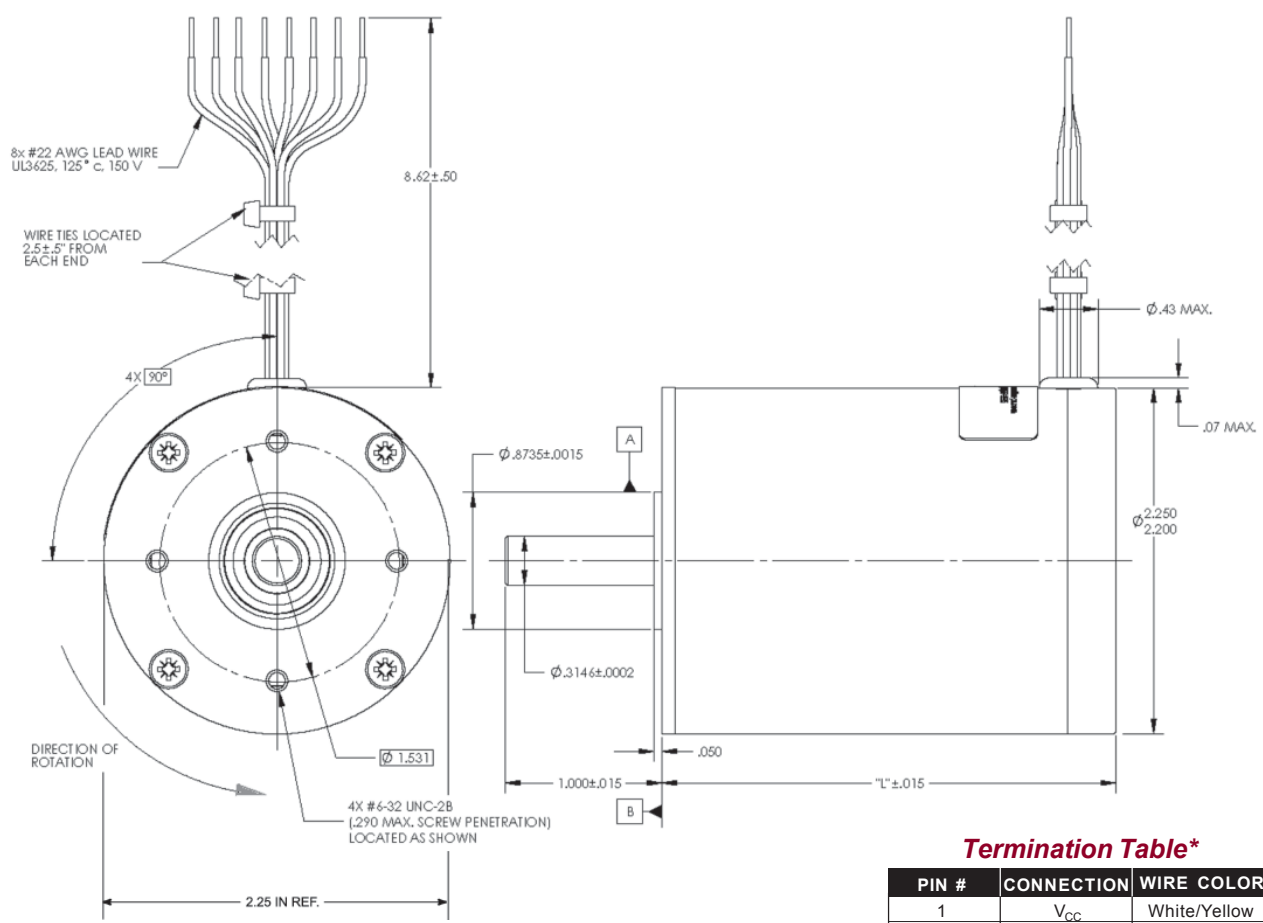
BN23 Performance Curves



Note: Intermittent region based upon 20% duty cycle - 1 minute on, 4 minutes off.

Brushless Motors

Typical Outline Drawing - BN23



Termination Table*

PIN #	CONNECTION	WIRE COLOR
1	V _{CC}	White/Yellow
2	GROUND	White/Gray
3	A COIL	White/Violet
4	B COIL	White/Black
5	C COIL	Green
6	S2 OUT	White/Blue
7	S1 OUT	White/Brown
8	S3 OUT	White

*We reserve the right to use solid color wires or white wires with color trace.

BN34HS SPECIFICATIONS - Continuous Stall Torque 48 - 99 oz-in (0.3390 - 0.6991 Nm) Peak Torque 177 - 363 oz-in (1.2499 - 2.5633 Nm)

Part Number*		BN34HS-25AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			BN34HS-35AF- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Winding Code**		01	02	03	01	02	03
L = Length	inches	2.50			3.50		
	millimeters	63.5			88.9		
Terminal Voltage	volts DC	24.0	50.0	100.0	24.0	50.0	100.0
Peak Torque	oz-in	177.0	177.0	177.0	363.0	363.0	363.0
	N m	1.2499	1.2499	1.2499	2.5633	2.5633	2.5633
Continuous Stall Torque	oz-in	48.0	49.0	48.0	91.0	98.0	99.0
	N m	0.3390	0.3460	0.3390	0.6426	0.6920	0.6991
Rated Speed	RPM	14011.0	13900.0	14640.0	7100.0	9340.0	9400.0
	rad/sec	1467	1456	1533	744	978	984
Rated Torque	oz-in	34.0	34.0	34.0	78.0	78.0	78.0
	N m	0.2401	0.2401	0.2401	0.5508	0.5508	0.5508
Rated Current	Amps	18.60	8.60	4.50	22.40	13.00	6.50
Rated Power	watts	396.0	381.0	397.0	478.0	591.0	591.0
Torque Sensitivity	oz-in/amp	1.94	4.20	8.08	3.59	6.21	12.42
	Nm/amp	0.0137	0.0297	0.0571	0.0254	0.0439	0.0877
Back EMF	volts/KRPM	1.43	3.10	5.97	2.66	4.59	9.18
	volts/rad/sec	0.0137	0.0297	0.0571	0.0254	0.0439	0.0877
Terminal Resistance	ohms	0.054	0.242	0.920	0.063	0.163	0.638
Terminal Inductance	m H	0.18	0.85	3.14	0.33	0.99	3.95
Motor Constant	oz-in/sq.rt.watts	8.35	8.54	8.42	14.30	15.38	15.55
	Nm/sq.rt.watts	0.05895	0.06029	0.05949	0.10100	0.10862	0.10980
Rotor Inertia	oz-in-sec ² x10 ⁻³	7.30	7.30	7.30	14.00	14.00	14.00
	g-cm ²	515.2	515.2	515.2	988.0	988.0	988.0
Weight	oz	38.0	38.0	38.0	65.0	66.0	66.0
	g	1079.2	1079.2	1079.2	1846.0	1874.4	1874.4
# of Poles		4.0	4.0	4.0	4.0	4.0	4.0
Timing		120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	14.8	14.2	14.6	9.7	8.4	8.2
Electrical Time Constant	ms	3.33	3.51	3.41	5.24	6.07	6.19
Thermal Resistivity	deg. C/watt	1.1	1.3	1.3	0.8	0.9	1.0
Speed/Torque Gradient	rpm/oz-in	58.5	55.8	57.3	19.8	17.1	16.8

Notes:

1. Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
2. Maximum winding temperature of 155°C.
3. Typical electrical specifications at 25°C.
4. Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact an applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

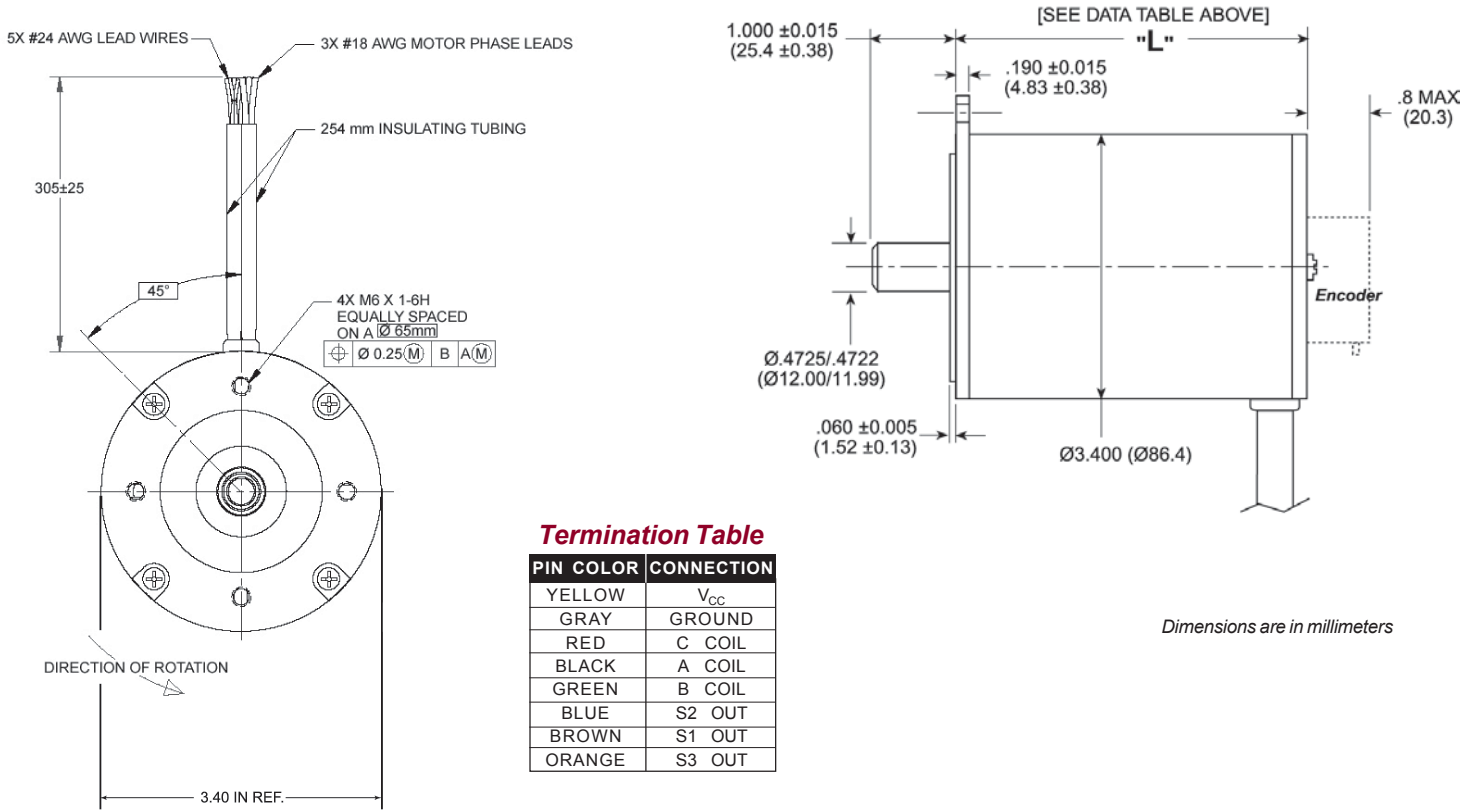
Select your options below and place their code in its corresponding block as shown on page 32.

T TERMINATION	F FEEDBACK OPTIONS	O OTHER OPTIONS
L – Leads (std)	H – Hall Effect (std)	D – Drive
C – Connector	R – Resolver	E – Encoder
M – MS Connector	S – Sensorless	G – Gearhead

Brushless Motors

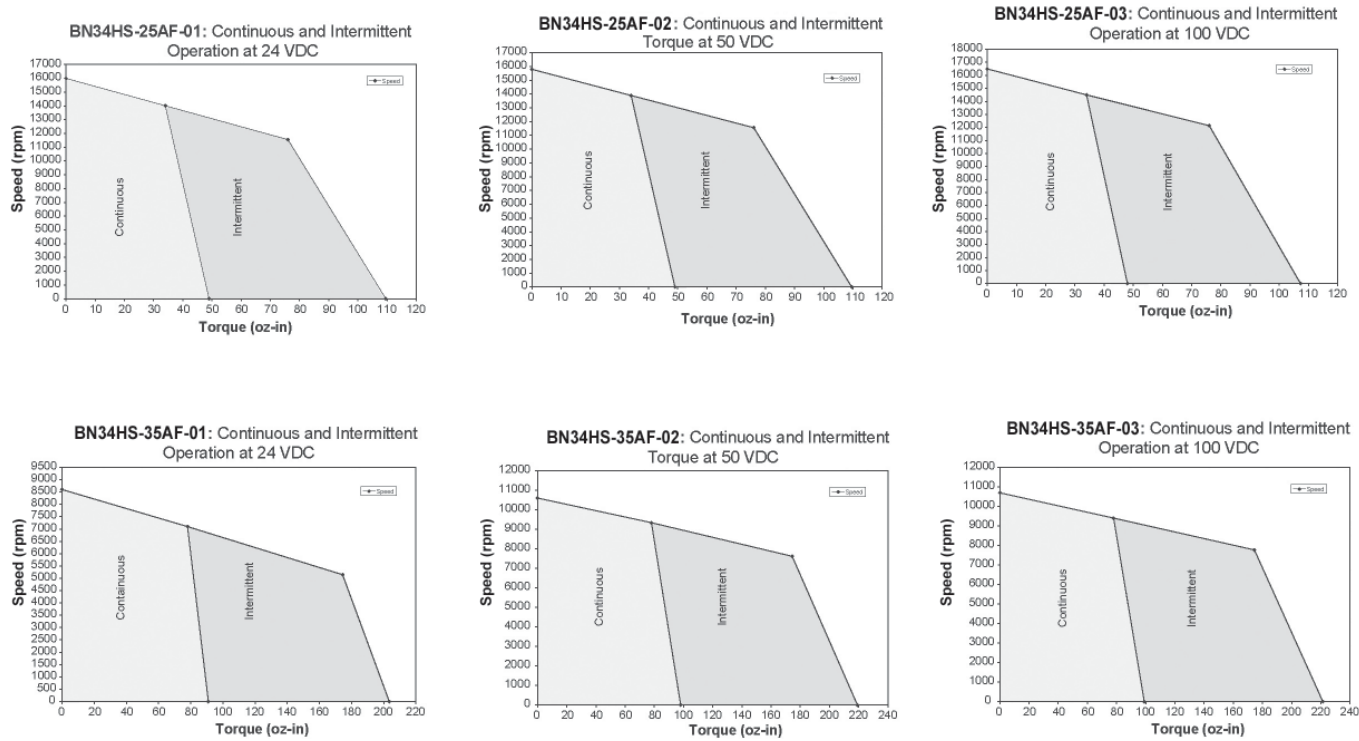
Typical Outline Drawing - BN34

Figure 1



Note: Square or Round Cap Available: AF (standard version) comes standard with square cap, see drawing on page 21. For round cap version, see figure 1 above.

BN34 Performance Curves



Note: Intermittent region based upon 20% duty cycle - 1 minute on, 4 minutes off.

Silencer[™] Series Brushless DC Motor

TYPICAL APPLICATIONS

- Medical equipment - pumps, blowers and electric scooters and wheelchairs
- Automatic door and window openers
- Computer-controlled embroidery machines
- Scanners
- Packaging equipment and printing products
- HVAC equipment (air handling)
- Robotic tape storage and retrieval
- Semiconductor handling and insertion machines
- Actuators

FEATURES

- Inside rotor construction for quick acceleration
- 8 pole motor standard, 4 pole motors optional for high speed applications
- Compact size – lengths from 1.8 to 2.8 inches
- Continuous torques from 29 to 58 oz-in
- High energy sintered neodymium magnets
- Safe, arcless operation
- High torque per dollar ratio

BENEFITS

- Operation at any single speed - not limited to AC frequency
- Motor life is not limited to brush or commutator life
- An essentially linear speed/torque curve
- Efficient operation without losses associated with brushes and commutation or armature induction
- Precise, variable speed control
- Extremely quiet operation
- Long-life operation

BN23 High Performance



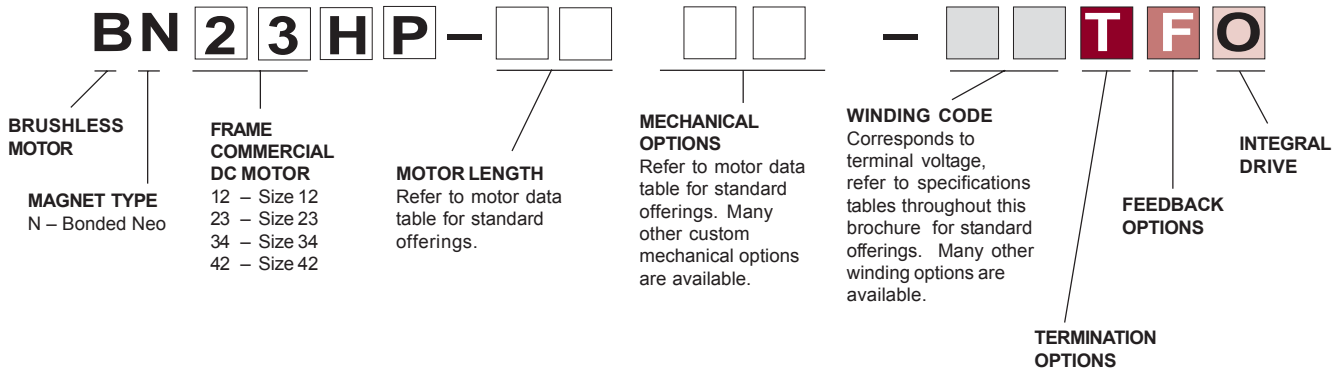
Utilizing high energy sintered neodymium magnets, the BN23HP brushless motor offers almost 2 times the torque capability of the standard BN23. When maximum performance and minimum size are important, the BN23HP offers an effective solution.

Finned black motor housing offers excellent heat transfer characteristics. Typical options include electronic drives, encoders, gearheads, as well as Hall effect, resolvers, and sensorless feedback.

For more information about how this product can be tailored to fit your specific application, contact our application engineers.

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



BN23HP SPECIFICATIONS -

Continuous Stall Torque 36 - 70 oz-in (0.25 - 0.49 Nm)
Peak Torque 238 - 729 oz-in (1.68 - 5.15 Nm)

Part Number*		BN23HP-18HP [] [] [] T F O			BN23HP-23HP [] [] [] T F O			BN23HP-28HP [] [] [] T F O		
Winding Code**		01	02	03	01	02	03	01	02	03
L = Length	inches	1.91			2.41			2.91		
	millimeters	48.5			61.2			73.9		
Terminal Voltage	volts DC	24	36	48	24	36	48	24	36	48
Peak Torque	oz-in	238	287	307	514	637	684	556	681	729
	Nm	1.68	2.03	2.17	3.63	4.50	4.83	3.93	4.81	5.15
Continuous Stall Torque	oz-in	36	35	35	52	53	53	68	69	70
	Nm	0.25	0.25	0.25	0.37	0.37	0.37	0.48	0.49	0.49
Rated Speed	RPM	3000	3881	4198	4022	4800	5151	2796	3368	3628
	rad/sec	314	406	440	421	503	539	293	353	380
Rated Torque	oz-in	32	30	29	40	37	36	58	56	55
	Nm	0.23	0.21	0.20	0.28	0.26	0.25	0.41	0.40	0.39
Rated Current	Amps	3.7	2.9	2.3	5.9	4.3	3.3	6.1	4.6	3.6
Rated Power	watts	71	86	90	119	131	137	120	140	148
Torque Sensitivity	oz-in/amp	9.11	11.02	13.71	7.26	9.38	11.76	10.06	12.94	16.37
	Nm/amp	0.064	0.078	0.097	0.051	0.066	0.083	0.071	0.091	0.116
Back EMF	volts/KRPM	6.74	8.15	10.14	5.37	6.94	8.70	7.44	9.57	12.10
	volts/rad/sec	0.064	0.078	0.097	0.051	0.066	0.083	0.071	0.091	0.116
Terminal Resistance	ohms	0.90	1.36	2.13	0.33	0.52	0.82	0.43	0.68	1.06
Terminal Inductance	mH	0.86	1.26	1.98	0.34	0.57	0.90	0.48	0.79	1.25
Motor Constant	oz-in/sq.rt.watt	9.60	9.45	9.39	12.64	13.0	13.0	15.34	15.69	15.90
	Nm/sq.rt.watt	0.068	0.067	0.066	0.089	0.092	0.092	0.108	0.111	0.112
Rotor Inertia	oz-in-sec ² x10 ⁻³	0.99	0.99	0.99	1.50	1.50	1.50	1.90	1.90	1.90
	g-cm ²	69.9	69.9	69.9	105.9	105.9	105.9	134.1	134.1	134.1
Weight	oz	15	15	15	21	21	21	26	26	26
	g	426	426	426	596	596	596	738	738	738
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	1.5	1.6	1.6	1.3	1.3	1.3	1.1	1.1	1.1
Electrical Time Constant	ms	0.96	0.93	0.93	1.03	1.10	1.10	1.12	1.16	1.18
Thermal Resistivity	deg. C/watt	5.9	5.7	5.2	4.6	4.5	4.9	4.0	4.0	4.2
Speed/Torque Gradient	rpm/oz-in	14.7	15.1	15.3	8.5	8.0	8.0	5.7	5.5	5.4

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact an applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown above.

T TERMINATION

L – Leads (std)
C – Connector
M – MS Connector

F FEEDBACK OPTIONS

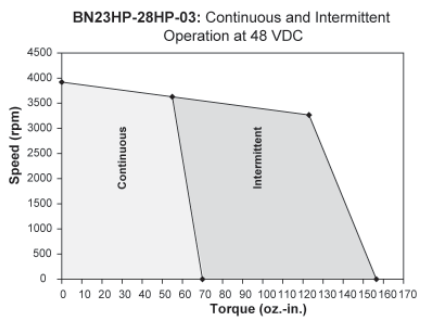
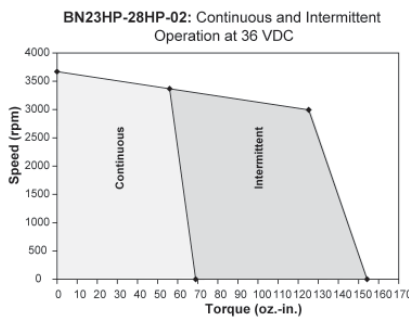
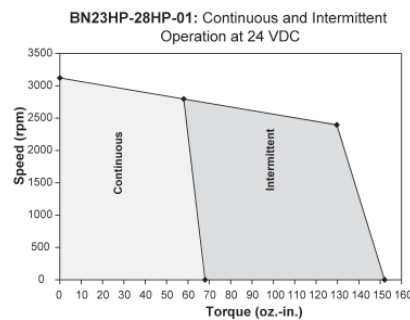
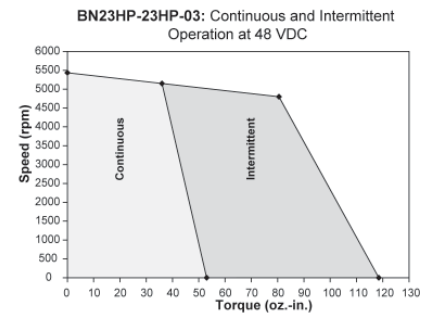
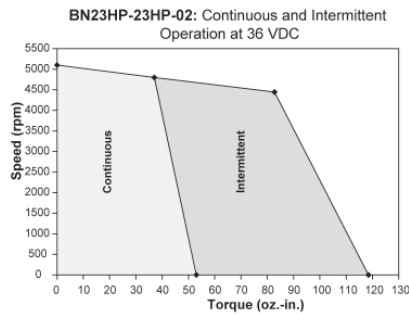
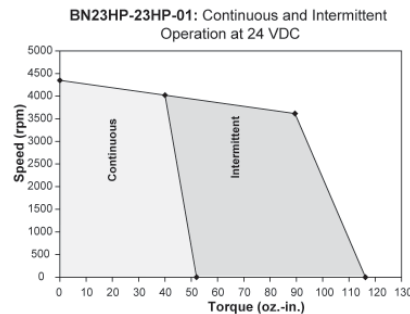
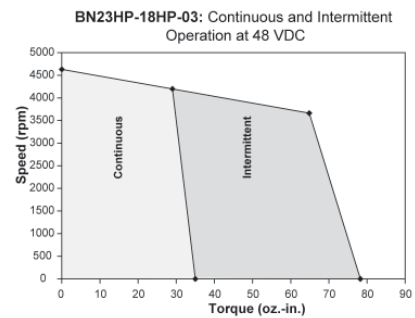
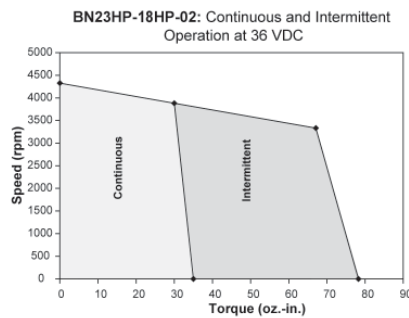
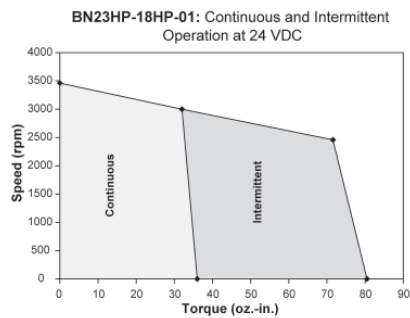
H – Hall Effect (std)
R – Resolver
S – Sensorless

O OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

Brushless Motors

BN23HP Performance Curves

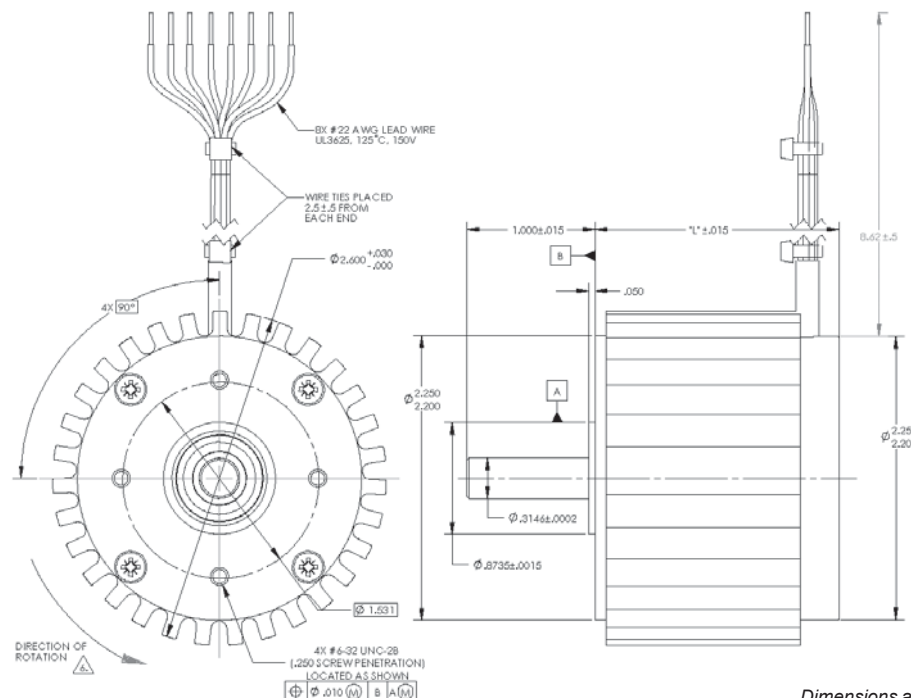


Typical Outline Drawing - BN23

Termination Table*

MOTOR LEADS		SENSOR LEADS	
COLOR	CONNECTION	COLOR	CONNECTION
VIOLET	A COIL	YELLOW	Vcc
BLACK	B COIL	BROWN	S1 OUT
GREEN	C COIL	BLUE	S2 OUT
		WHITE	S3 OUT
		GRAY	GROUND

*We reserve the right to use solid color wires or white wires with color trace.



Dimensions are in inches

Note: Standard housing $\varnothing 2.250$ is available.

Silencer™ Series

Brushless DC

Motors with

Integral Drive

TYPICAL APPLICATIONS

- Medical equipment - small pumps and blowers
- Semiconductor handling and insertion machines
- Robotic tape storage and retrieval
- Industrial automation equipment
- Office automation equipment
- Actuators

FEATURES

- Integral two quadrant speed controllers for electronically commutating three-phase brushless motors
- Uses built-in Hall effect sensors for rotor position feedback
- All motor, drive and feedback connections are pre-wired internally to the package
- Maximum current limit has been pre-set to protect motor and drive
- Efficient PWM speed control using power MOSFET technology
- Compact size - lengths from 1.8" to 2.3"
- Torque ratings from 4.5 oz-in to 5.5 oz-in
- Operating temperature range -20 to +45° C
- Optional cover can for electronics available

BENEFITS

- Compact packaging minimizes space required
- Integrated electronics simplifies installation and wiring
- Complete system testing insures high reliability
- High performance, low cost speed controller
- Motor life not limited to brush and commutator life
- Extremely quiet operation
- Low emitted EMI
- Efficient operation
- Long life

*BN23 Low Cost
1.84" and 2.34" Length*



Low Cost Brushless Motors

Silencer™ brushless DC motors with integral electronics provide smooth, quiet and efficient operation over a wide speed range. Moog Components Group has already performed motor/drive system integration, mechanically, electrically and thermally and offers off-the-shelf models for a wide variety of applications.

Very simple, low cost integral driver allows the end user to replace existing brush motors with highly reliable brushless motors.

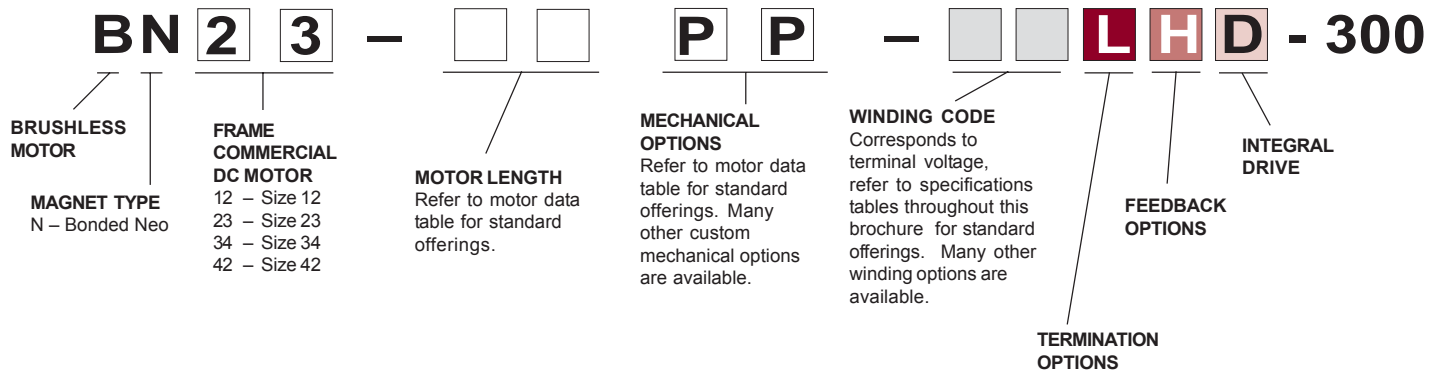
Utilizing bonded NEO magnets and Surface Mount Technology (SMT), the BN Low Cost series motors provide excellent value with their low cost and ease of installation. The compact BND motors are well suited for applications demanding low audible noise, long life and ease of installation.

For more information about how this product can be tailored to fit your specific application, contact our applications engineers.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



BN23 SPECIFICATIONS - Typical Electrical Specifications (25°C)

Part Number*		BN23-13PP-[] [] L H D -300	BN23-18PP-[] [] L H D -300
Winding Code**		03	03
L = Length (Motor + Driver)	inches	1.85	2.35
	millimeters	46.7	59.4
No-Load Speed @ 12 VDC	RPM	2272.0	1947.0
	rad/sec	238	204
Rated Speed @ 12 VDC @ 1.0 Amp	RPM	1660	1740
	rad/sec	174	182
Rated Torque @ 12 VDC @ 1.0 Amp	oz-in (max)	4.5	5.5
	Nm (max)	0.0318	0.0388
No-Load Speed @ 24 VDC	RPM	5363	4566
	rad/sec	562	478
Rated Speed @ 24 VDC @ 1.0 Amp	RPM	4750	4370
	rad/sec	497	458
Rated Torque @ 24 VDC @ 1.0 Amp	oz-in (max)	4.5	5.0
	Nm (max)	0.0318	0.0353
Torque Sensitivity (Kt)	oz-in/amp +/- 10%	5.26	6.18
	Nm/amp +/- 10%	0.0371	0.0436
Rotor Inertia	oz-in-sec ² x 10 ⁻³	0.51	0.99
	g-cm ²	36.0	69.0
Weight	oz	14.0	19.0
	gm	397.6	539.6
Number of Poles		8.0	8.0
Mech. Time Constant	ms	4.9	2.9
Electrical Time Constant	ms	0.81	1.04
Speed/Torque Gradient	RPM/oz-in	140.0	45.0

Notes:

1. Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
2. Maximum winding temperature of 155°C.
3. Typical electrical specifications at 25°C.
4. Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

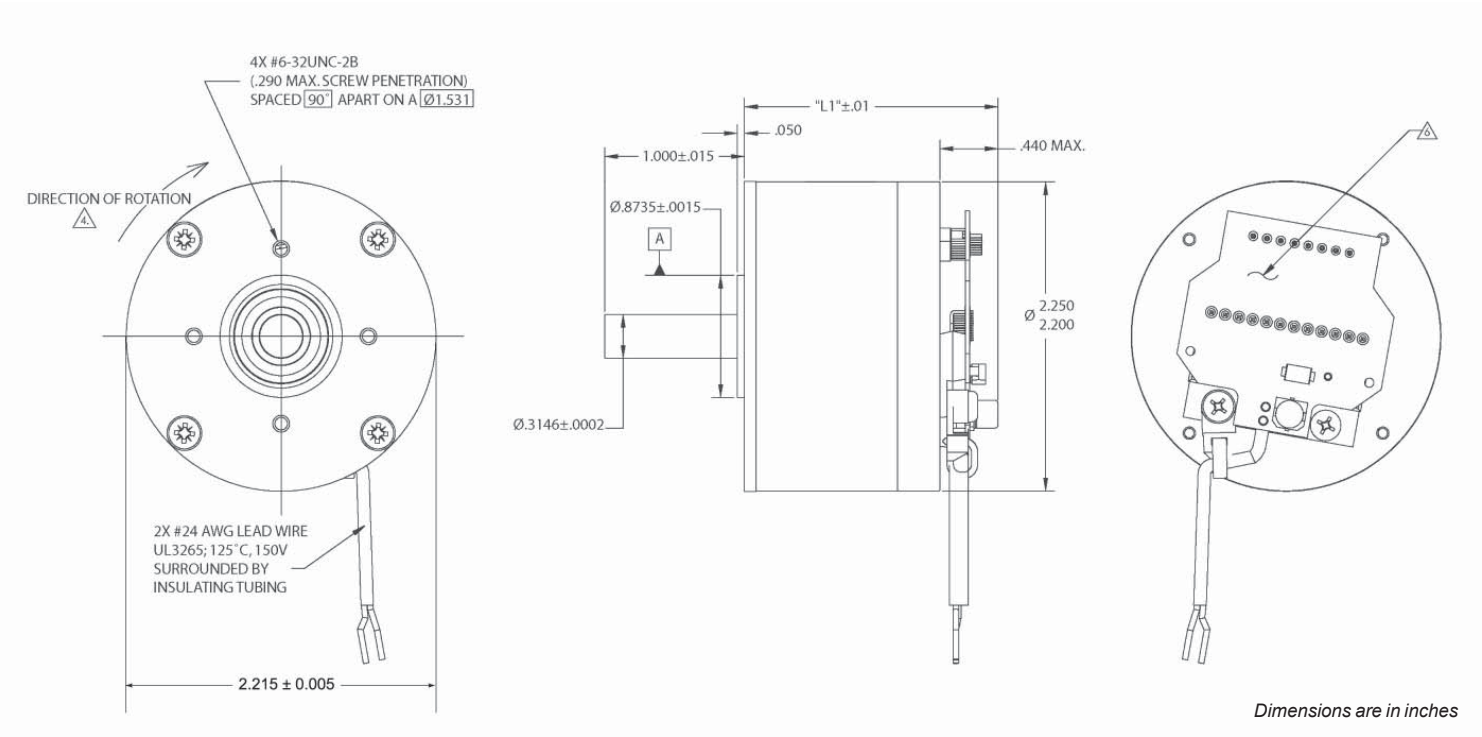
Select your options below and place their code in its corresponding block as shown above.

L TERMINATION OPTIONS
L – Leads (std)
C – Connector
M – MS Connector

H FEEDBACK OPTIONS
H – Hall Effect (std)

D OTHER OPTIONS
D – Drive
G – Gearhead

Typical Outline Drawing - BN23



Connection Diagram

DESIGNATOR	WIRE COLOR
+ VDC	RED
GND	BLACK

UNIT TYPE	"L"
BN23-13PP - [] []	1.85
BN23-18PP - [] []	2.35

- Notes:**
1. Observe proper polarity in connecting + input and GND to power supply. Reverse polarity will damage or destroy drive circuitry and will void warranty.
 2. Voltage range 12 to 24 VDC.

TYPICAL APPLICATIONS

- Medical equipment - pumps, blowers and centrifuges
- HVAC and other air handling equipment
- Packaging and printing equipment
- Semiconductor handling and insertion machines
- Robotic tape storage and retrieval
- Industrial automation equipment
- Office automation equipment
- Actuators

FEATURES

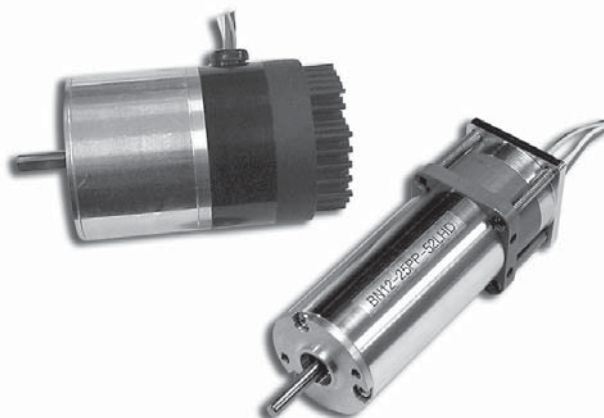
- Integral two quadrant speed controllers for electronically commutating three-phase brushless motors
- Uses built-in Hall effect sensors for rotor position feedback
- All motor, drive and feedback connections are pre-wired internally to the package
- Motor speed is controlled by an external 0 - 5 VDC command voltage
- Direction of rotation is set by the direction input control
- Maximum current limit has been pre-set to protect motor and drive
- Controller is protected against thermal overload by means of an internal thermal cutoff (BN23)
- Efficient PWM speed control using power MOSFET technology
- Compact size - lengths from 2.4" to 4.3"
- Torque ratings from 1.7 oz-in to 22.0 oz-in
- Operating temperature range -10 to 45° C

BENEFITS

- Compact packaging minimizes space required
- Matched motors and drives from a single supplier
- Integrated electronics simplifies installation and wiring
- Complete system testing insures high reliability
- High performance, low cost speed controller
- Motor life not limited to brush and commutator life
- Extremely quiet operation
- Low emitted EMI
- Efficient operation
- Long life

Silencer™ Series Brushless DC Motors with Integral Drives

*BN12 and BN23
1.2" and 2.25" Diameter with
Integral Drive Electronics*



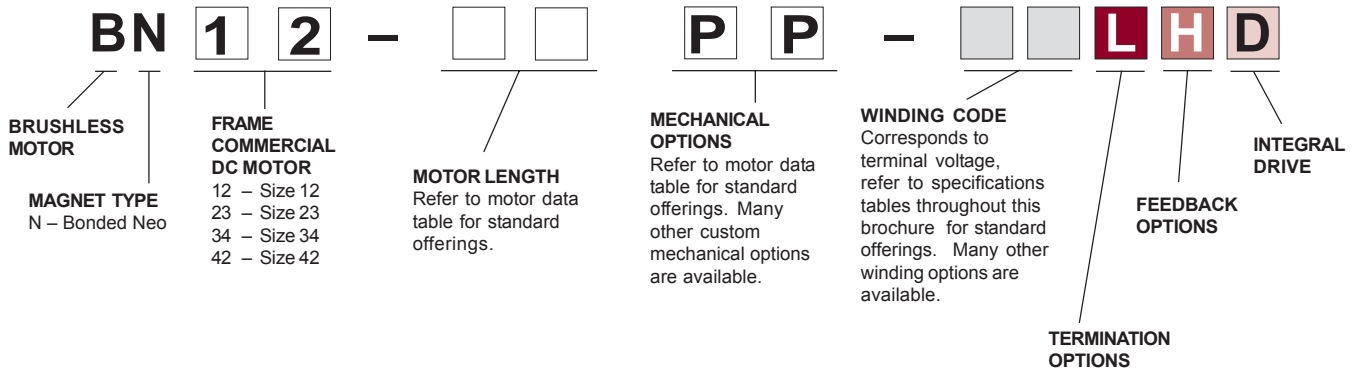
Silencer™ Brushless DC motors with integral electronics provide smooth, quiet and efficient operation over a wide speed range. Each frame size is available in several different lengths, with the electronics optimized for the specific motor's operating parameters. Moog Components Group has already performed motor/drive system integration, mechanically, electrically and thermally and offers off-the-shelf models for a wide variety of applications.

Utilizing bonded neo magnets and Surface Mount Technology (SMT), the BN series motors provide excellent value with their low-cost and high torque. The compact BN motors are well suited for applications demanding low audible noise, long life and ease of installation.

If you have any questions about the Silencer BN motors and drives, or would like to speak with an application engineer, please call us toll-free or visit our web site.

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



BN12 SPECIFICATIONS - Continuous Stall Torque 3 - 5 oz-in (0.0212 - 0.0353 Nm) Peak Torque 15 - 27 oz-in (0.1059 - 0.1907 Nm)

Part Number*		BN12-13PP- [] [] L H D -100	BN12-18PP- [] [] L H D -100	BN12-23PP- [] [] L H D -100
Winding Code**		02	03	03
L = Length	inches	2.37	2.37	2.87
	millimeters	60.2	60.2	72.9
Terminal Voltage	volts DC (nom)	24	24	24
Peak Torque	oz-in (max)	15	9	24
	Nm (max)	0.1059	0.0636	0.1695
Continuous Stall Torque	oz-in (max)	3	2	5
	Nm (max)	0.0212	0.0141	0.0353
Rated Speed	RPM	11700	6510	6480
	rad/sec	1225	682	679
Rated Torque	oz-in (max)	1.7	2.1	4.0
	Nm (max)	0.0120	0.0148	0.0282
Rated Current	amps	0.93	0.75	1.20
Rated Power	watts	15	10	19
Torque Sensitivity (K _T)	oz-in/amp	2.22	3.18	3.69
	Nm/amp	0.0157	0.0225	0.0261
Back EMF (K _E)	volts/KRPM	1.64	2.35	2.73
	volts/rad/sec	0.0157	0.0225	0.0261
Motor Constant (K _M)	oz-in/sq.rt.watt	1.17	1.11	1.91
	Nm/sq.rt.watt	0.00823	0.00738	0.01348
Rotor Inertia	oz-in-sec ² x 10 ⁻³	0.04	0.04	0.08
	g-cm ²	2.8	2.9	5.7
Weight	oz	5	5	7
	gm	142.0	142.0	198.8
Number of Poles		8	8	8
Timing		120°	120°	120°
Mech. Time Constant	ms	4.2	4.7	3.1
Electrical Time Constant	ms	0.14	0.13	0.21
Thermal Resistivity	deg. C/watt	13.8	13.3	10.9
Speed/Torque Gradient	rpm/oz-in	996.8	1100.5	370.7

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown above.

TERMINATION OPTIONS

L – Leads (std)
C – Connector
M – MS connector

FEEDBACK OPTIONS

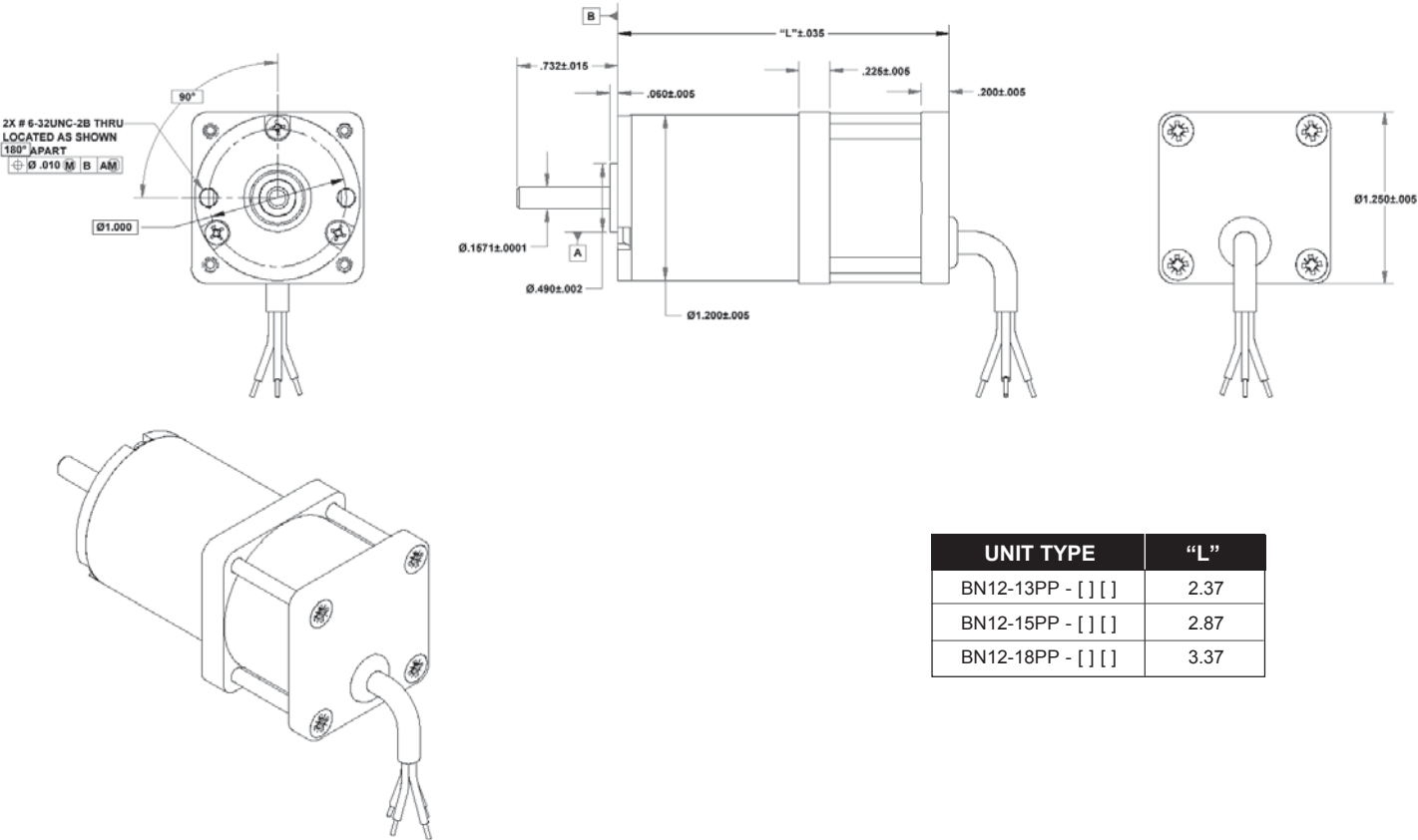
H – Hall Effect (std)

OTHER OPTIONS

D – Drive
G – Gearhead

Brushless Motors

Typical Outline Drawing



UNIT TYPE	"L"
BN12-13PP - [] []	2.37
BN12-15PP - [] []	2.87
BN12-18PP - [] []	3.37

Connection Diagram

DESIGNATOR	WIRE COLOR
+ Input	RED
GND	*BLACK
Speed Command	*YELLOW

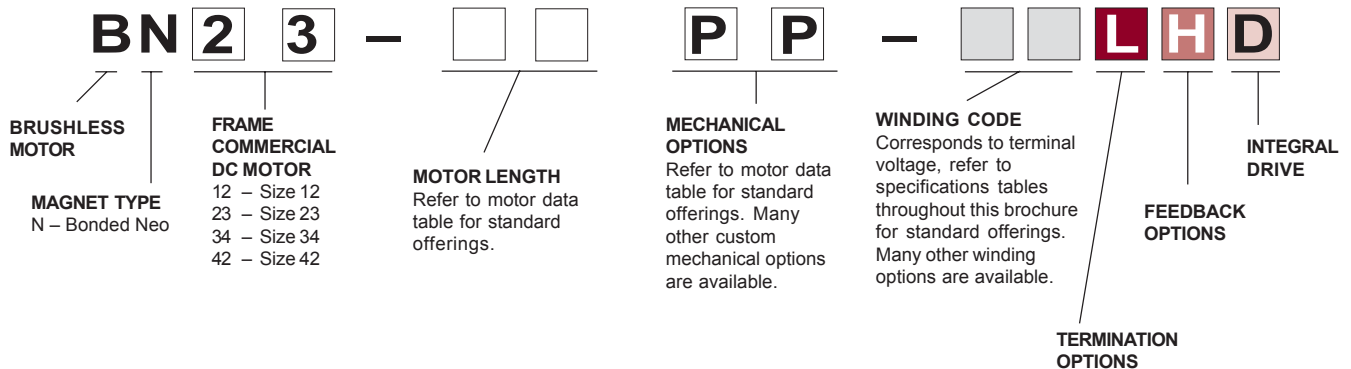
*Apply 0 - 5 VDC speed command between (+) and GND (-), being sure to observe polarity.

