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BM/BMS Brushless Motor Hardware Manual

P/N: EDA135 (Revision 2.06.00)



Dedicated to the Science of Motion

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NOTE: All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your software CD ROM or on www.aerotech.com.

NOTE: This manual and any additional instructions included with the BM/BMS should be read in their entirety before operating the BM/BMS .

NOTE: This product is intended for light industrial manufacturing or laboratory use.

This manual contains proprietary information and may not be reproduced, disclosed, or used in whole or in part without the express written permission of Aerotech, Inc. Product names mentioned herein are used for identification purposes only and may be trademarks of their respective companies.

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Chapter 1: BM/BMS Brushless Motor Hardware Manual

The BM/BMS series comprise Aerotech's high-performance, brushless, permanent magnet rotary servomotors. The motors feature rare earth magnets for maximum torque and acceleration in a small package.

BM Series

The BM series motors can reach speeds up to 10,000 rpm and accelerations to 270,000 rad/sec^2 for improved machine cycle times. Unlike DC brush-type servomotors, the BM series are brushless and maintenance free. This makes them ideal for critical applications where downtime cannot be tolerated. In addition, the BM series motors have very high power density resulting in high torque in a compact package. Optional IP65 sealing make these motors ideal for harsh environments such as machine tool and even in wash down applications such as food processing.

BMS Series

Aerotech's BMS series brushless, slotless, servo motors represent the ultimate in high-performance rotary motors. Available in standard NEMA frame sizes, these motors are unlike conventional brushless servomotors because they incorporate a totally slotless stator design that provides the ultimate in smooth velocity control. These motors are designed for applications requiring superior torque and stability performance.



Figure 1-1: BM/BMS Series Brushless Motors

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1.1. EC Declaration of Conformity

Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238 USA
Product	BMS (excluding VAC6 versions)
Model/Types	All

This is to certify that the aforementioned product is in accordance with the applicable requirements of the following Directive(s):

2006/95/EC	Low Voltage Directive

and is in conformity with the applicable requirements of the following documents when installed and used in accordance with the manufacturer's supplied installation instructions.

IEC 60034-1:2004	Rotating Electrical Machines
IEC 61010-1:2001	Safety requirements for Electrical Equipment for measurement, control, and laboratory use
NOTE:	Safe operation of the motor requires over speed and over current protection. This may be done by the connected controller / amplifier combination.

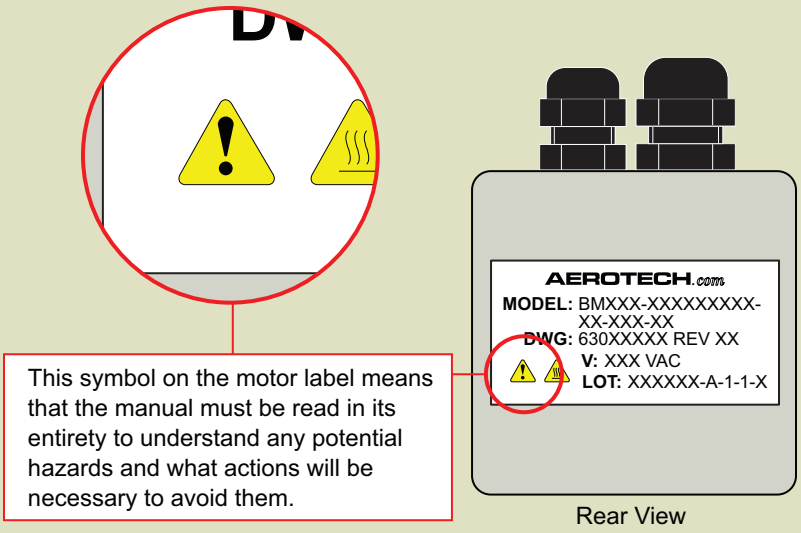
Name	/ Alex Weibel
Position	Engineer Verifying Compliance
Location	Pittsburgh, PA
Date	September 2010

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1.2. Safety Procedures and Warnings

Read this manual in its entirety before installing, operating, or servicing this product. If you do not understand the information contained here, contact an Aerotech representative before proceeding. Strictly adhere to the statements given in this section and other handling, use, and operational information given throughout the manual to avoid injury to you and damage to the equipment.

NOTE:



NOTE: BM/BMS motors (all Aerotech equipment) are not to be used in a manner not specified by Aerotech, Inc.