Notes:

1. Observe proper polarity in connecting + input and GND to power supply. Reverse polarity will damage or destroy drive circuitry and will void warranty.
2. Reverse and TACH output available upon request - contact factory for information.
3. Voltage range 12 to 24 VDC.

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



BN23 SPECIFICATIONS - Typical Electrical Specifications (25°C)

Part Number*		BN23-13PP- [] [] L H D -100	BN23-18PP- [] [] L H D -100	BN23-23PP- [] [] L H D -100
Winding Code**		01	02	02
L = Length (Motor + Driver)	inches	3.27	3.27	3.77
	millimeters	83.1	83.1	95.8
No Load Speed @ 12 VDC	rpm	5659	3967	3058
	rad/sec	593	415	320
Rated Speed @ 12 VDC	rpm	4820	2690	2280
	rad/sec	505	282	239
Rated Torque @12 VDC	oz-in (max)	11	12	20
	Nm (max)	0.0777	0.0847	0.1412
Rated Current @ 12 VDC	amps	4.5	3.4	4.3
No-Load Speed @ 24 VDC	rpm	11956	8335	6377
	rad/sec	1252	873	668
Rated Speed @ 24 VDC	rpm	10850	7050	5610
	rad/sec	1136	738	587
Rated Torque @ 24 VDC	oz-in (max)	8.7	12	20
	Nm (max)	0.0614	0.0847	0.1412
Rated Current @ 24 VDC	amps	3.8	3.5	4.4
Torque Sensitivity (Kt)	oz-in/amp	2.59	3.70	4.84
	Nm/amp	0.0183	0.0261	0.0342
Rotor Inertia	oz-in-sec ² x 10 ⁻³	0.51	0.51	0.99
	g-cm ²	36	36	69.9
Weight	oz	14	14	19
	gm	397.06	397.6	539.6
Number Of Poles		8	8	8
Mech. Time Constant	ms	5	5	3
Elect. Time Constant	ms	0.80	0.81	1.05
Thermal Resistivity	deg. C/watt	1.7	1.2	1
Speed/Torque Gradient	rpm/oz-in	127	108	39

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown above.

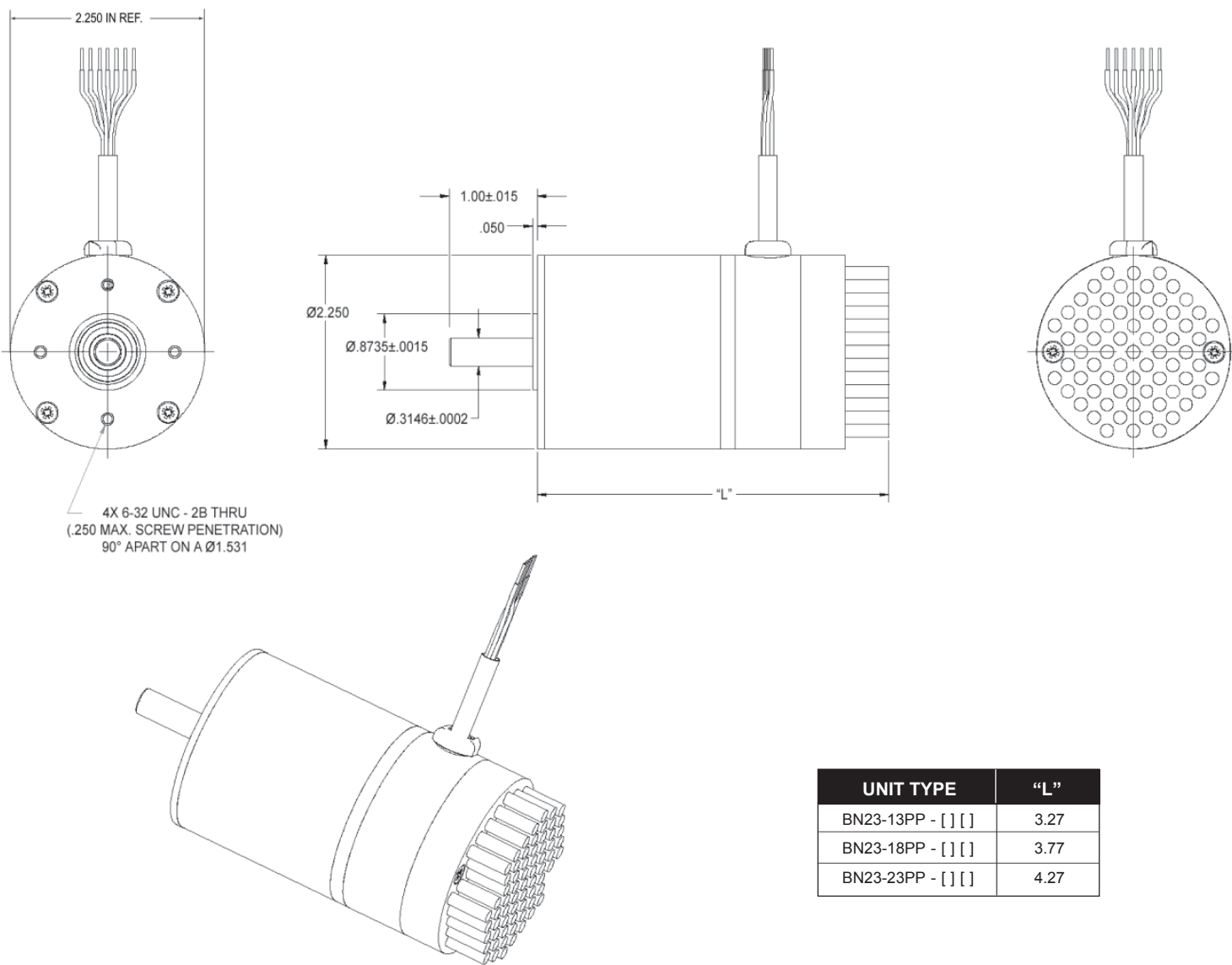
L TERMINATION OPTIONS
 L – Leads (std)
 C – Connector
 M – MS connector

H FEEDBACK OPTIONS
 H – Hall Effect (std)

D OTHER OPTIONS
 D – Drive
 G – Gearhead

Brushless Motors

Typical Outline Drawing - BN23D



UNIT TYPE	"L"
BN23-13PP - [] []	3.27
BN23-18PP - [] []	3.77
BN23-23PP - [] []	4.27

Connection Diagram

CONTROL INPUT	INPUT OPEN OR HIGH	INPUT GND OR LOW
REV	Motor Runs CCW	Motor Runs CW
DIS	Controller Active	Controller Inactive
BRAKE	Controller Inactive	Controller Active

DESIGNATOR	WIRE COLOR
+ Input	RED
GND	*BLACK
SV	*YELLOW
REV	ORANGE
DIS	WHITE
BRAKE	BLUE

* Apply 0 - 5 VDC speed command between SV (+) and GND (-), being sure to observe polarity.

- Notes:**
1. Observe proper polarity in connecting + input and GND to power supply. Reverse polarity will damage or destroy drive circuitry and will void warranty.
 2. Reverse and TACH output available upon request - contact factory for information.
 3. Voltage range 12 to 40 VDC.

Brushless DC Motors

Outside Rotor Fractional Horsepower

TYPICAL APPLICATIONS

- Medical equipment (pumps, blowers, others)
- HVAC systems (air handling equipment)
- Industrial automation
- Scanners
- Office automation equipment

FEATURES

- Compact lengths - from 1.1" to 1.8"
- Continuous torques from 4.0 to 8.2 oz-in
- Low cost bonded ferrite magnets
- Safe, arcless operation
- High speed capabilities – up to 16,000 rpm
- 4 pole motors standard
- Options include electronic drives, encoders, Hall effect or sensorless feedback
- Available as a parts-set or a complete housed motor

BENEFITS

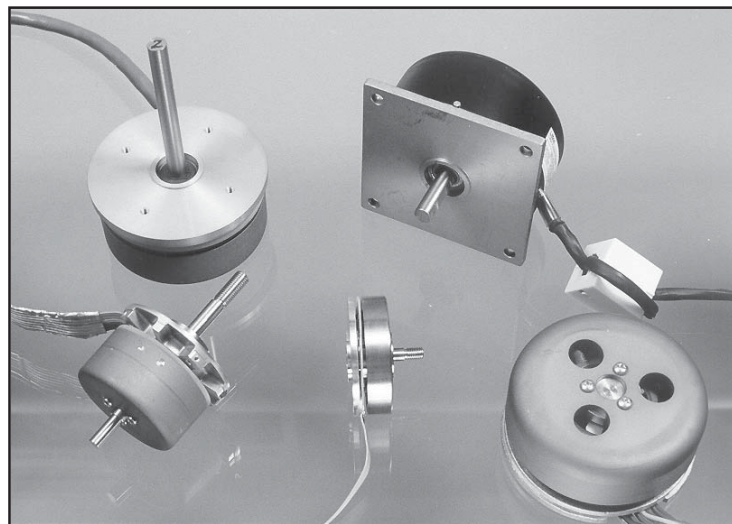
- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Precise, variable speed control
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associated with brushes and commutation or armature induction

ENCODERS

High resolution, high reliability, and state-of-the-art technology in a small package:

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL / CMOS compatible
- Other configurations and resolutions available

BOF16 Series



Quiet, Brushless Motors

BOF 16 motors provide smooth, efficient operation at high speeds. The brushless design ensures low audible noise and long life. Utilizing bonded ferrite magnets, these brushless motors provide excellent performance and value demonstrated by their low cost to high torque ratio. They are available in two lengths with a variety of options, including custom windings to achieve different speed/torque operating points, electronic drives, encoders, and Hall effect or sensorless feedback.

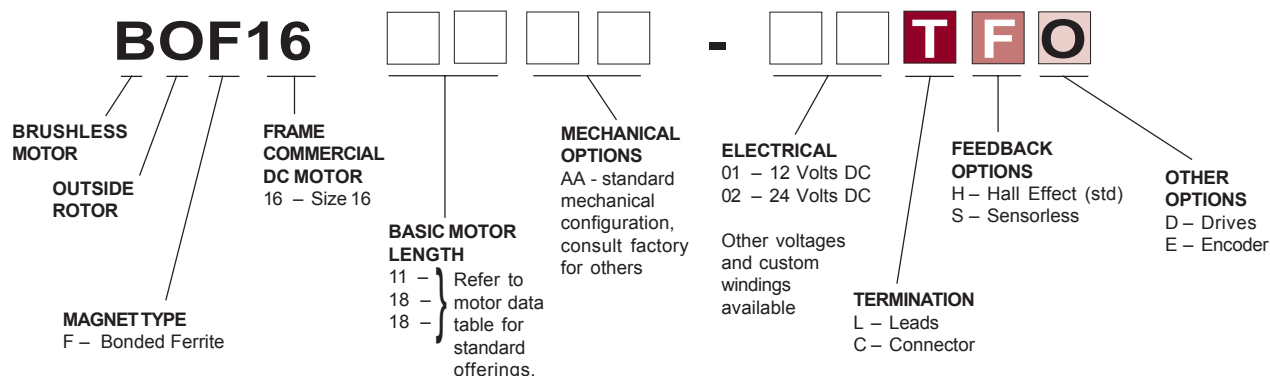
In some applications, motors with an outside rotor enjoy several advantages over their counterparts with inside rotors. Motors with outside rotors perform especially well in applications with significant torque oscillation. Also, BOF outside rotor motors have relatively low profile dimensions for height so they can easily fit in an envelope that is wider than it is tall - such as some medical equipment or industrial machines.

We've designed thousands of DC motors, so if our BOF series doesn't meet your needs, call us to talk about your specifications. One of our other designs may meet your needs, or our engineering department can design a motor to meet your specific requirement.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

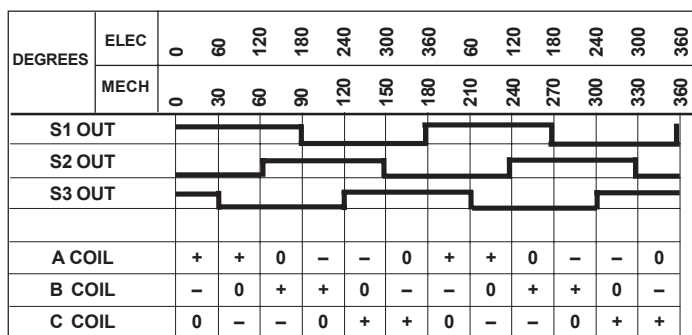
Part Numbering System Guide



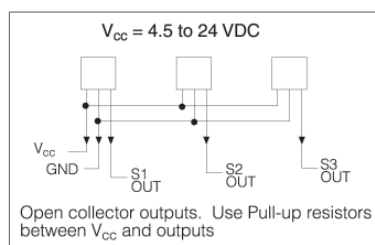
Conversion Table

FROM	TO	MULTIPLY BY
Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281×10^{-2}
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527×10^{-2}
lb	oz	16.0
g	lb	2.205×10^{-3}
oz	lb	6.250×10^{-2}
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383×10^4
g-cm	oz-in	1.389×10^{-2}
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233×10^{-5}
oz-in	lb-ft	5.208×10^{-3}
Rotation		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745×10^{-2}
rpm	rad/sec	.1047
Moment Of Inertia		
oz-in ²	g-cm ²	182.9
lb-ft ²	g-cm ²	4.214×10^5
g-cm ²	oz-in ²	5.467×10^{-3}
lb-ft ²	oz-in ²	2.304×10^3
g-cm ²	lb-ft ²	2.373×10^{-6}
oz-in ²	lb-ft ²	4.340×10^{-4}
oz-in-sec ²	g-cm ²	7.062×10^4

Timing Diagram CCW @ SHAFT



Hall Effect Switches









Termination Table

PIN NUMBER	CONNECTION	COLOR
1	GROUND	BROWN
2	S3 OUT	RED
3	S2 OUT	ORANGE
4	S1 OUT	YELLOW
5	V_{CC}	GREEN
6	C COIL	BLUE
7	B COIL	VIOLET
8	A COIL	GRAY

IMPORTANT

The operational life and performance of any motor is dependent upon individual operating parameters, environment, temperature, and other factors. Your specific application results may vary. Please consult the factory to discuss your requirements.

BOF16 SPECIFICATIONS - Continuous Stall Torque 4.3 - 8.6 oz-in (0.0304 - 0.0607 Nm) Peak Torque 19 - 39 oz-in (0.1342 - 0.2754 Nm)

Part Number*		BOF16-11AA-   		BOF16-18AA-   	
Winding Code**		01	02	01	02
L = Length	inches	1.6		1.8	
	millimeters	40.64		45.72	
Terminal Voltage	volts DC (nom)	12.0	24.0	12.0	24.0
Peak Torque	oz-in (max)	19.0	18.0	38.0	39.0
	Nm (max)	0.1342	0.1271	0.2683	0.2754
Continuous Stall Torque	oz-in (max)	4.3	4.2	8.5	8.6
	Nm (max)	0.0304	0.0297	0.0600	0.0607
Rated Speed	RPM	7432.0	6789.0	4903.0	5100.0
	rad/sec	778	711	513	534
Rated Torque	oz-in (max)	4.1	4.0	8.1	8.2
	Nm (max)	0.0290	0.0282	0.0572	0.0579
Rated Current	Amps	3.26	1.50	4.11	2.12
Rated Power	watts	23.0	20.0	29.0	31.0
Torque Sensitivity	oz-in/amp +/-10%	1.59	3.38	2.42	4.75
	Nm/amp +/-10%	0.0112	0.0239	0.0171	0.0335
Back EMF	volts/KRPM +/-10%	1.18	2.50	1.79	3.51
	volts/rad/sec	0.0112	0.0238	0.0171	0.0335
Terminal Resistance	ohms +/-10%	0.97	4.45	0.77	2.88
Terminal Inductance	mH +/-30%	0.36	1.61	0.42	1.61
Motor Constant	oz-in/sq.rt.watt	1.61	1.60	2.76	2.80
	Nm/sq.rt.watt	0.01140	0.01131	0.01947	0.01977
Rotor Inertia	(oz-in-sec ²) x 10 ⁻³	2.00	2.00	3.90	3.90
	g-cm ²	141.1	141.1	275.2	275.2
Weight	oz	6.96	6.96	9.00	9.00
	gm	197.7	197.7	255.6	255.6
# of Poles		4.0	4.0	4.0	4.0
Timing		120°	120°	120°	120°
Mech. Time Constant	ms	108.6	110.2	72.6	70.5
Elect. Time Constant	ms	0.37	.036	0.55	0.56
Thermal Resistivity	°C/watt	6.3	6.6	5.3	5.3

Notes:

- Motor mounted to a 4" x 4" x 1/4" aluminum plate, still air.
- Maximum winding temperature of 155°C.
- Typical electrical specifications at 25°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 52.

TERMINATION

L – Leads (std)
C – Connector
M – MS connector

FEEDBACK OPTIONS

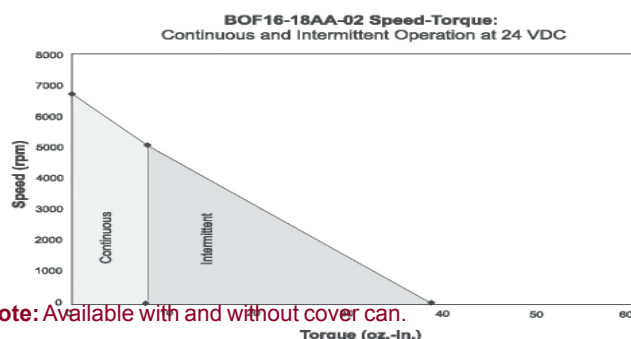
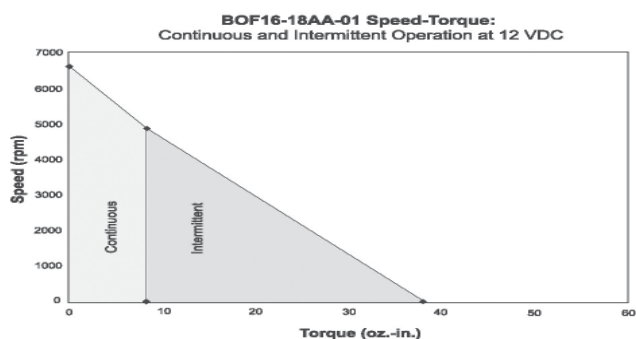
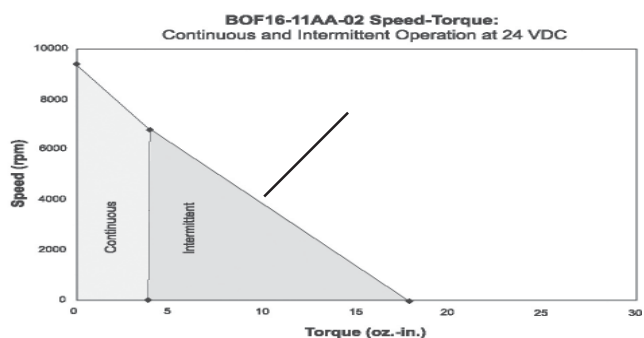
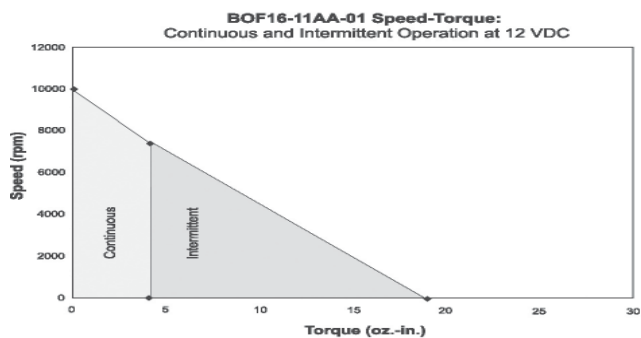
H – Hall Effect (std)
R – Resolver
S – Sensorless

OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

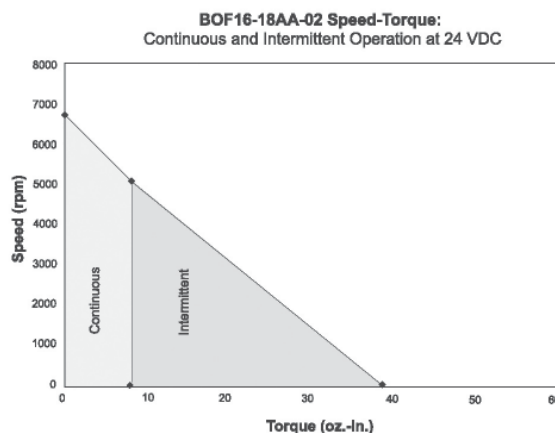
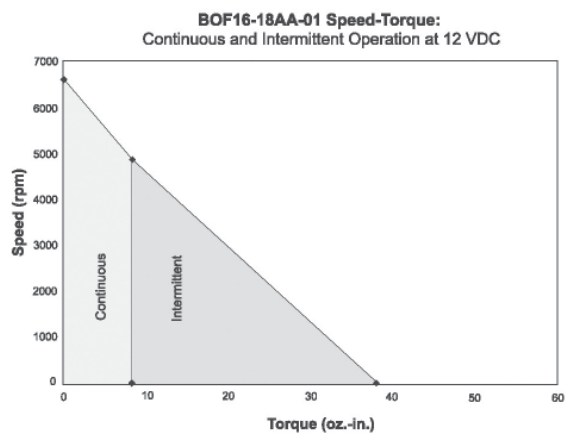
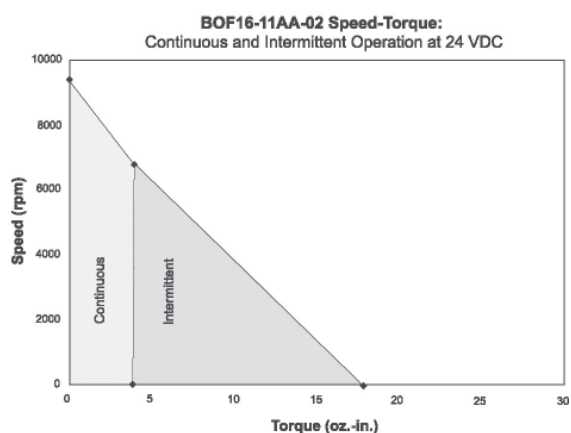
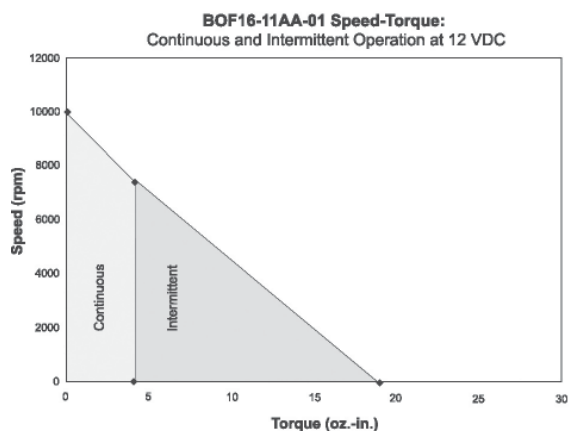
Brushless Motors

BOF16 Typical Outline Drawing



Note: Available with and without cover can.

BOF16 Performance Curves



Brushless DC Motors

Outside Rotor Fractional Horsepower

TYPICAL APPLICATIONS

- Medical equipment (pumps, blowers, others)
- HVAC systems (air handling equipment)
- Industrial automation
- Scanners
- Office automation equipment

FEATURES

- Compact lengths - from 1.1" to 2.4"
- Continuous torques from 5.9 to 19.2 oz-in
- Low cost bonded ferrite magnets
- Safe, arcless operation
- High speed capabilities – up to 6,700 rpm
- 8 pole motors standard
- Options include electronic drives, encoders, Hall effect or sensorless feedback
- Available as a parts set or a complete housed motor

BENEFITS

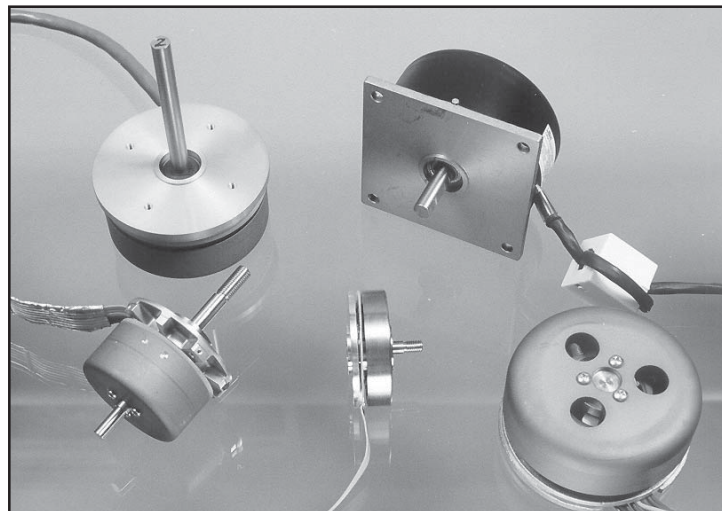
- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Precise, variable speed control
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associated with brushes and commutation or armature induction

ENCODERS

High resolution, high reliability, and state-of-the-art technology in a small package:

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL/CMOS compatible
- Other configurations and resolutions available

BOF23 Series



Quiet, Brushless Motors

BOF 23 motors provide smooth, efficient operation at high speeds. The brushless design ensures low audible noise and long life. Utilizing bonded ferrite magnets, these brushless motors provide excellent performance and value demonstrated by their low cost to high torque ratio. They are available in three lengths with a variety of options, including custom windings to achieve different speed/torque operating points, electronic drives, encoders, and Hall effect or sensorless feedback.

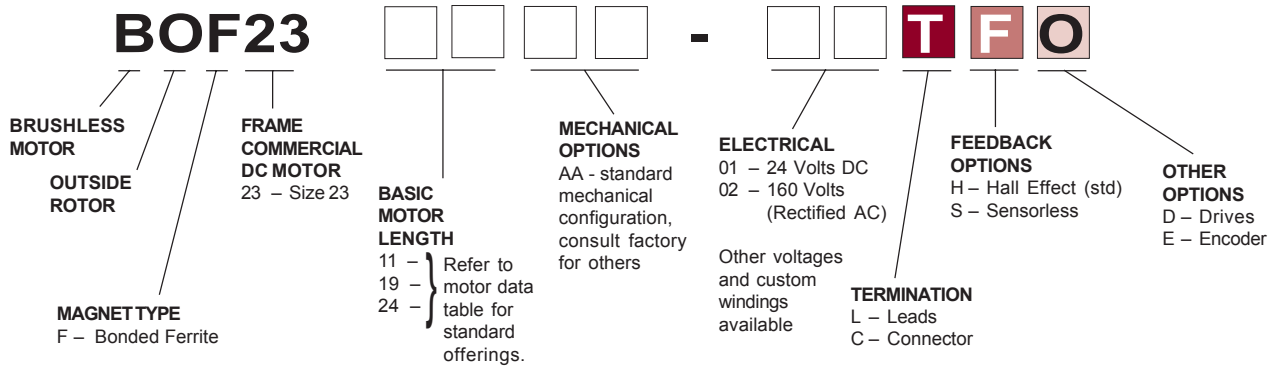
In some applications, motors with an outside rotor enjoy several advantages over their counterparts with inside rotors. Motors with outside rotors perform especially well in applications with significant torque oscillation. Also, BOF outside rotor motors have relatively low profile dimensions for height so they can easily fit in an envelope that is wider than it is tall - such as some medical equipment or industrial machines.

We've designed thousands of DC motors, so if our BOF series doesn't meet your needs, call us to talk about your specifications. One of our other designs may meet your needs, or our engineering department can design a motor to meet your specific requirement.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

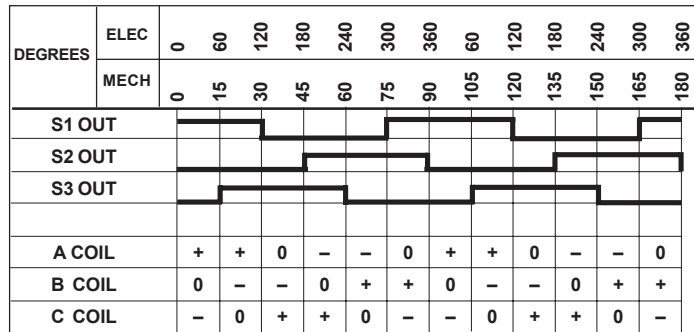
Part Numbering System Guide



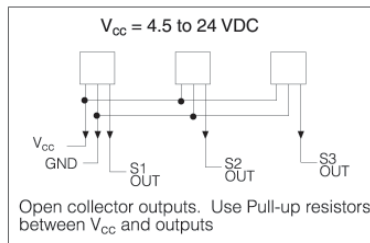
Conversion Table

FROM	TO	MULTIPLY BY
Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281 x 10 ⁻²
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527 x 10 ⁻²
lb	oz	16.0
g	lb	2.205 x 10 ⁻³
oz	lb	6.250 x 10 ⁻²
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383 x 10 ⁴
g-cm	oz-in	1.389 x 10 ⁻²
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233 x 10 ⁻⁵
oz-in	lb-ft	5.208 x 10 ⁻³
Rotation		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745 x 10 ⁻²
rpm	rad/sec	.1047
Moment Of Inertia		
oz-in ²	g-cm ²	182.9
lb-ft ²	g-cm ²	4.214 x 10 ⁵
g-cm ²	oz-in ²	5.467 x 10 ⁻³
lb-ft ²	oz-in ²	2.304 x 10 ³
g-cm ²	lb-ft ²	2.373 x 10 ⁻⁶
oz-in ²	lb-ft ²	4.340 x 10 ⁻⁴
oz-in-sec ²	g-cm ²	7.062 x 10 ⁴

Timing Diagram for Hall Switches



Hall Effect Switches



Termination Table

PIN NUMBER	CONNECTION	COLOR
1	C COIL	BROWN
2	B COIL	RED
3	A COIL	ORANGE
4	S1 OUT	YELLOW
5	S3 OUT	GREEN
6	S2 OUT	BLUE
7	Vcc	VIOLET
8	GROUND	GRAY

IMPORTANT

The operational life and performance of any motor is dependent upon individual operating parameters, environment, temperature, and other factors. Your specific application results may vary. Please consult the factory to discuss your requirements.

BOF23 SPECIFICATIONS - Continuous Stall Torque 5.9 - 19.2 oz-in (0.0417 - 0.1356 Nm) Peak Torque 33 - 155 oz-in (0.2330 - 1.0945 Nm)

Part Number*		BOF23-11AA- <input type="checkbox"/> T <input type="checkbox"/> F <input type="checkbox"/> O		BOF23-19AA- <input type="checkbox"/> T <input type="checkbox"/> F <input type="checkbox"/> O		BOF23-24AA- <input type="checkbox"/> T <input type="checkbox"/> F <input type="checkbox"/> O	
Winding Code**		01	02	01	02	01	02
L = Length	inches	1.10		1.90		2.40	
	millimeters	27.9		48.3		61.0	
Terminal Voltage	volts DC (nom.)	24.0	160.0	24.0	160.0	24.0	160.0
Peak Torque	oz-in (max.)	33.0	31.0	94.0	90.0	141.0	155.0
	Nm (max.)	0.2330	0.2189	0.6638	0.6355	0.9957	1.0945
Continuous Stall Torque	oz-in (max.)	5.9	6.0	13.6	13.6	18.4	19.2
	Nm (max.)	0.0417	0.0424	0.0960	0.0960	0.1299	0.1356
Rated Speed	RPM	6890.0	6251.0	5387.0	5080.0	5513.0	5582.0
	rad/sec	722	655	564	532	577	585
Rated Torque	oz-in (max.)	5.5	5.6	12.9	13.0	17.4	18.2
	Nm (max.)	0.0388	0.0395	0.0911	0.0918	0.1229	0.1285
Rated Current	Amps	1.90	0.27	3.07	0.44	4.06	0.64
Rated Power	watts	28.0	25.9	51.4	48.8	71.0	75.1
Torque Sensitivity	oz-in/amp +/-10%	3.82	27.20	5.33	37.00	5.39	35.90
	Nm/amp +/-10%	0.0270	0.1921	0.0376	0.2613	0.0381	0.2535
Back EMF	volts/KRPM +/-10%	2.83	20.10	3.94	27.40	3.99	26.60
	volts/rad/sec	0.0270	0.1921	0.0376	0.2613	0.0381	0.2535
Terminal Resistance	ohms +/-10%	2.75	138.00	1.36	65.80	0.91	37.10
Terminal Inductance	mH +/-30%	1.33	67.40	1.06	51.30	0.73	32.20
Motor Constant	oz-in/sq.rt.watt	2.30	2.32	4.57	4.56	5.65	5.89
	Nm/sq.rt.watt	0.01627	0.01635	0.03227	0.03221	0.03990	0.04162
Rotor Inertia	(oz-in-sec ²) x 10 ⁻³	5.80	5.80	12.30	12.30	17.50	17.50
	g-cm ²	409.3	409.3	868.0	868.0	1235.0	1235.0
Weight	oz	10.0	10.0	16.0	16.0	21.0	21.0
	gm	284.0	284.0	454.4	454.4	596.4	596.4
# of Poles		8.0	8.0	8.0	8.0	8.0	8.0
Timing		120°	120°	120°	120°	120°	120°
Mech. Time Constant	ms	154.7	153.1	83.3	83.7	77.6	71.3
Elect. Time Constant	ms	0.48	.049	0.78	0.78	0.80	0.87
Thermal Resistivity	°C/watt	6.0	6.1	4.7	4.9	4.0	3.9

Notes:

- Motor mounted to a 6" x 6" x 1/4" aluminum plate, in still, 25°C ambient air.
- Maximum winding temperature of 155°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 56.

T TERMINATION

- L – Leads (std)
- C – Connector
- M – MS connector

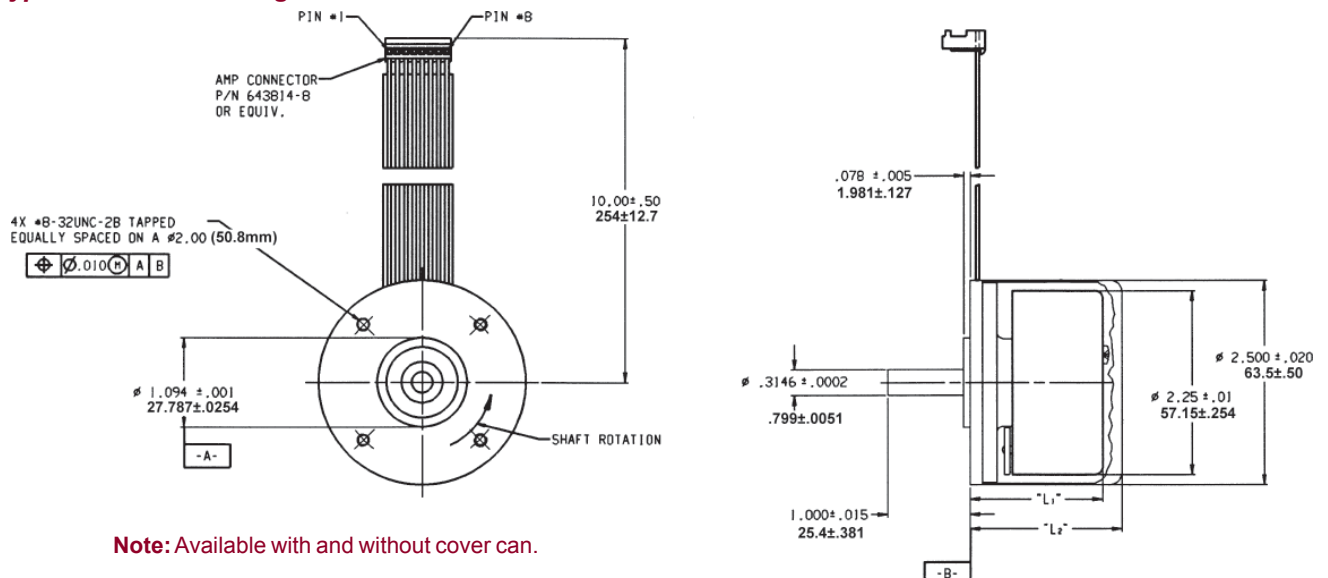
F FEEDBACK OPTIONS

- H – Hall Effect (std)
- R – Resolver
- S – Sensorless

O OTHER OPTIONS

- D – Drive
- E – Encoder
- G – Gearhead

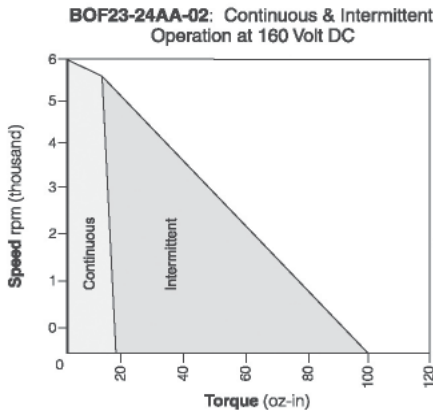
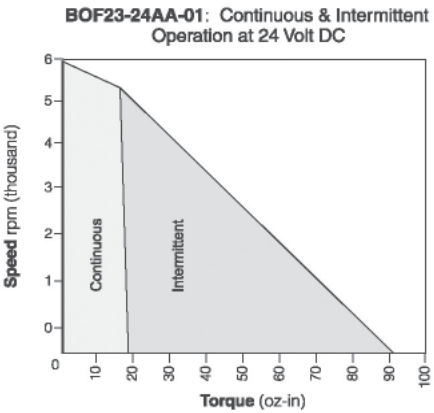
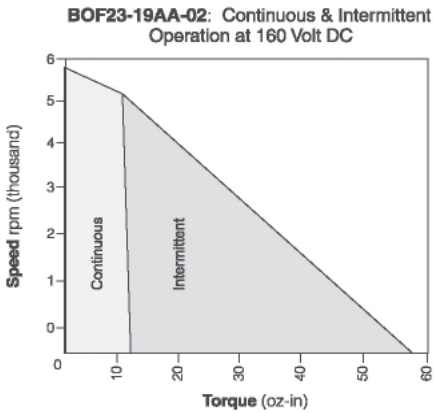
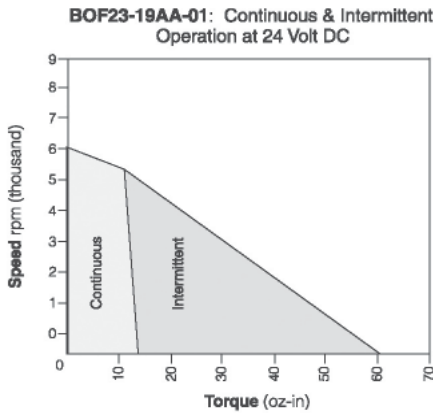
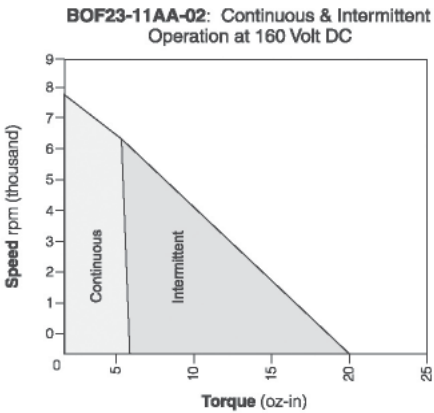
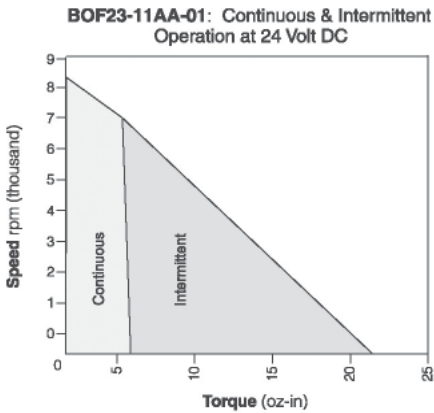
BOF23 Typical Outline Drawing



Note: Available with and without cover can.

Brushless Motors

BOF23 Performance Curves



Brushless DC Motors

Outside Rotor Fractional Horsepower

TYPICAL APPLICATIONS

- Medical equipment (pumps, blowers, others)
- HVAC systems (air handling equipment)
- Industrial automation
- Scanners
- Office automation equipment

FEATURES

- Lengths - from 1.9" to 2.2"
- Continuous torques from 29.9 to 44.5 oz-in
- Low cost bonded ferrite magnets
- Safe, arcless operation
- High speed capabilities – up to 16,000 rpm
- 4 and 8 pole designs
- Options include electronic drives, encoders, Hall effect or sensorless feedback
- Available as a parts set or a complete housed motor

BENEFITS

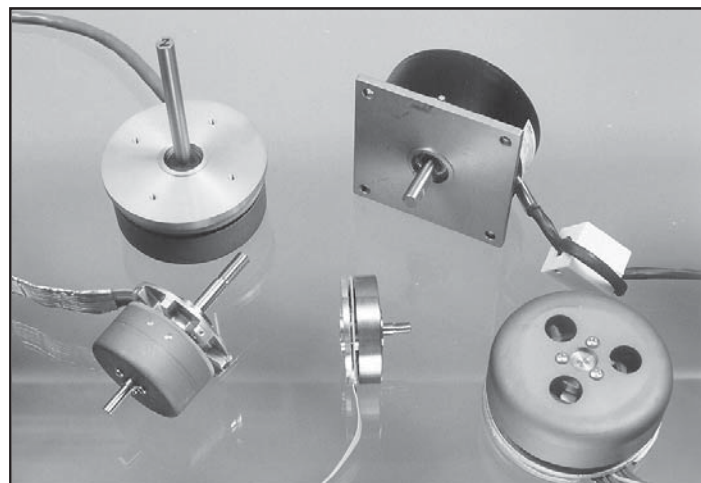
- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Precise, variable speed control
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associated with brushes and commutation or armature induction

ENCODERS

High resolution, high reliability, and state-of-the-art technology in a small package:

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL/CMOS compatible
- Other configurations and resolutions available

BOF35 Series



Quiet, Brushless Motors

BOF 35 motors provide smooth, efficient operation at high speeds. The brushless design ensures low audible noise and long life. Utilizing bonded ferrite magnets, these brushless motors provide excellent performance and value demonstrated by their low cost to high torque ratio. They are available in two lengths with a variety of options, including custom windings to achieve different speed/torque operating points, electronic drives, encoders, and Hall effect or sensorless feedback.

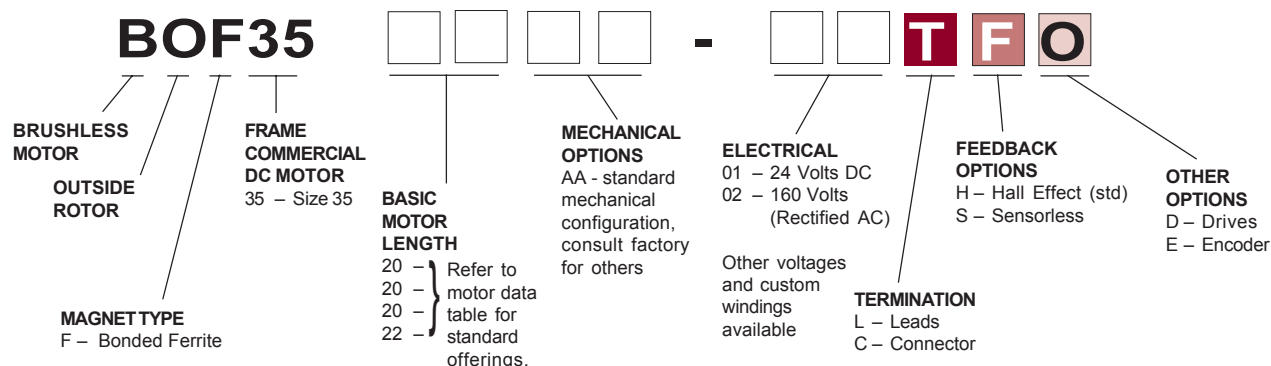
In some applications, motors with an outside rotor enjoy several advantages over their counterparts with inside rotors. Motors with outside rotors perform especially well in applications with significant torque oscillation. Also, BOF outside rotor motors have relatively low profile dimensions for height so they can easily fit in an envelope that is wider than it is tall - such as some medical equipment or industrial machines.

We've designed thousands of DC motors, so if our BOF series doesn't meet your needs, call us to talk about your specifications. One of our other designs may meet your needs, or our engineering department can design a motor to meet your specific requirement.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

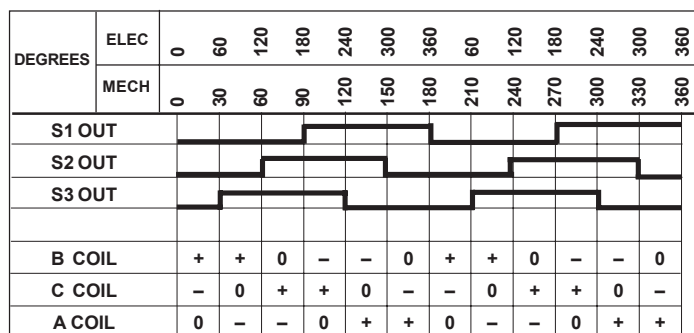
Part Numbering System Guide



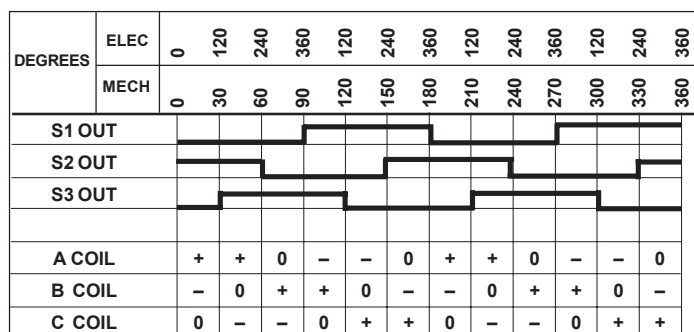
Conversion Table

FROM	TO	MULTIPLY BY
Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281 x 10 ⁻²
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527 x 10 ⁻²
lb	oz	16.0
g	lb	2.205 x 10 ⁻³
oz	lb	6.250 x 10 ⁻²
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383 x 10 ⁴
g-cm	oz-in	1.389 x 10 ⁻²
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233 x 10 ⁻⁵
oz-in	lb-ft	5.208 x 10 ⁻³
Rotation		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745 x 10 ⁻²
rpm	rad/sec	.1047
Moment Of Inertia		
oz-in ²	g-cm ²	182.9
lb-ft ²	g-cm ²	4.214 x 10 ⁵
g-cm ²	oz-in ²	5.467 x 10 ⁻³
lb-ft ²	oz-in ²	2.304 x 10 ³
g-cm ²	lb-ft ²	2.373 x 10 ⁻⁶
oz-in ²	lb-ft ²	4.340 x 10 ⁻⁴
oz-in-sec ²	g-cm ²	7.062 x 10 ⁴

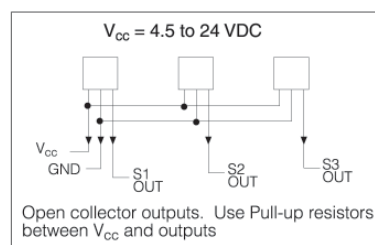
Timing Diagram CCW Shaft Rotation - 4 Poles



Timing Diagram CCW Shaft Rotation - 8 Poles



















Hall Effect Switches



Termination Table

PIN NUMBER	FUNCTION	COLOR
3	A	BLUE
2	B	PURPLE
1	C	GRAY
6	S1	ORANGE
5	S2	YELLOW
4	S3	GREEN
7	Vcc	RED
8	GROUND	BROWN

BOF35 SPECIFICATIONS - Continuous Stall Torque 29.9 - 44.5 oz-in (0.2111 - 0.3142 Nm) Peak Torque 117 - 286 oz-in (0.8262 - 2.0196 Nm)

Part Number*		BOF35-20AA-    		BOF35-22AA-    		BOF35-20BA-    		BOF35-22BA-    	
Winding Code**		01	02	01	02	01	02	01	02
L = Length	inches	1.91		2.20		1.91		2.20	
	millimeters	48.5		55.9		48.5		55.9	
Terminal Voltage	volts DC	24.0	160.0	24.0	160.0	24.0	160.0	24.0	160.0
Peak Torque	oz-in	117.0	126.0	177.0	195.0	180.0	200.0	253.0	286.0
	Nm	0.8262	0.8897	1.2499	1.3770	1.2711	1.4123	1.7866	2.0196
Continuous Stall Torque	oz-in	29.9	30.5	39.5	40.1	32.6	33.9	42.7	44.5
	Nm	0.2111	0.2154	0.2789	0.2832	0.2302	0.2394	0.3015	0.3142
Rated Speed	RPM	3986.0	4354.0	4173.0	4641.0	5140.0	5451.0	4853.0	5195.0
	rad/sec	417	456	437	486	538	571	508	544
Rated Torque	oz-in	29.1	29.6	38.4	38.9	31.7	32.9	41.5	43.2
	Nm	0.2055	0.2090	0.2712	0.2747	0.2238	0.2323	0.2931	0.3051
Rated Current	Amps	6.50	1.03	8.09	1.30	7.50	1.20	8.92	1.44
Rated Power	watts	86.0	95.0	118.0	133.0	120.0	133.0	149.0	166.0
Torque Sensitivity	oz-in/amp	5.42	34.65	5.70	35.84	5.13	33.20	5.60	36.02
	Nm/amp	0.0383	0.2447	0.0403	0.2531	0.0362	0.2344	0.0395	0.2544
Back EMF	volts/KRPM	4.01	25.62	4.22	26.50	3.79	24.55	4.14	26.63
	volts/rad/sec	0.0383	0.2447	0.0403	0.2531	0.0362	0.2344	0.0395	0.2544
Terminal Resistance	ohms	1.11	43.51	0.77	29.26	0.68	26.37	0.53	20.06
Terminal Inductance	mH	1.13	45.97	0.86	34.12	0.53	22.13	0.47	19.48
Motor Constant	oz-in/sq.rt.watt	5.14	5.25	6.50	6.63	6.22	6.47	7.69	8.04
	Nm/sq.rt.watt	0.03633	0.03709	0.04587	0.04679	0.04393	0.04565	0.05432	0.05679
Rotor Inertia	oz-in-sec ²	53.00	53.00	65.00	65.00	53.00	53.00	65.00	65.00
	g-cm ²	3740.2	3740.2	4587.1	4587.1	3740.2	3740.0	4587.1	4587.1
Weight	oz	32.2	32.2	39.5	39.5	30.5	30.5	37.9	37.9
	g	913.9	913.9	1121.8	1120.9	866.8	866.2	1076.4	1076.4
# of Poles		4.0	4.0	4.0	4.0	8.0	8.0	8.0	8.0
Timing		60°	60°	60°	60°	120°	120°	120°	120°
Mech. Time Constant	m s	283.4	271.8	218.0	209.5	193.8	179.4	155.5	142.2
Electrical Time Constant	m s	1.02	1.06	1.12	1.17	0.78	0.84	0.89	0.97
Thermal Resistivity	°C/watt	1.5	1.5	1.4	1.4	1.8	1.8	1.6	1.6

Notes:

- Motor mounted to a 6" x 6" x 1/4" aluminum plate, in still, 25°C ambient air.
- Maximum winding temperature of 155°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 60.