WARNING: The BM/BMS Servo Motors are not intended to be directly connected to an electrical power distribution system. They are meant to be part of a drive package consisting of an amplifier and controller. The motor relies on the drive package for all manners of fault protection. Aerotech, Inc. does not approve their motors for use in any other manner.

WARNING: Only trained personnel should operate, inspect, and maintain the BM/BMS .

WARNING: To prevent electrical shock hazards only allow qualified persons to install and service this equipment. Equipment grounds must be in place and maintained to reduce the risk of potentially fatal or serious injury from electrical shock.

WARNING: Never install or operate equipment that appears to be damaged.

WARNING: Disconnect electrical power to the motor before performing maintenance procedures. In addition, uncouple or otherwise prevent motor-coupled machinery from moving the motor during servicing.

DANGER: The motor temperature can pose a burn hazard. Do not touch the motor until it has cooled sufficiently.

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DANGER: These motors are not rated for use in explosive atmospheres. They are not to be operated in the presence of potentially explosive mixtures of air-borne dust or combustible vapors.



DANGER: Motors and their associated drives, cabling, etc. are sources of electromagnetic fields. Persons with external or implanted medical devices need to evaluate the risks associated with these devices before entering an area where they are in use.

NOTE: All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your software CD ROM or on www.aerotech.com.

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. Refer to the most recent edition of the Aerotech Motion Control Product Guide for the most current product information at www.aerotech.com.

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1.3. Motor Installation

Motors are installed by bolting the motor flange to a mounting surface using four holes on the motor flange. The load is connected to the motor shaft using keyways and/or flats.

1.3.1. Connector Pin Assignment

The pin assignment for the MS motor power connector is displayed in Table 1-1, the MS feedback connector is shown in Table 1-2, the optional resolver MS connector is shown in Table 1-3, and the D-sub motor and feedback connector pin assignments are shown in Table 1-4 and Table 1-5.

WARNING: During operation,do not allow motor connection cables to contact the motor frame.

Table 1-1: Motor Power Connector Pin Assignment (MS3101A-18-10P)

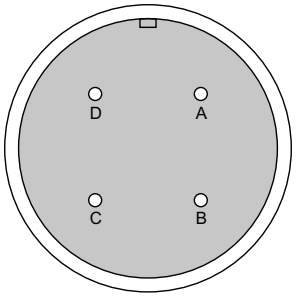
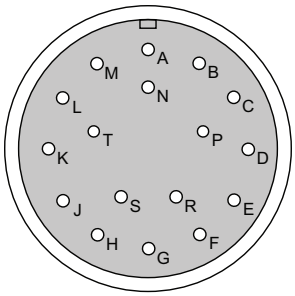
Pin	Function	Connector
A	Motor Phase A	 MS3101A-10P
B	Motor Phase B	
C	Motor Phase C	
D	Motor Frame Ground	
Backshell	Motor Cable Shield	

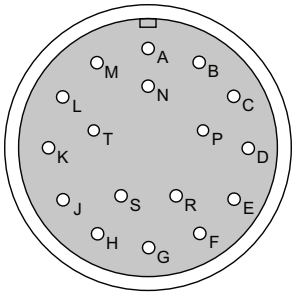
Table 1-2: Feedback Connector Pin Assignment (MS3101A-20-29P)

Pin	Function	Connector
A	Cosine	 MS3101A-20-29P
B	Cosine-N	
C	Sine	
D	Sine-N	
E	Marker	
F	Marker-N	
G	Common	
H	+5V	
J	Shield (no connection to frame)	
K	Hall Effect A	
L	Over-Temperature Thermistor Sensor (1)	
M	Hall Effect B	
N	Reserved	
P	Hall Effect C	
R	Reserved	
S	Brake + (2)	
T	Brake - (2)	

(1) BMS motors only. Reserved on all other motors.
(2) 24 VDC @ 1 A max

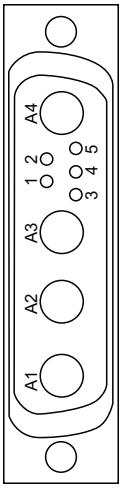
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Table 1-3: Resolver Connector Pin Assignment (MS3101A-20-29P)

Pin	Function	
A	Sine +	
B	Sine -	
C	Cosine +	
D	Cosine -	
E	Ref +	
F	Ref -	
N	Sine Shield (no connection to frame)	
P	Cosine Shield (no connection to frame)	
R	Reference Shield (no connection to frame)	
S	Brake + (1)	
T	Brake - (1)	
(1) 24 VDC @ 1 A max		