T TERMINATION

L – Leads (std)
C – Connector
M – MS connector

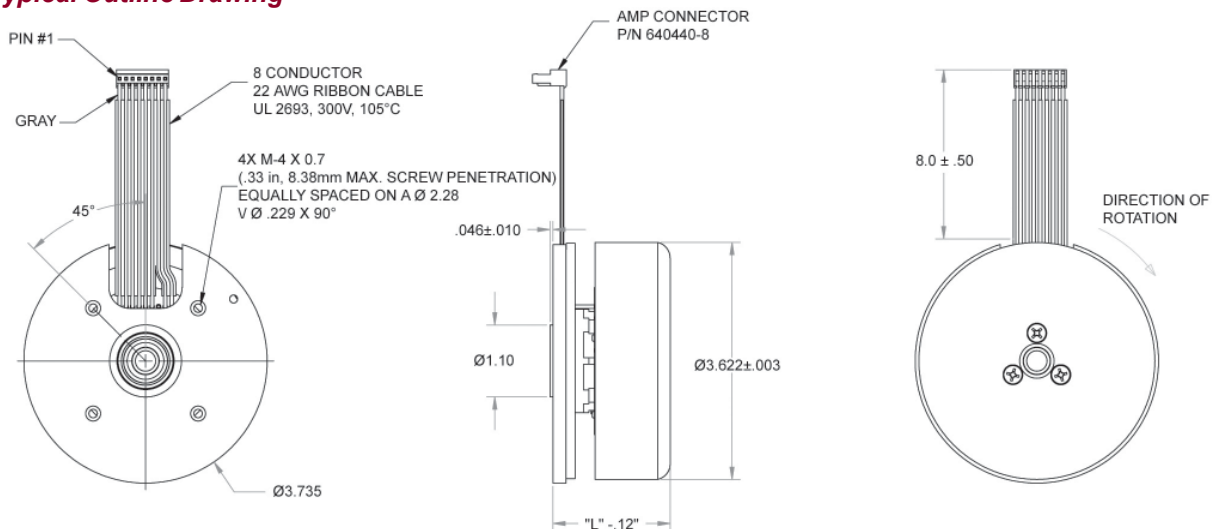
F FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

O OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

BOF35 Typical Outline Drawing

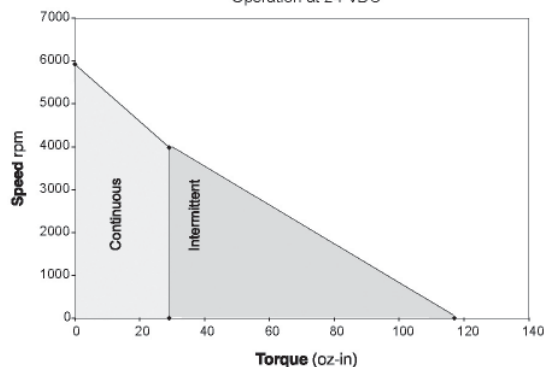


Note: Available with and without cover can.

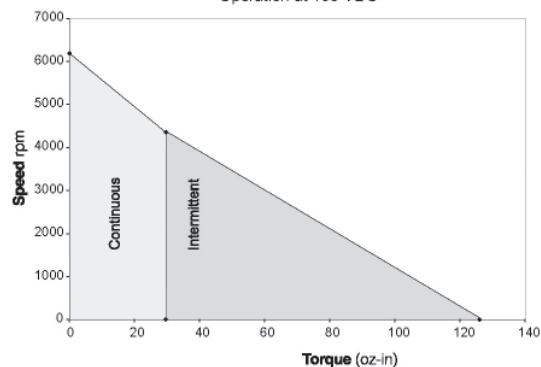
Brushless Motors

BOF35 Performance Curves

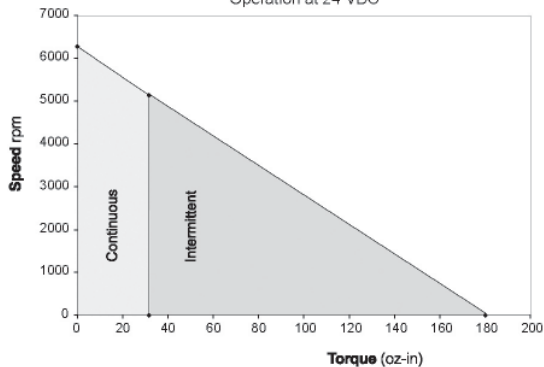
BOF35-20AA-01 Speed-Torque: Continuous and Intermittent Operation at 24 VDC



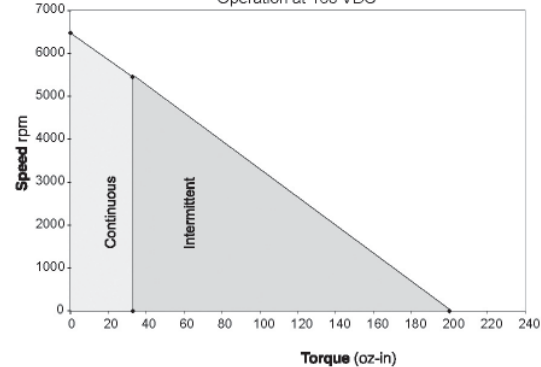
BOF35-20AA-02 Speed-Torque: Continuous and Intermittent Operation at 160 VDC



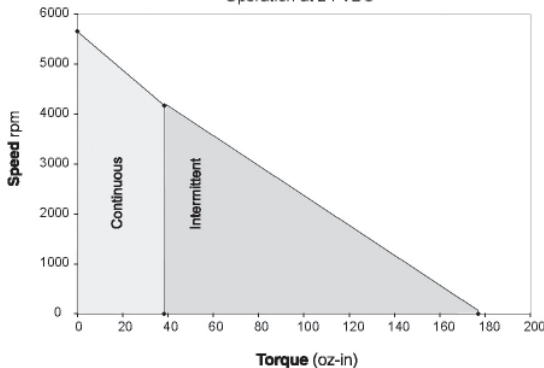
BOF35-20BA-01 Speed-Torque: Continuous and Intermittent Operation at 24 VDC



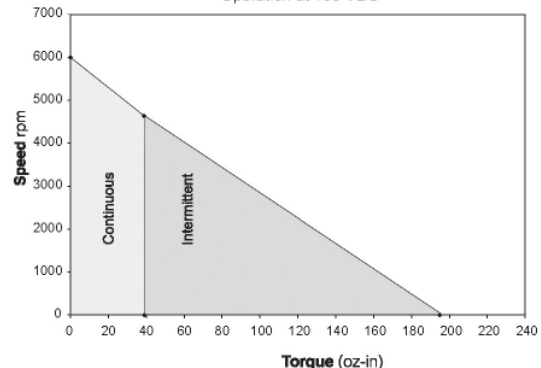
BOF35-20BA-02 Speed-Torque: Continuous and Intermittent Operation at 160 VDC



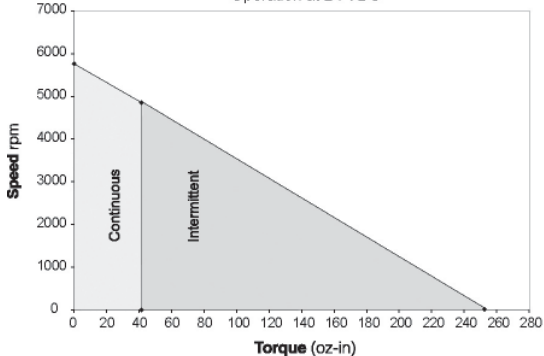
BOF35-22AA-01 Speed-Torque: Continuous and Intermittent Operation at 24 VDC



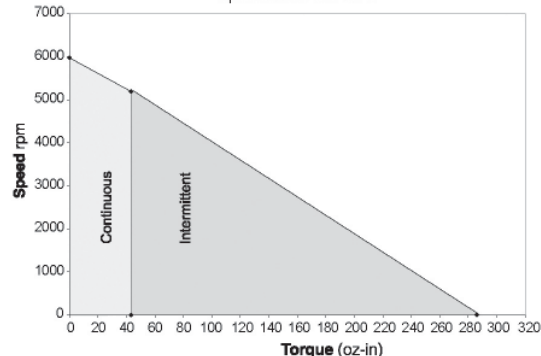
BOF35-22AA-02 Speed-Torque: Continuous and Intermittent Operation at 160 VDC



BOF35-22BA-01 Speed-Torque: Continuous and Intermittent Operation at 24 VDC



BOF35-22BA-02 Speed-Torque: Continuous and Intermittent Operation at 160 VDC



Brushless DC Motors

Outside Rotor Fractional Horsepower

TYPICAL APPLICATIONS

- Medical equipment (pumps, blowers, others)
- HVAC systems (air handling equipment)
- Industrial automation
- Scanners
- Office automation equipment

FEATURES

- Length - 2.0"
- Continuous torques from 58.0 to 76.0 oz-in
- Bonded neodymium magnets
- Safe, arcless operation
- High speed capabilities – up to 6,700 rpm
- 4 and 8 pole designs
- Options include electronic drives, encoders, Hall effect or sensorless feedback
- Available as a parts set or a complete housed motor

BENEFITS

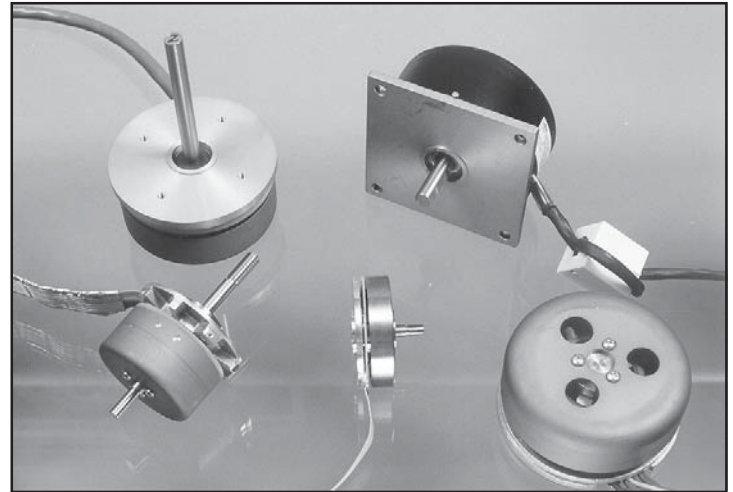
- Operate over a wide range of speeds - not limited to AC frequency
- Extremely quiet operation with long life capability
- Precise, variable speed control
- Motor life is not limited to brush or commutator life
- Efficient operation without losses associated with brushes and commutation or armature induction

ENCODERS

High resolution, high reliability, and state-of-the-art technology in a small package:

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL/CMOS compatible
- Other configurations and resolutions available

BON35 Series



Quiet, Brushless Motors

BON 35 motors provide smooth, efficient operation at high speeds. The brushless design ensures low audible noise and long life. Utilizing bonded neodymium magnets, these brushless motors provide excellent performance and value demonstrated by their low cost to high torque ratio. Available with a variety of options, including custom windings to achieve different speed/torque operating points, electronic drives, encoders, and Hall effect or sensorless feedback.

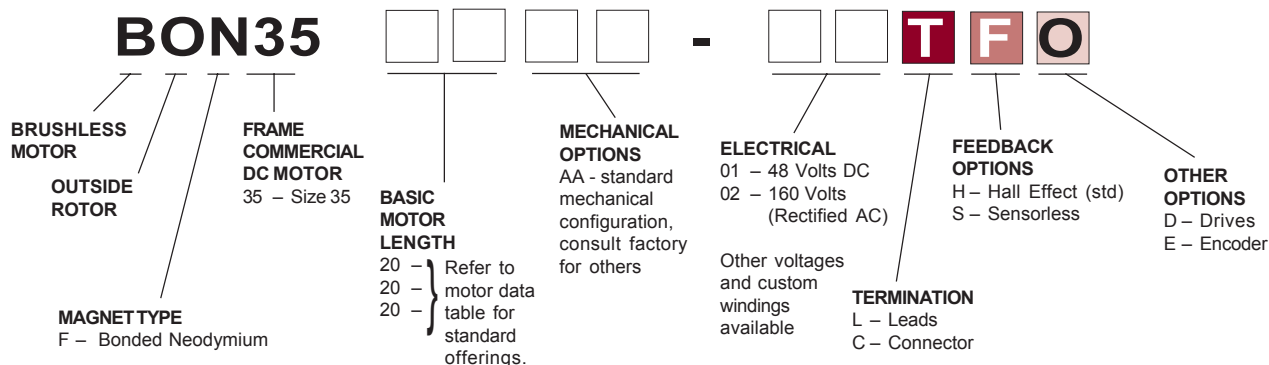
In some applications, motors with an outside rotor enjoy several advantages over their counterparts with inside rotors. Motors with outside rotors perform especially well in applications with significant torque oscillation. Also, BON outside rotor motors have relatively low profile dimensions for height so they can easily fit in an envelope that is wider than it is tall - such as some medical equipment or industrial machines.

We've designed thousands of DC motors, so if our BON series doesn't meet your needs, call us to talk about your specifications. One of our other designs may meet your needs, or our engineering department can design a motor to meet your specific requirement.

Brushless Motors

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



Conversion Table

FROM	TO	MULTIPLY BY
------	----	-------------

Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281 x 10 ⁻²

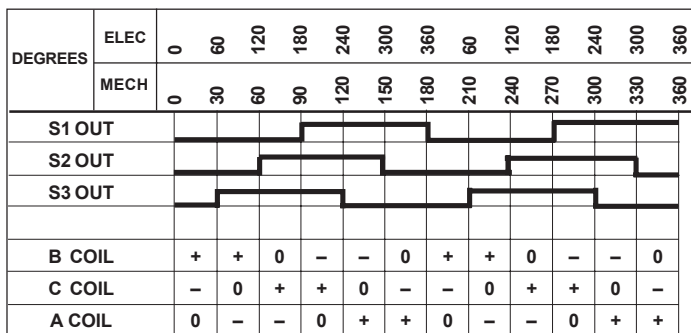
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527 x 10 ⁻²
lb	oz	16.0
g	lb	2.205 x 10 ⁻³
oz	lb	6.250 x 10 ⁻²

Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383 x 10 ⁴
g-cm	oz-in	1.389 x 10 ⁻²
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233 x 10 ⁻⁵
oz-in	lb-ft	5.208 x 10 ⁻³

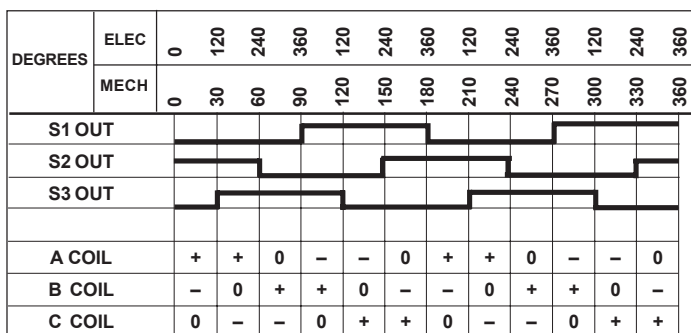
Rotation		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745 x 10 ⁻²
rpm	rad/sec	.1047

Moment Of Inertia		
oz-in ²	g-cm ²	182.9
lb-ft ²	g-cm ²	4.214 x 10 ⁵
g-cm ²	oz-in ²	5.467 x 10 ⁻³
lb-ft ²	oz-in ²	2.304 x 10 ³
g-cm ²	lb-ft ²	2.373 x 10 ⁻⁶
oz-in ²	lb-ft ²	4.340 x 10 ⁻⁴
oz-in-sec ²	g-cm ²	7.062 x 10 ⁴

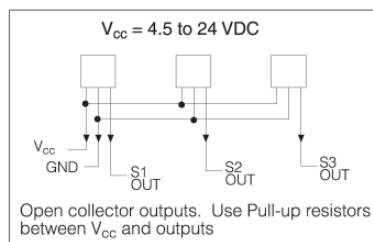
Timing Diagram CCW Shaft Rotation - 4 Poles



Timing Diagram CCW Shaft Rotation - 8 Poles



Hall Effect Switches



Termination Table

PIN NUMBER	FUNCTION	COLOR
3	A	BLUE
2	B	PURPLE
1	C	GRAY
6	S1	ORANGE
5	S2	YELLOW
4	S3	GREEN
7	Vcc	RED
8	GROUND	BROWN

BON35 SPECIFICATIONS - Continuous Stall Torque 59.7 - 78.3 oz-in (0.4216 - 0.5529 Nm) Peak Torque 379 - 806 oz-in (2.6763 - 5.6916 Nm)

Part Number*		BON35-20AA- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		BON35-20BA- <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
Winding Code**		01	02	01	02
L = Length	inches	2.00		2.00	
	millimeters	50.8		50.8	
Terminal Voltage	volts DC	48.0	160.0	48.0	160.0
Peak Torque	oz-in	379.0	457.0	755.0	806.0
	Nm	2.6763	3.2271	5.3314	5.6916
Continuous Stall Torque	oz-in	59.7	60.3	76.2	78.3
	Nm	0.4216	0.4258	0.5382	0.5529
Rated Speed	RPM	4000.0	4900.00	4000.0	4000.0
	rad/sec	419	513	419	419
Rated Torque	oz-in	58.0	58.5	74.0	76.0
	Nm	0.4096	0.4131	0.5226	0.5367
Rated Current	Amps	5.56	1.95	6.74	2.10
Rated Power	watts	172.0	212.0	219.0	225.0
Torque Sensitivity	oz-in/amp	11.72	33.80	12.44	41.04
	Nm/amp	0.0828	0.2387	0.0878	0.2898
Back EMF	volts/KRPM	8.66	24.99	9.20	30.35
	volts/rad/sec	0.0828	0.2387	0.0878	0.2898
Terminal Resistance	ohms	1.48	11.80	0.79	8.13
Terminal Inductance	mH	2.26	18.78	1.16	12.62
Motor Constant	oz-in/sq.rt.watt	9.63	9.84	14.00	14.39
	Nm/sq.rt.watt	0.06803	0.06948	0.09883	0.10164
Rotor Inertia	oz-in-sec ²	99.00	99.00	99.00	99.00
	g-cm ²	6986.4	6986.4	6986.4	6986.4
Weight	oz	44.1	44.1	42.5	42.5
	g	1251.6	1253.3	1207.9	1207.0
# of Poles		4.0	4.0	8.0	8.0
Timing		60°	60°	120°	120°
Mech. Time Constant	ms	151.0	144.7	71.5	67.6
Electrical Time Constant	ms	1.53	1.59	1.47	1.55
Thermal Resistivity	°C/watt	1.1	1.1	1.0	0.9

Notes:

- Motor mounted to a 6" x 6" x 1/4" aluminum plate, in still, 25°C ambient air.
- Maximum winding temperature of 155°C.
- Motor Terminal Voltages are representative only; motors may be operated at voltages other than those listed in the table. For assistance please contact our applications engineer.

*Many other custom mechanical options are available – consult factory.

**Many other winding options are available – consult factory.

Select your options below and place their code in its corresponding block as shown on page 64.

T TERMINATION

L – Leads (std)
C – Connector
M – MS connector

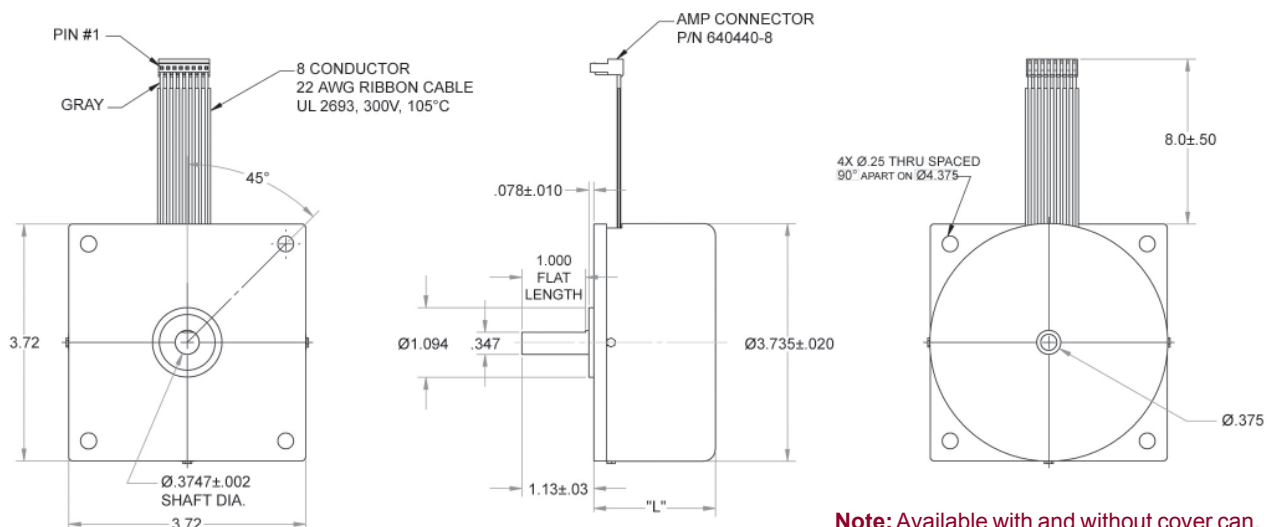
F FEEDBACK OPTIONS

H – Hall Effect (std)
R – Resolver
S – Sensorless

O OTHER OPTIONS

D – Drive
E – Encoder
G – Gearhead

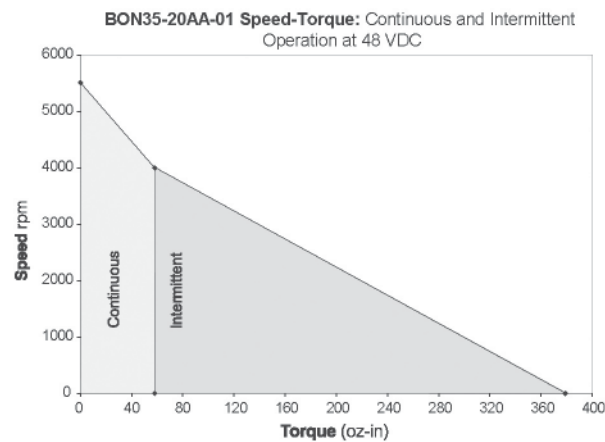
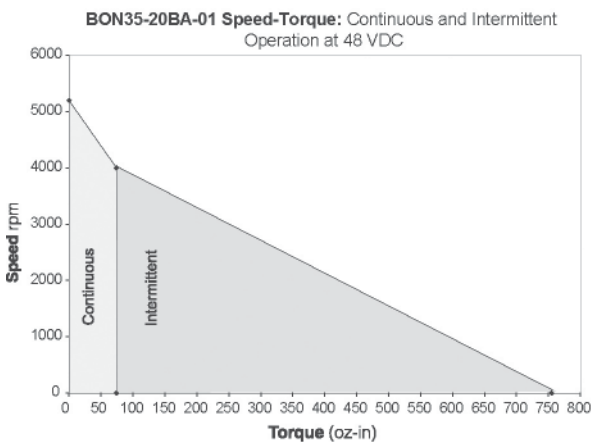
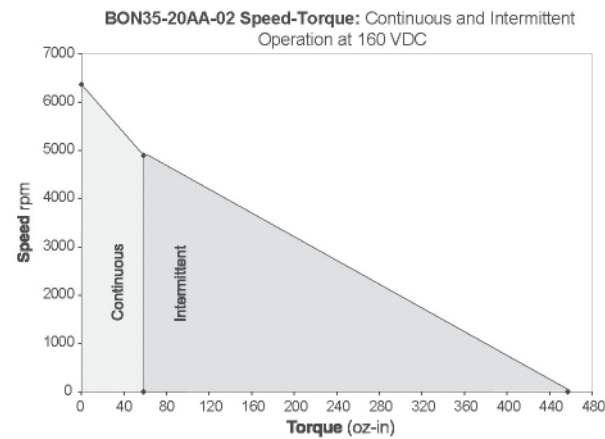
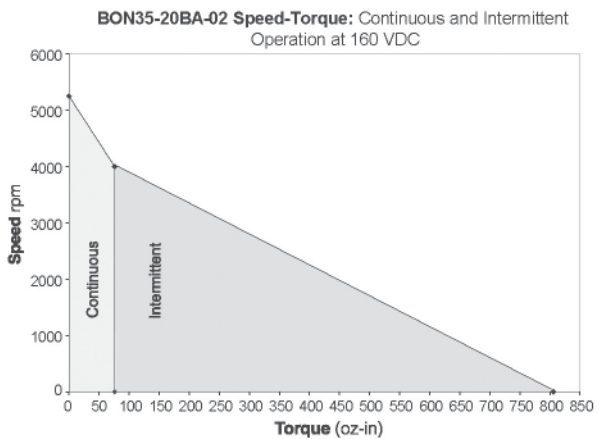
BON35 Typical Outline Drawing



Note: Available with and without cover can.

Brushless Motors

BON35 Performance Curves



Brushless Torque & Toroidal Motors

TYPICAL APPLICATIONS

- Speed and rotation control systems
- Gimbals for FLIR and inertial navigation systems
- Stabilized gun and fire control systems for combat vehicles
- Fire control radars for land and ship board defense
- Cockpit instrumentation for military and commercial aircraft
- Missile seeker and Fin actuator systems
- Space and vacuum instruments, actuation systems and momentum wheels

FEATURES

- Double insulated high temp magnet wire minimizes leakage current, promotes superior insulation.
- Molded brush block assembly features interchangeable brush blocks, optimizing brush position on commutator. Brush contour is done on automatic tooling rather than "run-in" individually.
- Brushes mechanically fastened to brush spring in addition to soldering assures brush alignment during soldering operation plus proper mechanical and electrical bond between brush spring and brush.
- Stable high temp encapsulation material minimizes movement or working of windings under large temperature variations. This high temp material will not crack under temperature variations, and eliminates voids, exposed windings and humidity traps.
- Special magnetic material alloy allows higher torque per unit of volume, higher torque to inertia ratio. It will not corrode under high humidity as does silicon iron or other materials.
- Plated magnet assemblies resist environmental extremes and require no special handling.
- Rare earth magnets typical
- High torque and low speed
- High torque to inertia ratio
- Low speed with high accuracy
- Compact
- Large axial holes through armature for easy application to shafts and bosses

Export of these commodities may require a Department of State export license. Please ensure you inform your Sales Administrator of your intent to export.



Moog Components Group designs and manufactures precision motion technology components and subsystems for defense, aerospace and industrial applications. Our broad range of components includes DC torque and servomotors, position feedback devices and slip ring/twist capsule products.

Our DC brush and brushless torque and servomotors can be supplied housed with a variety of shaft configurations but typically as a direct drive rotor/stator part-set that will be directly attached to the load. This form of attachment eliminates backlash and increases servo stiffness for an optimized direct drive system.

DC torque motors are used in applications that require high torque at slow speeds with input power minimized. Our DC servomotors are used in applications that require high speed and positional accuracy. Custom controllers can be supplied on a design-to-specification basis.

For more information about how this product can be tailored to fit your specific application, contact our applications engineers.

Brushless Motors

BRUSHLESS DC TORQUE AND TOROIDAL MOTOR SPECIFICATIONS

Torquer Motors - Brushless	Torquer Dimensions Max., (inches)			Peak Torque, T _{pk} (oz-in)	Volts @ Peak Torque, V _p (volts)	Amps @ Peak Torque, I _p (amps)	Torque Sensitivity, K _t (oz-in/amp)	Back EMF, K _e (V/RAD/SEC)	Terminal Resistance, R _t (ohms) nom.	Terminal Inductance, L _t (millihenries) nom.	Rotor Inertia, J _R (oz-in-sec ²)	Friction Torque, T _f (oz-in) max.	Motor Constant, K _M (oz-in/sq. ft.watts)	# of Phases	Weight (oz) nom.	Commutation
	UNIT TYPE	O.D.	I.D.	WIDTH												
DB-1250-A-2-XX	1.250	0.375	0.40	3	9	0.82	3.7	0.026	11	0.74	0.00012	0.25	1.1	3 DELTA	1	NONE
*DB-1500-G-4	1.500	0.455	1.250	50	16	4.46	11.9	0.084	3.6	0.71	0.0049	2	6.27	3 WYE	7	NONE
DB-1840-A-1S	1.840	0.315	1.735	243	12.8	32	7.6	0.536	0.4	0.32	0.00048	1.8	12	3 WYE	14	HALL EFFECTS
DB-2475-A-1ES	2.475	0.751	0.750	60	25	1.76	34	0.24	14.2	5.5	0.0027	1.3	9.03	2 CT	8	NONE
DB-3950-A-1ES	3.950	3.000	0.375	42	100	0.273	154	1.09	365	25.3	0.0109	3	8.06	2	4.2	NONE
DB-4180-A-1ES	4.180	1.000	0.620	160	119	0.595	270	1.91	200	103	0.003	4.5	19.2	2	19.2	NONE
DB-4230-A-1ES-XX	4.230	1.500	0.950	400	59	4.6	87	0.615	12.8	9.5	0.0104	5	24.3	3 WYE	13.4	NONE
**DBB-5280-A-1S	5.280	1.740	1.610	954	90	4.5	212	1.5	20	17	0.034	6	47.4	3 WYE	39	NONE
DB-6680-A-1SC	6.680	3.705	1.020	1290	65	5	258	1.82	12.9	6.2	0.117	25	71.8	3 WYE	31	NONE
DB-9000-A-1ESC	9.000	4.000	2.542	6995	25	16.9	414	2.93	1.48	3.7	0.65	70	340	3WYE	298	HALL EFFECTS
DB-14200-A-1ES	14.200	9.600	2.000	7041	22	14.67	480	3.4	1.5	2	2.1	160	392	3 WYE	272	HALL EFFECTS
DB-16750-A-1ESC	16.750	10.000	2.980	21900	25	20	1095	7.75	1.25	3.4	18.5	300	979	3 WYE	760	HALL EFFECTS

*Outer member is the armature.

**This is a dual unit for redundancy purposes.

CT - Center Tap

XX - Denotes typical model number. Contact factory for assistance.

A Brushless DC torque motor is a motor which is electronically commutated and exhibits the linear speed torque characteristic of a conventional DC motor. The performance of the Brushless DC motor is dependent on the commutation of current in the motor windings, which is controlled by a separate electronic controller. Most controllers require some type of position feedback for proper operation. Common feedback devices are Hall Effect sensors, resolvers, and encoders. Moog Components Group offers all three types, and provides technical assistance in choosing the correct sensor for your application. We offer a wide variety of single and multi-speed resolvers including design to specification.

- Brushless designs (*no commutator and flex leads*) can be available in the above mechanical configurations.
- Brushless torque motors range from 1.250-16.750 inches O.D. and peak torques up to 21900 oz-in.

Toroidal Motors - Brushless	Toroidal Dimensions Max., (inches)			Excursion Angle (degrees)	Peak Torque, T _{pk} (oz-in)	Torque Sensitivity, K _t (oz-in/amp)	Back EMF, K _e (V/RAD/SEC)	Resistance, R _m (ohms) nom.	Inductance, L _m (millihenries) nom.	Input Voltage, V _p (volts)	Input Current, I _p (amps)	Motor Constant, K _M (oz-in/sq. ft.watts)	Friction Torque, T _f (oz-in)	Rotor Inertia, J _M (oz-in-sec ²)	Weight (oz)	Max Winding Temperature (degree C)	# of Poles
	UNIT TYPE	O.D.	I.D.	WIDTH													
TD-0600-A-1-XX	0.600	0.125	0.250	5	1	1.0	0.0072	8.25	0.634	12	1.5	.293	.06	.00000469	0.25	150	4
TD-0805-A-1	0.800	0.161	0.0350	42	1.25	1.02	0.0072	11.6	3.4	16	1.37	0.3	0.045	.00001	0.75	150	2
TD-1375-D-1	1.375	0.500	0.375	35	5.5	3.3	0.026	9.6	24	20.2	2	1.06	0.06	.00021	1.8	180	2
TD-1375-F-1	1.373	0.500	0.420	28	16.5	3.36	0.024	6	TBD	34	5.7	1.37	0.08	.00018	1.5	150	4
TD-1500-F-1SC	1.500	0.5005	0.500	+/-30	22	5.75	0.0406	5.75	2	27	4.25	2.40	0.35	.0020	2.5	150	4
TD-1750-C-1-XX	1.750	0.625	0.395	31	12	4	0.028	6.2	TBD	19	3	1.48	0.05	.00066	2.5	150	4
TD-1750-E-1-XX	1.750	0.250	0.700	60	7.5	2.5	0.017	3.4	1.8	9.0	2.5	1.35	0.3	.0019	5.0	150	2
TD-1900-A-1	1.900	0.312	1.260	35	18.0	6.28	0.044	3.2	2	10	3	0.61	0.5	.0034	10	120	2
TD-2250-A-1/K052	2.250	0.500	0.625	7.5	18.8	33	0.233	0.67	18	24	0.648	4.77	0.5	.0026	7.5	150	4
TD-2380-A-1S	2.380	1.107	0.450	+/-8	12.5	5	0.35	6.0	3.0	15	2.5	2.04	.35	.00178	3.5	150	4
TD-2500-F-1	2.500	0.625	0.500	60	18	5.9	0.0417	6.3	TBD	20	3.17	2.35	0.3	.0023	6.5	150	2
TD-3182-2S	3.182	0.8125	0.500	+/-6	20	22	.155	48	31.5	95	1.96	3.17	.20	.006	8.5	150	4
TD-3300-J-1SC	3.300	1.850	0.600	22.5	25	22	0.156	10.4	11.9	24	1.14	6.82	1	.0149	11	150	4
TD-3300-K-1-XX	3.300	1.850	1.250	22.5	65	26	0.184	3.8	TBD	12	3.16	13.34	1	.031	23.2	150	4
TD-4094-A-1-XX	4.094	0.500	0.889	15	144	48	0.338	5	2.6	28	3	21.5	0.75	.076	24	180	6
TD-4180-D-1	4.180	1.250	0.625	7	50	25	0.177	7	14	14	2	9.5	0.1	.025	16	150	6
TD-4580-B-2S/K059	4.57	1.75	1.135	+/-5	120	110	.777	11	15	17	1.55	33.17	6	.032	30.5	150	6
TD-4882-A-1-XX	4.882	1.102	0.924	15	350	52	0.368	5	11.5	34	6.73	23.3	0.75	.083	41.3	150	6
TD-4960-A-1	4.960	1.378	1.102	15	120	82	0.58	5.5	2.5	18	1.46	35	0.75	.119	24.00	150	6

- Brushless DC motor
- Rapid response, limited travel
- Constant torque sensitivity over the limited excursion angle.
- No commutation, eliminating electrical noise
- Slotless stator core ensures ripple free torque
- Rare earth magnets
- Windings are encapsulated for ruggedness
- Unhoused or housed
- Can be custom modified to meet specific requirements

Toroidal Tachometer Motors - Brushless	Dimensions Max., (inches)			Excursion Angle (degrees)		Ripple % Max.	Tachometer Sensitivity (V/RAD/SEC)	Resistance, R _M (ohms) nom.	Inductance, L _M (millihenries) nom.	Friction Torque, T _F (oz-in)	Rotor Inertia, J _M (oz-in-sec ²)	Weight (oz)	Max Winding Temperature (degree C)	# of Poles
	UNIT TYPE	O.D.	I.D.	WIDTH										
	TG-1000-A-1	1.00	.1875	.235	+/-7	0.5	.044	114	13.4	.35	.00034	2.0	150	4
	TG-1000-B-1	1.00	.125	.405	+/-35	0.5	.029	50	13	.25	.00029	.9	150	2
	TG-1073-A-1S	1.073	.280	1.19	+/-5	0.5	.110	60	5.50	.35	.000208	1.95	150	4

Design Considerations

All diameters listed have finished, ground lamination surfaces. They can be complemented with rings and hubs for mounting convenience.

Moog Components Group torque motors are normally delivered in kit form.

If you require integral bearings such as, a cartridge assembly containing a torquer motor and synchro, potentiometer or similar component, we can design the entire assembly to your mechanical dimensions and performance requirements.

Electrical Considerations

For each mechanical configuration shown, different winding designs to modify torque, torque sensitivity, DC resistance, and so on, can be supplied by Moog Components Group to suit your special system requirement. In each case, you have the option of selecting one of the existing designs or specifying a new winding designed to meet your special requirements. If your power source (voltage or current) is limited, the mathematical relationships shown to the right in Table 1 will allow you to calculate a particular performance characteristic at the voltage or power capability of your existing power supply.

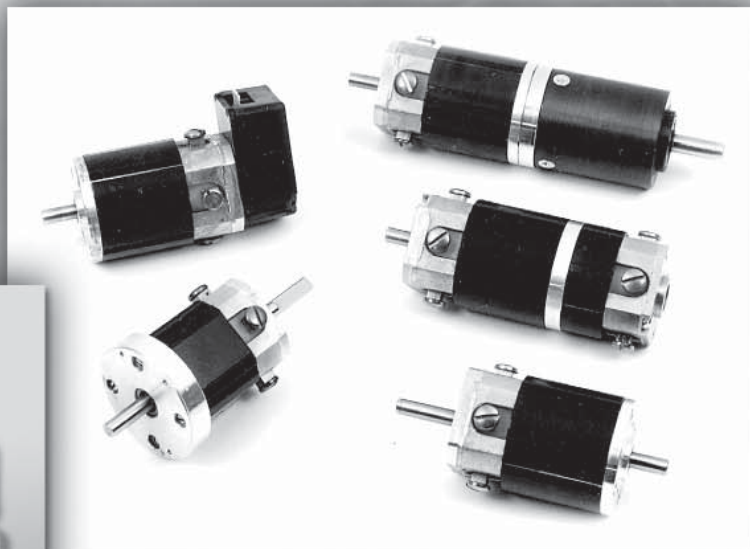
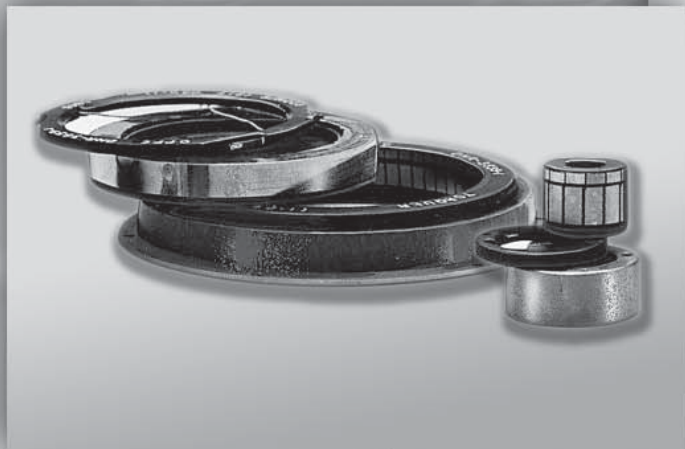
Mounting Considerations

Since torque motors are normally delivered in kit form, you provide the mounting surfaces and bearings. When you design the mechanics of the mount, be sure to observe these rules:

1. Eccentricities from the inner member mounting surface should not exceed 0.002 inches for Alnico designs and 0.004 for rare earth motor designs.
2. Surfaces in contact with the permanent magnet portion of the motor must be non-magnetic.
3. The bore of the mounting surface should be perpendicular to the mounting seat within 0.001 inch for Alnico designs and 0.002 for rare earth designs.

Table 1

PARAMETER	SYMBOL	UNITS	RELATIONSHIP TO PUBLISHED PARAMETER
Electrical Time Constant	τ_E	milliseconds	L_T / R_T
Mechanical Time Constant	τ_M	milliseconds	$\frac{J_M \cdot R_T}{K_E \cdot K_T}$
Power Input, Stalled At Peak Torque (25°C)	P_P	watts	$V_P \cdot I_P$
Viscous Damping Coefficients			
Zero Source Impedance	F_O	oz-in/rad/sec	$\frac{K_T \cdot K_E}{R_T}$
Infinite Source Impedance	F_I	oz-in/rad/sec	$T_F / 2\omega_{NL}$
¹ Motor Friction Torque (Actual)	T_F	oz-in	$K_T \cdot \text{starting current}$
Maximum Power Rate	P	oz-in/sec ²	T_{PK}^2 / J_M
Maximum Theoretical Acceleration	ω_M	rad/sec ²	T_{PK} / J_M
² Theoretical No Load Speed	ω_{NL}	rad/sec	V_P / K_E
¹ T_F is specified as a maximum value and includes brush friction, magnetic detent and test fixture bearing friction which is considered negligible. ² In cases where motor is to be operated at some voltage less than V_P due to power supply limitations the new ω_{NL} becomes V_A / K_E where V_A = voltage applied.			



TYPICAL APPLICATIONS

- Robotics
- Factory automation
- Medical equipment
- Computer peripherals and office equipment
- Portable, battery-operated equipment
- Textile machinery
- Packaging machinery
- Actuators

FEATURES

- Long-life, replaceable metal graphite brushes
- Stainless steel shafts, 0.125 and 0.187 inch diameters, single and double extensions
- Permanently lubricated ball bearings, ABEC 5 standard
- Polyester resin impregnated insulated windings for reliable high speed and high voltage operation
- Rare earth magnets for high power density
- Diamond turned commutator for quiet operation and long brush life
- 13 bar commutator for superior servo performance
- High torque in a "small package" size
- Low noise and backlash

BENEFITS

- High torque-to-inertia ratio
- Up to 1274 oz-in peak starting torque
- Highly resistant to demagnetization
- Weighs only 6.8 oz
- High energy/high power in small packages

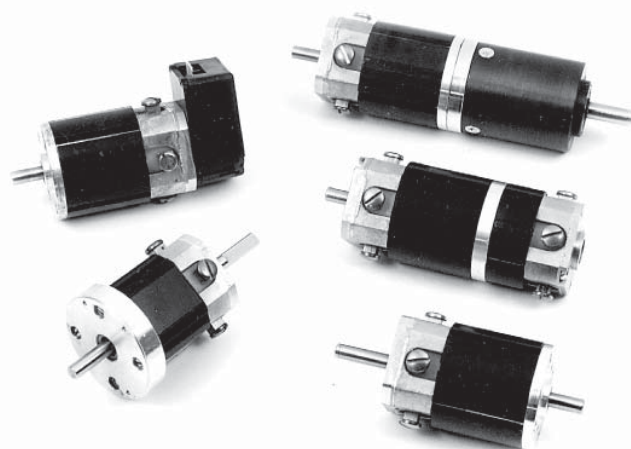
OPTIONS AVAILABLE

- Custom endcaps and mounting configurations are available
- Skewed rotors available for minimum cogging torque
- Encoder and tachometer packages
- Custom shaft and end cap configurations

† Previously the AS-780D Series

Miniature High-Torque, DC Servomotors and DC Gearmotors

Series C13 Samarium Cobalt[†]



Available with integrated tachometers or encoders for closed-loop control

The series C13 high energy rare earth servomotors provide fast response and high starting torque, but are priced significantly less than comparable rare earth motors. They offer high coercivity and high flux density for greater mechanical output.

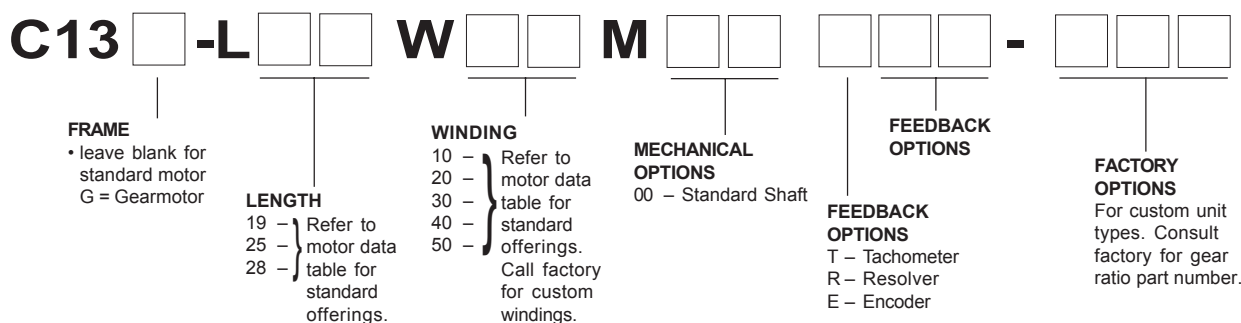
Permanent magnet DC rare earth motors are lightweight, yet are highly reliable. They will not demagnetize under severe conditions.

A series of high precision gearmotors is obtained by matching high precision planetary gearheads with the C13 rare earth motors. We offers a wide range of output torque and speed options with standard and custom gear ratios.

Custom-modified shaft designs, mounting configurations, speed variations, and various DC input voltages are available. Consult our engineering department to help you develop a motor that is tailored to your application.

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



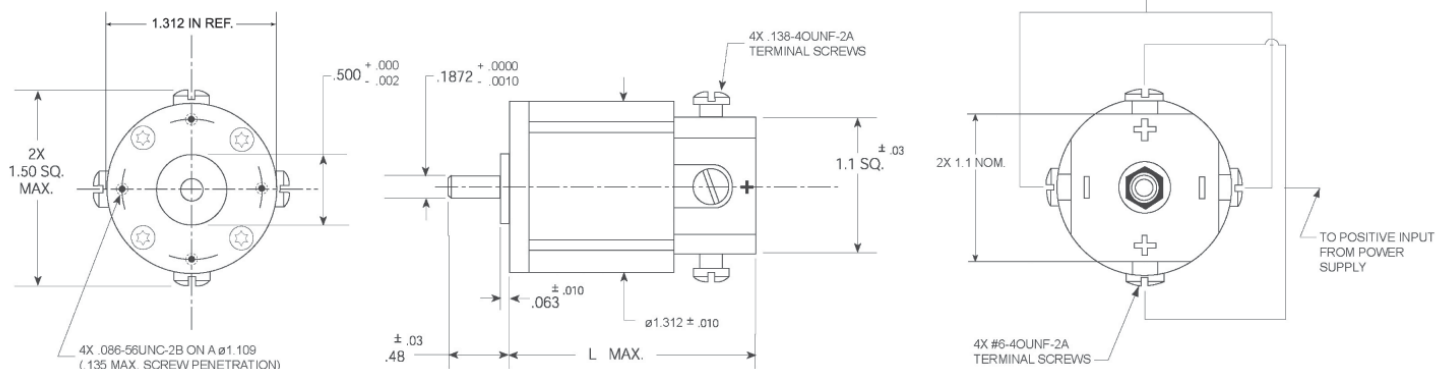
C13 SERIES SPECIFICATIONS – Continuous Stall Torque 7.5 - 13.0 oz-in (0.053 - 0.092 Nm) Peak Torque 50 - 100 oz-in (0.353 - 0.706 Nm)

Part Number*		C13-L19-					C13-L25-	C13-L28-	
Winding Code**		10	20	30	40	50	10	10	20
L = Length	inches	1.902					2.45	2.802	
	millimeters	48.3					62.2	71.2	
Peak Torque	oz-in	50	50	50	50	50	75	100	100
	N m	0.353	0.353	0.353	0.353	0.353	0.530	0.706	0.706
Continuous Stall Torque	oz-in	7.5	7.5	7.5	7.5	7.5	10.0	13.0	13.0
	N m	0.053	0.053	0.053	0.053	0.053	0.071	0.092	0.092
Rated Terminal Voltage	volts DC	6 - 18	6 - 24	6 - 24	12 - 36	12 - 48	12 - 24	6 - 24	12 - 36
Terminal Voltage	volts DC	12	12	24	36	48	12	12	24
Rated Speed	RPM	3000	1880	2875	2225	2877	2400	1643	2439
	rad/sec	314	197	301	233	301	251	172	255
Rated Torque	oz-in	5.8	6.9	6.4	6.7	7.5	10.3	14	12.3
	N m	0.04	0.05	0.05	0.05	0.05	0.07	0.10	0.09
Rated Current	Amps	2.05	1.8	1.4	0.95	1.4	1.95	3.5	2
Rated Power	Watts	12.9	9.6	13.6	11.0	16.0	18.0	17.0	22.2
	Horsepower	0.02	0.01	0.02	0.01	0.02	0.09	0.02	0.03
Torque Sensitivity	oz-in/amp	3.42	4.35	5.45	8.1	10.25	6.04	4.6	7.85
	Nm/amp	0.0242	0.0307	0.0385	0.0572	0.0724	0.0427	0.0325	0.0554
Back EMF	volts/KRPM	2.53	3.21	4.03	5.99	7.57	4.47	3.4	5.81
	volts/rad/sec	0.0242	0.0307	0.0385	0.0572	0.0723	0.0427	0.0325	0.0555
Terminal Resistance	ohms	1.55	2.30	3.35	7.90	12.00	2.64	1.30	3.70
Terminal Inductance	m H	0.52	0.84	1.30	3.00	4.80	0.71	0.90	2.60
Motor Constant	oz-in/watt ^{1/2}	2.7	2.9	3.0	2.9	3.0	3.7	4.0	4.1
	Nm/watt	0.019	0.020	0.021	0.020	0.021	0.026	0.028	0.029
Rotor Inertia	oz-in-sec ²	.00026	.00026	.00026	.00026	.00026	0.004	.00043	.00043
	g-cm ²	18.4	18.4	18.4	18.4	18.4	282.5	30.4	30.4
Friction Torque	oz-in	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00
	N m	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Thermal Resistance	°C/watt	11.0	11.0	11.0	11.0	11.0	7.8	5.5	5.5
Damping Factor	oz-in/KRPM	0.1	0.1	0.1	0.1	0.1	0.1	0.57	0.57
	Nm/KRPM	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004
Weight	oz	6.8	6.8	6.8	6.8	6.8	9	11.2	11.2
	g	193	193	193	193	193	255	318	318
Electrical Time Constant	millisecond	0.3355	0.3652	0.3881	0.3797	0.4000	0.2689	0.6923	0.7027
*Mech. Time Constant	millisecond	4.8764649	4.483876	4.152057	4.432363	4.209995	40.95115	3.742155	3.652339
Speed/Torque Gradient	rpm/oz-in	-179.1369	-164.715	-152.526	-162.8228	-154.654	-97.7821	-83.1202	-81.1252

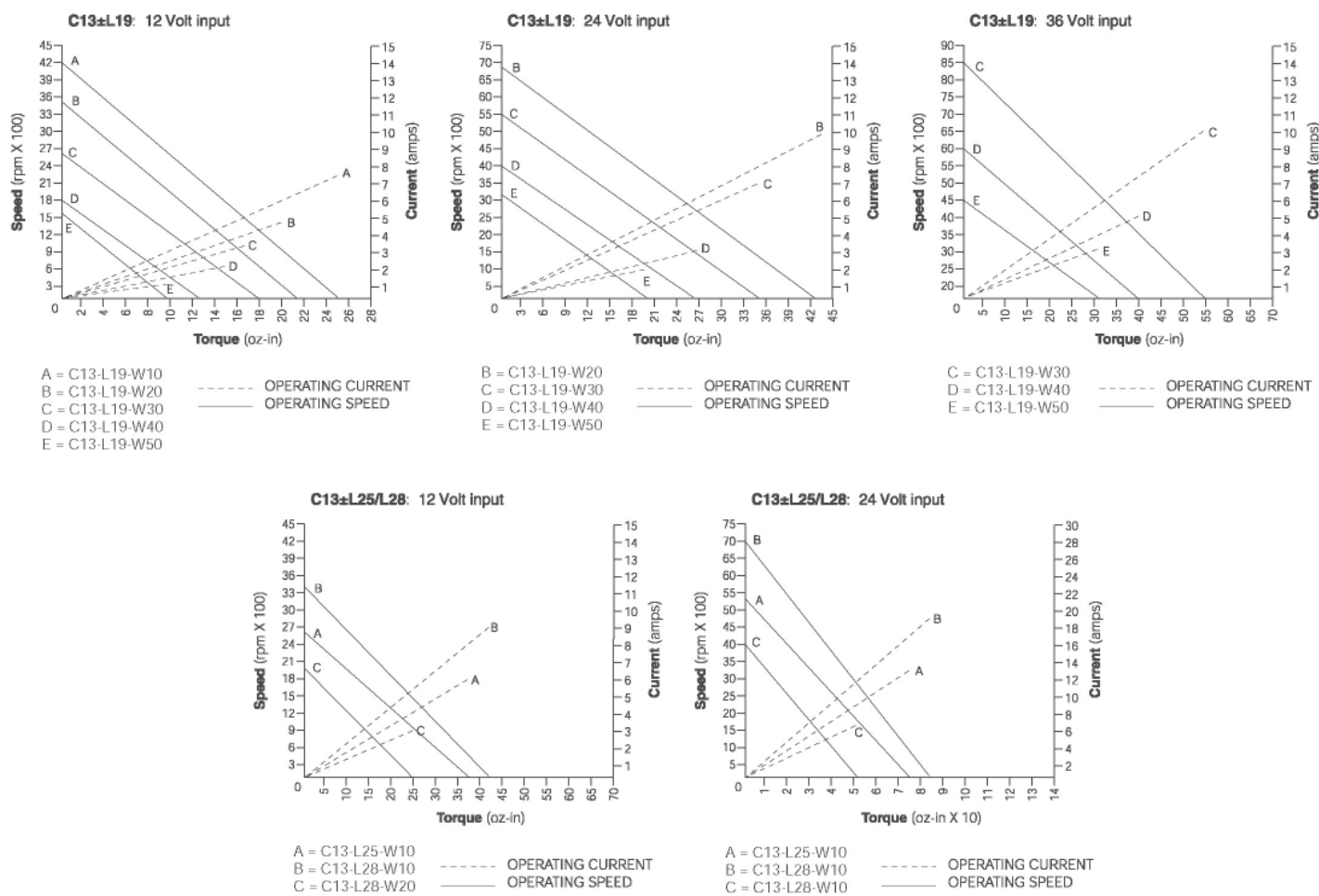
IMPORTANT

Typical performance characteristics at 25°C. The operational life of any motor is dependent upon individual operating parameters, environment, temperature, and other factors. Your specific application results may vary. Please consult the factory to discuss your requirements.

Typical Outline Drawing



Torque/Speed Curves



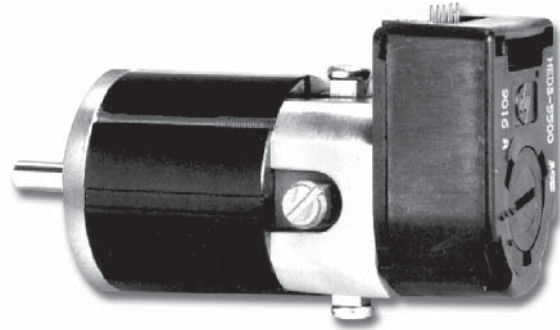
INTEGRAL FEEDBACK DEVICES FOR CLOSED-LOOP CONTROL

All feedback devices are pre-assembled, aligned and fully tested, with output requirements matched (even custom designed) to your application. They are ideal for sensing rotary speed and angular position where space is a premium and low inertia is required.

Encoders

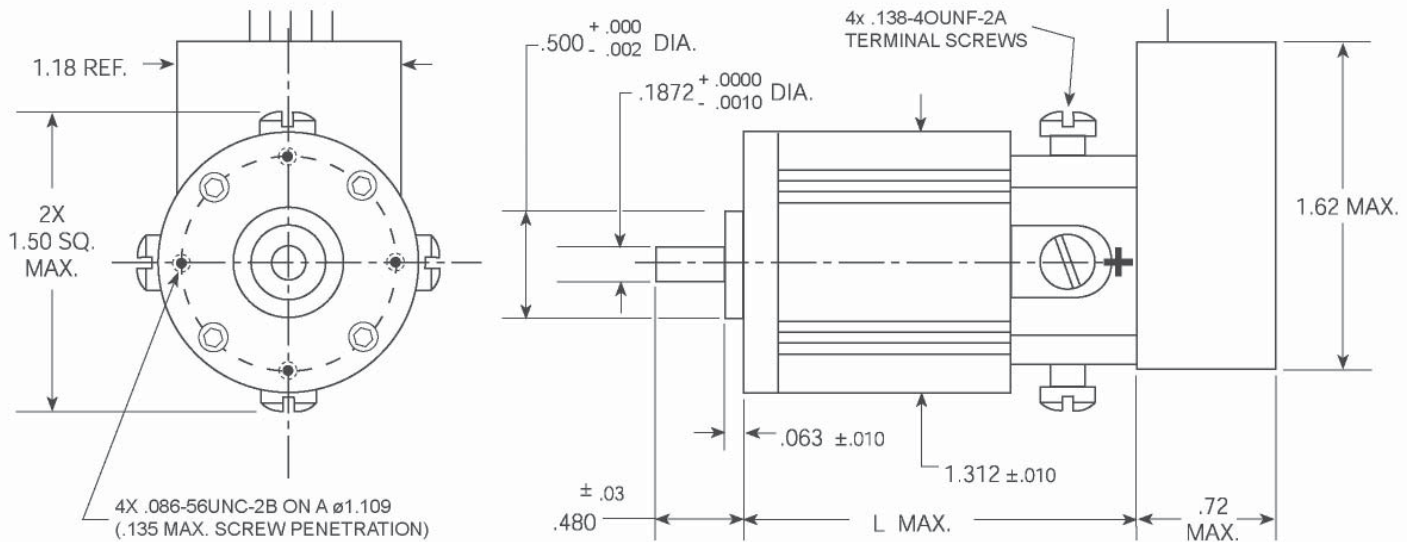
High resolution, high reliability, and state-of-the-art technology in a small package.

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL/CMOS compatible
- Other configurations and resolutions available



Reproduced with permission of Hewlett-Packard Company.

Typical Outline Drawing



C13G Series – DC Gearmotors – 27 - 637 oz - in

Our gearboxes are assembled in a modular configuration from one, two or three planetary gear stages connected in series.

All planetary gearboxes conform to protection class IP 44. The output shaft ball bearings are protected by sealing washers, the input side is sealed from the motor as well.

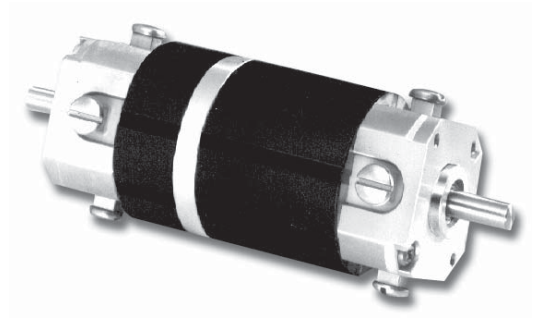
FEATURES

- Coaxial input and output
- Small size
- High tooth efficiency
- Small rotating mass
- Power distributed among several planet gears
- Low noise and backlash
- Reduction ratios from 4:1 to 308:1 in standard range. Other ratios available, please consult factory.

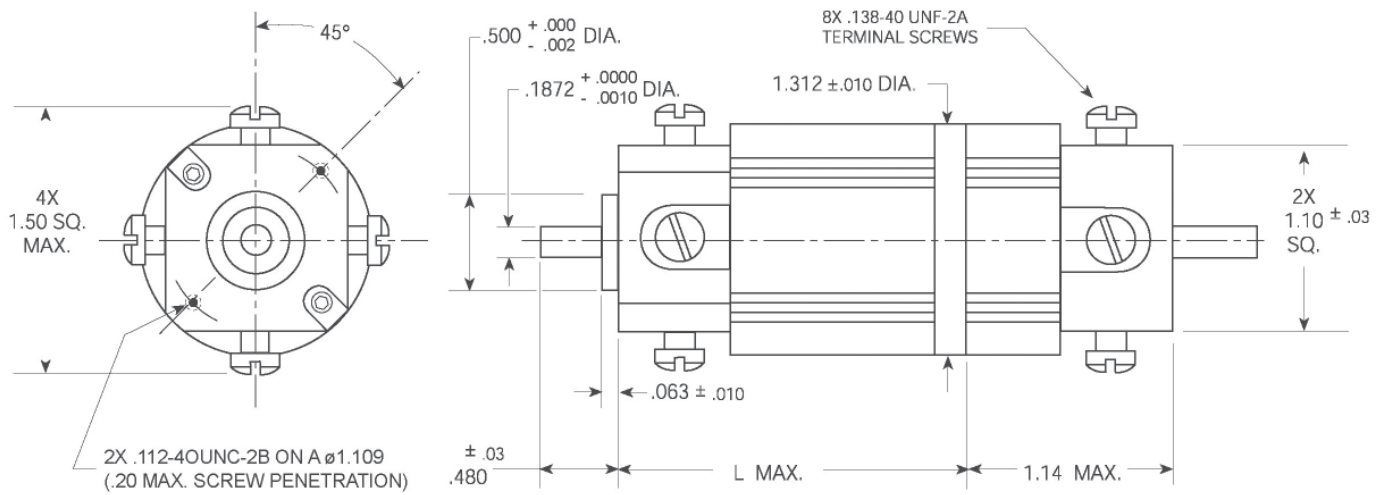
Tachometers

Analog tachometers are an economical and efficient choice for applications requiring velocity feedback. These tachometers are integral to the motor on a common shaft, eliminating coupling or mounting irregularities.

- Voltage gradient: 2 V / Krpm
- Ripple voltage: 20% max peak to peak



Typical Outline Drawing



Permanent Magnet DC Motors

TYPICAL APPLICATIONS

Robotics and factory automation

- Pick-and-place robots
- Positioning tables
- Welding wire feeders
- Automatic guided vehicles
- Barcoding equipment

Computer and office equipment

- Copier and microfilm machines
- Printers / plotters
- Tape drives

Industrial equipment

- Automatic door actuators
- Material handling equipment
- Packaging, marking and sorting equipment
- Machine tools
- Web drives
- Gimbal controlled cameras for security systems
- Antenna drives

Medical equipment

- Electric wheelchairs and scooters
- Bio-analytical equipment
- Medical pumps
- Centrifuges

FEATURES

- Long-life, externally replaceable brushes; various grade materials available for high/low voltage applications
- Superior protection provided by totally enclosed, high strength, zinc-plated steel housing
- Shaft configuration optional
- Machined aluminum end-cap for precise locating; round or square. Precision-tapped mounting holes provided to your specifications
- Silicon steel laminations
- Diamond turned commutator for quiet operation and long brush life
- Skewed rotors available for minimal cogging torque
- Rotors are dynamically balanced to ISO G2.5
- Available with standard NEMA mountings
- Polyester resin impregnated insulated windings
- Double-shielded, permanently lubricated ball bearings, ABEC 5 standard; others optional

BENEFITS

- Optional pre-aligned encoders provide accurate positioning
- Tachometers are available - 7, 10, 14 V/KRPM
- These motors offer continuous torques from 16.5 to 560 oz-in, peak torques from 125 to 3500 oz-in
- Motor lengths from 3.33 to 9.0 inches
- Permanently lubricated bearings
- Available with carbon steel or stainless steel shafts; single or double ended extensions
- Custom shaft and end cap configurations are also available

C23, 34, 42 Series 2.25" to 4.0" Diameter



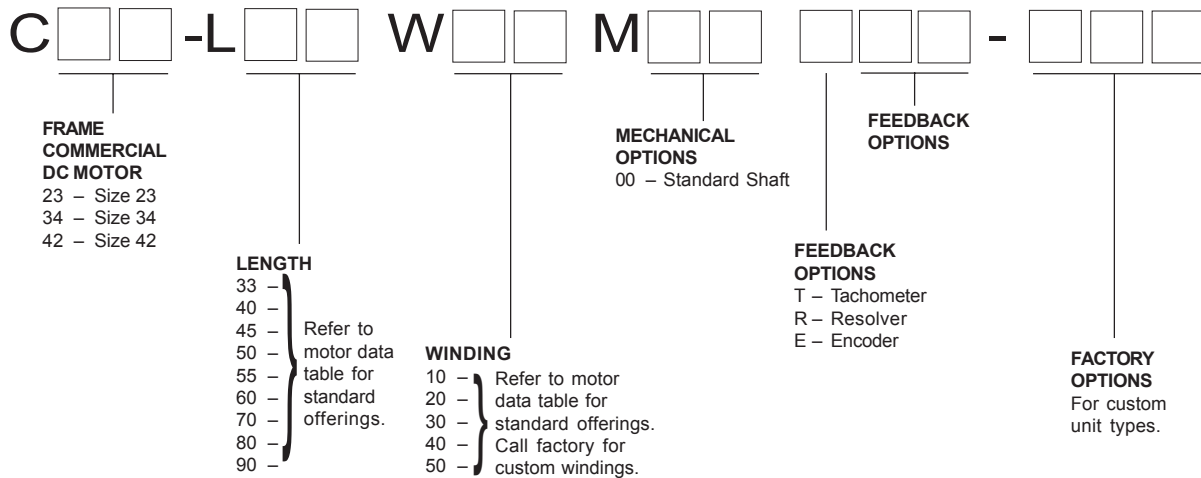
Available with integrated tachometers, resolvers and encoders for closed-loop control

Moog Components Group offers a complete line of 2.25" to 4" diameter permanent magnet motors. Integrated feedback devices (i.e. tachometers and encoders) are available for closed-loop control.

We offer a variety of standard sizes. If mechanical modifications are needed custom options are available for your specific application. Our engineering department is prepared to discuss your application to help tailor a permanent magnet motor to fit your needs.

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System



C23 SERIES SPECIFICATIONS – Continuous Stall Torque 16.5 - 27 oz-in (0.117 - 0.191 Nm) Peak Torque 125 - 250 oz-in (0.883 - 1.765 Nm)

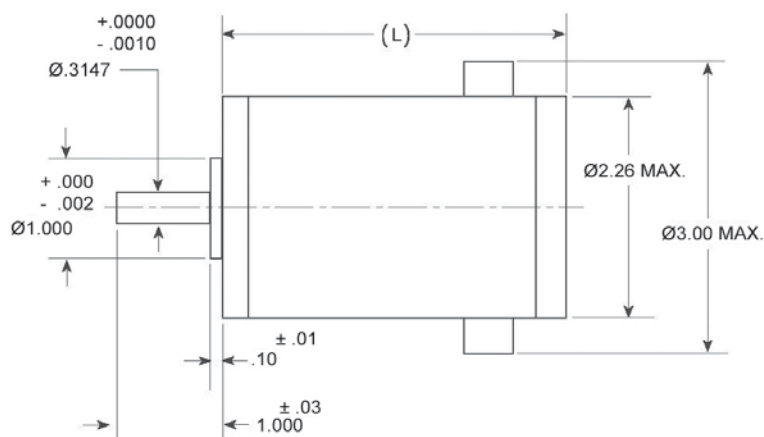
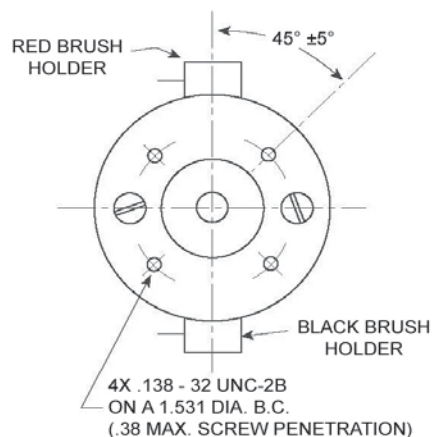
Part Number*		C23-L33					C23-L40				
Winding Code**		10	20	30	40	50	10	20	30	40	50
L = Length	inches	3.33					4				
	millimeters	84.6					101.6				
Peak Torque	oz-in	125.0	125.0	125.0	125.0	125.0	250.0	250.0	250.0	250.0	250.0
	Nm	0.883	0.883	0.883	0.883	0.883	1.765	1.765	1.765	1.765	1.765
Continuous Stall Torque	oz-in	16.5	16.5	16.5	16.5	16.5	27.0	27.0	27.0	27.0	27.0
	Nm	0.117	0.117	0.117	0.117	0.117	0.191	0.191	0.191	0.191	0.191
Rated Terminal Voltage	volts DC	12 - 24	12 - 24	12 - 36	12 - 60	12 - 60	12 - 24	12 - 48	12 - 60	12 - 60	12 - 60
Terminal Voltage	volts DC	12	12	24	36	48	12	24	36	48	60
Rated Speed	RPM	4700	2150	4200	3750	3000	2300	3600	3500	2850	2250
	rad/sec	492	225	440	393	314	241	377	367	298	236
Rated Torque	oz-in	7.5	12.6	12.7	14.4	15.8	17.3	25.5	25.3	25.6	24.2
	Nm	0.05	0.09	0.09	0.10	0.11	0.12	0.18	0.18	0.18	0.17
Rated Current	Amps	4.75	4.3	3	2	1.4	4.9	4.3	2.75	1.8	1.1
Rated Power	Watts	26.1	20.0	39.5	40.0	35.1	29.4	67.9	65.5	54.0	40.3
	Horsepower	0.03	0.03	0.05	0.05	0.05	0.04	0.09	0.09	0.07	0.05
Torque Sensitivity	oz-in/amp	2.65	4.25	6.2	10.25	15.75	4.84	7.74	12	18.5	28.75
	Nm/amp	0.0187	0.0300	0.0438	0.0724	0.1112	0.0342	0.0547	0.0847	0.1306	0.2030
Back EMF	volts/KRPM	2	3.15	4.6	7.6	11.5	3.58	5.72	8.82	13.82	21.22
	volts/rad/sec	0.0191	0.0301	0.0439	0.0726	0.1098	0.0342	0.0546	0.0842	0.1320	0.2026
Terminal Resistance	ohms	0.60	1.00	1.70	4.00	9.00	0.70	0.96	2.30	5.50	12.00
Terminal Inductance	mH	0.35	0.94	2.00	5.50	13.00	0.50	1.30	3.10	7.36	18.00
Motor Constant	oz-in/watt ^{1/2}	3.4	4.3	4.8	5.1	5.3	5.8	7.9	7.9	7.9	8.3
	Nm/watt	0.024	0.030	0.034	0.036	0.037	0.041	0.056	0.056	0.056	0.059
Rotor Inertia	oz-in-sec ²	0.0022	0.0022	0.0022	0.0022	0.0022	0.004	0.004	0.004	0.004	0.004
	g-cm ²	155.4	155.4	155.4	155.4	155.4	282.5	282.5	282.5	282.5	282.5
Friction Torque	oz-in	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Nm	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Thermal Resistance	°C/watt	6.2	6.2	6.2	6.2	6.2	5.4	5.4	5.4	5.4	5.4
Damping Factor	oz-in/KRPM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Nm/KRPM	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Weight	oz	27	27	27	27	27	38	38	38	38	38
	g	765	765	765	765	765	1077	1077	1077	1077	1077
Electrical Time Constant	millisecond	0.5833	0.9400	1.1765	1.3750	1.4444	0.7143	1.3584	1.3478	1.3382	1.5000
Mech. Time Constant	millisecond	26.07623	17.2056	13.72994	11.82747	11.44547	16.91906	9.052773	9.100907	9.00927	8.237676
Speed/Torque Gradient	rpm/oz-in	-113.2075	-74.69655	-59.60729	-51.34788	-49.68944	-40.39891	-21.61598	-21.73091	-21.51211	-19.66971

C23 SERIES SPECIFICATIONS –

Continuous Stall Torque 34 - 50 oz-in (0.240 - 0.353 Nm)
Peak Torque 310 - 430 oz-in (2.189 - 3.037 Nm)

Part Number*		C23-L45					C23-L50					C23-L55				
Winding Code**		10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
L = Length	inches	4.5					5					5.45				
	millimeters	114.3					127.0					138.4				
Peak Torque	oz-in	310.0	310.0	310.0	310.0	310.0	360.0	360.0	360.0	360.0	360.0	430.0	430.0	430.0	430.0	430.0
	Nm	2.189	2.189	2.189	2.189	2.189	2.542	2.542	2.542	2.542	2.542	3.037	3.037	3.037	3.037	3.037
Continuous Stall Torque	oz-in	34.0	34.0	34.0	34.0	34.0	42.0	42.0	42.0	42.0	42.0	50.0	50.0	50.0	50.0	50.0
	Nm	0.240	0.240	0.240	0.240	0.240	0.297	0.297	0.297	0.297	0.297	0.353	0.353	0.353	0.353	0.353
Rated Terminal Voltage	volts DC	12 - 24	12 - 48	12 - 60	12 - 60	12 - 60	12 - 24	12 - 60	12 - 60	18 - 60	24 - 60	12 - 24	12 - 60	12 - 60	18 - 60	24 - 60
Terminal Voltage	volts DC	12	24	36	48	60	12	24	36	48	60	12	24	36	48	60
Rated Speed	RPM	1950	2600	2600	2100	1555	1600	2150	2150	1800	1283	1350	1800	1700	1300	887
	rad/sec	204	272	272	220	163	168	225	225	188	134	141	188	178	136	93
Rated Torque	oz-in	25.3	26.5	25.8	23.3	23	27.1	30.1	32	31.5	34.3	36.4	39.3	40.5	40.9	43.5
	Nm	0.18	0.19	0.18	0.16	0.16	0.19	0.21	0.23	0.22	0.24	0.26	0.28	0.29	0.29	0.31
Rated Current	Amps	5.8	3.75	2.4	1.4	0.95	5.1	3.5	2.4	1.5	1.05	5.6	3.75	2.5	1.6	1.1
Rated Power	Watts	36.5	51.0	49.6	36.2	26.5	32.1	47.9	50.9	42.0	32.6	36.4	52.3	50.9	39.3	28.6
	Horsepower	0.05	0.07	0.07	0.05	0.04	0.04	0.06	0.07	0.06	0.04	0.05	0.07	0.07	0.05	0.04
Torque Sensivity	oz-in/amp	6.06	9.75	14.9	23.5	36	7.32	11.7	18	28.3	43.4	8.78	14.04	21.6	34	52.1
	Nm/amp	0.0428	0.0689	0.1052	0.1659	0.2542	0.0517	0.0826	0.1271	0.1998	0.3065	0.0620	0.0991	0.1525	0.2401	0.3679
Back EMF	volts/KRPM	4.5	7.2	11	17.25	26.5	5.41	8.65	13.3	20.9	32	6.49	10.38	16	25.14	38.5
	volts/rad/sec	0.0430	0.0688	0.1050	0.1647	0.2531	0.0517	0.0826	0.1270	0.1996	0.3056	0.0620	0.0991	0.1528	0.2401	0.3676
Terminal Resistance	ohms	0.54	1.40	3.27	8.13	19.0	0.63	1.60	3.20	7.00	16.50	0.56	1.43	3.39	8.40	19.10
Terminal Inductance	mH	0.72	1.75	4.26	10.24	24.20	0.77	1.96	4.66	11.44	27.00	0.97	2.38	5.50	13.73	32.28
Motor Constant	oz-in/watt ^{1/2}	8.2	8.2	8.2	8.2	8.2	9.3	9.2	10.1	10.7	10.7	11.7	11.7	11.7	11.7	11.7
	Nm/watt	0.058	0.058	0.058	0.058	0.058	0.065	0.065	0.071	0.076	0.075	0.083	0.083	0.083	0.083	0.083
Rotor Inertia	oz-in-sec ²	0.0052	0.0052	0.0052	0.0052	0.0052	0.0065	0.0065	0.0065	0.0065	0.0065	0.0078	0.0078	0.0078	0.0078	0.0078
	g-cm ²	367.2	367.2	367.2	367.2	367.2	459.0	459.0	459.0	459.0	459.0	550.8	550.8	550.8	550.8	550.8
Friction Torque	oz-in	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6
	Nm	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Thermal Resistance	°C/watt	4.7	4.7	4.7	4.7	4.7	4.3	4.3	4.3	4.3	4.3	3.9	3.9	3.9	3.9	3.9
Damping Factor	oz-in/KRPM	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
	Nm/KRPM	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002
Weight	oz	46	46	46	46	46	56	56	56	56	56	65	65	65	65	65
	g	1304	1304	1304	1304	1304	1588	1588	1588	1588	1588	1843	1843	1843	1843	1843
Electrical Time Constant	millisecond	1.3309	1.2500	1.3028	1.2595	1.2670	1.2300	1.2250	1.4563	1.6343	1.6364	1.7321	1.6643	1.6224	1.6345	1.6386
Mech. Time Constant	millisecond	10.80095	10.85778	10.86223	10.91902	10.90021	10.75786	10.75915	9.096742	8.054255	8.085451	8.025833	8.013327	8.010641	8.025579	8.020641
Speed/Torque Gradient	rpm/oz-in	-19.83865	-19.94302	-19.95119	-20.0555	-20.02096	-15.8076	-15.8095	-13.36675	-11.83492	-11.88076	-9.82763	-9.812617	-9.809028	-9.82732	-9.821273

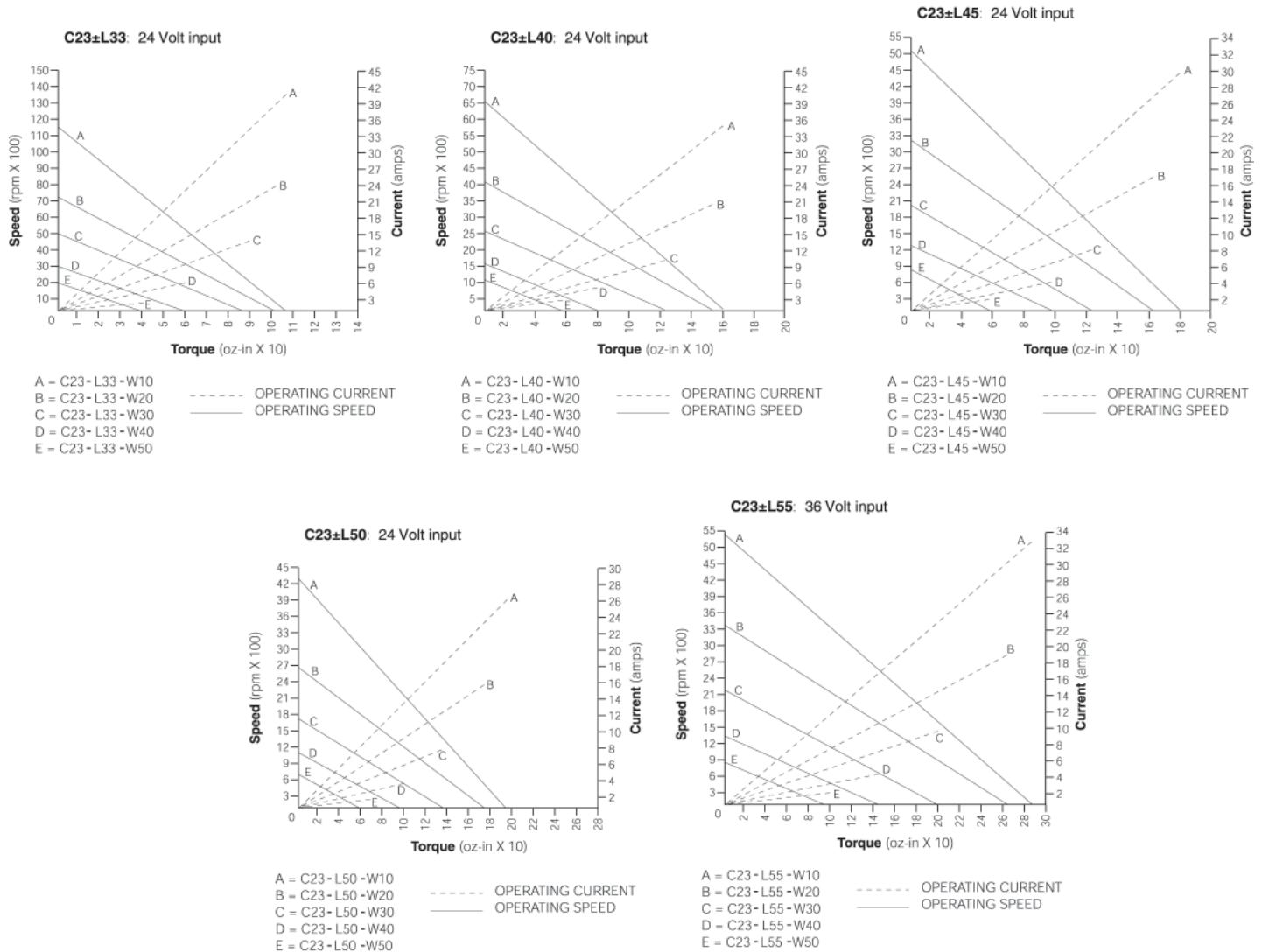
C23 Typical Outline Drawing



IMPORTANT

Typical performance characteristics at 25°C. The operational life of any motor is dependent upon individual operating parameters, environment, temperature, and other factors. Your specific application results may vary. Please consult the factory to discuss your requirements.

C23 Torque/Speed Curves



• Skewed Armatures standard on C13 series - available on all other series upon request.

Note:

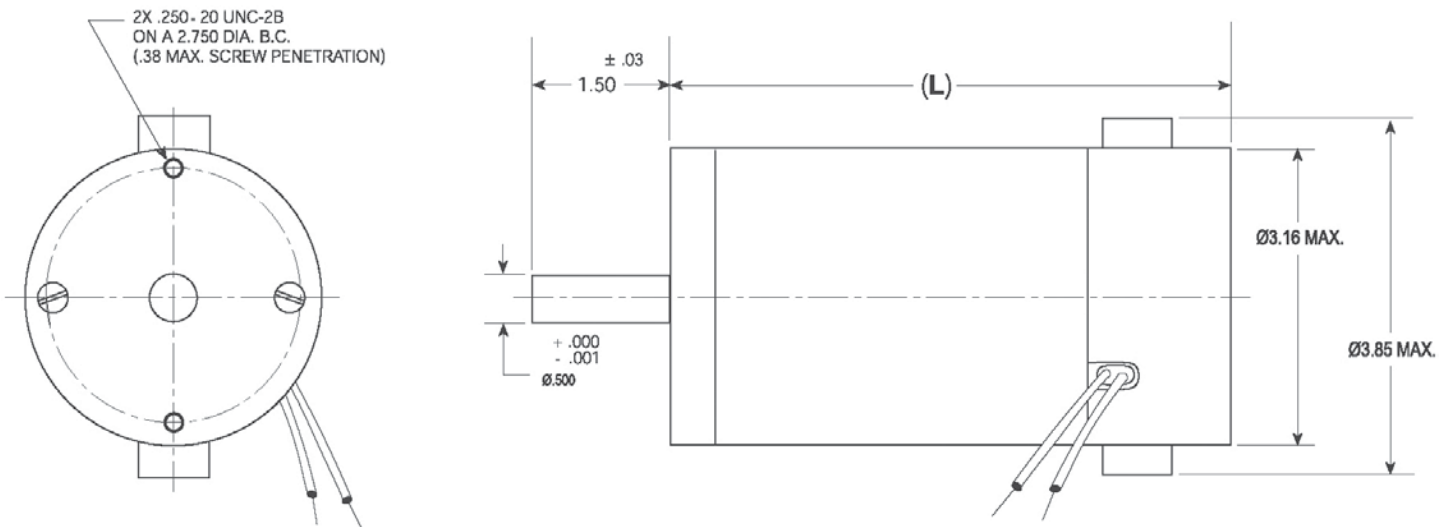
A skewed armature is one in which the laminations do not line up, but rather are on a skew for the length of the armature stack. There are some distinct advantages to a motor utilizing a skewed armature, the greatest being a REDUCTION OF COGGING.

C34 SERIES SPECIFICATIONS –

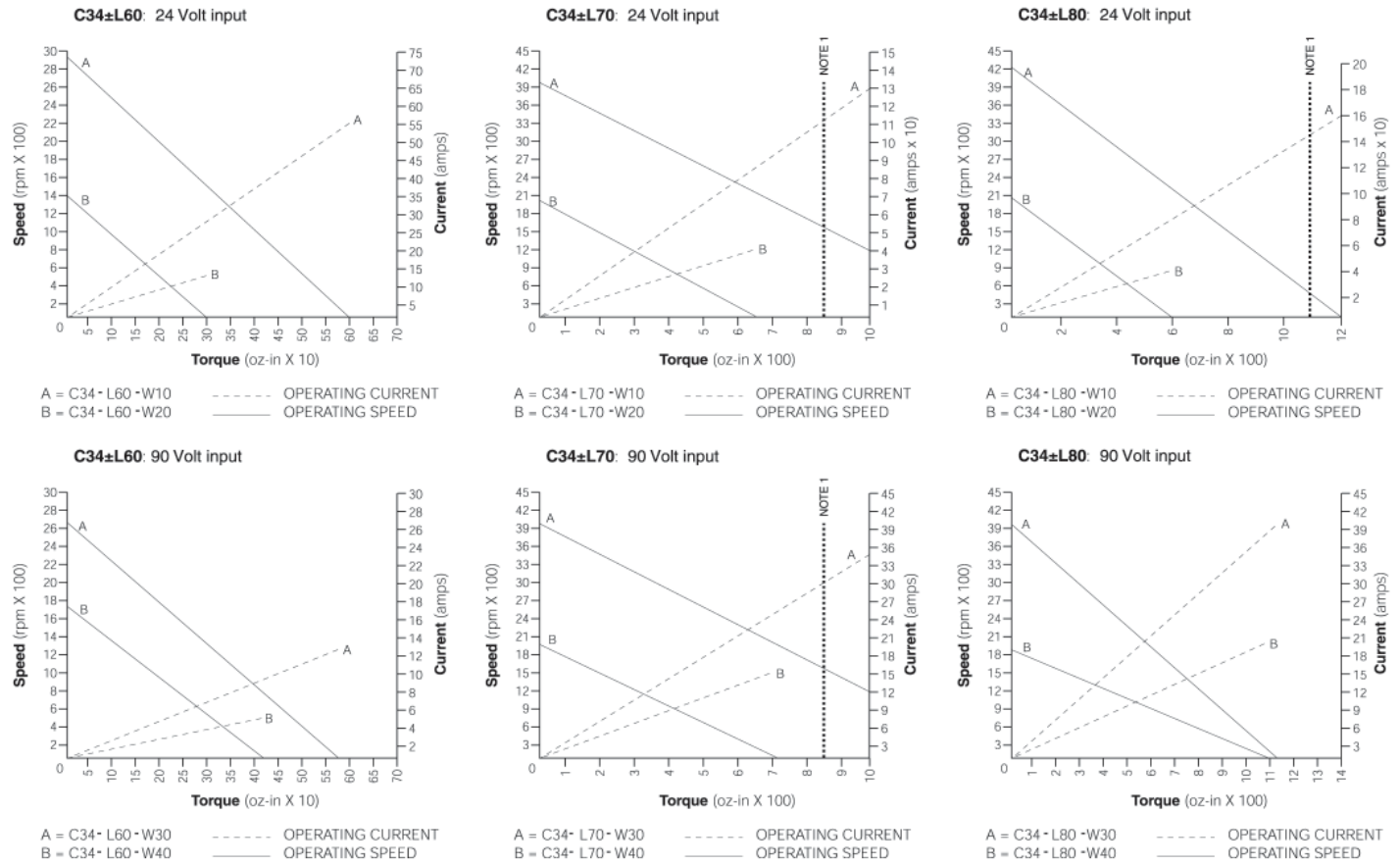
Continuous Stall Torque 63 - 125 oz-in (0.445 - 0.883 Nm)
Peak Torque 580 - 1110 oz-in (4.096 - 7.838 Nm)

Part Number*		C34-L60				C34-L70				C34-L80			
Winding Code**		10	20	30	40	10	20	30	40	10	20	30	40
L = Length	inches	6.00				7.00				8.00			
	millimeters	152.40				177.80				203.20			
Peak Torque	oz-in	580.0	580.0	580.0	580.0	855.0	855.0	855.0	855.0	1110.0	1110.0	1110.0	1110.0
	Nm	4.096	4.096	4.096	4.096	6.038	6.038	6.038	6.038	7.838	7.838	7.838	7.838
Continuous Stall Torque	oz-in	63.0	63.0	63.0	63.0	95.0	95.0	95.0	95.0	125.0	125.0	125.0	125.0
	Nm	0.445	0.445	0.445	0.445	0.671	0.671	0.671	0.671	0.883	0.883	0.883	0.883
Rated Terminal Voltage	volts DC	12 - 30	12 - 48	18 - 60	30 - 72	12 - 30	12 - 48	18 - 78	30 - 120	12 - 30	12 - 48	18 - 90	30 - 132
Terminal Voltage	volts DC	24	36	60	72	24	36	48	72	12	24	48	72
Rated Speed	RPM	2700	1900	1447	952	4450	2720	1800	1313	1800	1750	1847	1424
	rad/sec	282.74	198.97	151.53	99.69	466.00	284.84	188.50	137.50	188.50	183.26	193.42	149.12
Rated Torque	oz-in	60.7	55.1	63.9	76.1	75.0	110.0	85.0	96.1	81.7	94.9	80.4	115.0
	Nm	0.43	0.39	0.45	0.54	0.53	0.78	0.60	0.68	0.58	0.67	0.57	0.81
Rated Current	Amps	8.20	3.70	2.05	1.55	13.00	7.00	3.75	2.15	15.00	8.50	3.70	2.50
Rated Power	Watts	121.3	77.5	68.4	53.6	247.0	221.4	113.2	93.4	108.8	122.9	109.9	121.2
	Horsepower	0.16	0.10	0.09	0.07	0.33	0.30	0.15	0.13	0.15	0.16	0.15	0.16
Torque Sensitivity	oz-in/amp	10.90	21.80	43.60	68.00	7.79	15.58	31.20	59.00	7.50	15.00	30.00	60.00
	Nm/amp	0.08	0.15	0.31	0.48	0.06	0.11	0.22	0.42	0.05	0.11	0.21	0.42
Back EMF	volts/KRPM	8.00	16.10	32.20	50.30	5.76	11.50	23.00	43.60	5.50	11.00	22.00	44.40
	volts/rad/sec	0.08	0.15	0.31	0.48	0.06	0.11	0.22	0.42	0.05	0.11	0.21	0.42
Terminal Resistance	ohms	0.43	1.72	6.80	14.50	0.14	0.56	2.24	7.40	0.15	0.60	2.40	4.90
Terminal Inductance	mH	0.90	4.80	18.00	35.00	0.24	1.12	4.50	14.50	0.18	0.72	3.10	11.20
Motor Constant	oz-in/watt ^{1/2}	16.62	16.62	16.72	17.86	20.82	20.82	20.85	21.69	19.36	19.36	19.36	27.11
	Nm/watt	0.12	0.12	0.12	0.13	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.19
Rotor Inertia	oz-in-sec ²	0.030	0.030	0.030	0.030	0.042	0.042	0.042	0.042	0.055	0.055	0.055	0.055
	g-cm ²	2118.45	2118.45	2118.45	2118.45	2965.83	2965.83	2965.83	2965.83	3883.83	3883.83	3883.83	3883.83
Friction Torque	oz-in	15	15	15	15	17	17	17	17	20	20	20	20
	Nm	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.14	0.14	0.14	0.14
Thermal Resistance	°C/watt	3.90	3.90	3.90	3.90	3.70	3.70	3.70	3.70	3.50	3.50	3.50	3.50
Damping Factor	oz-in/KRPM	2.50	2.50	2.50	2.50	3.00	3.00	3.00	3.00	3.80	3.80	3.80	3.80
	Nm/KRPM	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Weight	oz	100.00	100.00	100.00	100.00	128.00	128.00	128.00	128.00	152.00	152.00	152.00	152.00
	g	2834.95	2834.95	2834.95	2834.95	3628.74	3628.74	3628.74	3628.74	4309.12	4309.12	4309.12	4309.12
Electrical Time Constant	millisecond	2.0930	2.7907	2.6471	2.4138	1.7143	2.0000	2.0089	1.9595	1.2000	1.2000	1.2917	2.2857
Mech. Time Constant	millisecond	15.48888	15.39267	15.21369	13.31555	13.72031	13.74418	13.72656	12.64996	20.94	20.94	20.94	10.59184
Speed/Torque Gradient	rpm/oz-in	-4.931193	-4.900564	-4.843581	-4.23927	-3.120097	-3.125523	-3.121516	-2.876691	-3.636364	-3.636364	-3.636364	-1.839339

C34 Typical Outline Drawing



C34 Torque/Speed Curves



- Skewed Armatures standard on C13 series - available on all other series upon request.

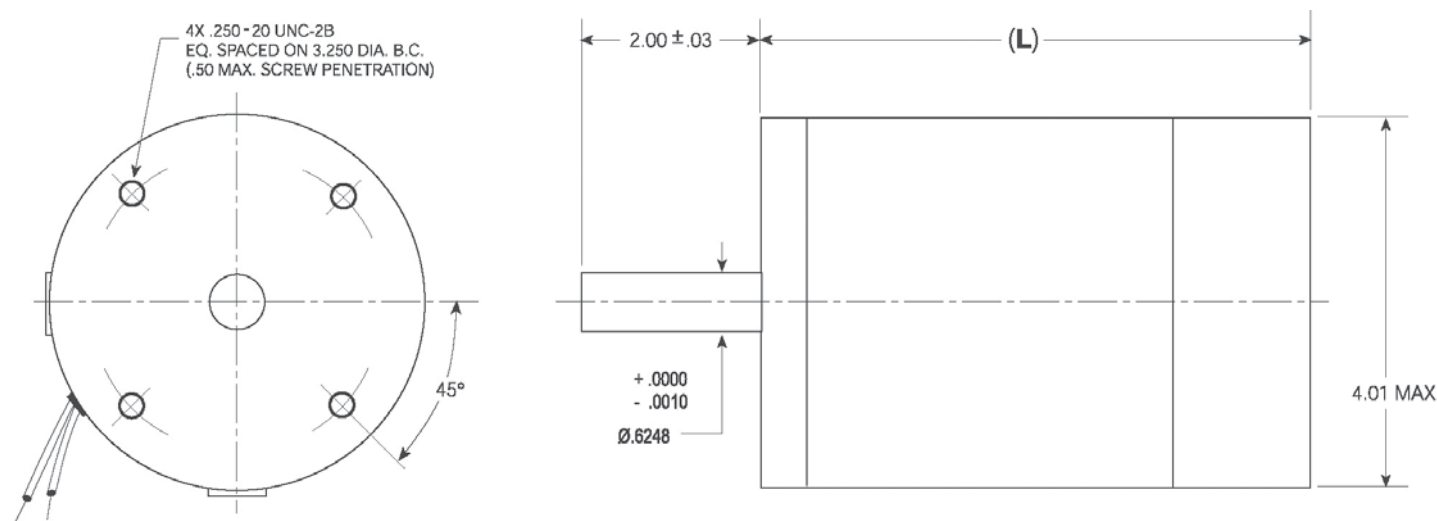
Note:

A skewed armature is one in which the laminations do not line up, but rather are on a skew for the length of the armature stack. There are some distinct advantages to a motor utilizing a skewed armature, the greatest being a **REDUCTION OF COGGING**.