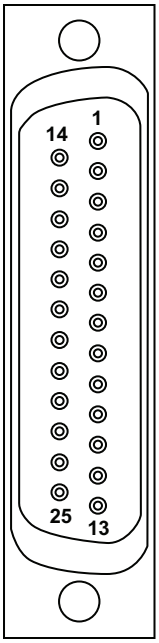
MS3101A-20-29P

Table 1-4: 9-Pin D-Connector Pin Assignment

Pin	Description	Connector
A1	MTR ØA (Motor Phase A)	
A2	MTR ØB (Motor Phase B)	
A3	MTR ØC (Motor Phase C)	
1	Shield for motor wiring connector	
2	Reserved: Not Used	
3	Reserved: Not Used	
4	Reserved: Not Used	
5	Reserved: Not Used	
A4	Ground to motor frame	

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Table 1-5: 25-Pin D-Connector Pin Assignment

Pin	Label	Description	Connector
1	SIG SHLD	Signal shield connection	
2	Thermistor (1)	Over-temperature Thermistor Sensor	
3	Encoder +5V	+5 V supply input for optical encoders (the typical requirement is 250 mA).	
5	HALL B	Hall Effect sensor, phase B	
6	MKR-N	Marker-N	
7	MKR	Marker	
10	HALL A	Hall Effect sensor, phase A	
11	HALL C	Hall Effect sensor, phase C	
13	Brake -(2)	Brake -	
14	COS	Cosine	
15	COS-N	Cosine-N	
16	Limit +5V	+5V supply input for optical limit switch boards (the typical requirement is 50 mA).	
17	SIN	Sine	
18	SIN-N	Sine-N	
20	Limit Common	Common ground to limit switch.	
21	Encoder Common	Common ground to encoder power	
25	Brake +(2)	Brake +	

(1) BMS motors only. Reserved on all other motors.
(2) With Brake option only (-BK or -BKH)

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1.4. External Motor Wiring

All external wiring to the motor must meet certain requirements to provide for safe and reliable operation. The wiring must be able to supply the rated current without overheating. The wire insulation must be rated for the voltage and temperature at which the motor is operating. And, efforts must also be made to reduce EMI emissions and to increase EMI immunity through proper cable selection and installation. In addition to supplying the external wiring the customer is also responsible for providing over current protection for the motor.

Guidelines are given below to help with the selection and installation of the wiring.

1.4.1. Motor Power Conductors

The motor power conductors must be sized to handle the electrical current requirements of the motor. The motor data sheets list the required values for the various motors. The wire insulation voltage rating is chosen based on the maximum voltage that will be applied to the motor.

1.4.2. Protective Ground

The protective ground is a safety conductor used to ground the motor case. The protective ground conductor must have a current carrying capacity at least equal to that of the motor wires. The insulation is standard Green/Yellow and must be rated for the maximum voltage applied to the motor winding. The protective ground wire is usually bundled along with the motor wires, but system requirements may be that a separate protective ground wire is needed.

1.4.3. Over Current Protection

Motors need to be provided with over current protection to prevent motor overheating. Over current protection can be accomplished using programmable current limits, traps, over current protection circuitry, or fusing. Fuse values should be selected according to the RMS current rating of the motor. For most applications slow-blow type fuses should be used.

When the motor is part of an Aerotech system utilizing an Aerotech controller and drive, the "A_{pk}" continuous current rating of the motor must be used to set the motor over-current protection fault. If the motor is being installed in a system not configured by Aerotech the customer is responsible for providing the necessary over current protection.

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1.4.4. Hall-Effect Device and Thermistor Wiring

The insulation of these wires should have a rating for at least the maximum voltage applied to the motor winding. The temperature rating of the wire insulation must also be sufficiently high to withstand the operating temperatures specific to the application.

1.4.5. Wiring Guidelines

The wiring guidelines given below can help to reduce EMI related problems which can result in poor overall system performance.

- Keep cable lengths as short as possible. Long cable runs are more susceptible to EMI pickup than short runs.
- Use grounded shielded cables for both the motor power and signal wiring
- The use of twisted pair shielded cabling can help reduce magnetically induced currents.
- Braided shield has a slightly better low frequency shielding capability than a foil shield. Foil is often used where RF shielding is necessary.
- Do not bundle signal, motor power cables, or AC power lines within the same protective shield or conduit. Instead, use separate protective shields or conduits.
- Do not introduce multiple paths to ground from a grounding point. Multiple paths to ground can create ground loops within the system.
- The use of EMI suppression devices may be necessary where the EMI environment warrants their use.