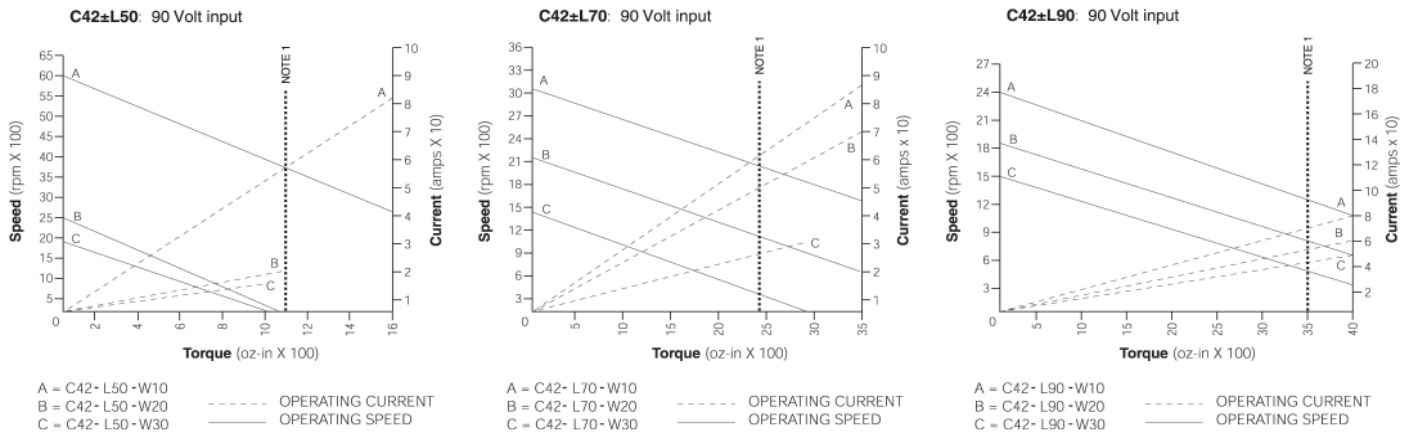
C42 SERIES SPECIFICATIONS – Continuous Stall Torque 145 - 560 oz-in (1.024 - 3.955 Nm) Peak Torque 1100 - 3500 oz-in (7.768 - 24.716 Nm)

Part Number*		C42-L50			C42-L70			C42-L90		
Winding Code**		10	20	30	10	20	30	10	20	30
L = Length	inches	5.00			7.00			9.00		
	millimeters	127.0			177.8			228.6		
Peak Torque	oz-in	1100.0	1100.0	1100.0	2400.0	2400.0	2400.0	3500.0	3500.0	3500.0
	Nm	7.768	7.768	7.768	16.948	16.948	16.948	24.716	24.716	24.716
Continuous Stall Torque	oz-in	145.0	145.0	145.0	400.0	400.0	400.0	560.0	560.0	560.0
	Nm	1.024	1.024	1.024	2.825	2.825	2.825	3.955	3.955	3.955
Rated Terminal Voltage	volts DC	12 - 36	24 - 72	36 - 96	12 - 48	24 - 72	36 - 96	24 - 60	24 - 84	36 - 96
Terminal Voltage	volts DC	48	72	84	36	48	72	48	60	90
Rated Speed	RPM	3226	1885	1526	1160	1130	1060	1273	1238	1517
	rad/sec	338	197	160	121	118	111	133	130	159
Rated Torque	oz-in	80.3	98.2	126.7	249	237	263	336	341	320
	Nm	0.57	0.69	0.89	1.76	1.67	1.86	2.37	2.41	2.26
Rated Current	Amps	5.3	2.7	2.4	8	5.75	3.9	8.5	6.7	5
Rated Power	Watts	192	137	143	214	198	206	317	312	359
	Horsepower	0.26	0.18	0.19	0.29	0.27	0.28	0.42	0.42	0.48
Torque Sensitivity	oz-in/amp	20	46	65	39	52.8	85	50	64.3	82
	Nm/amp	0.1412	0.3248	0.4590	0.2754	0.3729	0.6002	0.3531	0.4541	0.5791
Back EMF	volts/KRPM	14.8	34	48	28.8	39	62.85	37	47.5	60
	volts/rad/sec	0.1413	0.3247	0.4584	0.2750	0.3724	0.6002	0.3533	0.4536	0.5730
Terminal Resistance	ohms	0.7	4	5.7	0.62	1.2	2.6	0.6	0.95	1.45
Terminal Inductance	mH	1.3	6.6	13.5	2	3.7	9.6	2	3.3	5.4
Motor Constant	oz-in/watt ^{1/2}	23.9	23.0	27.2	49.5	48.2	52.7	64.5	66.0	68.1
	Nm/watt	0.169	0.162	0.192	0.350	0.340	0.372	0.456	0.466	0.481
Rotor Inertia	oz-in-sec ²	0.09	0.09	0.09	0.21	0.21	0.21	0.31	0.31	0.31
	g-cm ²	6355.4	6355.4	6355.4	14829.2	14829.2	14829.2	21890.7	21890.7	21890.7
Friction Torque	oz-in	14.0	14.0	14.0	20.0	20.0	20.0	24	24	24
	Nm	0.10	0.10	0.14	0.14	0.14	0.17	0.17	0.17	
Thermal Resistance	°C/watt	2.20	2.20	2.20	1.30	1.30	1.30	0.85	0.85	0.85
Damping Factor	oz-in/KRPM	5.25	5.25	5.25	10.00	10.00	10.00	10.00	10.00	10.00
	Nm/KRPM	0.037	0.037	0.037	0.071	0.071	0.071	0.071	0.071	0.071
Weight	oz	110	110	110	200	200	200	262	262	262
	g	3118	3118	3118	5670	5670	5670	7428	7428	7428
Electrical Time Constant	millisecond	1.8571	1.6500	2.3684	3.2258	3.0833	3.6923	3.3333	3.4737	3.7241
Mech. Time Constant	millisecond	22.28412	24.09974	17.2151	12.1367	12.81294	10.70077	10.52659	10.09549	9.565579
Speed/Torque Gradient	rpm/oz-in	-2.36486	-2.55754	-1.82692	-0.55199	-0.58275	-0.48669	-0.32432	-0.31104	-0.29472

C42 Typical Outline Drawing



C42 Torque/Speed Curves



NOTE 1: Do not operate motor beyond this line. Maximum current and torque must be limited to data sheet values to avoid possibility of magnet demagnetization.

INTEGRAL FEEDBACK DEVICES FOR CLOSED-LOOP CONTROL

All feedback devices are pre-assembled, aligned and fully tested, with output requirements matched (even custom designed) to your application. They are ideal for sensing rotary speed and angular position where space is a premium and low inertia is required.

Encoders

High resolution, high reliability, and state-of-the-art technology in a small package.

- Bidirectional incremental code
- Up to 1024 cycles standard
- Up to 3 channels: A, B, and index
- TTL / CMOS compatible
- Other configurations and resolutions available

Tachometers

Analog tachometers are an economical and efficient choice for applications requiring velocity feedback. These tachometers are integral to the motor on a common shaft, eliminating coupling or mounting irregularities.

- Voltage gradient: 7, 10, 14 V / Krpm
- Ripple voltage: 20% max peak to peak



HOW TO SELECT A MOTOR

The motor you require can be customized to your application. Review the motor data tables shown above to determine the size and winding that most closely matches your needs. Then supply us with the following information:

- | | |
|---|---|
| <input type="checkbox"/> Maximum voltage and current available | <input type="checkbox"/> Maximum motor dimensions |
| <input type="checkbox"/> Load torque required | <input type="checkbox"/> Shaft and endcap configuration |
| <input type="checkbox"/> Load inertia, oz-in / sec ² | <input type="checkbox"/> Feedback options |
| <input type="checkbox"/> Velocity profile: speed vs time | |

DC Cube Torque Motors

TYPICAL APPLICATIONS

- Avionics - cockpit instrumentation (altitude, latitude), displays (indicators and instruments) for military and commercial aircraft
- Robotic control systems
- Military targeting/fire control systems
- Sighting systems
- Missiles
- Military actuators
- Direct drive servo systems
- Medical equipment

FEATURES

- 4 pole 13 bar motors - 2 brushes standard and 4 brushes available
- Stainless steel shafts for durable, rugged wear
- Meets MIL-SPEC 810
- Standard nickel plated housing resists corrosion in harsh environments
- Peak torques from 1.0 to 20 oz-in
- Optional gearheads, brakes, resolvers, encoders and potentiometers available
- Available in 3/4" and 1" frame sizes:
 - Model 21 - 1" x 1" x 1"
 - Model 22 - 1" x 1" x .75"
 - Model 23 - 1" x 1" x 1.35"
 - Model 24 - .75" x .75" x .75"
- Silver alloy brushes
- Speeds up to (7,500) rpm
- Variety of windings available
- Gold plated terminals
- Gold alloy commutator
- Shaft can be modified with front and rear extensions, integrated gear, or a pinion

BENEFITS

- High torque-to-inertia ratio in a small package
- Rapid response at all speeds
- Cartridge brush is easily field-replaceable
- Skewed rotors provide minimum cogging torque
- Gold-clad commutator for long life
- Rare earth magnets provide higher performance than standard permanent magnets
- Cubical shape provides weight and space savings and easy mounting
- Torque increases directly with input current for high linearity as a direct servo drive
- Low self inductance

21, 22, 23 and 24 Series



High torque-to-inertia ratio in a compact size

Moog Components Group's family of miniature permanent magnet DC cube torque motors is available in 3/4" and 1" frame sizes. These are rapid response motors at all operating speeds because of their high torque-to-inertia ratio and low self-inductance. Torque increases directly with input current for high linearity.

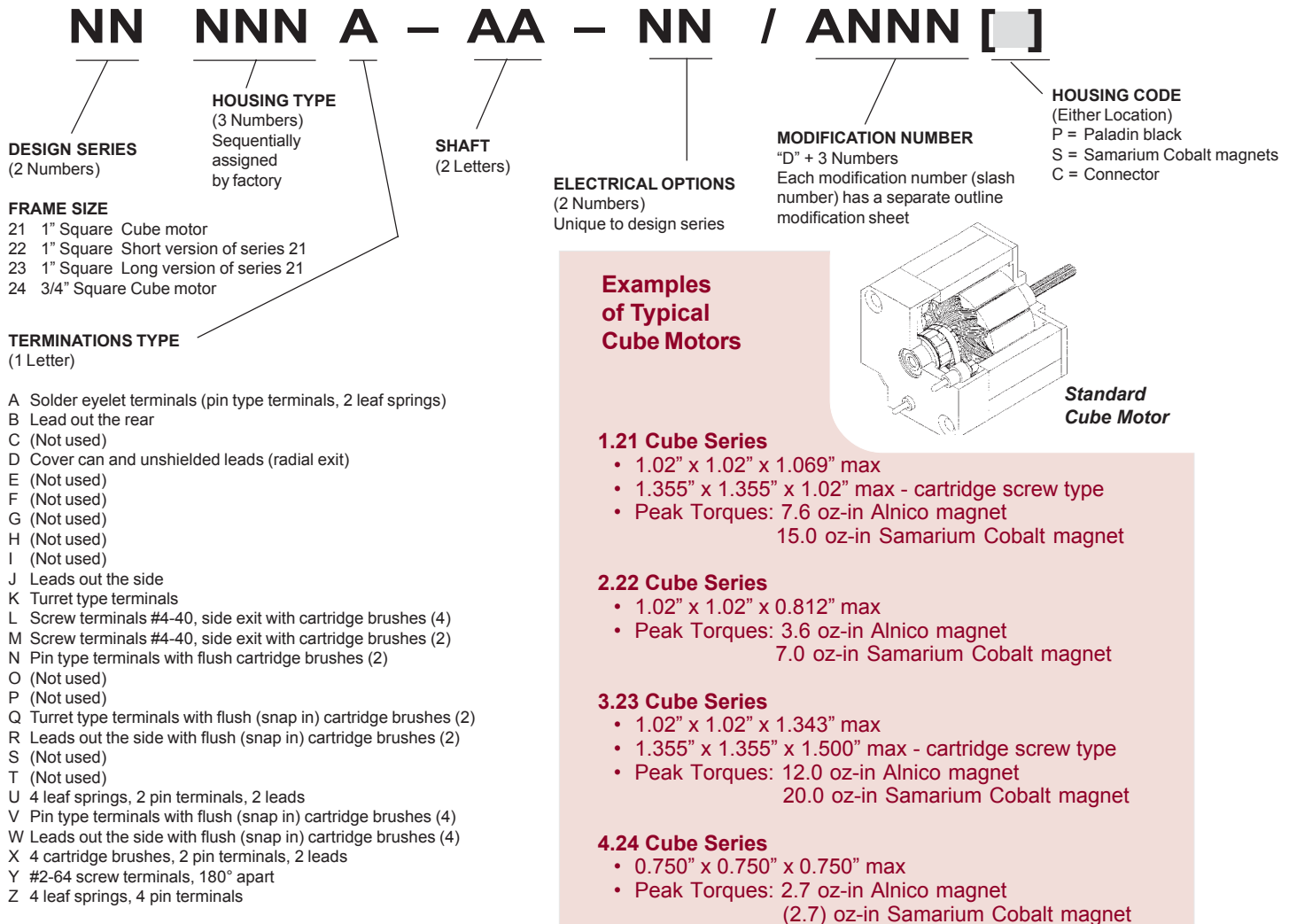
Cube motors are often used in applications where high torque is required, but the available space is limited. Cube motors lend themselves to easier mounting than cylindrical motors in many applications and are easier to lock into an envelope.

Moog Components Group offers a choice of Alnico or Samarium Cobalt magnet materials to satisfy most any requirement. These rare earth magnets produce a higher magnetic energy per unit volume than most commercially available permanent magnets. Alnico magnets provide enhanced temperature stability while Samarium Cobalt magnets offer high energy with good, stable performance.

We're tooled for hundreds of designs with different windings, end caps and other options including gearheads, brakes, resolvers, encoders and potentiometers. Most designs can easily be adapted to meet different requirements. We can also provide custom engineering services.

CUBE MOTOR PARAMETERS

Part Numbering System Guide



Integrated Motion Technology

In many gimballed systems for the military, aerospace and industrial market segments, rotary electromechanical components such as motors, resolvers and slip ring assemblies often find themselves sharing common envelopes and structures. For this reason, Moog Components Group is carving a unique niche in the marketplace by providing and integrating these traditional components into one assembly wherein the individual components have been optimized to work together.

Today Moog Components Group is in the unique position to provide engineering and manufacturing expertise for all rotary components that share the gimbals' structure. Moog Components Group's fractional horsepower DC motors provide the torque for continuous rotation for scanning applications such as radar, missiles, seekers, aerial targets and target acquisition systems while our slip ring assemblies

pass the power and data (up to 1 gigahertz) across the rotating interface. Our resolvers provide the positional feedback often within arc seconds of accuracy.

These components can, of course, be provided separately or be integrated. Integrated products typically share a common structure and bearing which reduces piece part count and system weight. Integration and test is performed at the factory providing a "plug and play" subsystem. Moog Components Group also provides complete actuator systems with control electronics. This integrated concept reduces the number of items that would otherwise have to be procured and stocked by the OEM.

System enhancements and upgrades occur naturally when dealing with one company that has the engineering and manufacturing expertise for rotary component needs.

SPECIFICATIONS ON TYPICAL CUBE MOTORS

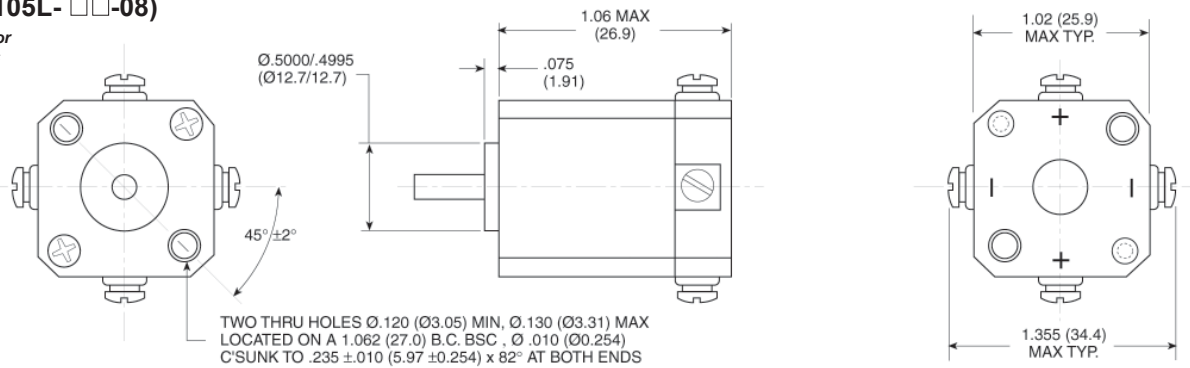
The following table presents a cross-section of Moog Components Group cube motor designs. Tooling charges may apply to new designs.

Part Number	Length inches (metric)	Peak Torque (oz-in) (mm)	Volts at Peak Torque (Nm)	Current at Peak Torque (amps)	Torque Constant (oz-in/amp)	Back EMF (V/rad/sec) x10E-2 (Nm/amp)	DC Resistance (Ohms)	Inductance (mh)	Inertia (oz-in-sec2) x10E-4 (KgCm2 x10E-4)	No Load Speed (RPM)	No Load Current (Ma)	Starling Voltage (Volts)	Weight (oz) (gm)
21105N-□□-03	1.06	7.5	26.0	1.7	5.3	3.74	15.0	6.0	1.3	6500	85	1.0	2.93
	26.9	.053	26.0	1.7	.037	3.74	15.0	6.0	.018	6500	85	1.0	83.06
21105A-□□-04	1.06	7.5	41.7	0.975	7.55	5.3	44.0	16.0	1.3	6500	60	0.75	2.93
	26.9	.053	41.7	0.975	.053	5.3	44.0	16.0	.018	6500	60	0.75	83.06
21105N-□□-08	1.06	8.6	13.0	3.3	2.6	1.8	3.9	1.3	1.3	6500	150	1.0	2.93
	26.9	.061	13.0	3.3	.018	1.8	3.9	1.3	.018	6500	150	1.0	83.06
21105N-□□-10	1.06	6.0	8.0	5.0	1.2	0.85	1.6	0.4	1.3	6500	225	1.0	2.93
	26.9	.042	8.0	5.0	.009	0.85	1.6	0.4	.018	6500	225	1.0	83.06
21105N-□□-12	1.06	6.5	26.0	1.7	4.6	3.25	15.0	6.0	1.3	7000	85	1.0	2.93
	26.9	.046	26.0	1.7	.033	3.25	15.0	6.0	.018	7000	85	1.0	83.06
21105N-□□-13	1.06	6.5	41.7	0.975	6.7	4.8	44.0	16.0	1.3	7000	60	1.0	2.93
	26.9	.046	41.7	0.975	.048	4.8	44.0	16.0	.018	7000	60	1.0	83.06
21605A-□□-14S	1.06	11.0 MIN	20.5	2.95	3.8	2.68	7	3.3	1.3	7000	217	1.0	2.93
	26.9	.078	20.5	2.95	.027	2.68	7	3.3	.018	7000	217	1.0	83.06
21607A-□□-15S	1.06	12.0 MIN	24	3.5	4.75	3.35	7.5	3.5	1.3	6500	90	0.75	2.93
	26.9	.85	24	3.5	.034	3.35	7.5	3.5	.018	6500	90	0.75	83.06
21607J-□□-16S	1.06	8.5	20	1.5	5.5	3.9	13	5	1.3	4600	100	1.5	2.93
	26.9	.060	20	1.5	.039	3.9	13	5	.018	4600	100	1.5	83.06
21607J-□□-19S	1.06	12.0	25.9	2.9	5.0	3.5	9	4	1.3	6800	60	1.0	2.93
	26.9	.085	25.9	2.9	.035	3.5	9	4	.018	6800	60	1.0	83.06
21605A-□□-20S	1.06	12.0	28	3.2	5.4	3.8	10.5	5	1.3	6700	60	0.75	2.93
	26.9	.085	28	3.2	.038	3.8	10.5	5	.018	6700	60	0.75	83.06
21105K-□□-22S	1.06	7.2	12	2.1	4.5	3.2	7	3.3	1.3	3400	60	1.0	2.93
	26.9	.051	12	2.1	.032	3.2	7	3.3	.018	3400	60	1.0	83.06
22613J-□□-01	0.812	3.6	26.0	0.6	6.0	4.2	43.0	12.0	0.65	5000	45	1.0	2.0
	20.6	.025	26.0	0.6	.042	4.2	43.0	12.0	.009	5000	45	1.0	56.70
22613M-□□-01	0.812	3.6	26.0	0.6	6.0	4.2	43.0	12.0	0.65	5000	45	1.5	2.0
	20.6	.025	26.0	0.6	.042	4.2	43.0	12.0	.009	5000	45	1.5	56.70
23101L-□□-01	1.50	10.0	26.0	2.1	4.8	3.4	12.0	5.0	2.2	5800	125	1.0	4.3
	38.1	.071	26.0	2.1	.034	3.4	12.0	5.0	.031	5800	125	1.0	121.9
23101L-□□-02	1.50	12.0	18.0	3.27	3.7	2.6	5.5	2.2	2.2	5500	175	1.0	4.3
	38.1	.085	18.0	3.27	.026	2.6	5.5	2.2	.031	5500	175	1.0	121.9
24618R-□□-04	0.75	1.7	15.0	0.58	3.7	2.6	26.0	8.5	0.35	5000	50	1.5	1.25
	19.1	.012	15.0	0.58	.026	2.6	26.0	8.5	.005	5000	50	1.5	35.44
24618N-□□-05	0.75	2.7	12.0	1.0	2.7	1.9	12	—	0.35	5725	50	1.0	1.25
	19.1	.019	12.0	1.0	.019	1.9	12	—	.005	5725	50	1.0	35.44
24618R-□□-09	0.75	1.0	6	0.75	1.35	0.95	8	1.4	0.35	6000	125	1.0	1.25
	19.1	.007	6	0.75	.010	0.95	8	1.4	.005	6000	125	1.0	35.44
24618V-□□-10	0.75	2.5	26	0.425	5.75	4.1	61	—	0.35	5500	30	1.0	1.25
	19.1	.018	26	0.425	.041	4.1	61	—	.005	5500	30	1.0	35.44
24618V-□□-11	0.75	1.5	15.0	0.555	2.7	1.9	22.5	—	0.35	6600	75	1.25	1.25
	19.1	.011	15.0	0.555	.019	1.9	22.5	—	.005	6600	75	1.25	35.44
24618V-□□-15	0.75	1.0	7.5	0.575	1.8	1.3	13	1.4	0.35	5000	70	0.75	1.25
	19.1	.007	7.5	0.575	.013	1.3	13	1.4	.005	5000	70	0.75	35.44

Cube Motor Typical Outlines

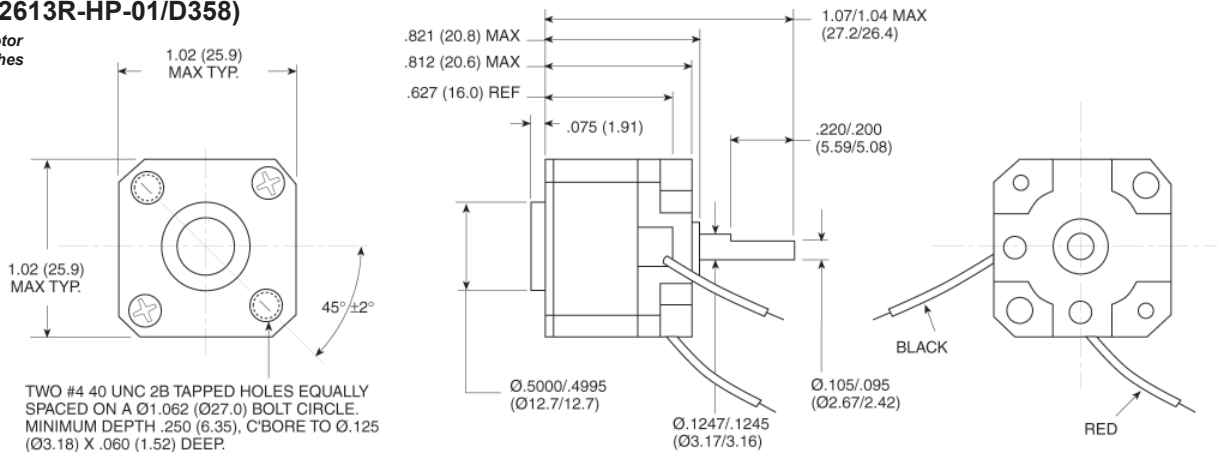
21 Series (21105L-□□-08)

Standard 1" cube motor
with cartridge brushes
and screw terminals



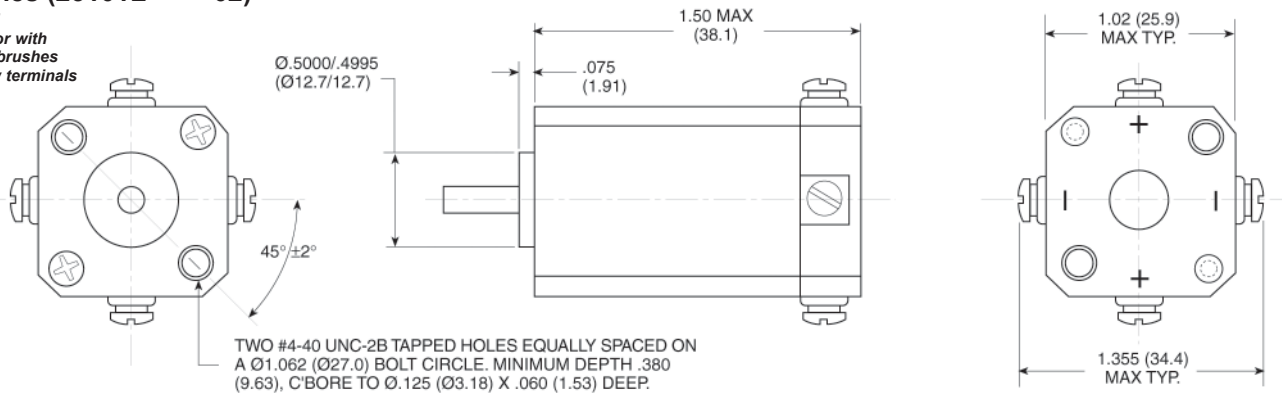
22 Series (22613R-HP-01/D358)

"Short" 1" cube motor
with cartridge brushes
and lead wires



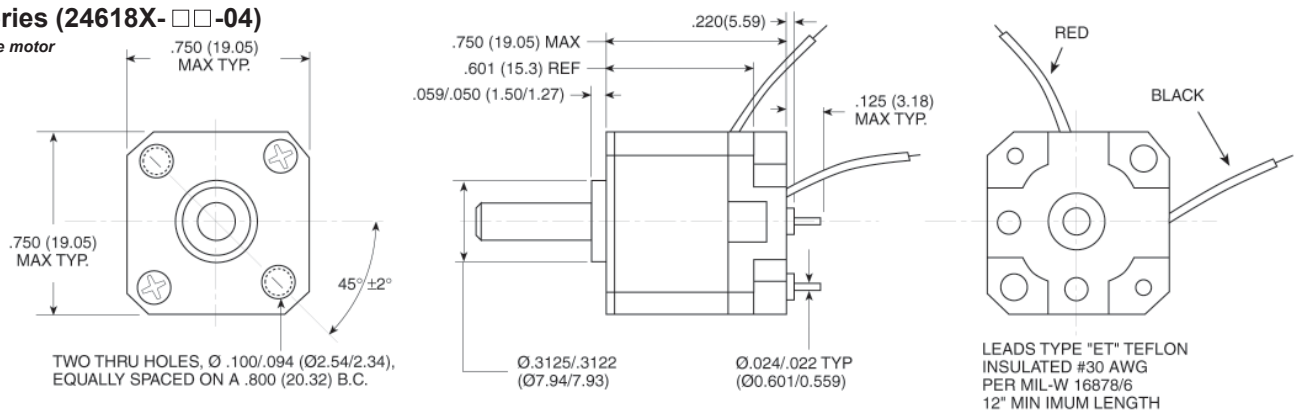
23 Series (23101L-□□-02)

"Long" 1" cube motor with
cartridge brushes
and screw terminals



24 Series (24618X-□□-04)

3/4" cube motor



Brush Torque Motors Application Guide

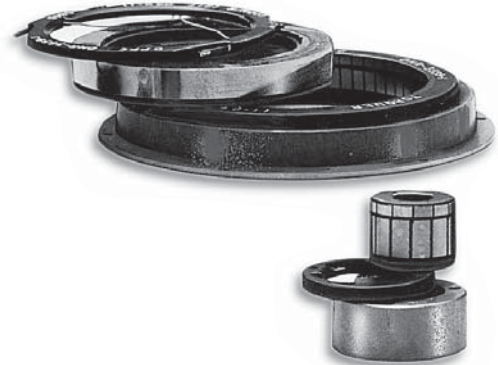
TYPICAL APPLICATIONS

- Speed and rotation control systems
- Gimbals for FLIR and inertial navigation systems
- Stabilized gun and fire control systems for combat vehicles
- Fire control radars for land and ship board defense
- Cockpit instrumentation for military and commercial aircraft
- Missile seeker and Fin actuator systems
- Space and vacuum instruments, actuation systems and momentum wheels

FEATURES

- Double insulated high temp magnet wire minimizes leakage current, promotes superior insulation.
- Molded brush block assembly features interchangeable brush blocks, optimizing brush position on commutator. Brush contour is done on automatic tooling rather than "run-in" individually.
- Brushes mechanically fastened to brush spring in addition to soldering assures brush alignment during soldering operation plus proper mechanical and electrical bond between brush spring and brush.
- Stable high temp encapsulation material minimizes movement or working of windings under large temperature variations. This high temp material will not crack under temperature variations, and eliminates voids, exposed windings and humidity traps.
- Special magnetic material alloy allows higher torque per unit of volume, higher torque to inertia ratio. It will not corrode under high humidity as does silicon iron or other materials.
- Plated magnet assemblies resist environmental extremes and require no special handling.
- Rare earth magnets typical
- High torque and low speed
- High torque to inertia ratio
- Low speed with high accuracy
- Compact
- Large axial holes through armature for easy application to shafts and bosses

Export of these commodities may require a Department of State export license.
Please ensure you inform your Sales Administrator of your intent to export.



Moog Components Group designs and manufactures precision motion technology components and subsystems for defense, aerospace and industrial applications. Our broad range of components includes DC torque and servomotors, position feedback devices and slip ring/twist capsule products.

Our DC brush and brushless torque and servomotors can be supplied housed with a variety of shaft configurations but typically as a direct-drive rotor/stator part-set that will be directly attached to the load. This form of attachment eliminates backlash and increases servo stiffness for an optimized direct drive system.

DC torque motors are used in applications that require high torque at slow speeds with input power minimized. Our DC servomotors are used in applications that require high speed and positional accuracy. Custom controllers can be supplied on a design-to-specification basis.

For more information about how this product can be tailored to fit your specific application, contact our applications engineers.

Brush Motors

Torquer Motors - Brush	Torquer Dimensions Max., (inches)															
	UNIT TYPE	O.D.	I.D.	WIDTH	Peak Torque, T_{PK} (oz-in)	Volts @ Peak Torque, V_P (volts)	Amps @ Peak Torque, I_P (amps)	Torque Sensitivity, K_T (oz-in/amp)	Back EMF, K_E (VRAD/SEC)	Terminal Resistance, R_T (ohms) nom.	Terminal Inductance, L_t (millihenries) nom.	Rotor Inertia, J_A (oz-in-sec ² x 10 ⁻⁶ nom.)	Friction Torque, T_F (oz-in) max.	Motor Constant, K_M (oz-in/sq.rt.watts)	Ripple Max Avg. to Peak, T_R (%)	Weight (oz) nom.
D-1125-A-1	1.125	.188	.565	6.6	33.0	1.60	4.10	0.029	20.8	4.5	1.5	0.2	0.90	7	1.8	
D-1125-A-2	1.125	.188	.565	6.6	41.8	1.21	5.47	0.039	34.6	8.2	1.5	0.2	0.93	7	1.8	
D-1125-A-3-XX	1.125	.188	.565	6.6	20.2	2.49	2.65	0.019	8.4	2.0	1.5	0.2	0.91	7	1.8	
D-1125-A-4	1.125	.188	.565	6.6	26.4	1.91	3.45	0.024	13.8	3.4	1.5	0.2	0.93	7	1.8	
D-1125-A-5-XX	1.125	.188	.565	6.6	58.5	1.05	6.24	0.044	55.2	13.0	1.5	0.2	0.84	7	1.8	
D-1125-A-7-XX	1.125	.188	.565	6.6	44.9	1.33	4.95	0.035	33.8	7.8	1.5	0.2	0.85	7	1.8	
D-1125-A-8-XX	1.125	.188	.565	6.6	71.2	0.84	7.88	0.056	84.7	16.0	1.5	0.2	0.86	7	1.8	
D-1125-B-1	1.125	.188	.562	6.6	33	1.6	4.1	0.029	20.8	4.5	1.5	0.2	0.9	7	1.8	
D-1500-C-2-XX	1.500	.625	.513	15.0	50.0	1.25	12.0	0.085	40.0	14.0	5.5	0.5	1.9	7	2.4	
D-1500-C-3-XX	1.500	.625	.513	15.0	26.0	2.73	5.50	0.040	9.5	3.5	5.5	0.5	1.8	7	2.4	
D-1500-C-4-XX	1.500	.625	.513	15.0	64.0	1.00	15.10	0.110	64.0	23.0	5.5	0.5	1.9	7	2.4	
D-1500-C-5-XX	1.500	.625	.513	15.0	42.5	1.77	8.50	0.060	42.0	8.5	5.5	0.5	1.7	7	2.4	
D-1500-D-6-XX	1.500	.625	.375	10.5	32.4	1.75	6.00	0.042	18.5	4.0	4.0	0.5	1.4	7	1.8	
D-1500-Y-1	1.500	.522	2.066	18.2	28	1.3	14	0.099	21.5	9.7	14	0.95	3	10	6.4	
D-1938-D-1	1.938	.700	.400	11.0	26.0	0.81	14.00	0.100	32.0	8.5	8.0	0.6	2.5	6	2.5	
D-1938-G-1-XX	1.938	.625	.625	40.0	87.5	1.25	32.10	0.227	70.0	15.0	20.0	1.2	3.8	7	5.5	
D-1938-J-1	1.938	.625	.609	23.0	30.1	1.77	13.00	0.093	17.0	3.0	10.0	1.0	3.16	7	5.0	
D-1938-P-1	1.938	.562	1.250	79.0	39.6	2.20	35.80	0.250	18.0	11.0	37.0	2.0	8.4	5	12.0	
D-2780-B-1	2.780	1.675	.450	14.0	26.0	0.456	30.60	0.240	57.0	7.0	50.0	1.2	4.05	6	4.0	
D-2813-D-1	2.813	1.000	.995	90.0	10.25	4.10	22.0	0.156	2.5	1.6	135.0	2.5	13.9	5	19.0	
D-2813-G-1HT	2.813	1.000	1.125	95	17.6	2.2	43.3	0.306	8	4.6	146	2.5	15.3	5	21	
D-2910-B-1-XX	2.910	1.630	.640	60.0	26.0	1.45	41.00	0.290	18.0	6.0	125.0	1.2	9.8	5	9.5	
D-2910-C-1-XX	2.910	1.630	.545	33.0	26.0	0.866	43.00	0.300	30.0	15.0	110.0	1.0	7.85	5	6.5	
D-3000-D-1	3.000	1.750	.705	93.0	39.0	1.50	62.00	0.438	26.0	16.0	160.0	2.5	12.2	5	10.0	
D-3029-A-2	3.029	1.44	0.54	33	26	0.866	43	0.3	30	15	1.24	1.0	7.85	5	6.5	
D-3180-A-2-XX	3.180	1.500	1.565	480.0	26.0	10.00	48.00	0.340	2.6	3.2	350.0	10.0	30.0	7	33.0	
D-3180-A-3-XX	3.180	1.500	1.565	354.0	104.0	1.30	272.00	1.940	80.0	72.0	350.0	7.0	30.7	5	31.0	
D-3375-A-1-XX	3.375	2.250	.633	33.0	16.5	0.80	41.00	0.290	20.6	5.0	170.0	2.0	9.1	5	10.0	
D-3582-A-1	3.582	1.421	.735	75.0	56.0	1.00	75.00	0.530	56.0	18.0	125.0	3.0	10.0	5	10.2	
D-3620-A-1	3.620	2.180	.418	28.0	14.9	0.72	39.00	0.280	20.7	5.0	160.0	2.0	8.5	5	8.0	
D-3625-F-2	3.625	1.749	.700	97.5	26.0	1.30	75.00	0.600	20.0	7.0	420.0	4.0	16.7	6	16.2	
D-3625-G-1	3.625	2.500	.400	44.0	39.0	1.50	29.20	0.206	26.0	5.0	115.0	2.0	5.7	5	5.3	
D-3730-C-1-XX	3.730	1.640	1.097	265.0	49.1	5.40	49.10	0.350	9.1	4.3	440.0	2.6	16.3	5	21.0	
*D-3839-B-2	3.839	1.880	.520	26.0	26.0	0.765	38.00	0.270	34.0	12.0	320.0	1.0	6.5	5	8.7	
D-4193-A-1	4.193	1.811	.400	60.0	70.0	1.43	42.00	0.300	49.0	9.0	148.0	2.9	6.0	5	6.5	
D-5125-C-3	5.125	3.500	.615	160.0	15.7	3.33	48.00	0.340	4.7	2.1	980.0	5.0	22.0	5	18.5	
D-5125-E-1	5.125	3.500	1.340	520.0	14.0	10.00	52.00	0.368	1.4	1.0	1700.0	10.0	43.9	5	49.0	
D-5125-F-5E	5.125	3.500	1.35	720	27	6	120	0.849	4.5	3	2400	12	56.6	5	52	

*Outer member is the armature
XX - Denotes typical model number.
Contact factory for assistance.

*Peak torque values listed are for Alnico field designs and are not necessarily the maximum available for that particular mechanical configuration. By modifying the windings and magnet materials, the values listed in the column T_{PK} can be supplied with no change to the mechanical dimensions.

****Above frame sizes represent only a small sampling of the total range manufactured, consult factory for custom designs.**

- Tachometers range in similar configurations and specifications.
- Torque motors and tachometers are designed to meet the requirements of MIL-E-5400.
- All published parameters are considered nominal (25°C) unless otherwise specified.
- We are currently tooled on some items to house the torque motor on its own bearings and incorporate, if required, a potentiometer and a tachometer.
- Windings can be modified for specific applications.

Brush type DC cube servomotors are also available from Moog Components Group.

Design Considerations

All diameters listed have finished, ground lamination surfaces. They can be complemented with rings and hubs for mounting convenience.

Moog Components Group torque motors are normally delivered in kit form.

If you require integral bearings such as, a cartridge assembly containing a torquer motor and synchro, potentiometer or similar component, we can design the entire assembly to your mechanical dimensions and performance requirements.

Mounting Considerations

Since torque motors are normally delivered in kit form, you provide the mounting surfaces and bearings. When you design the mechanics of the mount, be sure to observe these rules:

1. Eccentricities from the inner member mounting surface should not exceed 0.002 inches for Alnico designs and 0.004 for rare earth motor designs.
2. Surfaces in contact with the permanent magnet portion of the motor must be non-magnetic.
3. The bore of the mounting surface should be perpendicular to the mounting seat within 0.001 inch for Alnico designs and 0.002 for rare earth designs.

Electrical Considerations

For each mechanical configuration shown, different winding designs to modify torque, torque sensitivity, DC resistance, and so on, can be supplied by Moog Components Group to suit your special system requirement. In each case, you have the option of selecting one of the existing designs or specifying a new winding designed to meet your special requirements. If your power source (voltage or current) is limited, the mathematical relationships shown in Table 1 will allow you to calculate a particular performance characteristic at the voltage or power capability of your existing power supply.

Table 1			
PARAMETER	SYMBOL	UNITS	RELATIONSHIP TO PUBLISHED PARAMETER
Electrical Time Constant	τ_E	milliseconds	L_T / R_T
Mechanical Time Constant	τ_M	milliseconds	$\frac{J_M \cdot R_T}{K_E \cdot K_T}$
Power Input, Stalled At Peak Torque (25°C)	P_P	watts	$V_P \cdot I_P$
Viscous Damping Coefficients			
Zero Source Impedance	F_O	oz-in/rad/sec	$\frac{K_T \cdot K_E}{R_T}$
Infinite Source Impedance	F_I	oz-in/rad/sec	$T_F / 2\omega_{NL}$
¹ Motor Friction Torque (Actual)	T_F	oz-in	$K_T \cdot \text{starting current}$
Maximum Power Rate	P	oz-in/sec ²	T_{PK} / J_M
Maximum Theoretical Acceleration	ω_M	rad/sec ²	T_{PK} / J_M
² Theoretical No Load Speed	ω_{NL}	rad/sec	V_P / K_E
¹ T_F is specified as a maximum value and includes brush friction, magnetic detent and test fixture bearing friction which is considered negligible. ² In cases where motor is to be operated at some voltage less than V_P due to power supply limitations the new ω_{NL} becomes V_A / K_E where V_A = voltage applied.			

Conversion Factors

For convenience of calculation or comparison, the following constants are provided for rapid conversion to or from the units Moog Components Group uses to express torque motor parameters.

Conversion Table		
FROM	TO	MULTIPLY BY
Length		
inches	cm	2.540
feet	cm	30.48
cm	inches	.3937
cm	feet	3.281×10^{-2}
Mass		
oz	g	28.35
lb	g	453.6
g	oz	3.527×10^{-2}
lb	oz	16.0
g	lb	2.205×10^{-3}
oz	lb	6.250×10^{-2}
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383×10^4
g-cm	oz-in	1.389×10^{-2}
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233×10^{-5}
oz-in	lb-ft	5.208×10^{-3}
Rotation		
rpm	degrees/sec	6.0
rad/sec	degrees/sec	57.30
degrees/sec	rpm	.1667
rad/sec	rpm	9.549
degrees/sec	rad/sec	1.745×10^{-2}
rpm	rad/sec	.1047
Moment Of Inertia		
oz-in ²	g-cm ²	182.9
lb-ft ²	g-cm ²	4.214×10^5
g-cm ²	oz-in ²	5.467×10^{-3}
lb-ft ²	oz-in ²	2.304×10^3
g-cm ²	lb-ft ²	2.373×10^{-6}
oz-in ²	lb-ft ²	4.340×10^{-4}
oz-in-sec ²	g-cm ²	7.062×10^4



Silencer™ Series Brushless Motor Drive Electronics

TYPICAL APPLICATIONS

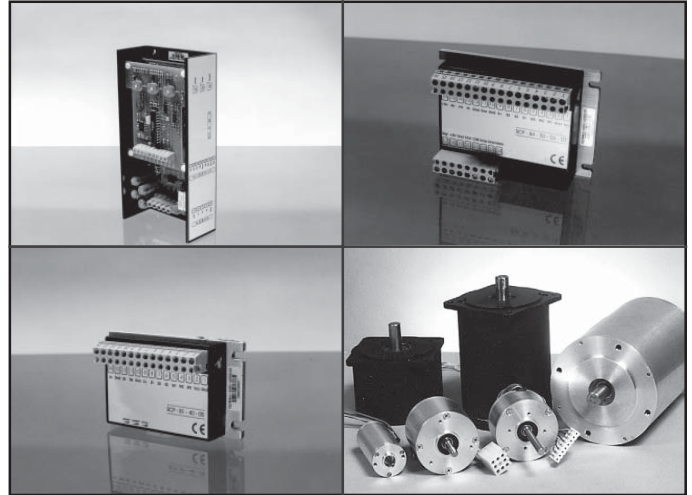
- Medical pumps and blowers
- Air handling equipment
- Packaging and printing products
- Semiconductor handling and insertion machines
- Industrial automation equipment
- Office automation equipment

FEATURES

- Compact size
- High performance
- Compatible with BN series motors
- Low cost
- 5 - 40 amp motor current
- 12 - 70 VDC supply voltage
- 150 - 1900 watt output
- Multiple operating modes available - commutation, velocity, torque, 2 and 4 quadrant
- Feedback using Hall effect sensor or encoder
- Efficient PWM speed control
- CE approved for European applications
- Operating temperature range is -10° to 45°C, storage range is -40° to 85°C

BENEFITS

- Back plate for mounting efficiency and convection cooling
- Compact packaging minimizes space demands
- Matched drives and motors from a single supplier
- Complete system testing provides high reliability
- Terminal block connections for ease of wiring
- Multiple methods of speed control
 - Input voltage
 - Internal potentiometer
 - External potentiometer
 - External voltage reference



Controllers for Brushless Motors

Moog Components Group Silencer™ Series electronic drives are matched for optimum performance with our line of brushless motors. The drives are low profile packages designed for ease of mounting in a small envelope, requiring minimal space in a cabinet / enclosure.

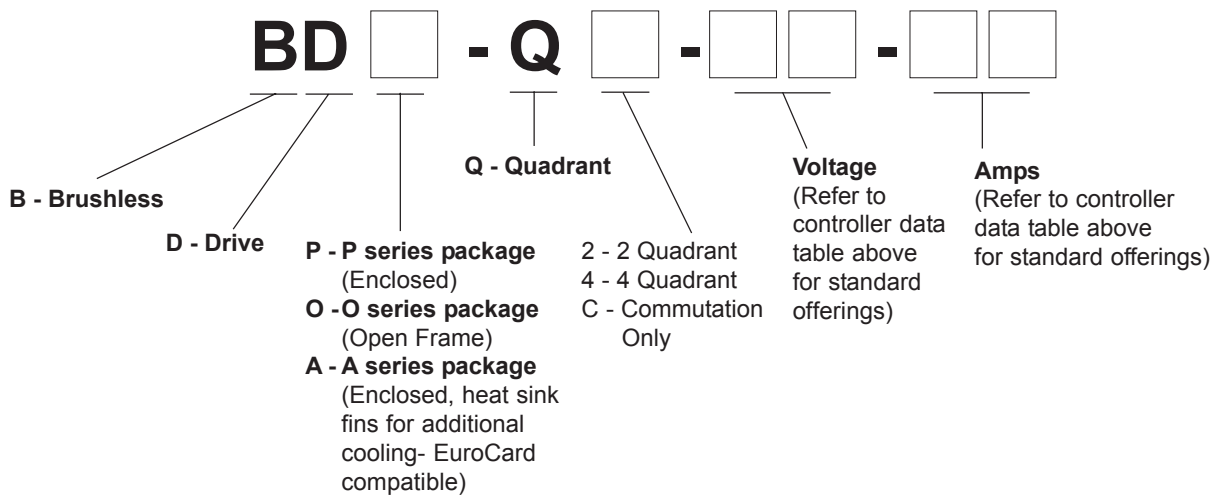
Call our application engineering department and let them help you select a motor and drive combination for your needs.

SELECTION GUIDE AND AVAILABLE MODELS

CONTROLLERS FOR MOOG COMPONENTS GROUP BN SERIES BRUSHLESS MOTORS						
Part Number	Mode of Operation	Max Power (watts)	Input Voltage (volts)	Max Motor Current (amps)	Size - L x W x H (mm), (inches)	Weight (gm), (oz)
BDP-QC-35-05	Commutation	150	12-35	5	(84x55x33),(3.31x2.17x1.30)	(100),(3.53)
BDP-QC-40-05	Commutation	175	12-40	5	(94x55x33),(3.70x2.17x1.30)	(120),(4.23)
BDO-Q2-40-05	2 Quadrant - Velocity	175	12-40	5	(90x30x50),(3.54x1.81x1.97)	(124),(4.37)
BDP-Q2-20-10	2 Quadrant - Velocity	175	12-20	10	(94x55x39),(3.70x2.17x1.54)	(142),(5.00)
BDP-Q2-50-10	2 Quadrant - Velocity	475	20-50	10	(94x55x39),(3.70x2.17x1.54)	(142),(5.00)
BDO-Q2-20-18	2 Quadrant - Velocity	325	12-20	18	(170x90x44),(6.69x3.54x1.73)	(366),(12.91)
BDO-Q2-50-18	2 Quadrant - Velocity	850	20-50	18	(170x90x44),(6.69x3.54x1.73)	(390),(13.76)
BDO-Q2-20-40	2 Quadrant - Velocity	750	12-20	40	(170x90x44),(6.69x3.54x1.73)	(390),(13.76)
BDO-Q2-50-40	2 Quadrant - Velocity	1900	20-50	40	(170x90x44),(6.69x3.54x1.73)	(390),(13.76)
BDA-Q4-70-10	4 Quadrant - Hall - Encoder - Torque	700	12-70	10	(180x100x40),(7.09x3.94x1.57)	(454),(16.00)

SPECIFICATION AND NUMBERING SYSTEM

Part Numbering System Guide



Brushless Controllers

TYPICAL APPLICATIONS

Control of Brushless Motors for:

- Medical pumps and blowers
- Air-handling equipment
- Packaging and printing products
- Semiconductor handling and insertion machines
- Industrial automation equipment
- Office automation and equipment

FEATURES

- 2-quadrant speed controllers for brushless motors
- Feedback using Hall effect sensors
- Motor speed is set by either an internal or external potentiometer
- Motor rotation direction can be present by the direction control input; the controller output stage can be activated and deactivated by the disable control input and brake input
- Maximum constant current can be adjusted via an on-board potentiometer
- Internal thermal cutoff prevents heat overload
- Very high efficiency is achieved by using POWER-MOS-FET technology in the controller output stage
- Efficient PWM speed control
- Operating temperatures from -10 to 45°C and storage temperatures from -40 to 85°C

BENEFITS

- Compact packaging minimizes space demands
- Matched drives and motors from a single supplier
- Complete system testing provides high reliability
- Terminal block connections for ease of wiring
- Multiple methods of speed control
 - Input voltage
 - Internal potentiometer
 - External potentiometer
 - External voltage reference

BDO-Q2-40-05 2-quadrant speed controller for brushless motors



Silencer™ brushless controllers are available in a variety of voltage and current ratings. Their compact packaging minimizes space demands. All controllers have generous terminal blocks to facilitate ease of wiring.

Silencer drives are compatible with Silencer Series Brushless DC Motors. Silencer motors are available in sizes 12, 17, 23, 28, 34 and 42 in standard frames with 1.2" to 4.15" diameters. They offer speeds up to 20,000 rpm and continuous torques ranging from 1.2 to 519 oz-in. Standard options include gearheads, resolvers and encoders.

If you have questions about Silencer drives or would like to speak to an applications engineer, please call us or visit our web site.

BDO-Q2-40-05 SPECIFICATIONS

Electrical Data	BDO-Q2-40-05
Operating voltage -+input and Gnd Residual voltage < 5 %	12 - 40 VDC
Maximum constant current (adjustable) • Without additional cooling surfaces (free convection) • With additional convection (< 1,8 K / W)	0.5 - 3.5 A 0.5 - 5.0 A
Peak current limitation (cycle by cycle)	10.0 A
Supply voltage for Hall sensors	6 V / 20 mA

Inputs

- Direction of rotation – (REV) open collector / TTL / CMOS / switch
- Brake - (BRAKE) open collector / TTI / CMOS / switch
- Disable output stage – (DIS) open collector / TTL / CMOS / switch

Temperature Range

Storage -104 to 185°F (-40 to +85°C)
Operation -50 to 113°F (-10 to +45°C)

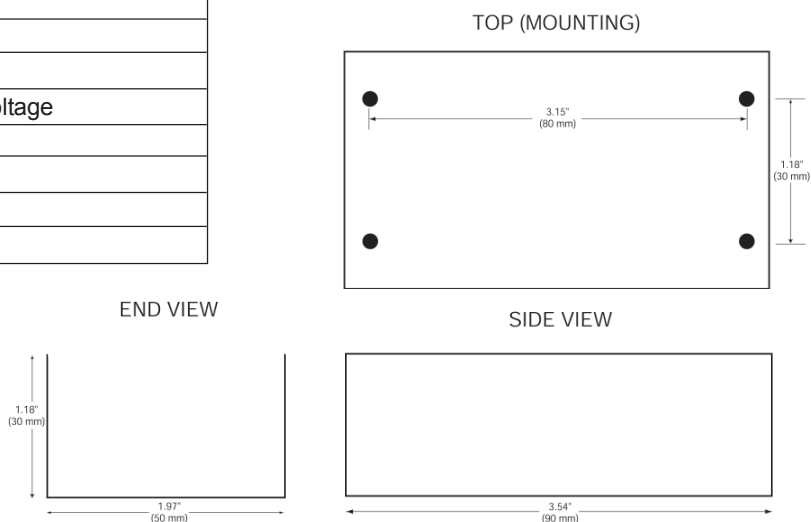
Moisture Range

20 to 80% non-condensed

Mechanical Data	BDO-Q2-40-05
Weight	4.37 oz 124 gm
Dimensions - (L x W x H) - 3.54 x 1.97 x 1.18 in (90 x 50 x 30 mm)	
Mounting - 4 x M4 with a distance between holes of 3.15 x 1.18 in (80 x 30 mm)	

Termination Table		
Terminal #	Nomenclature	Description
1	REV	Reverse Motor Direction
2	GND	Signal Ground
3	SV	External Speed Input
4	+6V	Reference Voltage for Control Inputs
5	GND	Supply Voltage - Ground
6	+INPUT	Supply Voltage - Positive
7	DIS	Controller Disable Input
8	BRAKE	Controller Brake Input
9	S1	Hall Switch #1
10	S2	Hall Switch #2
11	S3	Hall Switch #3
12	VCC	Hall Switch Supply Voltage
13	GND	Hall Switch Ground
14	ØB	Motor Phase B
15	ØC	Motor Phase C
16	ØA	Motor Phase A

Outline Drawing - Three views



Silencer™ Series

Brushless Controllers

TYPICAL APPLICATIONS

Control of Brushless Motors for:

- Medical pumps and blowers
- Air-handling equipment
- Packaging and printing products
- Semiconductor handling and insertion machines
- Industrial automation equipment
- Office automation and equipment

FEATURES

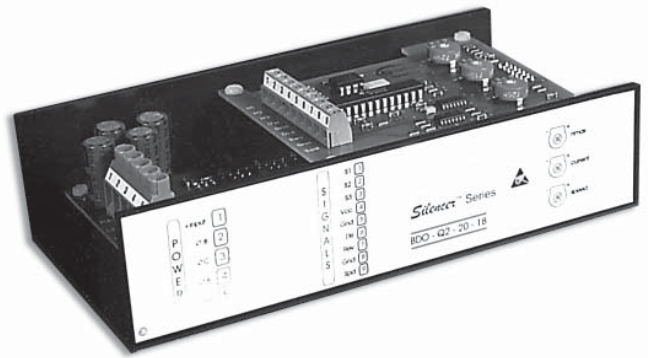
- 2-quadrant speed controllers for brushless motors
- Feedback using Hall effect sensors
- Motor speed is set by either an internal or external potentiometer
- Motor rotation direction can be present by the direction control input; the controller output stage can be activated and deactivated by the disable control input
- Maximum constant current can be adjusted via an on-board potentiometer
- Internal thermal cutoff prevents heat overload
- Very high efficiency is achieved by using POWER-MOS-FET technology in the controller output stage
- Efficient PWM speed control
- Operating temperatures from -10 to 45°C and storage temperatures from -40 to 85°C

BENEFITS

- Compact packaging minimizes space demands
- Matched drives and motors from a single supplier
- Complete system testing provides high reliability
- Terminal block connections for ease of wiring
- Multiple methods of speed control
 - Input voltage
 - Internal potentiometer
 - External potentiometer
 - External voltage reference

BDO-Q2-20-18, BDO-Q2-20-40 BDO-Q2-50-18, BDO-Q2-50-40

***2-quadrant speed controllers
for brushless motors***



Silencer™ brushless controllers are available in a variety of voltage and current ratings. Their compact packaging minimizes space demands. All controllers have generous terminal blocks to facilitate ease of wiring.

Silencer drives are compatible with Silencer Series Brushless DC Motors. Silencer motors are available in sizes 12, 17, 23, 28, 34 and 42 in standard frames with 1.2" to 4.15" diameters. They offer speeds up to 20,000 rpm and continuous torques ranging from 1.2 to 519 oz-in. Standard options include gearheads, resolvers and encoders.

If you have questions about Silencer drives or would like to speak to an applications engineer, please call us or visit our web site.

BDO-Q2-20-18, BDO-Q2-20-40, BDO-Q2-50-18 and BDO-Q2-50-40 SPECIFICATIONS

Electrical Data	BDO-Q2-20-18	BDO-Q2-50-18	BDO-Q2-20-40	BDO-Q2-50-40
Operating voltage -+input and Gnd Residual voltage < 5 %	12-28 VDC	20-60 VDC	12-28 VDC	20-60 VDC
Maximum constant current (adjustable)	18 A	18 A	40 A	40 A

Inputs

- Direction of rotation – (REV) open collector / TTL / CMOS / switch
- Disable output stage – (DIS) open collector / TTL / CMOS / switch

Temperature Range

Storage -104 to 185°F (-40 to +85°C)
Operation -50 to 113°F (-10 to +45°C)

Moisture Range

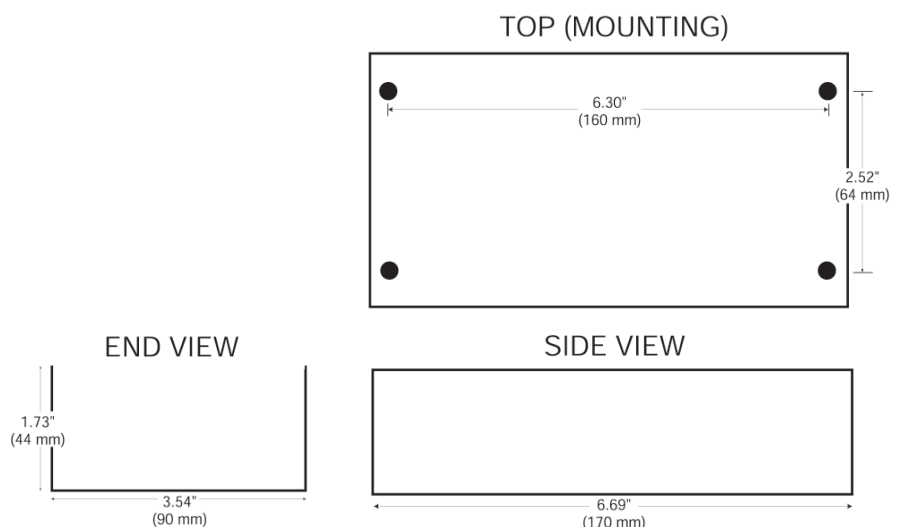
20 to 80% non-condensed

Mechanical Data	BDO-Q2-20-18	BDO-Q2-50-18	BDO-Q2-20-40	BDO-Q2-50-40
Weight	12.91 oz 366 gm	12.91 oz 366 gm	13.76 oz 390 gm	13.76 oz 390 gm
Dimensions - (L x W x H) - 6.69 x 3.54 x 1.73 in (170 x 90 x 44 mm)				
Mounting - 4 x M4 with a distance between holes of 6.30 x 2.52 in (160 x 64 mm)				
Diameter - 4.5 mm - (4) places - M4 screw				

Termination Table

Signal			Power		
Terminal #	Nomenclature	Description	Terminal #	Nomenclature	Description
1	S1	Hall Switch #1	1	Positive Input	Positive Supply Voltage
2	S2	Hall Switch #2	2	Phase B	Motor Phase B
3	S3	Hall Switch #3	3	Phase C	Motor Phase C
4	VCC	Supply for Hall Switches	4	Phase A	Motor Phase A
5	Gnd	Gnd for Hall Switches	5	Gnd	Gnd for Supply Voltage
6	DIS	Control Input - Disable			
7	REV	Control Input - Reverse			
8	GND	Gnd for Dis and Rev			
9	SPD	Set value input for speed			

Outline Drawing - Three Views



TYPICAL APPLICATIONS

Control of Brushless Motors for:

- Medical pumps and blowers
- Air-handling equipment
- Packaging and printing products
- Semiconductor handling and insertion machines
- Industrial automation equipment
- Office automation and equipment

FEATURES

- Electronic commutation speed controller for electronically commutating three-phase brushless motors with Hall sensors, which are arranged offset at 120 electrical degrees
- Speed of the motor is preset by means of either an internal or an external potentiometer
- Maximum constant current can be adjusted via an on-board potentiometer
- Direction of rotation of the motor can be preset by means of the direction control input. The controller output stage can be activated and deactivated by means of the disable control input
- Controller is safeguarded against heat overload by means of an internal thermal cutoff
- Controller output stage has been constructed using POWER-MOS-FET technology, resulting in very high efficiency

BENEFITS

- Compact packaging minimizes space demands
- Matched drives and motors from a single supplier
- Complete system testing provides high reliability
- Terminal block connections for ease of wiring
- Multiple methods of speed control
 - Input voltage
 - Internal potentiometer
 - External potentiometer
 - External voltage reference

Silencer™ Series Brushless Controllers

BDP-QC-35-05 and BDP-QC-40-05 *Electronic commutation speed controller for brushless motors*



Silencer™ brushless controllers are available in a variety of voltage and current ratings. Their compact packaging minimizes space demands. All controllers have generous terminal blocks to facilitate ease of wiring.

Silencer drives are compatible with Silencer Series Brushless DC Motors. Silencer motors are available in sizes 12, 17, 23, 28, 34 and 42 in standard frames with 1.2" to 4.15" diameters. They offer speeds up to 20,000 rpm and continuous torques ranging from 1.2 to 519 oz-in. Standard options include gearheads, resolvers and encoders.

If you have questions about Silencer drives or would like to speak to an applications engineer, please call us or visit our web site.

BDP-QC-40-05 SPECIFICATIONS

Electrical Data

Operating voltage -+input and Gnd	20-40 VDC
Residual voltage	< 5%
Maximum constant current (adjustable)	5A*
Supply voltage for Hall Switches	6 V / 20 mA

* Additional heatshrinking required for maximum current

Inputs

- Direction of rotation – (REV) open collector / TTL / CMOS / switch
- Disable output stage – (DIS) open collector / TTL / CMOS / switch

Temperature Range

Storage -104 to 185°F (-40 to +85°C)
Operation -50 to 113°F (-10 to +45°C)

Moisture Range

20 to 80% non-condensed

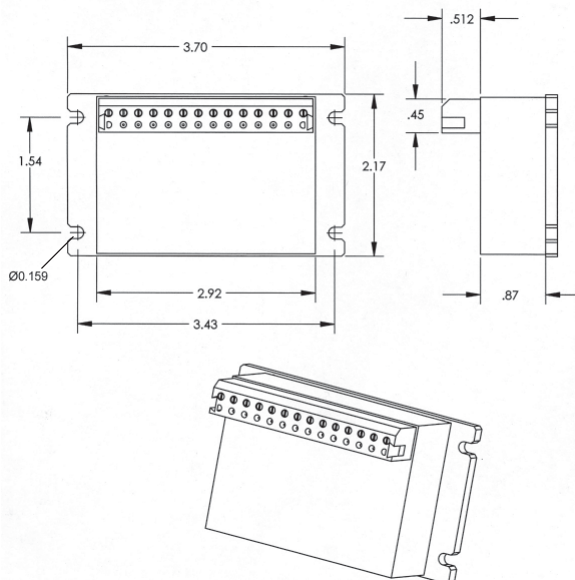
Mechanical Data

Weight	4.3 oz (120.0 grams)
Dimensions (L x W x H)	2.17 x 3.70 x 1.30 in (55 x 94 x 33 mm)
Mounting	4 x M3 with a distance between holes of 1.54 x 3.43 in (39 x 87 mm)
Drill Diameter	4.0 mm - (4) places

Termination Table

Terminal #	Nomenclature	Description
1	GND	Gnd for Supply Voltage
2	Positive Input	Positive Supply Voltage
3	Phase A	Motor Phase A
4	Phase C	Motor Phase C
5	Phase B	Motor Phase B
6	S3	Hall Switch #3
7	S2	Hall Switch #2
8	S1	Hall Switch #1
9	VCC	Supply for Hall Switches
10	GND	Gnd for Hall Switches
11	DIS	Control Input - Disable
12	REV	Control Input - Reverse
13	GND	Gnd for Dis and Rev
14	SPD	Set value input for speed

Outline Drawing - Three Views



Silencer™ Series Brushless Controllers

TYPICAL APPLICATIONS

Control of Brushless Motors for:

- Medical pumps and blowers
- Air-handling equipment
- Packaging and printing products
- Semiconductor handling and insertion machines
- Industrial automation equipment
- Office automation and equipment

FEATURES

- 2-quadrant speed controllers for electronically commutating three-phase brushless motors with Hall sensors, which are arranged offset at 120 electrical degrees
- Speed of the motor is preset by means of either an internal or an external potentiometer
- Maximum constant current can be adjusted via an on-board potentiometer
- Direction of rotation of the motor can be preset by means of the direction control input. The controller output stage can be activated and deactivated by means of the disable control input
- Controller is safeguarded against heat overload by means of an internal thermal cutoff
- Controller output stage has been constructed using POWER-MOSFET technology, resulting in very high efficiency

BENEFITS

- Compact packaging minimizes space demands
- Matched drives and motors from a single supplier
- Complete system testing provides high reliability
- Terminal block connections for ease of wiring
- Multiple methods of speed control
 - Input voltage
 - Internal potentiometer
 - External potentiometer
 - External voltage reference

BDP-Q2-50-10 BDP-Q2-20-10 *2-quadrant speed controller for brushless motors*



Silencer™ brushless controllers are available in a variety of voltage and current ratings. Their compact packaging minimizes space demands. All controllers have generous terminal blocks to facilitate ease of wiring.

Silencer drives are compatible with Silencer Series Brushless DC Motors. Silencer motors are available in sizes 12, 17, 23, 28, 34 and 42 in standard frames with 1.2" to 4.15" diameters. They offer speeds up to 20,000 rpm and continuous torques ranging from 1.2 to 519 oz-in. Standard options include gearheads, resolvers and encoders.

If you have questions about Silencer drives or would like to speak to an applications engineer, please call us or visit our web site.

BDP-Q2-50-10, BDP-Q2-20-10 SPECIFICATIONS

Electrical Data	BDP-Q2-50-10	BDP-Q2-20-10
Operating voltage -+input and Gnd	20 - 50 VDC	12 - 20 VDC
Residual voltage < 5%		
Maximum constant current (adjustable)*	10A	10A
Supply voltage for Hall switches	6 V / 20 mA	

*At higher input voltages, additional heat-sinking may be required for maximum current.

Inputs

- Direction of rotation – (REV) open collector / TTL / CMOS / switch
- Disable output stage – (DIS) open collector / TTL / CMOS / switch

Temperature Range

Storage -104 to 185° F (-40 to +85° C)
Operation -50 to 113° F (-10 to +45° C)

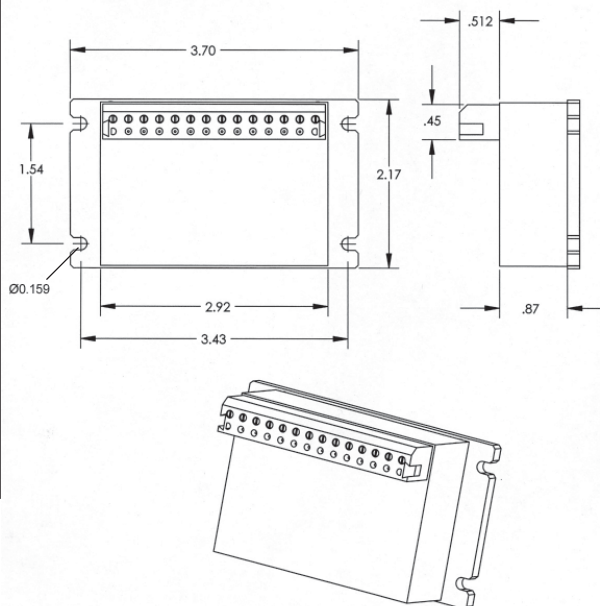
Moisture Range

20 to 80% non-condensed

Mechanical Data	BDP-Q2-50-10	BDP-Q2-20-10
Weight	4.93 oz	4.93 oz
	140 gm	140 gm
Dimensions - (L x W x H) - 2.17 x 3.70 x 1.54 in (55 x 94 x 39 mm)		
Mounting - 4 x M3 with a distance between holes of 1.54 x 3.43 in (39 x 87 mm)		
Drill Diameter - 4.0 mm - (4) places		

Termination Table		
Terminal #	Nomenclature	Description
1	GND	Gnd for Supply Voltage
2	Positive Input	Positive Supply Voltage
3	Phase A	Motor Phase A
4	Phase C	Motor Phase C
5	Phase B	Motor Phase B
6	S3	Hall Switch #3
7	S2	Hall Switch #2
8	S1	Hall Switch #1
9	VCC	Supply for Hall Switches
10	GND	Gnd for Hall Switches
11	DIS	Control Input - Disable
12	REV	Control Input - Reverse
13	GND	Gnd for Dis and Rev
14	SPD	Set value input for speed

Outline Drawing - Three Views



TYPICAL APPLICATIONS

Control of Brushless Motors for:

- Medical pumps and blowers
- Air-handling equipment
- Packaging and printing products
- Semiconductor handling and insertion machines
- Industrial automation equipment
- Office automation and equipment

FEATURES

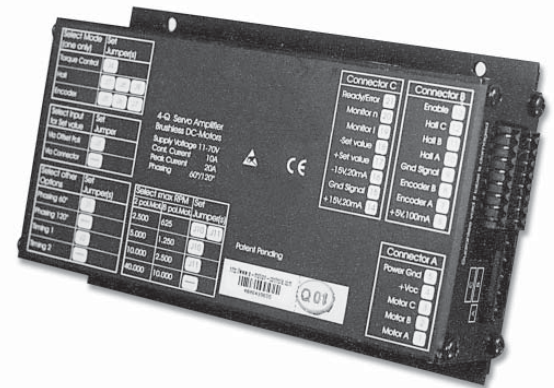
- Powerful 4-quadrant PWM speed controller for electronically commutating three-phase brushless motors with Hall sensor spacing of either 60 or 120 degrees
- Integral short-circuit and overheat protection
- Three jumper-selectable modes of operation:
 - Torque Control
 - Velocity Control using digital encoder feedback
 - Velocity Control using Hall sensor feedback
- Maximum constant current can be adjusted via an on-board potentiometer
- Wide operating voltage range (11 to 70 volts)
- Robust aluminum case with mounting holes
- Removable screw terminal connectors allow fast installation and removal
- Compact design allows optimum utilization of real estate
- Controller output stage has been constructed using POWER-MOS-FET technology, resulting in very high efficiency (up to 95%)

BENEFITS

- Compact packaging minimizes space demands
- Matched drives and motors from a single supplier
- Complete system testing provides high reliability
- Terminal block connections for ease of wiring
- Multiple methods of speed control
 - Input voltage
 - Internal potentiometer
 - External potentiometer
 - External voltage reference

Silencer™ Series Brushless Controllers

BDA-Q4-70-10 4-quadrant speed controller for brushless motors



Silencer™ brushless controllers are available in a variety of voltage and current ratings. Their compact packaging minimizes space demands. All controllers have generous terminal blocks to facilitate ease of wiring.

Silencer drives are compatible with Silencer Series Brushless DC Motors. Silencer motors are available in sizes 12, 17, 23, 28, 34 and 42 in standard frames with 1.2" to 4.15" diameters. They offer speeds up to 20,000 rpm and continuous torques ranging from 1.2 to 519 oz-in. Standard options include gearheads, resolvers and encoders.

If you have questions about Silencer drives or would like to speak to an applications engineer, please call us or visit our web site.

BDA-Q4-70-10 SPECIFICATIONS

Electrical Data	BDA-Q4-70-10
Operating Voltage --input and Gnd)	11 - 70 VDC
Current Ratings	20 A
- Peak (Impulse)	
- Continuous	10 A
Frequency of Power Output Stage	49 kHz
Efficiency	95%
Bandwidth of Current Controller	2.5 kHz

Inputs	BDA-Q4-70-10
Set Value (+ Set value, - Set value)	+/- 10 VDC
Encoder Input Signals (Encoder A, Encoder B)	Channel A, B-TTL-max 100 kHz
Enable (Enable)	8 - 30 VDC (active high)

Outputs	BDA-Q4-70-10
Current Monitor (Monitor I)	0.5 volts / amp
Speed Monitor (Monitor n)	10 VDC full scale of nMax
Supervision Output Signal (Ready/Error)	Open Collector - 30 VDC max
Auxiliary Voltage Sources	
(-15 V, 10 mA)	-15 VDC - 10 mA max
(+15 V, 10 mA)	+15 VDC - 10 mA max
(+5 V, 200 mA)	+5 VDC - 200 mA max

Display
2-color LED Green-Ready, Red - Error

Temperature Range
Storage -104 to 176°F (-40 to +80°C)
Operation -50 to 113°F (-10 to +45°C)

Moisture Range
20 to 80% non-condensed

Mechanical Data	BDA-Q4-70-10
Weight (including terminal connectors)	22.9 oz (650.0 grams)
Dimensions (L x W x H)	7.09 in x 3.94 in x 1.57 in (180 mm x 100 mm x 40 mm)
Mounting	4 x M4 with a distance between holes of 4.78 in x 3.54 in (121.5 mm x 90 mm)

Safety Notes

- Installation to be performed by skilled personnel only
- Operating voltages exceeding the specified values, or improper connections will destroy the controller and will void the product warranty
- Unauthorized opening and attempted repair will put the user in danger and will void the product warranty
- Device contains ESD sensitive components. Do not touch any of the terminal connector pins
- For initial commissioning, the motor shaft should be free to turn (no load applied to the motor)

Termination Table - Connector A

Terminal #	Nomenclature	Description
1	φ B	Motor Phase B
2	φ C	Motor Phase C
3	φ A	Motor Phase A
4	+ Input	Positive Power Supply Connection
5	Power Gnd	Negative Power Supply Connection

BDA-Q4-70-10 SPECIFICATIONS

Termination Table - Connector B

Terminal #	Nomenclature	Description
6	+5 V, 200 mA	+5 volt supply for Hall switches and/or Incremental Encoder
7	Encoder A	Channel A Encoder Input
8	Encoder B	Channel B Encoder Input
9	Signal Gnd	Ground for Hall Switches and/or Incremental Encoder
10	S1	Hall Switch #1
11	S2	Hall Switch #2
12	S3	Hall Switch #3
13	Enable	Enable Input (active high)

Termination Table - Connector C

Terminal #	Nomenclature	Description
14	+15 V, 10 mA	Auxiliary Voltage Source — +15 VDC
15	Signal Gnd	Signal Ground
16	-15 V, 10 mA	Auxiliary Voltage Source — -15 VDC
17	+ Set Value	Positive Voltage for Velocity Control
18	- Set Value	Negative Voltage for Velocity Control
19	Monitor I	Current Monitor Output
20	Monitor n	Speed Monitor Output
21	Ready / Error	Ready Signal Output

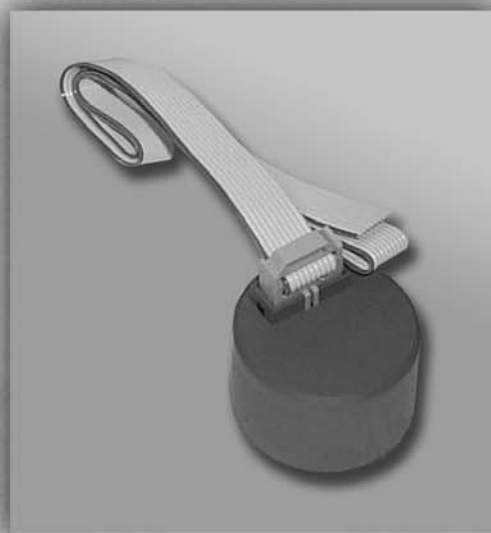
INPUTS

- **Set Value (17,18)** – These inputs are used to control the velocity of the motor. They have a range of –10 to +10 VDC, and are connected internally to a differential amplifier. The input impedance is 20 kilohms. An input of 0 volts to +10 volts will result in a motor speed of 0 rpm to maximum motor rpm, with the motor rotating **CWVSE (clockwise viewing shaft end)**. An input of 0 volts to –10 VDC will result in a motor speed of 0 rpm to maximum motor rpm, with the motor rotating **CCWVSE (counter-clockwise viewing shaft end)**.
- **Encoder A (7) – Encoder B (8)** – Inputs from digital encoder (channels A and B). These inputs are used when the **velocity mode using encoder feedback** is selected. (jumpers 5,6,and 7 set)
- **φ A (3), φ B (1), φ C (2)** – These are the motor phase lead inputs. Connect motor phase A to input A, motor phase B to input B, and motor phase C to input C.
- **S1 (10), S2 (11), S3 (12)** – These are the motor Hall sensor inputs. Connect motor Hall sensor S1 to input S1, motor Hall sensor S2 to input S2, and motor Hall sensor S3 to input S3.
- **Enable (13)** – Enables or disables the controller. Pulling this input high (**connecting to terminal 14**) will **enable** the controller, and voltage will be applied to the motor windings. Leaving this input with no connection or connecting it to ground (**terminal 15**) will **disable** the controller, and no voltage will be applied to the motor windings.
- **+ Input (4), Power Gnd (5)** – These inputs are for the supply voltage (11-70 volts). **Please Observe Polarity!** + Input connects to the **positive supply lead**, while the Power Gnd connects to the **negative supply lead**.

OUTPUTS

- **+5V, 200 mA (6)** – This output is an auxiliary voltage source for the supply of Hall switches and/or an incremental encoder. Use in conjunction with **Signal Gnd (terminal 9)**.
- **+15V, 10 mA (14), -15V, 10 mA (16)** – These outputs are auxiliary voltage sources for use as reference voltages for velocity control when using an external potentiometer.
- **Monitor I (19)** – This output is for supervisory purposes when it is necessary to monitor motor current. This analog signal (voltage) is directly proportional to **motor current**, and is output at the rate of 0.5 volts per amp of motor current. The output range is –10 VDC to +10 VDC.
- **Monitor n (20)** – This output is for supervisory purposes when it is necessary to monitor motor speed. This analog signal (voltage) is directly proportional to **motor speed**. The output range is –10 VDC to +10 VDC. The output impedance is 10 kilohms. The output proportionality is 10 VDC = Maximum Speed.
- **Ready/Error (21)** – This output signal is to show the status of the drive, and can be used to provide a feedback signal to other devices and controls. The open-collector output is normally turned on, which means the output is pulled to GND (low logic state) if there is no fault within the drive system. In the case of a fault (faults include: **under-voltage, over-voltage, overheat or overcurrent**), the output goes high (high logic state). Maximum input range is 30 VDC @ 20 mA. **A FAULT CAN BE RESET BY TOGGING THE ENABLE (TURNING THE ENABLE OFF THEN ON).**

Gearheads & Encoders



Low Cost Precision Planetary Gearheads

TYPICAL APPLICATIONS

- Conveyor systems
- Medical pumps
- Packaging equipment
- Machine tools
- Factory automation
- Any application requiring:
 - Speed reduction
 - Torque multiplication

FEATURES

- Fits C13 brush-type motors
- Fits BN12 brushless motors
- Precision manufactured in accordance with DIN EN ISO 9001 Standards
- Compact design
- High efficiency
- Suitable for continuous, reversing and intermittent operation
- Can be installed in any attitude
- Life-time lubricant for maintenance-free operation
- Available in either sintered or ball bearing versions
- Non-metallic input gear

BENEFITS

- Coaxial arrangement of input and output
- Compact design
- High efficiency
- Low moments-of-inertia
- Can be installed in any attitude
- Suitable for continuous, reversing and intermittent operation
- Low sensitivity to impact load
- Large range of ratios available

32 mm (1.26 inch) Diameter



Quiet Precision Gearheads

Moog Components Group precision gearheads, when coupled to our line of brush-type and brushless motors, provide the user with a quiet and powerful precision gearmotor. Available in a wide range of ratios and output torques, these gearmotors will meet the requirements of a vast number of applications. Life-time lubrication ensures long life and maintenance-free operation.

Our engineering department is available for consultation to help you tailor a gearmotor for your specific application.

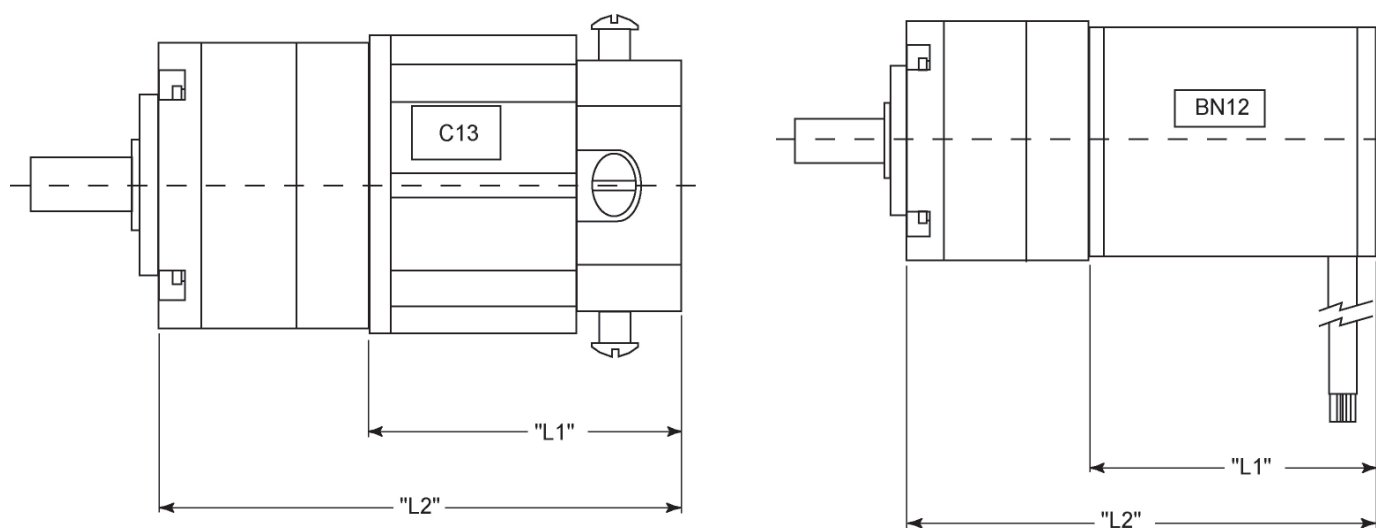
SPECIFICATIONS

Available Ratios	# of Stages	Output Torque	Shaft Inertia (gcm ²)
4:1 (3.70:1)	One	0.40 Nm (56.6 oz - in)	1.35
4:1 (4.28:1)	One	0.40 Nm (56.6 oz - in)	1.11
5:1 (5.18:1)	One	0.40 Nm (56.6 oz - in)	1.01
7:1 (6.75:1)	One	0.40 Nm (56.6 oz - in)	0.89
14:1 (13.73:1)	Two	1.0 Nm (141.6 oz - in)	1.38
16:1 (15.88:1)	Two	1.0 Nm (141.6 oz - in)	1.13
18:1 (18.36:1)	Two	1.0 Nm (141.6 oz - in)	1.12
19:1 (19.20:1)	Two	1.0 Nm (141.6 oz - in)	1.03
22:1 (22.20:1)	Two	1.0 Nm (141.6 oz - in)	1.02
25:1 (25.01:1)	Two	1.0 Nm (141.6 oz - in)	0.90
27:1 (26.85:1)	Two	1.0 Nm (141.6 oz - in)	1.01
29:1 (28.93:1)	Two	1.0 Nm (141.6 oz - in)	0.89
35:1 (34.97:1)	Two	1.0 Nm (141.6 oz - in)	0.89
46:1 (45.56:1)	Two	1.0 Nm (141.6 oz - in)	0.89
51:1 (50.89:1)	Three	2.0 Nm (283.2 oz - in)	1.38
59:1 (58.85:1)	Three	2.0 Nm (283.2 oz - in)	1.13
68:1 (68.06:1)	Three	2.0 Nm (283.2 oz - in)	1.12
71:1 (71.16:1)	Three	2.0 Nm (283.2 oz - in)	1.03
79:1 (78.71:1)	Three	2.0 Nm (283.2 oz - in)	1.12
93:1 (92.70:1)	Three	2.0 Nm (283.2 oz - in)	0.90
95:1 (95.17:1)	Three	2.0 Nm (283.2 oz - in)	1.02
100:1 (99.50:1)	Three	2.0 Nm (283.2 oz - in)	1.01
107:1 (107.20:1)	Three	2.0 Nm (283.2 oz - in)	0.89
115:1 (115.07:1)	Three	2.0 Nm (283.2 oz - in)	1.01
124:1 (123.97:1)	Three	2.0 Nm (283.2 oz - in)	0.89
130:1 (129.62:1)	Three	2.0 Nm (283.2 oz - in)	0.89
139:1 (139.13:1)	Three	2.0 Nm (283.2 oz - in)	1.01
150:1 (149.90:1)	Three	2.0 Nm (283.2 oz - in)	0.89
169:1 (168.84:1)	Three	2.0 Nm (283.2 oz - in)	0.89
181:1 (181.24:1)	Three	2.0 Nm (283.2 oz - in)	0.89
195:1 (195.26:1)	Three	2.0 Nm (283.2 oz - in)	0.89
236:1 (236.09:1)	Three	2.0 Nm (283.2 oz - in)	0.89
308:1 (307.54:1)	Three	2.0 Nm (283.2 oz - in)	0.89

32 mm Low Cost Technical Data

Parameter	Units	1-Stage	2-Stage	3-Stage
Max Input Speed	rpm	5000	5000	5000
Efficiency	%	75	70	65
Approx. Backlash(no-load, input locked)	DMS°	2.5	3.0	3.5
Sintered Bearing	-	-	-	-
Radial Load	N	15	30	45
Axial Load	N	5	10	15
Weight	g	100	115	130
Max Permitted Fitting Pressure	N	150	150	150
Dimension (diameter x length)	mm	32 x 56	32 x 65.5	32 x 84.5
Ball Bearing	-	-	-	-
Radial Load	N	40	70	100
Axial Load	N	10	20	30
Weight	g	120	135	150
Max Permitted Fitting Pressure	N	120	120	120
Dimension (diameter x length)	mm	32 x 52	32 x 61.5	32 x 80.5
Lubrication	Grease (life-time lubrication)			
Installation Attitude	Any			
Operating Temperature	-15 to +65° C			
Direction of Rotation	Same for input and output shaft			

Dimensional Drawings



Motor + Gearhead Dimensions*

Sintered Bearing Version	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C13-L19	1.90 in (48.3 mm)	3.317 in (84.3 mm)	3.691 in (93.8 mm)	4.065 in (103.3 mm)
C13-L25	2.45 in (62.2 mm)	3.867 in (98.2 mm)	4.241 in (107.7 mm)	4.615 in (117.2 mm)
C13-L28	2.78 in (70.6 mm)	4.197 in (106.6 mm)	4.571 in (116.1 mm)	4.945 in (125.6 mm)
BN12-15	1.50 in (38.1 mm)	3.350 in (85.1 mm)	3.724 in (94.6 mm)	4.098 in (104.1 mm)
BN12-20	2.00 in (50.8 mm)	3.850 in (97.8 mm)	4.224 in (107.3 mm)	4.598 in (116.8 mm)
BN12-25	2.50 in (63.5 mm)	4.350 in (110.5 mm)	4.724 in (120 mm)	5.098 in (129.5 mm)
BN12-30	3.00 in (76.2 mm)	4.850 in (123.2 mm)	5.224 in (132.7 mm)	5.598 in (142.2 mm)
Ball Bearing Version	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C13-L19	1.90 in (48.3 mm)	3.160 in (80.3 mm)	3.534 in (89.8 mm)	3.908 in (99.3 mm)
C13-L25	2.45 in (62.2 mm)	3.710 in (94.2 mm)	4.084 in (103.7 mm)	4.458 in (113.2 mm)
C13-L28	2.78 in (70.6 mm)	4.040 in (102.6 mm)	4.414 in (112.1 mm)	4.788 in (121.6 mm)
BN12-15	1.50 in (38.1 mm)	3.193 in (81.1 mm)	3.567 in (90.6 mm)	3.941 in (100.1 mm)
BN12-20	2.00 in (50.8 mm)	3.693 in (93.8 mm)	4.067 in (103.3 mm)	4.441 in (112.8 mm)
BN12-25	2.50 in (63.5 mm)	4.193 in (106.5 mm)	4.567 in (116 mm)	4.941 in (125.5 mm)
BN12-30	3.00 in (76.2 mm)	4.693 in (119.2 mm)	5.067 in (128.7 mm)	5.441 in (138.2 mm)

*All dimensions are reference dimensions

Ordering Information - Examples

32-SB-46:1 – 32 mm gearhead, 46:1 ratio, sintered bearing

32-BB-308:1 – 32 mm gearhead, 308:1 ratio, ball bearing

Precision Planetary Gearheads

TYPICAL APPLICATIONS

- Conveyor systems
- Medical pumps
- Packaging equipment
- Machine tools
- Factory automation
- Any application requiring:
 - Speed reduction
 - Torque multiplication

FEATURES

- Fits C13 brush-type motors
- Fits BN12 brushless motors
- Precision manufactured in accordance with DIN EN ISO 9001 Standards
- Compact design
- High efficiency
- Suitable for continuous, reversing and intermittent operation
- Can be installed in any attitude
- Life-time lubricant for maintenance-free operation

BENEFITS

- Coaxial arrangement of input and output
- Compact design
- High efficiency
- Low moments-of-inertia
- Can be installed in any attitude
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- Low sensitivity to impact load
- Large range of ratios available

32 mm (1.26 inch) Diameter



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Our engineering department is available for consultation to help you tailor a gearmotor for your specific application.

SPECIFICATIONS

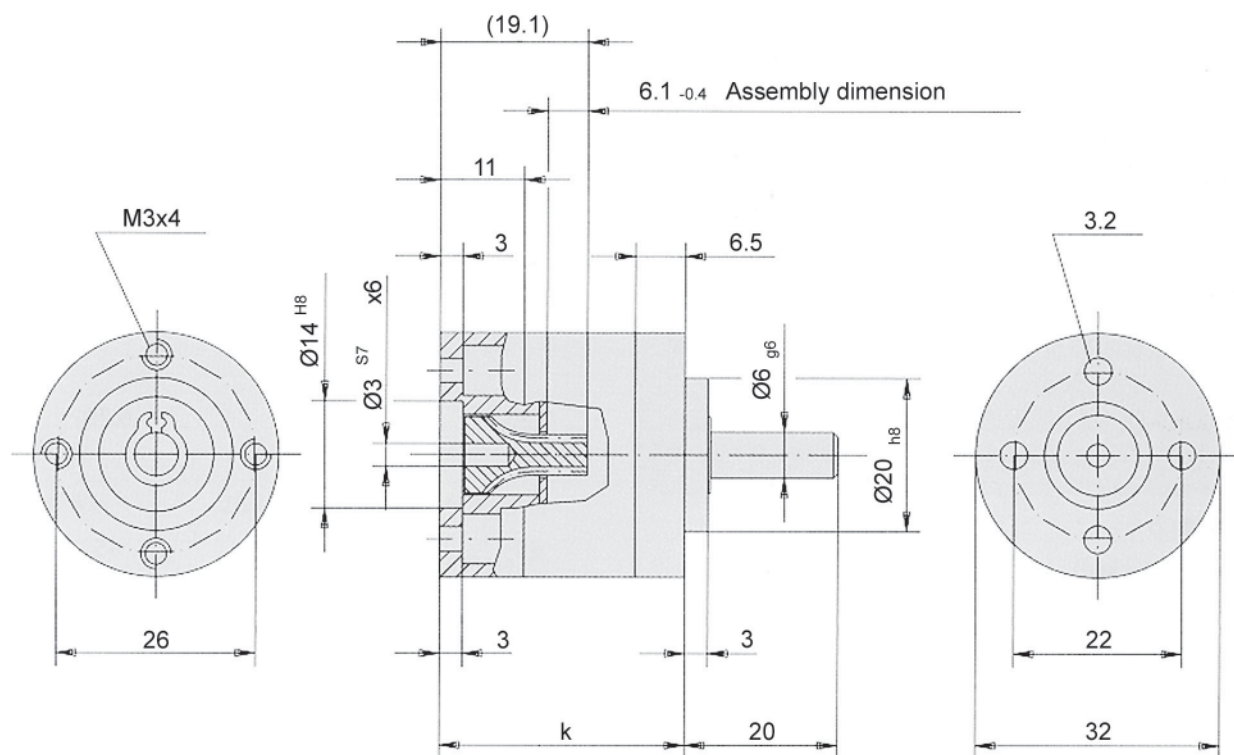
Available Ratios	# of Stages	Output Torque	Shaft Inertia (gcm ²)
4:1 (3.70:1)	One	0.75 Nm (106.2 oz - in)	1.54
4:1 (4.28:1)	One	0.75 Nm (106.2 oz - in)	1.29
5:1 (5.18:1)	One	0.75 Nm (106.2 oz - in)	1.14
7:1 (6.75:1)	One	0.75 Nm (106.2 oz - in)	0.89
14:1 (13.73:1)	Two	2.5 Nm (318.6 oz - in)	1.49
16:1 (15.88:1)	Two	2.5 Nm (318.6 oz - in)	1.25
18:1 (18.36:1)	Two	2.5 Nm (318.6 oz - in)	1.26
19:1 (19.20:1)	Two	2.5 Nm (318.6 oz - in)	1.12
22:1 (22.20:1)	Two	2.5 Nm (318.6 oz - in)	1.12
25:1 (25.01:1)	Two	2.5 Nm (318.6 oz - in)	0.96
27:1 (26.85:1)	Two	2.5 Nm (318.6 oz - in)	1.13
29:1 (28.93:1)	Two	2.5 Nm (318.6 oz - in)	0.96
35:1 (34.97:1)	Two	2.5 Nm (318.6 oz - in)	0.97
46:1 (45.56:1)	Two	2.5 Nm (318.6 oz - in)	0.98
51:1 (50.89:1)	Three	4.5 Nm (637.3 oz - in)	1.49
59:1 (58.85:1)	Three	4.5 Nm (637.3 oz - in)	1.25
68:1 (68.06:1)	Three	4.5 Nm (637.3 oz - in)	1.26
71:1 (71.16:1)	Three	4.5 Nm (637.3 oz - in)	1.12
79:1 (78.71:1)	Three	4.5 Nm (637.3 oz - in)	1.26
93:1 (92.70:1)	Three	4.5 Nm (637.3 oz - in)	0.96
95:1 (95.17:1)	Three	4.5 Nm (637.3 oz - in)	1.12
100:1 (99.50:1)	Three	4.5 Nm (637.3 oz - in)	1.13
107:1 (107.20:1)	Three	4.5 Nm (637.3 oz - in)	0.96
115:1 (115.07:1)	Three	4.5 Nm (637.3 oz - in)	1.13
124:1 (123.97:1)	Three	4.5 Nm (637.3 oz - in)	0.96
130:1 (129.62:1)	Three	4.5 Nm (637.3 oz - in)	0.97
139:1 (139.13:1)	Three	4.5 Nm (637.3 oz - in)	1.13
150:1 (149.90:1)	Three	4.5 Nm (637.3 oz - in)	0.97
169:1 (168.84:1)	Three	4.5 Nm (637.3 oz - in)	0.96
181:1 (181.24:1)	Three	4.5 Nm (637.3 oz - in)	0.97
195:1 (195.26:1)	Three	4.5 Nm (637.3 oz - in)	0.96
236:1 (236.09:1)	Three	4.5 Nm (637.3 oz - in)	0.96
308:1 (307.54:1)	Three	4.5 Nm (637.3 oz - in)	0.96

32 mm Technical Data

Parameter	Units	1-Stage	2-Stage	3-Stage
Max Input Speed	rpm	5000	5000	5000
Efficiency	%	80	75	70
Approx. Backlash (no-load, input locked)	DMS°	1.5	2.0	2.5
Radial Load	N	40	70	100
Axial Load	N	10	20	30
Max Permitted Fitting Pressure	N	120	120	120
Weight	g	160	210	260
Dimension (diameter x length)	mm	32 x 52	32 x 61.5	32 x 71
Lubrication	Grease (life-time lubrication)			
Installation Attitude	Any			
Operating Temperature	-15 to +80° C			
Direction of Rotation	Same for input and output shaft			

Package Dimensions

Basic Version

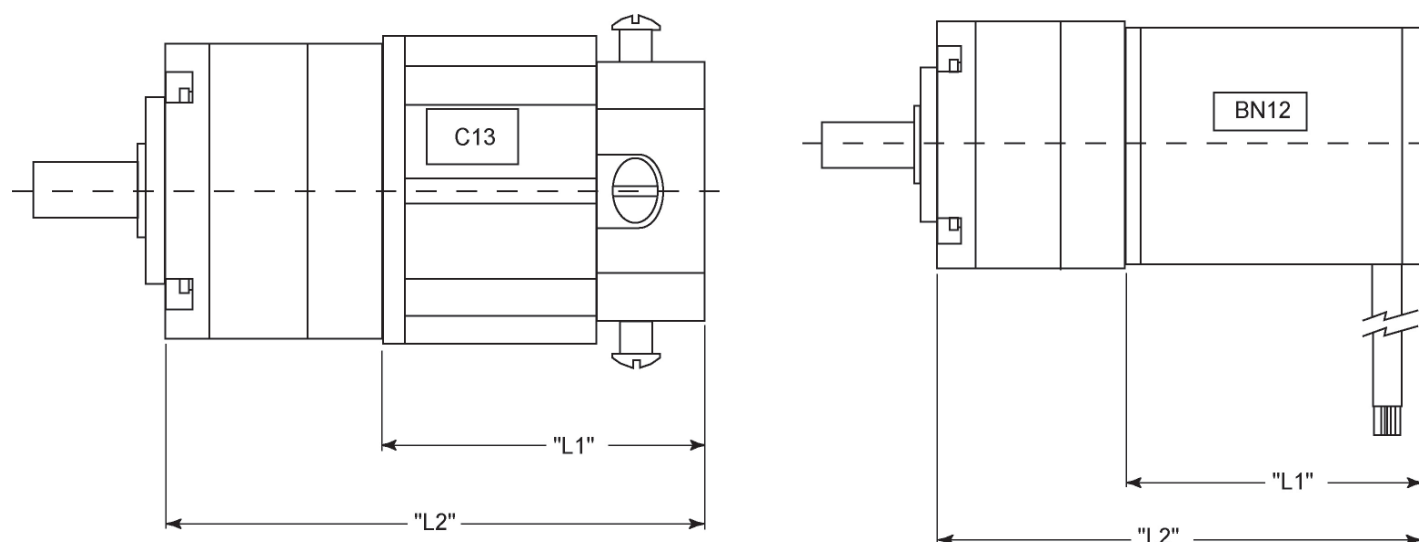


Gear Unit Length			1-Stage	2-Stage	3-Stage	4-Stage
K			32	41.5	51	60.5

We reserve the right to make technical changes.

Note: All dimension on this page are in millimeters.