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1.4.6. Thermal Protective Device

BMS motors incorporate a positive-temperature coefficient (PTC) thermistor as a thermal protection device. The nominal resistance of the thermistor is 100 ohms at 25°C. The thermistor exhibits a rapid increase in resistance to 1,000 ohms as the motor temperature approaches the thermistor's transition temperature of 100°C (refer to Figure 1-2).

WARNING: The thermal protective device used in the BMS style motor must be incorporated in an external shutdown circuit to provide protection to the motor.

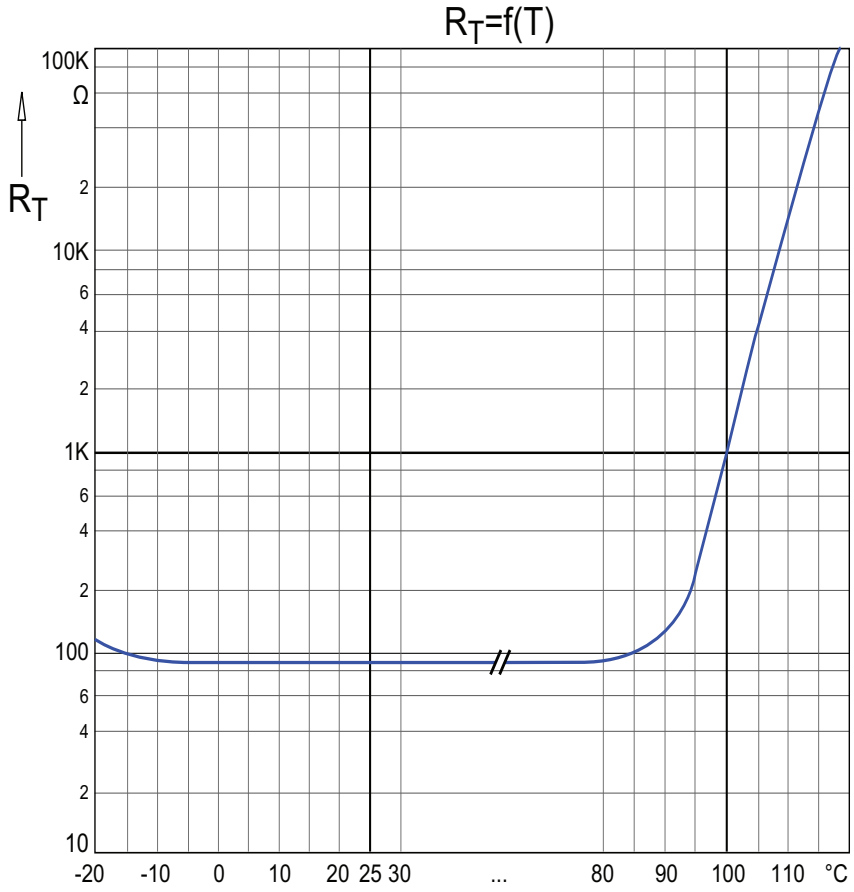


Figure 1-2: Typical Thermal Sensor Resistance as a Function of Temperature

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This thermistor can be used in a variety of different electronic interfaces. A precaution when using this type of device in an interface circuit is to avoid self-heating effects. An excessive amount of current through the thermistor will cause its temperature to rise. False triggering will then occur. See Figure 1-3 for a typical interface circuit.