Dimensional Drawings



Motor + Gearhead Dimensions*

	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C13-L19	1.90 in (48.3 mm)	3.160 in (80.3 mm)	3.534 in (89.8 mm)	3.908 in (99.3 mm)
C13-L25	2.45 in (62.2 mm)	3.710 in (94.2 mm)	4.084 in (103.7 mm)	4.458 in (113.2 mm)
C13-L28	2.78 in (70.6 mm)	4.040 in (102.6 mm)	4.414 in (112.1 mm)	4.788 in (121.6 mm)
BN12-15	1.50 in (38.1 mm)	3.193 in (81.1 mm)	3.567 in (90.6 mm)	3.941 in (100.1 mm)
BN12-20	2.00 in (50.8 mm)	3.693 in (93.8 mm)	4.067 in (103.3 mm)	4.441 in (112.8 mm)
BN12-25	2.50 in (63.5 mm)	4.193 in (106.5 mm)	4.567 in (116 mm)	4.941 in (125.5 mm)
BN12-30	3.00 in (76.2 mm)	4.693 in (119.2 mm)	5.067 in (128.7 mm)	5.441 in (138.2 mm)

*All dimensions are reference dimensions

Ordering Information - Examples

32-46:1 – 32 mm gearhead, 46:1 ratio
 32-308:1 – 32 mm gearhead, 308:1 ratio

Precision Planetary Gearheads

TYPICAL APPLICATIONS

- Conveyor systems
- Medical pumps
- Packaging equipment
- Machine tools
- Factory automation
- Any application requiring:
 - Speed reduction
 - Torque multiplication

FEATURES

- Fits C23 brush-type motors
- Fits BN23 brushless motors
- Precision manufactured in accordance with DIN EN ISO 9001 Standards
- Compact design
- High efficiency
- Suitable for continuous, reversing and intermittent operation
- Can be installed in any attitude
- Life-time lubricant for maintenance-free operation

BENEFITS

- Coaxial arrangement of input and output
- Compact design
- High efficiency
- Low moments-of-inertia
- Can be installed in any attitude
- Suitable for continuous, reversing and intermittent operation
- Low sensitivity to impact load
- Large range of ratios available

52 mm (2.44 inch) Diameter



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SPECIFICATIONS

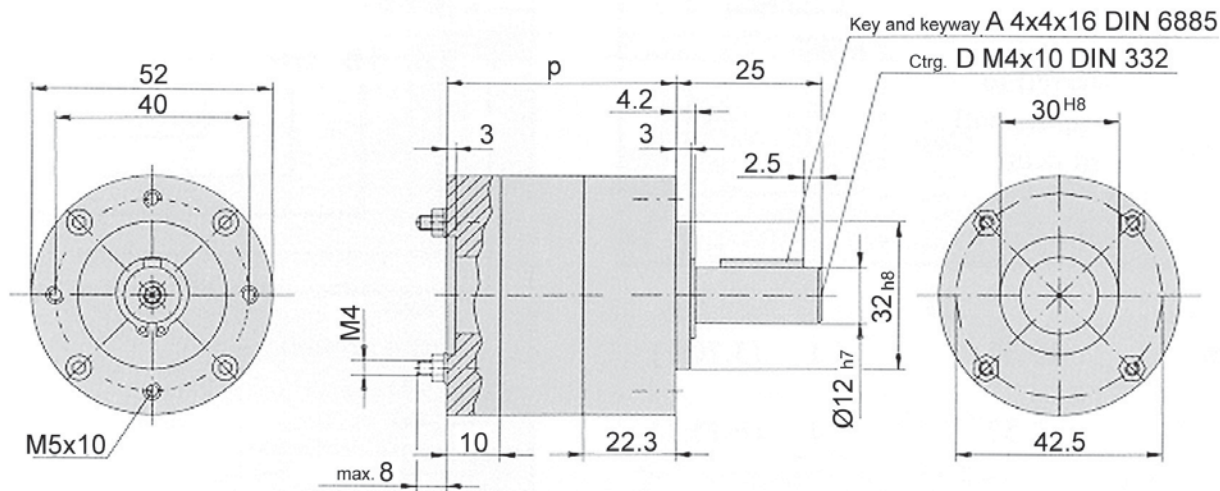
Available Ratios	# of Stages	Output Torque	Shaft Inertia (gcm ²)
4:1 (3.70:1)	One	4.0 Nm (2.95 ft - lbs)	16.57
7:1 (6.75:1)	One	4.0 Nm (2.95 ft - lbs)	9.52
14:1 (13.73:1)	Two	12.0 Nm (8.85 ft - lbs)	16.49
25:1 (25.01:1)	Two	12.0 Nm (8.85 ft - lbs)	9.33
46:1 (45.56:1)	Two	12.0 Nm (8.85 ft - lbs)	9.21
51:1 (50.89:1)	Three	25.0 Nm (18.4 ft - lbs)	16.49
93:1 (92.70:1)	Three	25.0 Nm (18.4 ft - lbs)	9.32
169:1 (168.84:1)	Three	25.0 Nm (18.4 ft - lbs)	9.21
308:1 (307.54:1)	Three	25.0 Nm (18.4 ft - lbs)	9.21

52 mm Technical Data

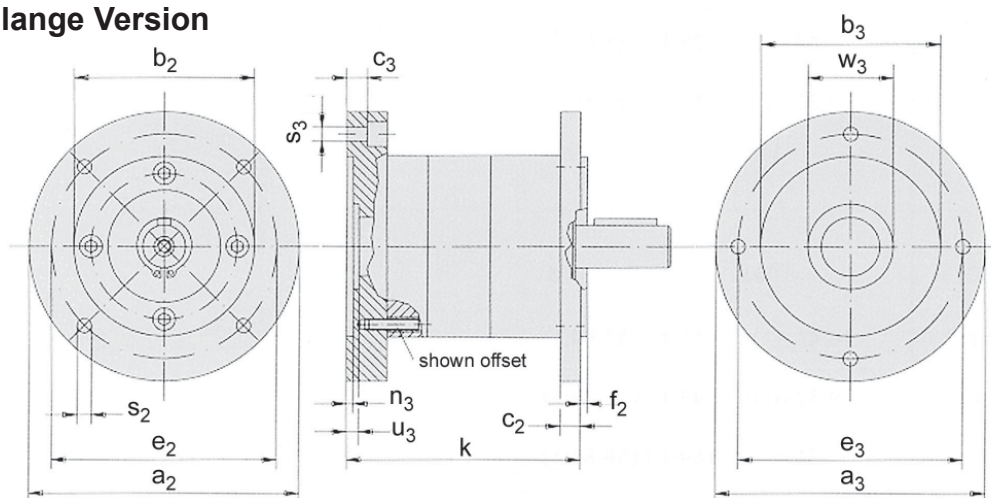
Parameter	Units	1-Stage	2-Stage	3-Stage
Max Input Speed	rpm	5000	5000	5000
Efficiency	%	80	75	70
Approx. Backlash(no-load, input locked)	Minutes	45	45	45
Radial Load	N	200	320	450
Axial Load	N	60	100	150
Max Permitted Fitting Pressure	N	500	500	500
Weight	kg	0.7	0.9	1.1
Dimension (diameter x length)	mm	52 x 81	52 x 95	52 x 109
Lubrication	Grease (life-time lubrication)			
Installation Attitude	Any			
Operating Temperature	-15 to +80° C			
Direction of Rotation	Same for input and output shaft			

Package Dimensions

Basic Version



Standard Flange Version



Gear Unit Length				1-Stage	2-Stage	3-Stage
P				56	70	84
K				83	97	111

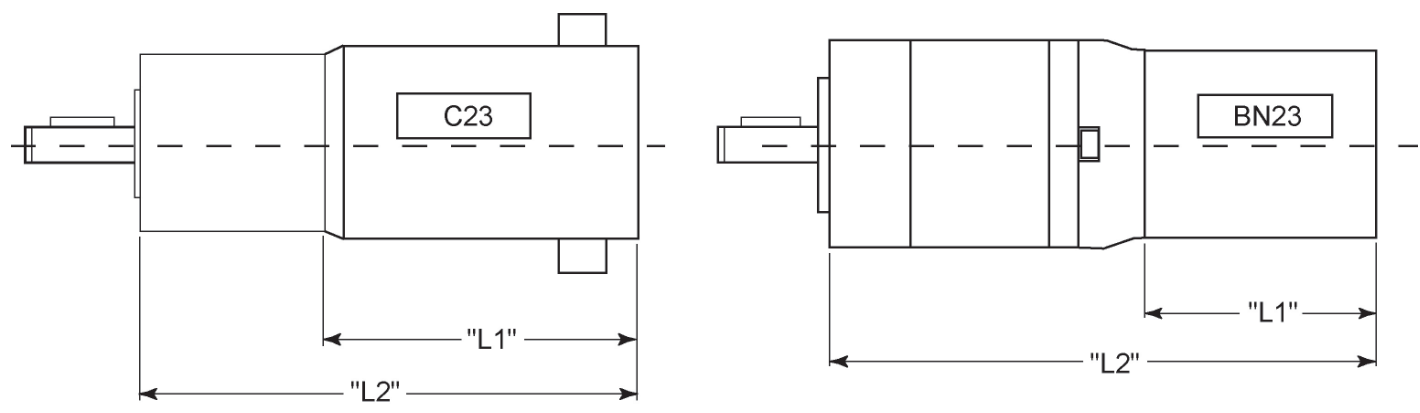
DIM of Motor Mounting Flange		a_3	b_3	u_3	c_3	e_3	n_3	w_3	s_3
Motor size 56	C 80	80	50 H7	38 H7	10.2	65	3	5.5	5.5
(B14, B3/B14)	C 105	105	70 H7	-	10.2	85	3	-	6.5

DIM of Gear Unit Output Flan		a_2	b_2	c_2	e_2	f_2	s_2
C 80		80	50 j7	9	65	2.5	5.5
C 90		90	60 j7	9	75	2.5	5.5
C 105		105	70 j7	9	85	2.5	6.5
C 120		120	80 j7	9	100	3.0	6.5

We reserve the right to make technical changes.

Note: All dimension on this page are in millimeters.

Dimensional Drawings



Motor + Gearhead Dimensions*

	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C23-L33	3.30 in (83.8 mm)	5.754 in (146.2 mm)	6.306 in (160.2 mm)	6.857 in (174.2 mm)
C23-L40	4.00 in (101.6 mm)	6.454 in (163.9 mm)	7.006 in (178 mm)	*7.557 in (191.9 mm)
C23-L45	4.50 in (114.3 mm)	6.954 in (176.6 mm)	7.506 in (190.7 mm)	8.057 in (204.6 mm)
C23-L50	5.00 in (127 mm)	7.454 in (189.3 mm)	8.006 in (203.4 mm)	8.557 in (217.3 mm)
C23-L55	5.50 in (139.7 mm)	7.954 in (202 mm)	8.506 in (216.1 mm)	9.057 in (230 mm)
BN23-13	1.30 in (33 mm)	4.038 in (102.6 mm)	4.590 in (116.6 mm)	5.141 in (130.6 mm)
BN23-18	1.80 in (45.7 mm)	4.538 in (115.3 mm)	5.090 in (129.3 mm)	5.641 in (143.3 mm)
BN23-23	2.30 in (58.4 mm)	5.038 in (128 mm)	5.590 in (142 mm)	6.141 in (156 mm)
BN23-28	2.80 in (71.1 mm)	5.538 in (140.7 mm)	6.090 in (154.7 mm)	6.641 in (168.7 mm)

*All dimensions are reference dimensions

Ordering Information - Examples

52-46:1 – 52 mm gearhead, 46:1 ratio
52-308:1 – 52 mm gearhead, 308:1 ratio

Precision Planetary Gearheads

TYPICAL APPLICATIONS

- Conveyor systems
- Medical pumps
- Packaging equipment
- Machine tools
- Factory automation
- Any application requiring:
 - Speed reduction
 - Torque multiplication

FEATURES

- Fits C23 brush-type motors
- Fits BN23 brushless motors
- Precision manufactured in accordance with DIN EN ISO 9001 Standards
- Compact design
- High efficiency
- Suitable for continuous, reversing and intermittent operation
- Can be installed in any attitude
- Life-time lubricant for maintenance-free operation

BENEFITS

- Coaxial arrangement of input and output
- Compact design
- High efficiency
- Low moments-of-inertia
- Can be installed in any attitude
- Suitable for continuous, reversing and intermittent operation
- Low sensitivity to impact load
- Large range of ratios available

62 mm (2.44 inch) Diameter



Quiet Precision Gearheads

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Our engineering department is available for consultation to help you tailor a gearmotor for your specific application.

SPECIFICATIONS

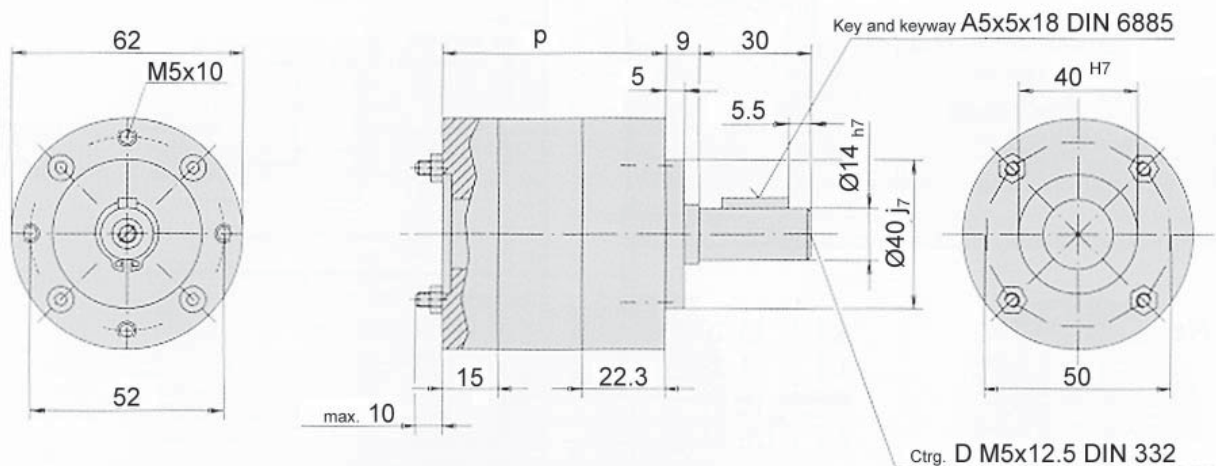
Available Ratios	# of Stages	Output Torque	Shaft Inertia (gcm ²)
4:1 (3.70:1)	One	8.0 Nm (5.90 ft - lbs)	0.037
4:1 (4.28:1)	One	8.0 Nm (5.90 ft - lbs)	0.029
5:1 (5.18:1)	One	8.0 Nm (5.90 ft - lbs)	0.023
7:1 (6.75:1)	One	8.0 Nm (5.90 ft - lbs)	0.017
14:1 (13.73:1)	Two	25.0 Nm (18.44 ft - lbs)	0.035
16:1 (15.88:1)	Two	25.0 Nm (18.44 ft - lbs)	0.028
18:1 (18.36:1)	Two	25.0 Nm (18.44 ft - lbs)	0.028
19:1 (19.20:1)	Two	25.0 Nm (18.44 ft - lbs)	0.022
22:1 (22.20:1)	Two	25.0 Nm (18.44 ft - lbs)	0.022
25:1 (25.01:1)	Two	25.0 Nm (18.44 ft - lbs)	0.017
27:1 (26.85:1)	Two	25.0 Nm (18.44 ft - lbs)	0.022
29:1 (28.93:1)	Two	25.0 Nm (18.44 ft - lbs)	0.017
35:1 (34.97:1)	Two	25.0 Nm (18.44 ft - lbs)	0.017
46:1 (45.56:1)	Two	25.0 Nm (18.44 ft - lbs)	0.017
51:1 (50.89:1)	Three	50.0 Nm (36.88 ft - lbs)	0.035
59:1 (58.85:1)	Three	50.0 Nm (36.88 ft - lbs)	0.028
68:1 (68.06:1)	Three	50.0 Nm (36.88 ft - lbs)	0.028
71:1 (71.16:1)	Three	50.0 Nm (36.88 ft - lbs)	0.021
79:1 (78.71:1)	Three	50.0 Nm (36.88 ft - lbs)	0.028
93:1 (92.70:1)	Three	50.0 Nm (36.88 ft - lbs)	0.016
95:1 (95.17:1)	Three	50.0 Nm (36.88 ft - lbs)	0.022
100:1 (99.50:1)	Three	50.0 Nm (36.88 ft - lbs)	0.022
107:1 (107.20:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
115:1 (115.07:1)	Three	50.0 Nm (36.88 ft - lbs)	0.022
124:1 (123.97:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
130:1 (129.62:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
139:1 (139.13:1)	Three	50.0 Nm (36.88 ft - lbs)	0.022
150:1 (149.90:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
169:1 (168.84:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
181:1 (181.24:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
195:1 (195.26:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
236:1 (236.09:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017
308:1 (307.54:1)	Three	50.0 Nm (36.88 ft - lbs)	0.017

62 mm Technical Data

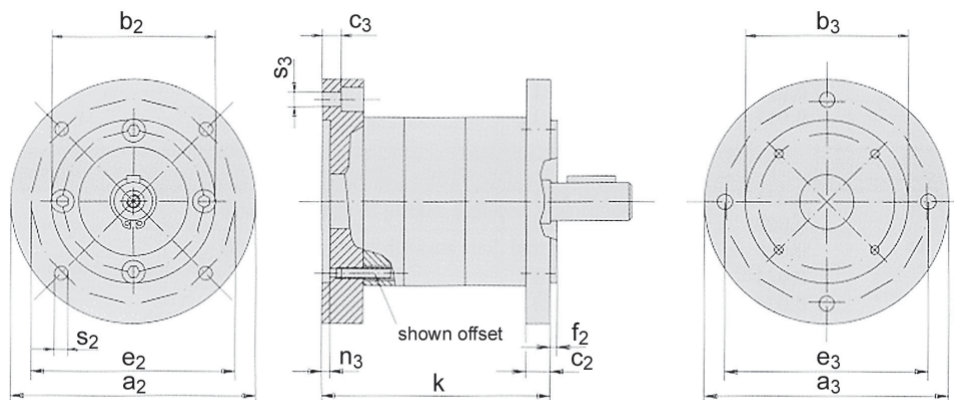
Parameter	Units	1-Stage	2-Stage	3-Stage
Max Input Speed	rpm	5000	5000	5000
Efficiency	%	80	75	70
Approx. Backlash (no-load, input locked)	DMS°	1.0	1.5	2.0
Radial Load	N	240	360	520
Axial Load	N	50	70	120
Max Permitted Fitting Pressure	N	1000	1000	1000
Weight	kg	0.8	1.2	1.6
Dimension (diameter x length)	mm	62 x 102	62 x 118	62 x 134
Lubrication	Grease (life-time lubrication)			
Installation Attitude	Any			
Operating Temperature	-15 to +80° C			
Direction of Rotation	Same for input and output shaft			

Package Dimensions

Basic Version



Standard Flange Version



Gear Unit Length				1-Stage	2-Stage	3-Stage
P				63	77	93
K				84	100	116

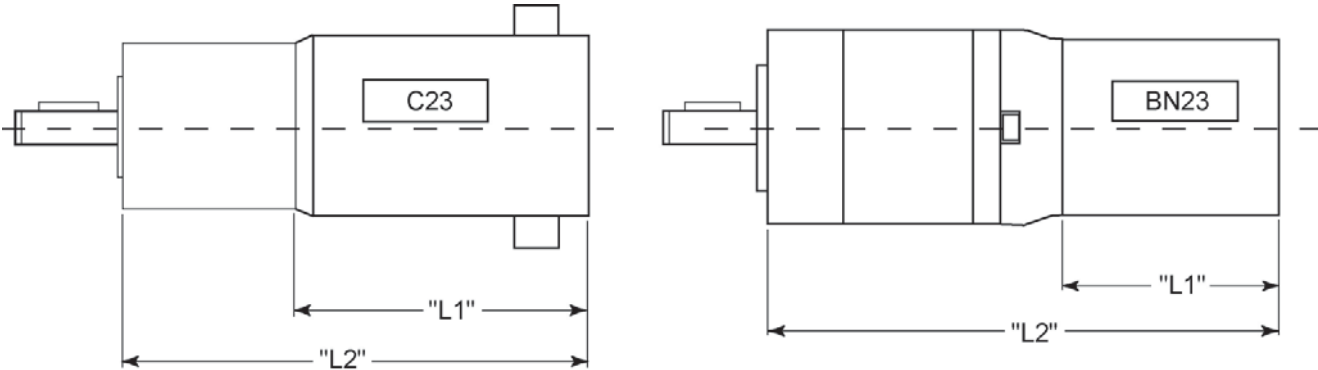
DIM of Motor Mounting Flange		a_3	b_3	c_3	e_3	n_3	s_3
Motor size 56 (B14, B3/B14)	C 80	80	50 H7	7	65	3	5.5
	C 105	105	70 H7	7	85	3	6.5
Motor size 63 (B14, B3/B14)	C 90	90	60 H7	7	75	3	5.5
	C 120	120	80 H7	7	100	3.5	6.5

DIM of Gear Unit Output Flange		a_2	b_2	c_2	e_2	f_2	s_2
C 80		80	50 J7	9	65	2.5	M5
C 90		90	60 J7	9	75	2.5	5.5
C 105		105	70 J7	9	85	2.5	6.5
C 120		120	80 J7	9	100	3.0	6.5

We reserve the right to make technical changes.

Note: All dimension on this page are in millimeters.

Dimensional Drawings



Motor + Gearhead Dimensions*

	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C23-L33	3.30 in (83.8 mm)	6.030 in (153.2 mm)	6.581 in (167.2 mm)	7.211 in (183.2 mm)
C23-L40	4.00 in (101.6 mm)	6.730 in (170.9 mm)	7.281 in (184.9 mm)	7.911 in (200.9 mm)
C23-L45	4.50 in (114.3 mm)	7.230 in (183.6 mm)	7.781 in (197.6 mm)	8.411 in (213.6 mm)
C23-L50	5.00 in (127 mm)	7.730 in (196.3 mm)	8.281 in (210.3 mm)	8.911 in (226.3 mm)
C23-L55	5.50 in (139.7 mm)	8.230 in (209 mm)	8.781 in (223 mm)	9.411 in (239 mm)
BN23-13	1.30 in (33 mm)	4.314 in (109.6 mm)	4.865 in (123.6 mm)	5.495 in (139.6 mm)
BN23-18	1.80 in (45.7 mm)	4.814 in (122.3 mm)	5.365 in (136.3 mm)	5.995 in (152.3 mm)
BN23-23	2.30 in (58.4 mm)	5.314 in (135 mm)	5.865 in (149 mm)	6.495 in (165 mm)
BN23-28	2.80 in (71.1 mm)	5.814 in (147.7 mm)	6.365 in (161.7 mm)	6.995 in (177.7 mm)

*All dimensions are reference dimensions

Ordering Information - Examples

62-46:1 – 62 mm gearhead, 46:1 ratio
62-308:1 – 62 mm gearhead, 308:1 ratio

Precision Planetary Gearheads

TYPICAL APPLICATIONS

- Conveyor systems
- Medical pumps
- Packaging equipment
- Machine tools
- Factory automation
- Any application requiring:
 - Speed reduction
 - Torque multiplication

FEATURES

- Fits C34 brush-type motors
- Fits BN34 brushless motors
- Precision manufactured in accordance with DIN EN ISO 9001 Standards
- Compact design
- High efficiency
- Suitable for continuous, reversing and intermittent operation
- Can be installed in any attitude
- Life-time lubricant for maintenance-free operation
- Large number of ratios available
- Wide operating temperature range

BENEFITS

- Coaxial arrangement of input and output
- Compact design
- High efficiency
- Low moments-of-inertia
- Can be installed in any attitude
- Suitable for continuous, reversing and intermittent operation
- Low sensitivity to impact load
- Large range of ratios available

81 mm (3.19 inch) Diameter



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Our engineering department is available for consultation to help you tailor a gearmotor for your specific application.

SPECIFICATIONS

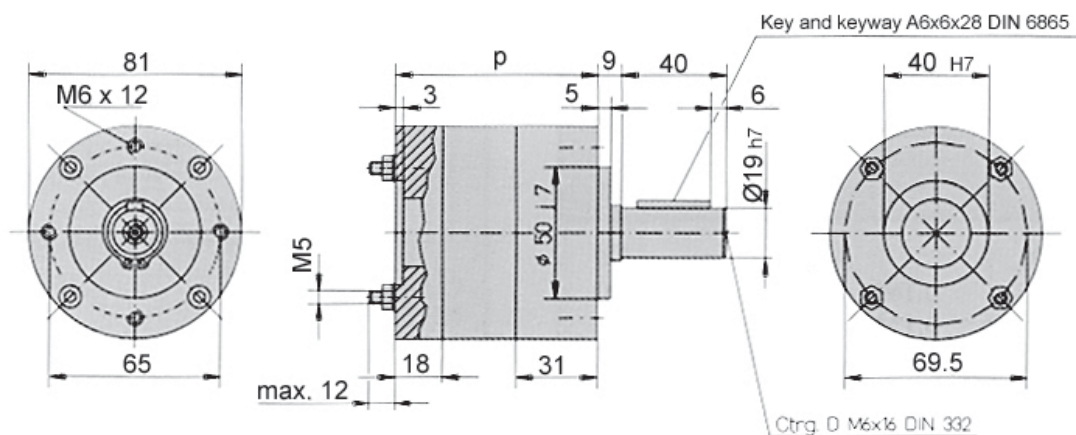
Available Ratios	# of Stages	Output Torque	Shaft Inertia (gcm ²)
4:1 (3.70:1)	One	20.0 Nm (14.75 ft - lbs)	0.165
4:1 (4.28:1)	One	20.0 Nm (14.75 ft - lbs)	0.134
5:1 (5.18:1)	One	20.0 Nm (14.75 ft - lbs)	0.109
7:1 (6.75:1)	One	20.0 Nm (14.75 ft - lbs)	0.091
14:1 (13.73:1)	Two	60.0 Nm (44.25 ft - lbs)	0.155
16:1 (15.88:1)	Two	60.0 Nm (44.25 ft - lbs)	0.127
18:1 (18.36:1)	Two	60.0 Nm (44.25 ft - lbs)	0.129
19:1 (19.20:1)	Two	60.0 Nm (44.25 ft - lbs)	0.100
22:1 (22.20:1)	Two	60.0 Nm (44.25 ft - lbs)	0.105
25:1 (25.01:1)	Two	60.0 Nm (44.25 ft - lbs)	0.125
27:1 (26.85:1)	Two	60.0 Nm (44.25 ft - lbs)	0.105
29:1 (28.93:1)	Two	60.0 Nm (44.25 ft - lbs)	0.088
35:1 (34.97:1)	Two	60.0 Nm (44.25 ft - lbs)	0.089
46:1 (45.56:1)	Two	60.0 Nm (18.44 ft - lbs)	0.089
51:1 (50.89:1)	Three	120.0 Nm (88.50 ft - lbs)	0.154
59:1 (58.85:1)	Three	120.0 Nm (88.50 ft - lbs)	0.126
68:1 (68.06:1)	Three	120.0 Nm (88.50 ft - lbs)	0.127
71:1 (71.16:1)	Three	120.0 Nm (88.50 ft - lbs)	0.104
79:1 (78.71:1)	Three	120.0 Nm (88.50 ft - lbs)	0.127
93:1 (92.70:1)	Three	120.0 Nm (88.50 ft - lbs)	0.088
95:1 (95.17:1)	Three	120.0 Nm (88.50 ft - lbs)	0.104
100:1 (99.50:1)	Three	120.0 Nm (88.50 ft - lbs)	0.105
107:1 (107.20:1)	Three	120.0 Nm (88.50 ft - lbs)	0.088
115:1 (115.07:1)	Three	120.0 Nm (88.50 ft - lbs)	0.105
124:1 (123.97:1)	Three	120.0 Nm (88.50 ft - lbs)	0.088
130:1 (129.62:1)	Three	120.0 Nm (88.50 ft - lbs)	0.088
139:1 (139.13:1)	Three	120.0 Nm (88.50 ft - lbs)	0.102
150:1 (149.90:1)	Three	120.0 Nm (88.50 ft - lbs)	0.088
169:1 (168.84:1)	Three	120.0 Nm (88.50 ft - lbs)	0.089
181:1 (181.24:1)	Three	120.0 Nm (88.50 ft - lbs)	0.088
195:1 (195.26:1)	Three	120.0 Nm (88.50 ft - lbs)	0.089
236:1 (236.09:1)	Three	120.0 Nm (88.50 ft - lbs)	0.089
308:1 (307.54:1)	Three	120.0 Nm (88.50 ft - lbs)	0.089

81 mm Technical Data

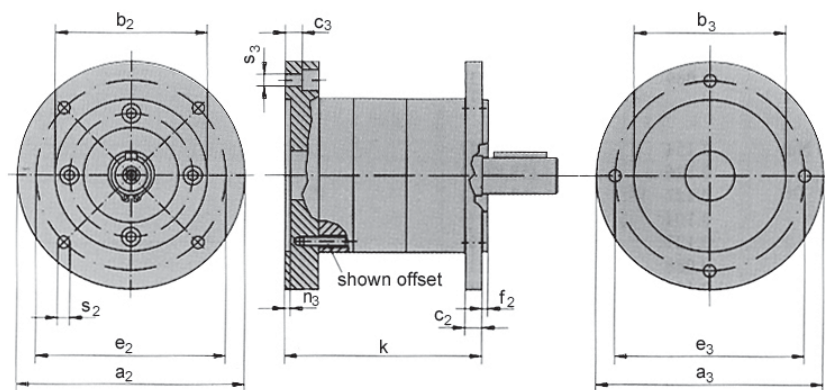
Parameter	Units	1-Stage	2-Stage	3-Stage
Max Input Speed	rpm	5000	5000	5000
Efficiency	%	80	75	70
Approx. Backlash (no-load, input locked)	DMS°	1.0	1.5	2.0
Radial Load	N	400	600	1000
Axial Load	N	80	120	200
Max Permitted Fitting Pressure	N	1500	1500	1500
Weight	kg	1.8	2.5	3.2
Dimension (diameter x length)	mm	81 x 126	81 x 148	81 x 170
Lubrication	Grease (life-time lubrication)			
Installation Attitude	Any			
Operating Temperature	-15 to +80° C			
Direction of Rotation	Same for input and output shaft			

Package Dimensions

Basic Version



Standard Flange Version



Gear Unit Length P81 / SP81		1-Stage	2-Stage	3-Stage
P		77	99	121
K		104	125	147

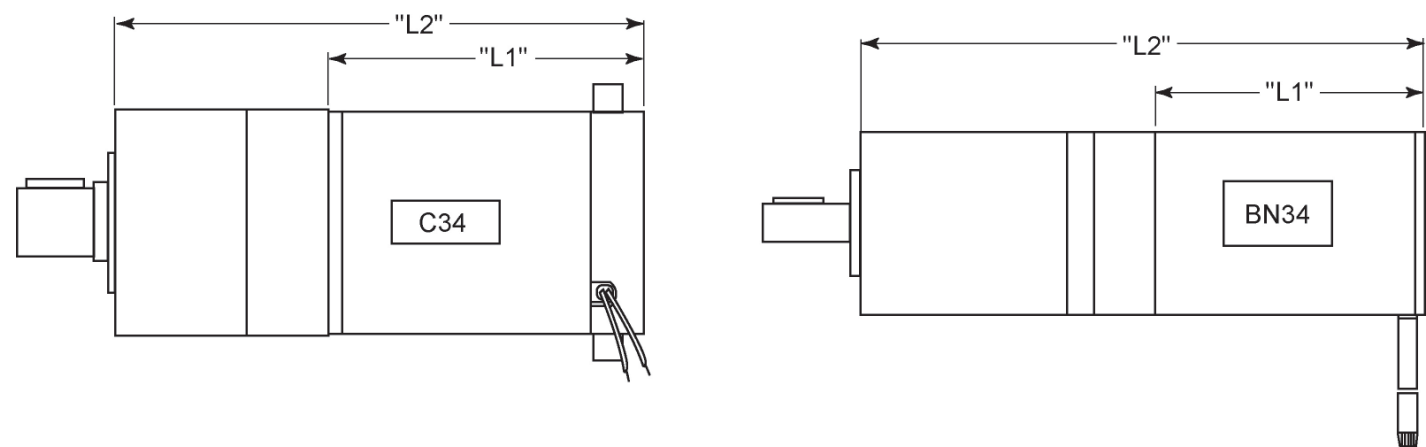
DIM of Motor Mounting Flange		a_3	b_3	c_3	e_3	n_3	s_3
Motor size 56 (B14, B3/B14)	C 80	81	50 H7	9	65	3.0	5.3
	C 105	105	70 H7	9	85	3.0	6.3
Motor size 63 (B14, B3/B14)	C 90	90	60 H7	9	75	3.0	5.3
	C 120	120	80 H7	9	100	3.5	6.3

DIM of Gear Unit Output Flange		a_2	b_2	c_2	e_2	f_2	s_2
C 90		90	60 J7	9	75	2.5	M5
C 105		105	70 J7	9	85	2.5	M6
C 120		120	80 J7	9	100	3.0	6.5

We reserve the right to make technical changes.

Note: All dimension on this page are in millimeters.

Dimensional Drawings



Motor + Gearhead Dimensions*

	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C34-L60	6.00 in (152.4 mm)	9.781 in (248.4 mm)	10.647 in (270.4 mm)	11.514 in (292.5 mm)
C34-L70	7.00 in (177.8 mm)	10.781 in (273.8 mm)	11.647 in (295.8 mm)	12.514 in (317.9 mm)
C34-L80	8.00 in (203.2 mm)	11.781 in (299.2 mm)	12.647 in (321.2 mm)	13.514 in (343.3 mm)
BN34-25	2.50 in (63.5 mm)	6.281 in (159.5 mm)	7.147 in (181.5 mm)	8.014 in (203.6 mm)
BN34-35	3.50 in (88.9 mm)	7.281 in (184.9 mm)	8.147 in (213.8 mm)	9.014 in (229 mm)
BN34-45	4.50 in (114.3 mm)	8.281 in (210.3 mm)	9.147 in (232.3 mm)	10.014 in (254.4 mm)
BN34-55	5.50 in (139.7 mm)	9.281 in (235.7 mm)	10.147 in (257.7mm)	11.014 in (279.8 mm)

*All dimensions are reference dimensions

Ordering Information - Examples

81-46:1 – 81 mm gearhead, 46:1 ratio
81-308:1 – 81 mm gearhead, 308:1 ratio

Precision Planetary Gearheads

TYPICAL APPLICATIONS

- Conveyor systems
- Medical pumps
- Packaging equipment
- Machine tools
- Factory automation
- Any application requiring:
 - Speed reduction
 - Torque multiplication

FEATURES

- Fits C42 brush-type motors
- Fits BN42 brushless motors
- Precision manufactured in accordance with DIN EN ISO 9001 Standards
- Compact design
- High efficiency
- Suitable for continuous, reversing and intermittent operation
- Can be installed in any attitude
- Life-time lubricant for maintenance-free operation

BENEFITS

- Coaxial arrangement of input and output
- Compact design
- High efficiency
- Low moments-of-inertia
- Can be installed in any attitude
- Suitable for continuous, reversing and intermittent operation
- Low sensitivity to impact load
- Large range of ratios available

120 mm (4.72 inch) Diameter



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Our engineering department is available for consultation to help you tailor a gearmotor for your specific application.

SPECIFICATIONS

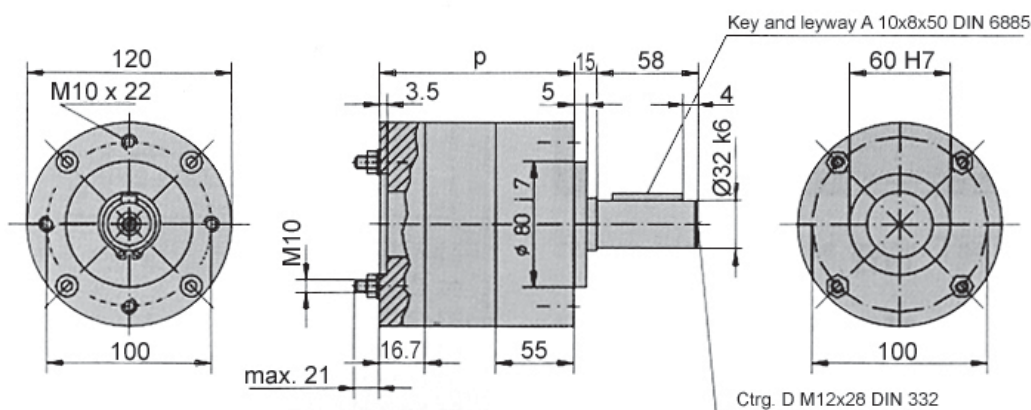
Available Ratios	# of Stages	Output Torque	Shaft Inertia (gcm ²)
4:1 (3.70:1)	One	50.0 Nm (36.88 ft - lbs)	1.112
7:1 (6.75:1)	One	50.0 Nm (36.88 ft - lbs)	0.557
14:1 (13.73:1)	Two	150.0 Nm (110.6 ft - lbs)	0.997
25:1 (25.01:1)	Two	150.0 Nm (110.6 ft - lbs)	0.515
46:1 (45.56:1)	Two	150.0 Nm (110.6 ft - lbs)	0.520
51:1 (50.89:1)	Three	300.0 Nm (221.3 ft - lbs)	0.967
93:1 (92.70:1)	Three	300.0 Nm (221.3 ft - lbs)	0.513
169:1 (168.84:1)	Three	300.0 Nm (221.3 ft - lbs)	0.519
308:1 (307.54:1)	Three	300.0 Nm (221.3 ft - lbs)	0.519

120 mm Technical Data

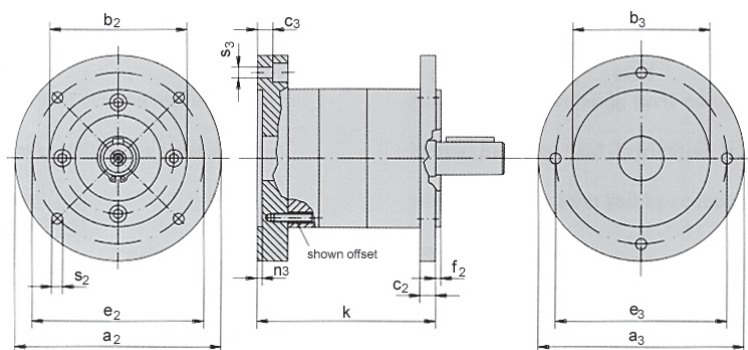
Parameter	Units	1-Stage	2-Stage	3-Stage
Max Input Speed	rpm	5000	5000	5000
Efficiency	%	80	75	70
Approx. Backlash (no-load, input locked)	DMS°	1.0	1.5	2.0
Radial Load	N	600	900	1500
Axial Load	N	120	180	300
Max Permitted Fitting Pressure	N	2500	2500	2500
Weight	kg	5.6	8.0	10.4
Dimension (diameter x length)	mm	120 x 180	120 x 214	120 x 248
Lubrication	Grease (life-time lubrication)			
Installation Attitude	Any			
Operating Temperature	-15 to +80° C			
Direction of Rotation	Same for input and output shaft			

Package Dimensions

Basic Version



Standard Flange Version



Gear Unit Length		1-Stage	2-Stage	3-Stage
P		107	141	175
Motor size 71	K	150	184	218
Motor size 80	K	160	194	228

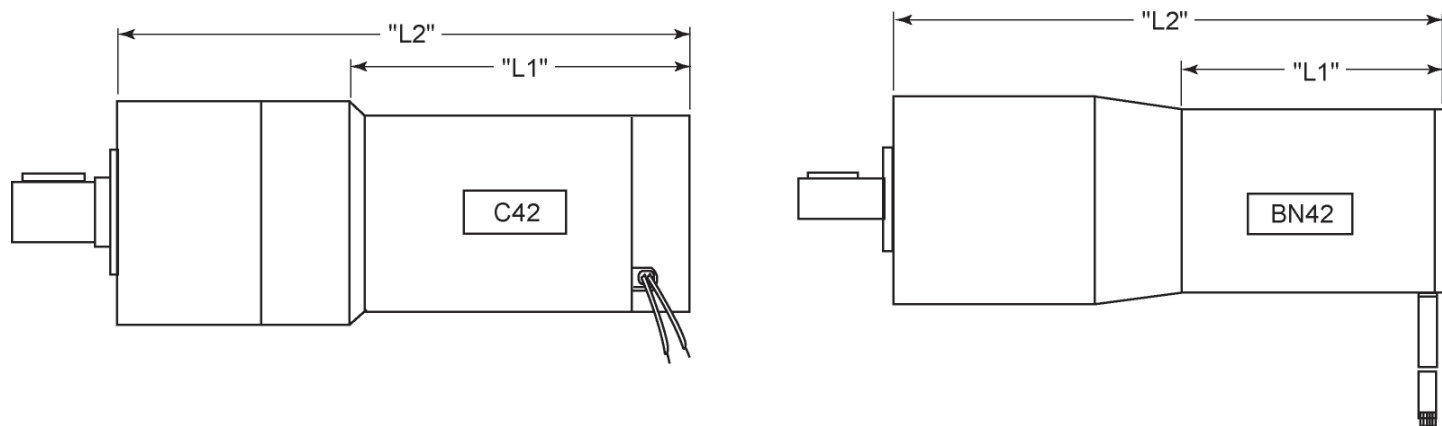
DIM of Motor Mounting Flange		a_3	b_3	c_3	e_3	n_3	s_3
Motor size 71 (B14, B3/B14)	C 105	120	70 H7	15	85	3.0	6.4
	C 140	140	95 H7	15	115	3.5	8.4
Motor size 80 (B14, B3/B14)	C 120	120	80 H7	15	100	3.5	6.4
	C 160	160	110 H7	15	130	4.0	8.4

DIM of Gear Unit Output Flange		a_2	b_2	c_2	e_2	f_2	s_2
C 140		140	95 J7	15	115	3.0	M8
C 160		160	110 J7	15	130	3.5	M8

We reserve the right to make technical changes.

Note: All dimension on this page are in millimeters.

Dimensional Drawings



Motor + Gearhead Dimensions*

	L1 Max	L2 Max (1-Stage)	L2 Max (2-Stage)	L2 Max (3-Stage)
C42-L50	5.00 in (127 mm)	10.213 in (259.4 mm)	11.551 in (293.4 mm)	12.890 in (327.4 mm)
C42-L70	7.00 in (177.8 mm)	12.213 in (310.2 mm)	13.551 in (344.2 mm)	14.890 in (378.2 mm)
C42-L90	9.00 in (228.6 mm)	14.213 in (361 mm)	15.551 in (395 mm)	16.890 in (429 mm)
BN42-23	2.30 in (63.5 mm)	7.513 in (190.8 mm)	8.851 in (224.8 mm)	10.190 in (258.8 mm)
BN42-33	3.30 in (88.9 mm)	8.513 in (216.2 mm)	9.851 in (250.2 mm)	11.190 in (284.2 mm)
BN42-43	4.30 in (114.3 mm)	9.513 in (241.6 mm)	10.851 in (275.6 mm)	12.190 in (309.6 mm)
BN42-53	5.30 in (134.6 mm)	10.513 in (267 mm)	11.851 in (301 mm)	13.190 in (335 mm)

*All dimensions are reference dimensions

Ordering Information - Examples

120-46:1 – 120 mm gearhead, 46:1 ratio
120-308:1 – 120 mm gearhead, 308:1 ratio

Gearhead Selection & Application Guidelines

APPLICATION CONSIDERATIONS

The primary reason to use a gearhead is that it makes it possible to control a large load inertia with a comparatively small motor inertia. Without the gearhead, acceleration or velocity control of the load would require that the motor torque, and thus current, would have to be as many times greater as the reduction ratio which is used. There are extensive motor and gearhead combinations that will meet the performance requirements of a specific application. We offer a selection of windings in each frame size, that combined with a selection of reduction ratios, offer an assortment of solutions to output requirements. Each combination of motor and gearhead offers unique advantages. Primary consideration in selection of the best combination of motor and gearhead is the output torque and speed required by the application. The no-load speed or peak torque may also be the driving consideration for certain applications.

The long and short-term capabilities of a gearmotor vary widely. Furthermore, the nature of the load being driven is a factor to consider when selecting the right gearmotor for the application. Shock loads shorten unit life, though the average torque may not exceed the specified rating. If there is doubt about the compatibility of a gearmotor selection for your application, consult the factory.

Duty cycle will limit the gearmotor's capability. Mechanisms that contribute to gearmotor failure often are related to heat and its effect on lubrication. Therefore, duty cycles long enough to experience significant temperature increases over ambient conditions should be avoided. The permitted output power for each motor is listed in the catalog. Compare these values to the RMS power output anticipated by the duty cycle for your design. The actual RMS power required by the load should not exceed the power rating for the gearbox.

Orientation, whether vertical, or horizontal, will effect lubrication distribution. Though the gearheads may be oriented in any position, horizontal mounting is recommended whenever possible.

Narrowing the selection process:

There are (3) basic steps presented here in matching the gearhead and motor. They are:

- 1. Determine the correct gear ratio and appropriate output torque rating.**
- 2. Determine the required input torque (motor torque).**
- 3. Insure the maximum power rating of the motor is not exceeded.**

EXAMPLE #1

For example, $n < 3000$ rpm. Actual gearhead speed < 5000 rpm.

A gearmotor application has the following requirements: What motor and gearhead combination will meet these requirements?

Supply Voltage = 12.0 vdc

Output Speed = 50 to 60 rpm

Output Torque (@ gearhead) = 225.0 oz-in

Brush-Type Motor

Step 1 – Determine the correct gearbox size and reduction ratio

$\omega_o = \omega_i / n$ **Where:** ω_o = output speed, ω_i = input speed, and n = reduction ratio

The required output speed is between 50 and 60 rpm, therefore:

50 = ω_i / n , and since the **input speed** to the gearhead must be limited to no more than **3000 rpm**, the equation becomes:

50 = 3000 / n , and solving for n yields a 60:1 ratio. Since the torque requirement is 400.0 oz-in and a ratio of around 60:1 is needed, the **32mm gearhead** will meet the requirements, as a 59:1 (58:85:1) ratio with a continuous torque rating of **637.3 oz-in** is available. The 59:1 ratio will yield an output speed of **50.97 rpm**.

Step 2 - Find the appropriate motor (determine the required input torque)

According to the gearhead literature, the **32mm** will work with either a **BN12** (brushless) or a **C13** (brush-type) motor. As the requirement was for a brush-type motor, we will look at the **C13** series.

$T_i = T_o / (\eta * n)$ **Where:** T_i = input torque, T_o = output torque, n = gearbox efficiency, and η = the gearbox ratio. The ratio we have selected is 59:1 (58:85:1). This is a 3-stage gearhead with an efficiency of 70%; therefore:

$$T_i = 225 \text{ oz-in} / (58.85 \times .7)$$

$$T_i = 5.46 \text{ oz-in}$$

Gearhead Selection & Application Guidelines

According to the motor literature, the C13-L19 has a continuous torque rating of 7.5 oz-in. The required input torque is only 5.46 oz-in, so a C13-L19 is selected. The other consideration is to determine what winding (W10, W20, W30, W40 or W50) to use. Since the supply voltage is 12.0 vdc, and the input speed must be limited to 3000 rpm, we need a winding that will yield a no-load speed of ≥ 3000 rpm. No-load speed may be calculated by:

$N_{nl} = V_s / K_e$ **Where:** N_{nl} = no-load speed, V_s = supply voltage, and K_e = the motor's back-emf constant (in krpm); therefore:

3000 = 12.0 volts / K_e By rearranging terms and solving for K_e , we find we need a K_e of 4.0 v / krpm. The C13-L19W30 has a back-emf constant of 4.03 v / krpm. We will select this motor and perform some new calculations.

$$N_{nl} = V_s / K_e - N_{nl} = 12.0 \text{ volts} / 4.03 \text{ v / krpm} = 2.97 \text{ krpm or } 2970 \text{ rpm}$$

$$\omega_o = \omega_i / n = \omega_o = 2970 / 58.85 = \omega_o = 50.46 \text{ rpm}$$

Step 3- Insure maximum power rating of motor is not exceeded

Output power is calculated by $P = T\omega$, where T = torque in Nm and ω = speed in rad / sec, or if the units are in oz-in and rpm, and alternate equation is $P = T \times S / 1352$. For our example, the output power is: **$P = 5.46 \text{ oz-in} \times 2970 \text{ rpm} / 1352 = 11.99 \text{ watts}$**

Note: (loaded speed will be somewhat less than no-load speed, but this will yield a more conservative answer) This value compared with the value given in the motor literature (13.0 watts), shows the choice is appropriate. The correct part numbers would be:

Motor – C13-L19W30

Gearhead – 32-59:1

EXAMPLE #2

A gearmotor application has the following requirements: What motor and gearhead combination will meet these requirements?

Supply Voltage = 36.0 vdc

Output Speed = 200 to 225 rpm

Output Torque (@ gearhead) = 2400 oz-in (12.5 ft-lbs)

Brush-Type Motor - 34 Frame

Step 1 – Determine the correct gearbox size and reduction ratio

$$\omega_o = \omega_i / n \quad \textbf{Where: } \omega_o = \text{output speed, } \omega_i = \text{input speed, and } n = \text{reduction ratio}$$

The required output speed is between 200 and 225 rpm, therefore:

200 = ω_i / n , and since the **input speed** to the gearhead must be limited to no more than **3000 rpm**, the equation becomes:

200 = 3000 / n , and solving for n yields a 15:1 ratio. Since the torque requirement is 14.06 ft-lbs, and a ratio of around 15:1 is needed, the **81mm gearhead (a 34 frame was specified - the 81mm matches with the 34 frame)**, will meet the requirements, as a 14:1 (13:73:1) ratio with a continuous torque rating of **44.25 ft-lbs** is available. The 14:1 ratio will yield an output speed of **218.5 rpm**.

Step 2 - Find the appropriate motor (determine the required input torque)

According to the gearhead literature, the **81mm** will work with either a **BN34** (brushless) or a **C34** (brush-type) motor. As the requirement was for a brushless motor, we will look at the **BN34** series.

$T_i = T_o / (\eta * n)$ **Where:** T_i = input torque, T_o = output torque, n = gearbox efficiency, and η = the gearbox ratio. The ratio we have selected is 14:1 (13:73:1). This is a 2-stage gearhead with an efficiency of 75%; therefore:

$$T_i = 2400 \text{ oz-in} / (13.73 \times .75)$$

$$T_i = 233 \text{ oz-in}$$

Gearhead Selection & Application Guidelines

According to the motor literature, the BN34-55 has a continuous torque rating of either 258 or 240 oz-in, depending upon the winding used. Since the supply voltage is 36.0 vdc, and the input speed must be limited to 3000 rpm, we need a winding that will yield a no-load speed of ≥ 3000 rpm. No-load speed may be calculated by:

$N_{nl} = V_s / K_e$ **Where:** N_{nl} = no-load speed, V_s = supply voltage, and K_e = the motor's back-emf constant (in krpm); therefore:

3000 = 36.0 volts / K_e By rearranging terms and solving for K_e , we find we need a K_e of 12.0 v / krpm. The BN34-55AF-02 has a back-emf constant of 12.3 v / krpm. We will select this motor and perform some new calculations.

$N_{nl} = V_s / K_e - N_{nl} = 36.0 \text{ volts} / 12.3 \text{ v / krpm} = 2.93 \text{ krpm or } 2930 \text{ rpm}$

$\omega_o = \omega_i / n = \omega_o = 2930 / 13.73 = \omega_o = 213 \text{ rpm}$

Step 3 - Insure maximum power rating of motor is not exceeded

Output power is calculated by $P = T\omega$, or if the units are in oz-in and rpm, an alternate equation is $P = T \times S / 1352$. For our example, the output power is: **P = 233.0 oz-in x 2930 rpm / 1352 = 504.9 watts.**

Note: (loaded speed will be somewhat less than no-load speed, but this will yield a more conservative answer) This value compared with the value given in the motor literature (694.0 watts), shows the choice is appropriate. The correct part numbers would be:

- **Motor – BN34-55AF-02LH**
- **Gearhead – 81-14:1**

Notes:

- 1. Please be aware that in some cases, the output torque of the gearbox will be much greater than input torque rating of the motor. An example would be:**

In example #2 the output torque requirement was 2400 oz-in (12.5 ft-lbs). Suppose the requirement was 4800 oz-in (25.0 ft-lbs). This is well within the rating for the **81mm - 14:1 ratio** (44.25 ft-lbs), but the required input torque - **$T_i = 4800 \text{ oz-in} / (13.73 \times .75) = 466.1 \text{ oz-in}$** is much greater than the available torque for a **BN34-55AF** (max = 258.0 oz-in).

- 2. Input speed (motor speed) must be limited to 3000 rpm.**

- 3. This application guide is intended to provide some fundamental insights into mating our motors and gearheads. Our staff of applications engineers is ready to assist you in selecting motors and gearheads based on your application. Please contact an applications engineer with your questions and requests.**

Application Engineering Assistance

800-577-8685 ext. 256 • 828-837-5115

FAX 828-837-3343 • email: mcg@moog.com

Optical Encoders

TYPICAL APPLICATIONS

Low cost motion detection for motors used in:

- Factory automation
- Packaging and printing products
- Office equipment and computer peripherals
- Robotic tape storage and retrieval
- Semiconductor handling and insertion machines
- Industrial automation
- Computer controlled embroidery machines
- Positioning tables
- Machine tools

FEATURES

- Two channel quadrature output with optional index pulse
- No signal adjustment required
- Low cost
- Small size
- Resolutions up to 1024 counts per revolution
- -40°C to 100°C operating temperature
- TTL compatible
- Single 5 volt supply

BENEFITS

- Feedback information may be used in conjunction with a position controller for precise motor shaft position
- Encoders used in conjunction with a 4-quadrant velocity controller, such as the BDA-Q4-70-10, allow precise velocity control of brushless motors.



All Moog Components Group motors can be fitted with an encoder. Moog Components Group uses the Hewlett-Packard HEDS and HEDM series of optical encoders as their standard offering. Other encoders are available; if you have a specific need please contact one of our applications engineers.

RENCO RCML15 encoders are also a standard offering.



SPECIFICATIONS

Specifications at 25°C (77°F)	HEDS 5500	HEDS 5540	HEDM 5500
Counts Per Revolution	96 to 512	96 to 512	1000 to 1024
Number of Channels	Two	Two + Index	Two
Supply Voltage (V_{cc}) (vdc)	4.5 to 5.5	4.5 to 5.5	4.5 to 5.5
Supply Current (I_{cc}) (mA – typical)	17	17	17
Load Capacitance (C_L) (pF max)	100	100	100
Count Frequency (f) (kHz max)	100	100	100
Pulse Width (P) (°e)	180 +/- 45	180 +/- 45	180 +/- 45
Phase Shift (ϕ) (°e)	90 +/- 20	90 +/- 20	90 +/- 20
Pulse Width Error (ΔP) (°e max)	45	35	45
Index Pulse Width (P_o) (°e max)	N/A	125	N/A
Signal Rise Time (t_r) (ns typ.)	200	180	180
Signal Fall Time (t_f) (ns typ.)	50	40	40
Operating Temperature (°C)	-40 to 100	-40 to 100	-40 to 100
Velocity (rpm) (max.)	30000	30000	30000
Acceleration (rad/sec ²) (max)	250000	250000	250000

Definitions

- **Count (N)** – the number of bar and window pairs or counts per revolution (CPR) of the codewheel
- **Pulse Width (P)** – the number of electrical degrees that an output is high during 1 cycle. This value is nominally 180°e or 1/2 cycle
- **Pulse Width Error (ΔP)** – the deviation, in electrical degrees, of the pulse width from its ideal value of 180°e
- **Phase (ϕ)** – the number of electrical degrees between the center of the high state of channel A and the center of channel B. This value is nominally 90°e for quadrature output.
- **Phase Error (Δf)** – the deviation of the phase from its ideal value of 90°e.
- **Index Pulse Width (P_o)** – the number of electrical degrees that an index output is high during one full shaft rotation. This value is nominally 90°e or 1/4 cycle.

Ordering Information

In order for us to provide the correct encoder for your application, it is necessary that you provide us with:

- # of channels
- CPR (counts per revolution)
- Whether or not Differential Lines Drivers are required

To facilitate the correct selection, simply fill in the blocks below.

HEDS 55

<input type="text"/>	<input type="text" value="0"/>	<input type="text"/>
# OF CHANNELS 0 = 2 Channel 4 = 3 Channel	RESOLUTION (CPR) K = 96 C = 100 D = 192 E = 200 F = 256 G = 360 H = 400 A = 500 I = 512	

HEDM 55

<input type="text"/>	<input type="text" value="0"/>	<input type="text"/>
# OF CHANNELS 0 = 2 Channel	RESOLUTION (CPR) B = 1000 J = 1024	

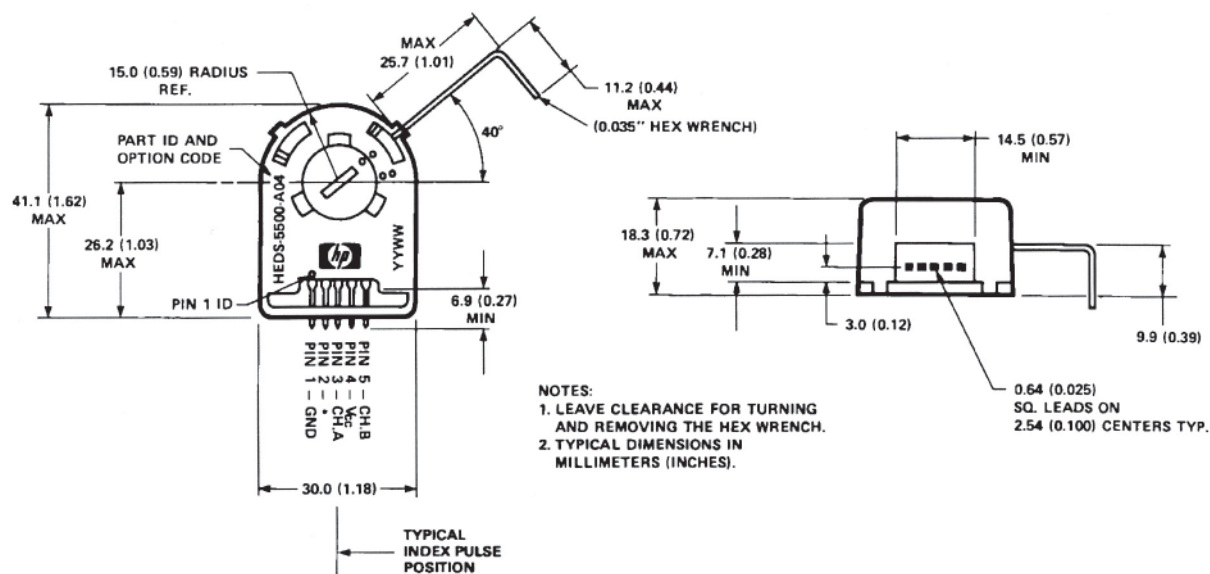
Note: If Differential Line Drivers are needed, simply substitute an L into the part # (ex. HEDL)

EXAMPLE

You need a 2-channel encoder with a line count (CPR) of 512, the correct part # would be: HEDS-5500-I.
If you needed the 2-channel, 512 CPR, but with differential line drivers, the correct part # would be: HEDL-5500-I.

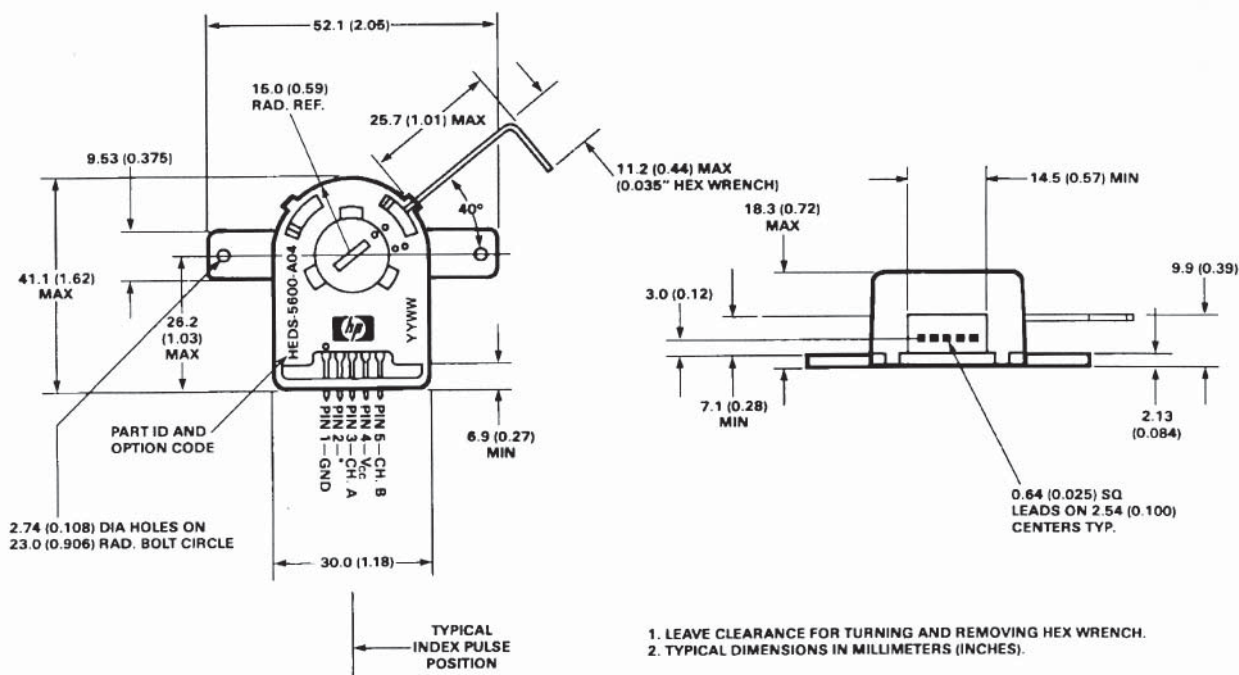
Package Dimensions

HEDS-5500/5540, HEDM-5500



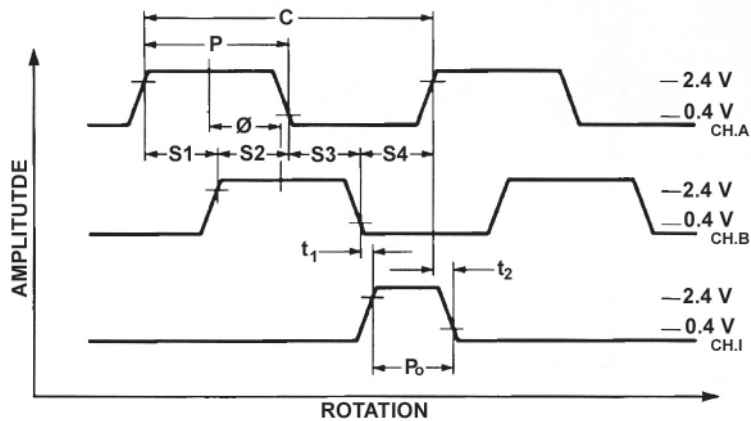
Note: For the HEDS-5500 and HEDM-5500, Pin #2 is a No Connect. For the HEDS-5540, Pin #2 is CH. I, the index output.

HEDS-5600/5640, HEDM-5600

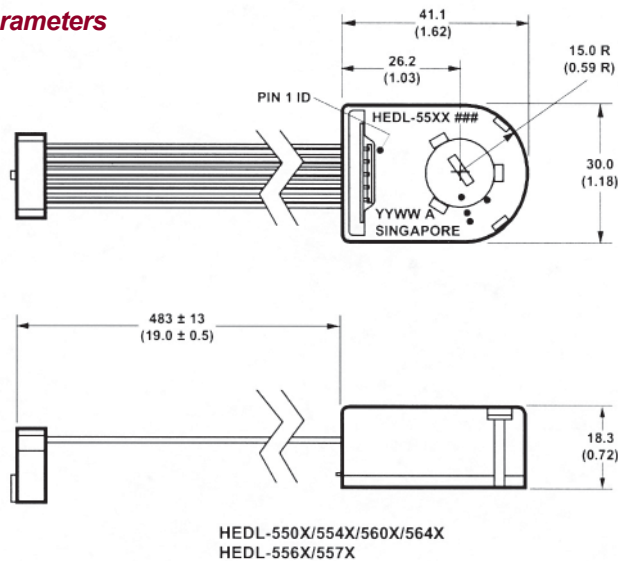


Note: For the HEDS-5600 and HEDM-5600, Pin #2 is a No Connect. For the HEDS-5640, Pin #2 is CH. I, the index output.

Output Waveforms

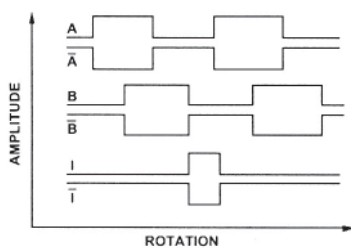


HEDL Parameters

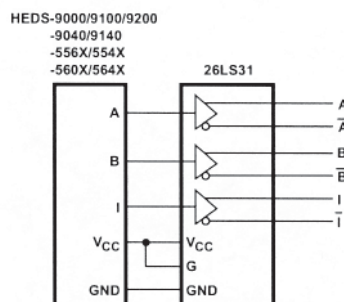


NOTE: DIMENSIONS IN MILLIMETERS (INCHES)

Waveforms

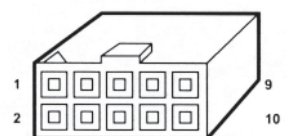


Block Diagram



Pinouts

10-PIN CONNECTOR		
NO.	COLOR	PARAMETER
1	BROWN	NC
2	RED	V _{CC} (+ 5 V)
3	ORANGE	GND
4	YELLOW	NC
5	GREEN	A
6	BLUE	A
7	VIOLET	B
8	GREY	B
9	WHITE	I (INDEX)



10 POSITION IDC CONNECTOR
CENTER POLARIZED.

Model RCML15 Commutation Encoder

MOUNTING REQUIREMENTS

Mounting Requirements	Per Figure 1
Outline	Per Figure 3
Shaft Size	.2500 +0/-0.0007 [6.35mm +0/-0.017]
Shaft Endplay	± 0.010" [±.254mm]
Shaft Runout	0.002" TIR [.051mm]
Set Screw	2-56 X 1/8 4-Spline (Wrench Supplied)
Disc Material	Metal Etched
Cover Material	Black Polycarbonate
Base Material	Polyphenylene Sulfide (Ryton R4)
Hub Material	Aluminum
Moment of Inertia	1.17 x 10 ⁻⁵ oz-in sec ² [.83 g-cm ²]

ELECTRICAL

Output	Per Figure 2
Supply Voltage	5.0 VDC ± 10%
Output Logic Levels	"1" 2.5 VDC MIN "0" 0.5 VDC MAX 4 mA MAX Sink Current
Output Type	Open Collector
Operating Frequency	300 KHz MAX
Flutter	1% MAX

ENVIRONMENTAL

Operating Temperature	-30°C to +100°C
Storage Temperature	-40°C to +115°C
Shock	50 G's for 11ms Duration
Vibration	5-2000 Hz @ 10 G's
IP Rating	IP 40
Humidity	90% Relative (Non-condensing)

TERMINATION TABLE

Pin Number	Function
1	GND
2	Z
3	CH A
4	+VCC
5	CH B
6	U
7	V
8	W

RESOLUTIONS*

Currently Available:	<u>No Commutation</u> 500/0, 512/0, 1000/0, 1024/0, 2000/0, 2048/0 <u>2 Cycles/360° (2 Pole Pairs)</u> 500/2, 512/2, 1000/2, 1024/2, 2000/2, 2048/2 <u>3 Cycles/360° (3 Pole Pairs)</u> 500/3, 512/3, 1000/3, 1024/3, 2000/3, 2048/3 <u>4 Cycles/360° (4 Pole Pairs)</u> 500/4, 512/4, 1000/4, 1024/4, 2000/4, 2048/4
----------------------	--

*Resolutions listed are for metal disks only. Consult factory for other options.

RENCO Encoders, Inc.



FEATURES

- Low profile (.350 height) [8.9 mm]
- Patented slide lock for easy installation
- 2 data channels in quadrature
- Standard 90° zero pulse
- 3 commutation channels
- Self-aligning
- Self-centering
- Self-gapping
- 300 KHz frequency response
- Wide selection of line counts & pole pairs
- Meets NEMA ICS-16 standard

The RCML 15 combines brushless motor commutation pulses and incremental position feedback in a low profile single optical encoder. This RENCO feature reduces cost while improving performance and reliability of the brushless motor/encoder package.

The patented slide lock mechanism makes installation and commutation track alignment simple. The low profile makes the RCML 15 perfect for designs where space is critical.

This newly developed encoder has many standard resolutions/pole pairs available. If your requirements are not listed, please consult factory for availability.

FIGURE 1 - Mounting Requirements

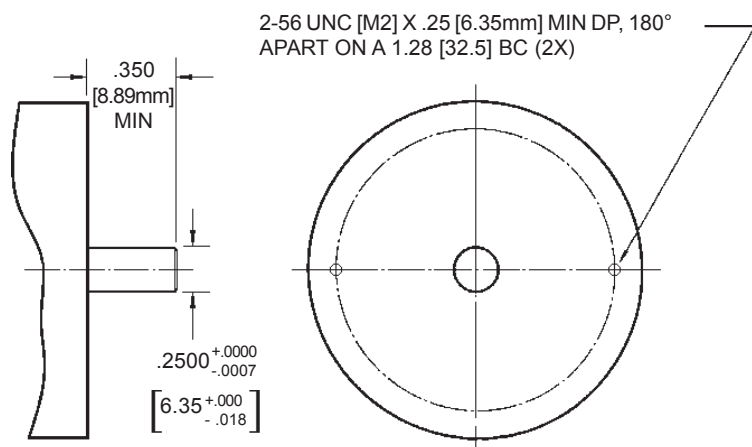


FIGURE 2 - Output Configuration

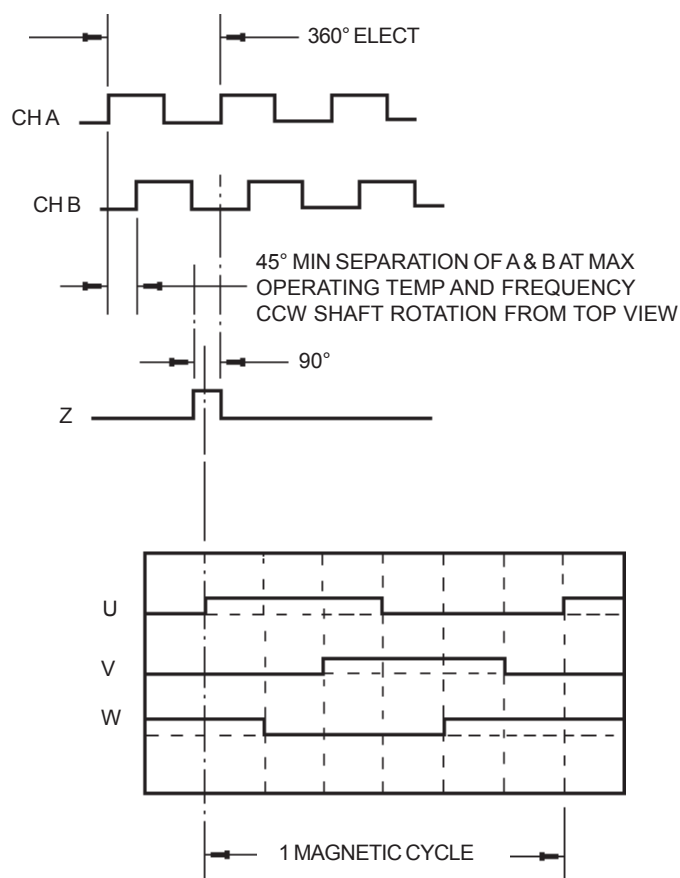
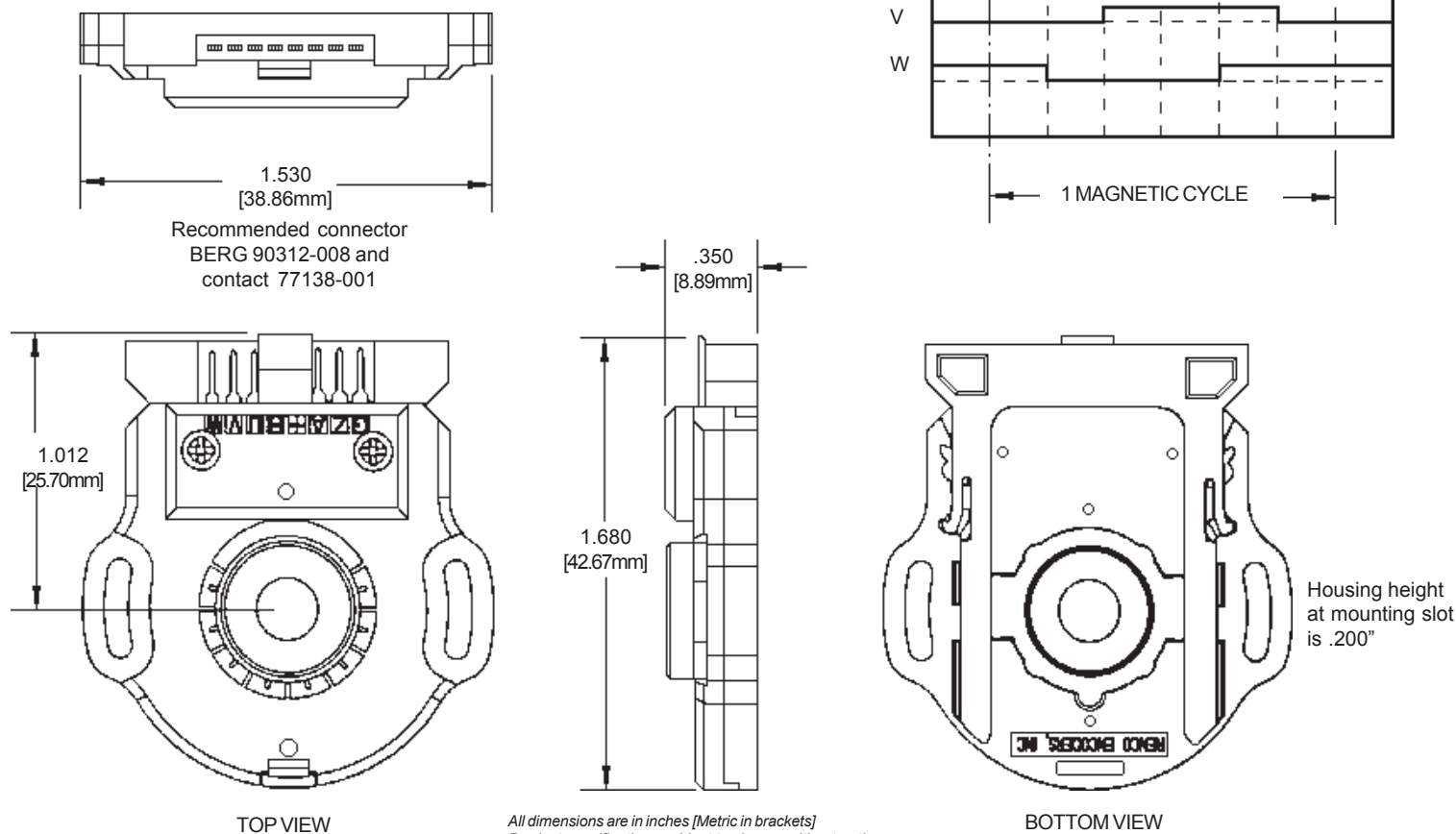


FIGURE 3 - Mechanical Outline



Ordering Information: To order, specify model resolution/commutation

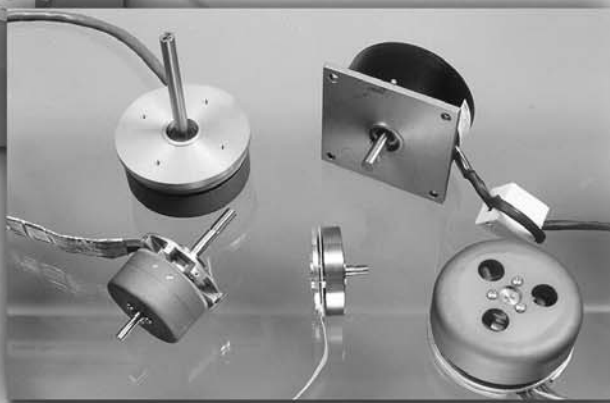
RCML15

-

_____/____

RESOLUTION/COMMUTATION
See Front of Sheet

Application Information



Moog Components Group manufactures a comprehensive line of brush-type and brushless motors, as well as brushless controllers. The purpose of this document is to provide a guide for the selection and application of DC motors and controllers. This document is not intended to be a design guide. The terms presented herein are simple and straightforward; the calculations are simplified but accurate. If more information is necessary, an applications engineer will be happy to answer any question or address any concern that may arise.

APPLICATIONS - WHAT TO CONSIDER

It is safe to say that no two applications are exactly the same. An apparatus that spins a pulley or fan is much different from one that precisely positions a workpiece or cutting tool. Regardless of how simple or complex the application, there are common requirements to consideration for the selection of the proper motor and/or controller. Some common considerations are: (presented here in the form of questions)

What output torque is required?

Motor torque is a combination of the **internal torque losses** T_f (a function of motor design) and **external torque load** T_L . External torque load is a function of load inertia and load acceleration. This will be covered later.

What speed range is required?

How fast should the motor run when loaded and unloaded?

What space is available for the motor?

What length motor is required? What is the maximum motor diameter? Motor dimensions may be dictated by performance requirements.

What is the source of power for the motor?

Is the source AC or DC? What are the current limits of the source? What is the voltage range of the source?

Is there any special shaft and/or mounting requirements?

Does the shaft need a flat or a keyway? What length and diameter does the shaft need to be? Is a rear shaft extension required?

(rear shaft extensions are necessary when encoders, brakes, etc. are added)

Are there any environmental considerations? Environmental considerations include:

- Temperature
- Humidity
- Shock and Vibration
- Altitude
- Presence of chemicals, contaminants, vapors, etc.

Is the motor "Heat Sunked"?

A motor can be heat sunked by mounting it on a mass of thermally conductive material. The material conducts heat away from the motor. Heat sinking has a dramatic effect on motor performance. Effective heat sinking increases the continuous output torque capability of the motor.

What are the expected shaft axial and radial loads? What is the expected velocity profile?

A velocity profile is a graph that shows how quickly the motor accelerates to rated speed, the time the motor runs at rated speed, and how quickly the motor decelerates to zero speed.

Application Information

MOTOR TERMINOLOGY

Motor terminology can be confusing; especially all those darn subscripts (K_T , K_E , T_F , R_T , etc.) This section will define some basic motor terms as well as the more common subscripts. The units associated with the subscripts are also presented (both standard and metric).

1. **Terminal Voltage** – the voltage applied to the terminals of a motor.
2. **Peak Torque** – the maximum torque a motor can produce for short periods of time, before irreversible demagnetization of the motor's magnets occurs. In smaller motors with higher resistance, the impedance of the motor often limits the peak torque.
3. **Rated (Continuous) Torque** – the maximum torque, at rated speed, the motor can produce on a continuous basis, without exceeding the thermal rating of the motor.
4. **Continuous Stall Torque** – the maximum torque, at zero speed, the motor can produce without exceeding its thermal rating.
5. **Rated Current** – the approximate amount of current the motor will draw at its rated torque point.
6. **Rated Speed** – the approximate motor speed at its rated torque point.
7. **Rated Power** – the maximum output power the motor can produce without exceeding its thermal rating. (output power is a function of speed and torque)
8. **Torque Sensitivity** – the relationship of output torque to the input current of the motor.
9. **Back EMF** – This is the ratio of generated output voltage to driven speed. (Also referred to as CEMF counter-electromotive force or generator voltage.)
10. **Terminal Resistance (Brushless DC Motors)** – static line to line resistance @ 25 deg. C.
11. **Terminal Resistance (Brush-Type DC Motors)** – dynamic resistance of the armature, brushes, and lead wires at a predetermined current @ 25 deg. C.
12. **Friction Torque** – the amount of torque required to overcome a motor's static friction. Bearings, brushes, shaft seals, etc. all introduce friction into the motor.
13. **Thermal Resistance** – the ratio of a motor's temperature rise to the motor's power loss
14. **Motor Constant** – the ratio of a motor's output torque to the motor's input power. Motor constant is a figure of merit commonly used to compare motor capability.
15. **Speed/Torque Gradient** - the negative slope of the speed/torque line measured in rpm / oz-in.

COMMON SUBSCRIPTS

Subscript	Parameter	Units (English)	Units (SI)
T_c	Continuous Torque	oz-in	Nm
T_{pk}	Peak Torque	oz-in	Nm
T_{cs}	Continuous Stall Torque	oz-in	Nm
T_F	Friction Torque	oz-in	Nm
I_c	Continuous Current	amps	amps
I_{pk}	Peak Current	amps	amps
n_{nl}	No-Load Speed	rpm	rad / sec
P_t	Rated Power	watts	watts
V_T	Terminal Voltage	volts	volts
E_g	Generator Voltage	volts	volts
P_I	Input Power	watts	watts
P_O	Output Power	watts	watts

Subscript	Parameter	Units (English)	Units (SI)
K_T	Torque Constant	oz-in / amp	Nm / amp
K_E	Back EMF Constant	v / krpm	volts / rad / sec
K_M	Motor Constant	oz-in / \sqrt{w}	Nm / \sqrt{w}
R_T	Terminal Resistance	ohms	ohms
L_T	Terminal Inductance	millihenries	millihenries
J_r	Rotor Inertia	oz-in-sec ²	gram-cm ²
R_{th}	Thermal Resistivity	°C / watt	°C / watt

Conversions for some of the more commonly used motor parameters are:

K_T – Torque Constant

$$1 \text{ Nm / amp} = 141.612 \text{ oz-in / amp}$$

$$1 \text{ oz-in / amp} = 7.06155 \times 10^{-3} \text{ Nm / amp}$$

K_E – Back EMF Constant

$$1 \text{ v / krpm} = 9.5493 \times 10^{-3} \text{ volt / rad / sec}$$

$$1 \text{ volt / rad / sec} = 104.72 \text{ v / krpm}$$

K_M – Motor Constant

$$1 \text{ oz-in / } \sqrt{w} = 7.0615 \times 10^{-3} \text{ Nm / } \sqrt{w}$$

$$1 \text{ Nm / } \sqrt{w} = 141.612 \text{ oz-in / } \sqrt{w}$$

J_r – Rotor Inertia

$$1 \text{ oz-in-sec}^2 = 7.0615 \times 10^{-4} \text{ gm-cm}^2$$

$$1 \text{ gm-cm}^2 = 1.14 \times 10^{-5} \text{ oz-in-sec}^2$$

BASIC MOTOR THEORY

Permanent magnet DC motors convert electrical energy into mechanical energy. This conversion takes place due to the interaction of the motor's two magnet fields. One of these magnetic fields is created by a set of permanent magnets (on the brush-type motor, the **stator** usually contains the permanent magnets; the brushless motor's magnets are a part of the **rotor** assembly). The other magnetic field is created by current flowing through the motor's windings (the windings of a brush-type motor are contained in the **armature (rotor)**, while the brushless windings are part of the **stator** assembly. In general, the **stator** is the **stationary** member of the motor, while the **rotor** is the **rotating** portion of the motor. The interaction of these two fields causes a resulting **torque**; the result of which is motor rotation. As the rotor turns, the current in the windings is **commutated**, resulting in a continuous torque output. (brush-type motors are mechanically commutated, while brushless motors are electronically commutated),

Three basic concepts must be understood when examining basic motor operation. These concepts are:

1. Torque

Torque, also known as a *moment of force*, is a measure of the twisting effect that produces rotation about an axis. Simply stated mathematically, torque is the product of a force and the perpendicular distance from the pivot point to the force vector, or $T = F \times D$. Typical units of torque are Nm, oz-in, ft-lbs, etc. The torque produced by a $P_o = T \times S / 1352$ (units: watts; oz-in, rpm) motor is the sum of internal torque losses (friction and

Application Information

windage – commonly labeled T_f) the external load torque (T_L). In a motor, the output torque is a function of the magnetic circuit, the number of magnet poles, and the number and configuration of the winding conductors. One of the two most important constants is that of torque sensitivity, or the **torque constant** (K_T). The output torque of a motor may be found by the following equation:

$T = K_T \times I$ (units are: (SI) Nm; Nm / amp, amps (ENG.) oz-in; oz-in / amp, amps)

EXAMPLE #1

Problem:

A **C13-L19W10** has a torque constant of 3.42 oz-in / amp. The motor is drawing 1.5 amps. What is the output torque of the motor?

Solution:

The basic equation for motor output torque is $T = K_T \times I$. $T = 3.42 \text{ oz-in / amp} \times 1.5 \text{ amps}$. **$T = 5.13 \text{ oz - in}$**

2. Speed

Motor speed is also a function of the magnetic circuit, the number of magnet poles, and the number and configuration of the winding conductors. The second important constant to be considered is the **BACK EMF** or **voltage constant** (K_E). This is an important constant, as it will determine the speed of a motor at a specified applied (terminal) voltage. The basic motor voltage equation is:

$E_g = K_E \times n$ (units are: (SI) volts; volts / rad / sec, rad (ENG.) volts; volts / krpm, krpm)

Speed is usually specified as either **No-Load Speed** or as **Rated Speed**. (see definitions in previous section). There is a useful, though greatly simplified equation that will allow you to get a **rough** estimate of the no-load speed of a motor. This simplified equation is:

units are: (SI) rad / sec; volts, volts / rad / sec (ENG.) krpm; volts, volts / krpm

EXAMPLE #2

Problem:

A **BN34-25AF-01LH** is to be operated at 24VDC. What will the approx. no-load speed be?

Solution:

The basic equation for a rough approximation of no-load speed is:

The K_E for this motor is 3.10 v / krpm. The applied voltage is 24 VDC.

$N_{nl} = V_T / K_E = 24 \text{ volts} / 3.10 \text{ volts / krpm} = \mathbf{7.742 \text{ krpm (7,742 rpm)}}$

3. Power

Power is defined as the *rate of doing work*. In dealing with motors, two units are typically used; watts and horsepower. When dealing with motor power, one must differentiate between **input power** and **output power**. **Input power** is the product of the voltage applied to the motor and the current drawn by the motor ($P_i = EI$). **Output Power** is a function of the motor's speed and output torque. Output power may be calculated according to the following equations:

$P_o = Tw$ (units: watts; Nm, rad / sec)

Efficiency is the ratio of output power to input power. Efficiency is calculated by:

EXAMPLE #3

Problem:

A motor has a terminal voltage of 24 VDC. It draws 12.5 amps of current. The output torque is 120 oz-in at 2900 rpm. What is the input power? What is the output power? Determine the efficiency of the motor.

Solution:

$$P_i = EI = 24 \text{ volts} \times 12.5 \text{ amps} = \underline{300 \text{ watts}}$$

$$P_o = T \times S / 1352 = 120 \times 2900 / 1352 = \underline{257.4 \text{ watts}}$$

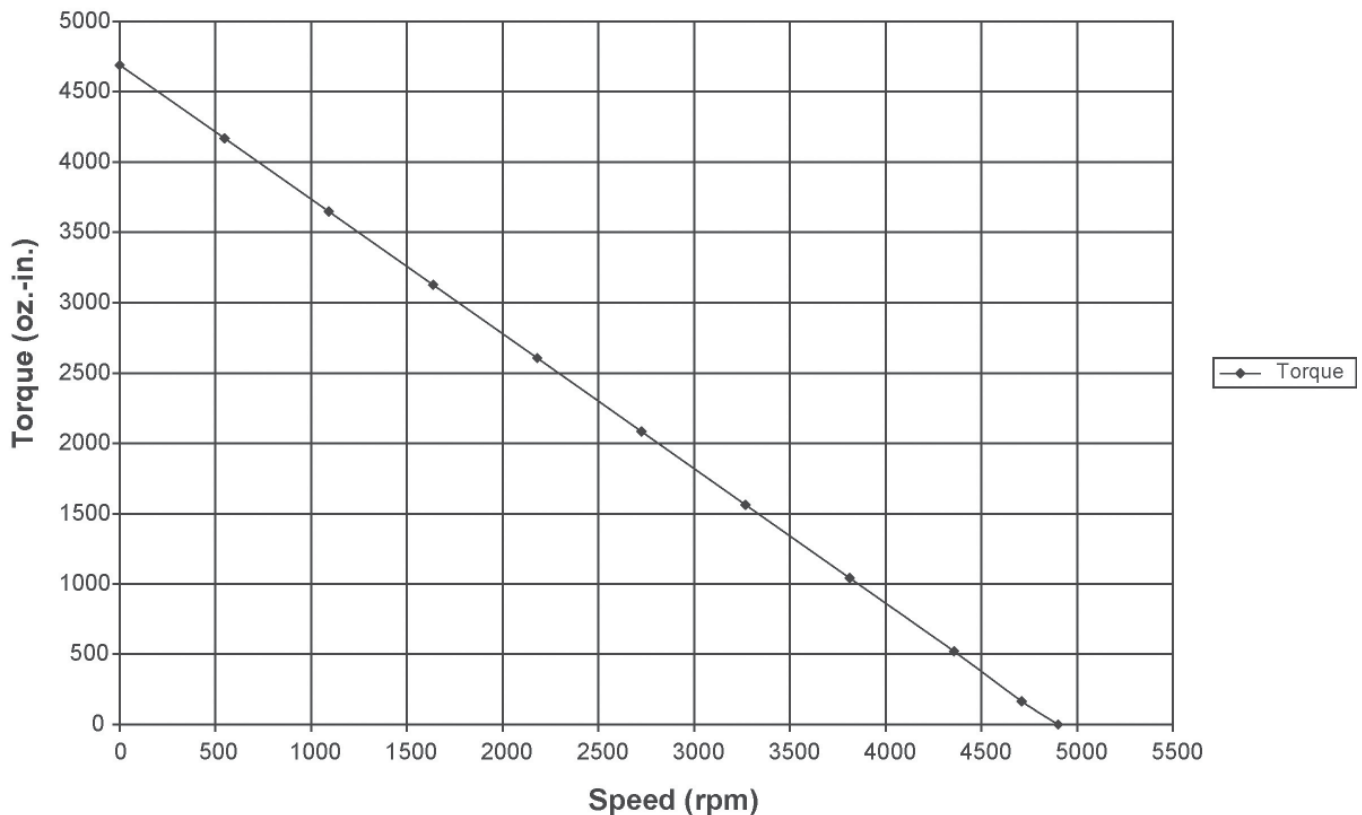
$$\text{Eff.(\%)} = \text{output power} / \text{input power} \times 100 = 257.4 \text{ watts} / 300 \text{ watts} \times 100 = \underline{85.8\%}$$

SPEED-TORQUE CURVE

The relationship between speed and torque in brush-type and brushless motors is linear. A linear speed-torque curve is very desirable, especially in servo applications. A typical speed-torque curve is shown in *Figure #1*.

Figure #1

Theoretical Speed vs. Torque Curve



Application Information

INCREMENTAL MOTION

A very common motor application is one in which the motor is accelerated from zero speed to operating speed in a certain time period, runs at speed for a period of time, and then decelerates to zero speed in yet another period of time. It is common to plot the speed and time values of a motor's motion. This graphical representation is known as a **velocity profile**. A typical velocity profile is one in which the resulting motion "waveform" is **trapezoidal**.

EXAMPLE #1

The above is a velocity profile for a brushless motor operating under closed-loop control. Metric units are used in working the example. We will solve for **torque required for each time period**, as well as **RMS torque**. The following motor and load parameters are:

Load Torque (T_L) – 1.0 Nm

Motor Friction (T_F) – 7.1×10^{-2} Nm

Motor Inertia (J_M) – 1.7×10^{-3} kg*m²

Load Inertia (J_L) – 4.0×10^{-4} kg*m²

Step #1 – Find Acceleration and Deceleration (times t1 and t3)

In this example the motor accelerates from 0 rad / sec to 500 rad / sec in .250 sec. The motor decelerates from 500 rad / sec to 0 rad / sec in .250 sec. Therefore:

$a = Dw/Dt = 500 \text{ rad / sec} / .250 \text{ sec}$

$a = 2000 \text{ rad/sec}^2$

Step #2 – Find Torque required for Acceleration (time t1)

In general, $T=Ia$ or torque is equal to the product of inertia and acceleration. When the motor is accelerating, Torque = (inertia x acceleration) + friction, or:

$T=(J_L + J_M)(a) + (T_F + T_L)$

$T=(4.0 \times 10^{-4} \text{ kg*m}^2 + 1.7 \times 10^{-3} \text{ kg*m}^2)(2000 \text{ rad / sec}^2) + (1.0 \text{ Nm} + .071 \text{ Nm})$

$T=(4.2 \text{ Nm}) + (1.071 \text{ Nm})$

$T=5.271 \text{ Nm}$

Step #3 – Find Torque required for Constant Velocity (time t2)

When the motor is not accelerating or decelerating, the required torque is equal to the sum of the motor's friction torque and the load torque. The equation is:

$T=(T_F + T_L)$

$T=(.071 \text{ Nm} + 1.0 \text{ Nm})$

$T=1.071 \text{ Nm}$

Step #4 – Find Torque required for Deceleration (time t3)

When the motor is decelerating, the friction introduced by the motor and load are subtractive; or simply stated, Torque = (inertia x acceleration) – friction, or:

$$T = (J_L + J_M)(a) - (T_F + T_L)$$

$$T = (4.0 \times 10^{-4} \text{ kg} \cdot \text{m}^2 + 1.7 \times 10^{-3} \text{ kg} \cdot \text{m}^2)(2000 \text{ rad} / \text{sec}^2) - (1.0 \text{ Nm} + .071 \text{ Nm})$$

$$T = (4.2 \text{ Nm}) - (1.071 \text{ Nm})$$

$$T = 3.129 \text{ Nm}$$

Step #5 – Find Torque required for Dwell (time t4)

Torque for dwell is 0 Nm.

Step #6– Find RMS Torque

RMS torque is calculated using:

T1 = torque required for each time period

t1 = time of each period

$$T_{\text{RMS}} = \sqrt{(5.271^2)(.250) + (1.071^2)(2.1) + (3.129^2)(.250) + (0)(.750) / (.250 + 2.1 + .250 + .75)}$$

$$T_{\text{RMS}} = 1.88 \text{ Nm}$$

CONTACT INFORMATION

For questions regarding torque and toroidal brushless and brush motors or cube motors please contact the numbers listed below.

Blacksburg Operations

Sales Assistance (factory)

800-336-2112 ext. 197 • 540-552-3011

FAX 540-557-6400 • email: mcg@moog.com

Application Engineering Assistance

800-336-2112 ext. 197 • 540-552-3011

FAX 540-557-6400 • email: mcg@moog.com

Literature Request

800-336-2112 ext. 279 • 540-552-3011

FAX 540-557-6400 • email: mcg@moog.com

For questions regarding DC brushless and brush motors, drive electronics, gearheads and encoders please contact the numbers below.

Murphy Operations

Sales Assistance (factory)

800-577-8685 ext. 239 • 828-837-5115

FAX 828-837-3343 • email: mcg@moog.com

Application Engineering Assistance

800-577-8685 ext. 256 • 828-837-5115

FAX 828-837-3343 • email: mcg@moog.com

Literature Request

800-336-2112 ext. 279 • 540-552-3011

FAX 540-557-6400 • email: mcg@moog.com

Some Useful Conversions

<i>From</i>	<i>To</i>	<i>Multiply By</i>
Length		
in	cm	2.540
ft	cm	30.48
cm	inches	.3937
cm	feet	3.281 x 10 ⁻²
Mass		
oz	gm	28.35
lbs	gm	453.6
gm	oz	3.527 x 10 ⁻²
gm	lbs	2.205 x 10 ⁻³
Torque		
oz-in	g-cm	72.01
lb-ft	g-cm	1.383 x 10 ⁴
g-cm	oz-in	1.389 x 10 ⁻²
lb-ft	oz-in	192.0
g-cm	lb-ft	7.233 x 10 ⁻⁵
oz-in	lb-ft	5.208 x 10 ⁻³
Nm	oz-in	141.612
Nm	ft-lb	0.73756
Nm	in-lb	8.85075
oz-in	Nm	7.0615 x 10 ⁻³
Rotation		
rpm	deg / sec	6.0
rad / sec	deg / sec	57.30
deg / sec	rpm	.1667
rad / sec	rpm	9.549
deg / sec	rad / sec	1.745 x 10 ⁻²
rpm	rad / sec	.1047
Energy		
joule	watt-sec	1.0
BTU	joule	1055.06
kcal	joule	4186.8
Power		
hp	watt	745.7.0
hp	ft-lb / sec	550.0192.0

Common Metric Prefixes

<i>Multiple</i>	<i>Prefix</i>	<i>Symbol</i>
10 ¹⁸	exa	E
10 ¹⁵	peta	P
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ²	hecto	h
10 ¹	deka	da
10 ⁻¹	deci	d
10 ⁻²	centi	c
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p
10 ⁻¹⁵	femto	f

Motor Application Data Sheet

Date _____ Salesperson _____

COMPANY INFORMATION

Company Name _____ Contact _____
Division _____ ☐ Buyer
Address _____ ☐ Engineer
_____ ☐ Other _____
City _____ State _____ Zip _____
Phone _____ FAX _____

Your cooperation is requested in supplying as much accurate information as possible concerning your requirements. This will assist our Engineering and Sales staff in assessing the best possible solution to your request.

1) Description of Application: _____

- | | | | |
|---|---|--|--|
| <input type="checkbox"/> Computer Peripherals | <input type="checkbox"/> Actuators | <input type="checkbox"/> Material Handling | <input type="checkbox"/> Machine Tools |
| <input type="checkbox"/> Food Processing | <input type="checkbox"/> Semiconductor Mfg. | <input type="checkbox"/> Medical Equipment | <input type="checkbox"/> Packaging |
| <input type="checkbox"/> Printing | <input type="checkbox"/> Robotics | <input type="checkbox"/> Industrial Automation | <input type="checkbox"/> Textile |
| <input type="checkbox"/> Other _____ | | | |

2) Type of Motor:

- | | | |
|--|---------------------------------------|--------------------------------------|
| <input type="checkbox"/> Brush Type DC | <input type="checkbox"/> Brushless DC | <input type="checkbox"/> Other _____ |
| <input type="checkbox"/> Stepper | <input type="checkbox"/> Torque Motor | |

3) This Application is: ☐ New _____

☐ Retrofit/Replacement

Current Supplier _____ Part Number _____

4) Estimated Annual Usage: _____ Price Target: _____

Estimated Life of Program: _____ Tooling \$ Available: _____

Production Start Date: _____

5) Size Constraints - Mechanical: _____

6) Electrical Brushless Specifications:

Brushless

Target Operating Point

Speed _____

Torque _____

Voltage _____

Maximum Current _____

Brush Type

Target Operating Point

Speed _____

Torque _____

Voltage _____

Maximum Current _____

Literature Request

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Technical Questions

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FAX 828-837-3343 • email: mcg@moog.com

MOOG
COMPONENTS GROUP

Motor Application Data Sheet

4X # _____
EQ. SP. ON Ø _____
(MAX SCREW
PENETRATION)

FRONT
SHAFT
EXT

OVERALL LENGTH

MAX

Ø

REAR SHAFT EXTENSION
LENGTH _____
DIAMETER _____

SHAFT KEYWAY REQUIREMENT _____
LENGTH _____
WIDTH _____
DEPTH _____

PILOT REQUIRED _____
DIAMETER _____

FLYING LEADS _____
CONNECTOR TYPE _____

FEEDBACK DEVICE M/N _____
____ ENCORDER
____ HALL EFFECT
____ RESOLVER
____ TACHOMETER

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Technical Questions
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FAX 828-837-3343 • email: mcg@moog.com



MOTION TECHNOLOGY

Motors

Moog Components Group provides a complete line of DC motors including brush, brushless and direct drive. These high quality motors are developed for a wide variety of applications, including medical, automation, commercial, aerospace and defense. Optional gearmotors, encoders and tachometers are available. Electronic drives are available for optimum system performance.

Slip Rings

Moog Components Group has over 6,000 slip ring designs that are used in systems that require continuous rotation while transmitting power and data from a stationary unit to a rotating device. In addition, we integrate fiber optic rotary joints into slip ring assemblies for applications that require extremely high data rate signals.

Resolvers

Moog Components Group's line of brushless resolvers are economical and highly accurate motion feedback sensors that are used to provide position and velocity information for closed-loop control, as well as brushless DC motor commutation.

Actuators

Moog Components Group offers high technology and utility electromechanical actuators for aerospace and commercial applications. These actuators utilize brush and brushless DC motors, planetary gears, modulated smart servo amplifiers, PWM amplifiers, multi-speed resolvers and potentiometers.

FIBER OPTICS

Moog Components Group expands and enhances its motion capabilities with expertise in fiber optic design and development. From MEMS-based fiber optic switches to large rotary joints to fiber optic modems, we offer an array of solutions for today's demanding applications.

CUSTOM SOLUTIONS

Moog Components Group does not stop with just standard models. Over the years, we have learned that many projects require a product that has unique specifications - either designed from scratch or modified from another design. One of Moog Components Group's strong points is providing exactly the right custom solution.

Specification and information are subject to change without prior notice.
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