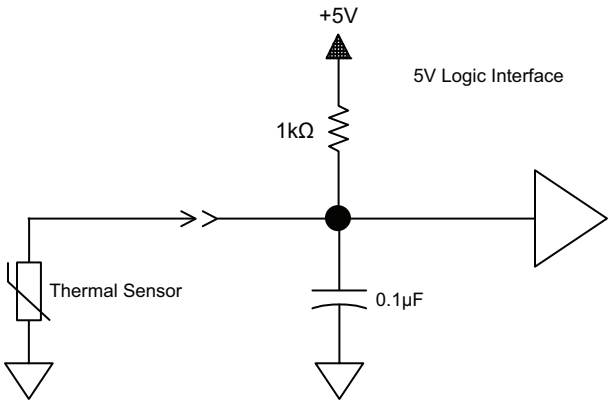
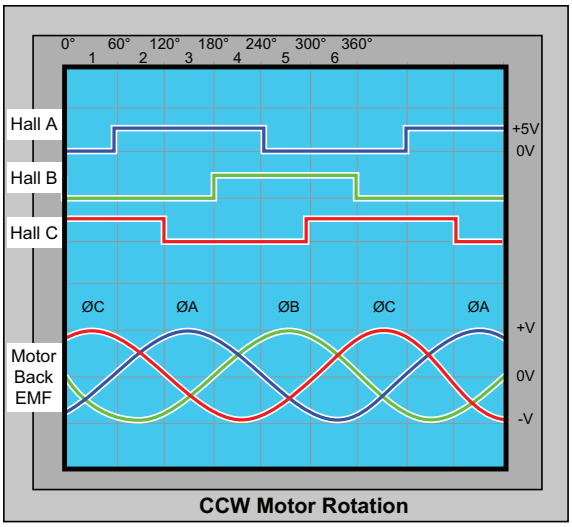


Figure 1-3: Typical Thermistor Interface Circuit

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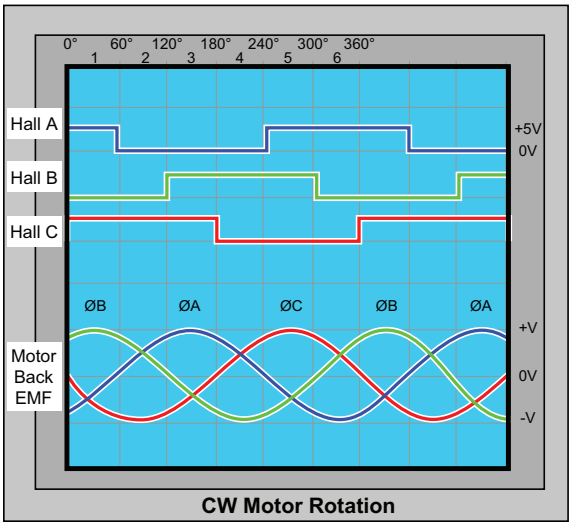
1.5. Hall-Effect Operation and Motor Phasing

Aerotech brushless motors are shipped from the factory with the correct motor phase to Hall effect relationship. Figure 1-4 shows the proper Hall effect to motor phasing for both clockwise (CW) and counter-clockwise (CCW) motor rotation viewed as shown.



During CCW motor rotation, each Hall effect signal is at a logic low state when its corresponding motor phase is at a negative voltage.





During CW rotation, each Hall effect signal is at a logic high state when its corresponding motor phase is at a negative voltage.

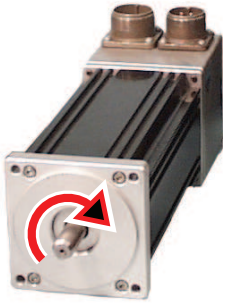


Figure 1-4: Hall Effect and Motor Phasing

The waveforms of the motor BEMF can be observed using an oscilloscope, a 5V power supply, and six 10,000 ohm resistors, see Figure 1-5. To view the waveforms remove all electrical connections to the motor, and configure the setup as shown in the figure. Motor leads 1, 2, and 3 are connected to the ends of the three resistors wired as shown. The Hall device power connections are as shown. The three Hall signal wires are connected via the remaining three resistors to the 5V lead of the power supply.

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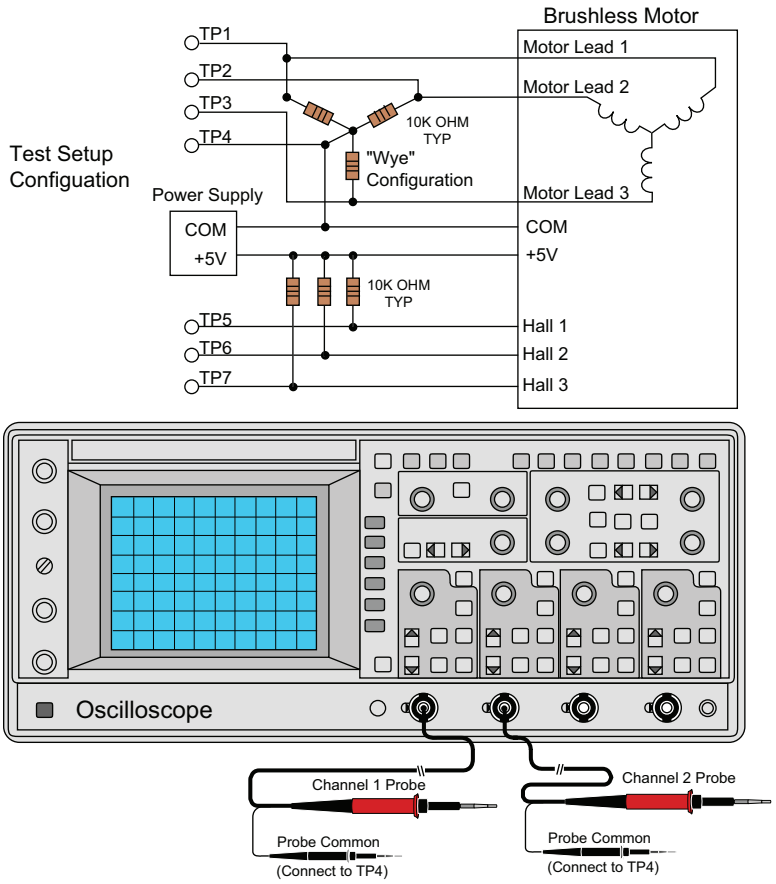


Figure 1-5: Test Setup Configuration

WARNING: The motor BEMF is monitored without power applied to the motor. Before performing these steps, remove all connections to the motor that are not part of the test setup shown in the figures. Remove all mechanical connections to the motor shaft also.

To determine the relative phasing/order of the three motor windings in relation to each other, connect channel 1 of the oscilloscope to TP1. Connect channel 2 to TP2 and move the motor in the positive direction (CW) by hand. Note the peak of the sine wave of channel 1 in comparison to the peak of the sine wave of channel 2. Next, disconnect channel 2 from TP2 and reconnect it to TP3 and again move the motor in the positive direction. Note the peak of the sine wave of channel 3 in comparison to the peak of the sine wave of channel 1.

Aerotech phasing expects ØC to be the lead signal in time, ØB to follow it, and ØA to follow ØB. This means that whichever signal has been determined to lead the others in time is designated as the ØC winding.

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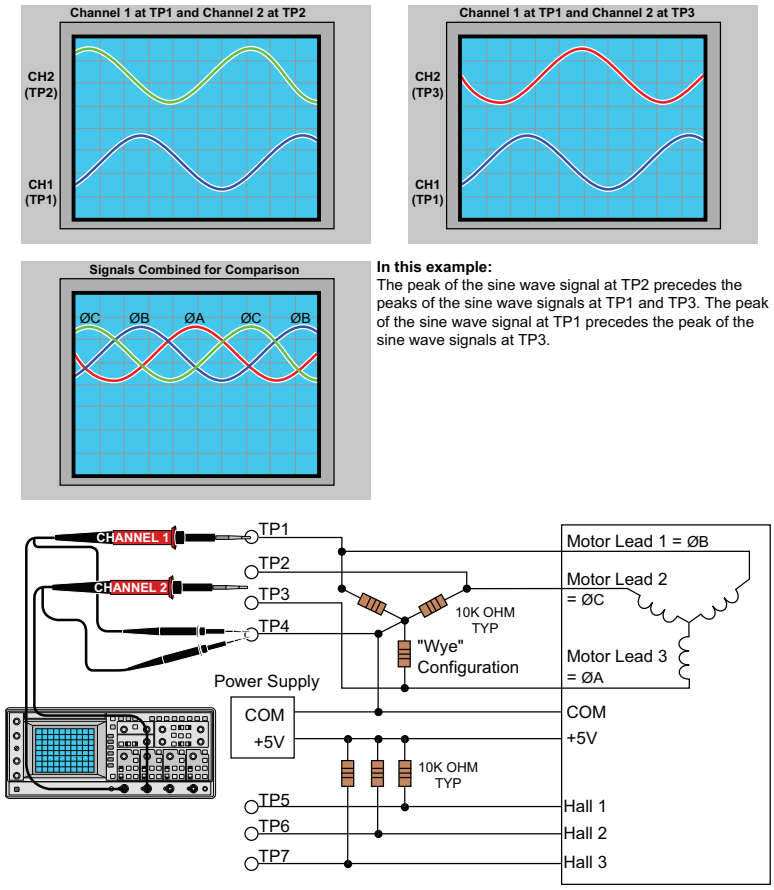


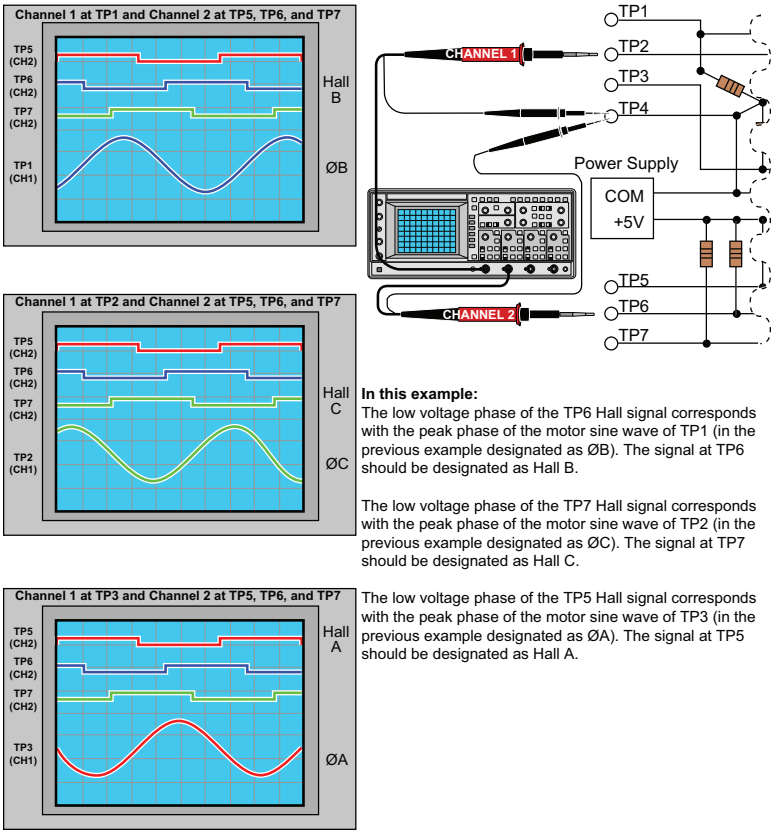
Figure 1-6: Motor Lead Phasing with Oscilloscope

After the phase relationships of the motor have been determined, the next step is to determine the phase relationships of the Hall signals. The expected relationship between motor BEMF and the Hall signal is the peak of the BEMF. This relationship should correspond to the low voltage phase of the Hall signal. The relationship is shown in Figure 1-7.

With channel 1 still connected to one of the motor leads, connect channel 2 of the oscilloscope to TP5, TP6, and then TP7, while advancing the motor in the positive direction after each connection. Note which of the three Hall signals have the complimentary phase relationship to the motor lead connected to channel 1.

Move channel 1 of the oscilloscope to the second motor lead and repeat the steps given above. Note which Hall signal corresponds to the currently selected motor lead. Repeat the process for the 3rd motor lead until the desired relationships are attained and noted.

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In this example:
The low voltage phase of the TP6 Hall signal corresponds with the peak phase of the motor sine wave of TP1 (in the previous example designated as ØB). The signal at TP6 should be designated as Hall B.

The low voltage phase of the TP7 Hall signal corresponds with the peak phase of the motor sine wave of TP2 (in the previous example designated as ØC). The signal at TP7 should be designated as Hall C.

The low voltage phase of the TP5 Hall signal corresponds with the peak phase of the motor sine wave of TP3 (in the previous example designated as ØA). The signal at TP5 should be designated as Hall A.

Figure 1-7: Hall Phasing with Oscilloscope

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1.6. Resolver Commutation

An optional resolver can be used as the feedback device for the motor. The resolver is aligned at the factory such that the null position of the resolver corresponds to a motor phase angle of zero degrees (refer to Figure 1-8). The null position of the resolver is considered to be the point at which the sine feedback signal is resting at a zero level and the cosine signal is resting at its positive peak.

WARNING: The sine and cosine signals shown in Figure 1-8 represent demodulated waveforms. In actual operation, these signals are transmitted on a high frequency carrier (e. g., 5 KHz, 10 KHz).

The zero degree phase angle of the motor is defined as the position that the motor shaft will align to if phase A is energized with a positive voltage with respect to phases B and C. The 8 pole motors (4 pole pairs) have four zero degree points per revolution, and the 6 pole motors have 3 zero degree points per revolution.

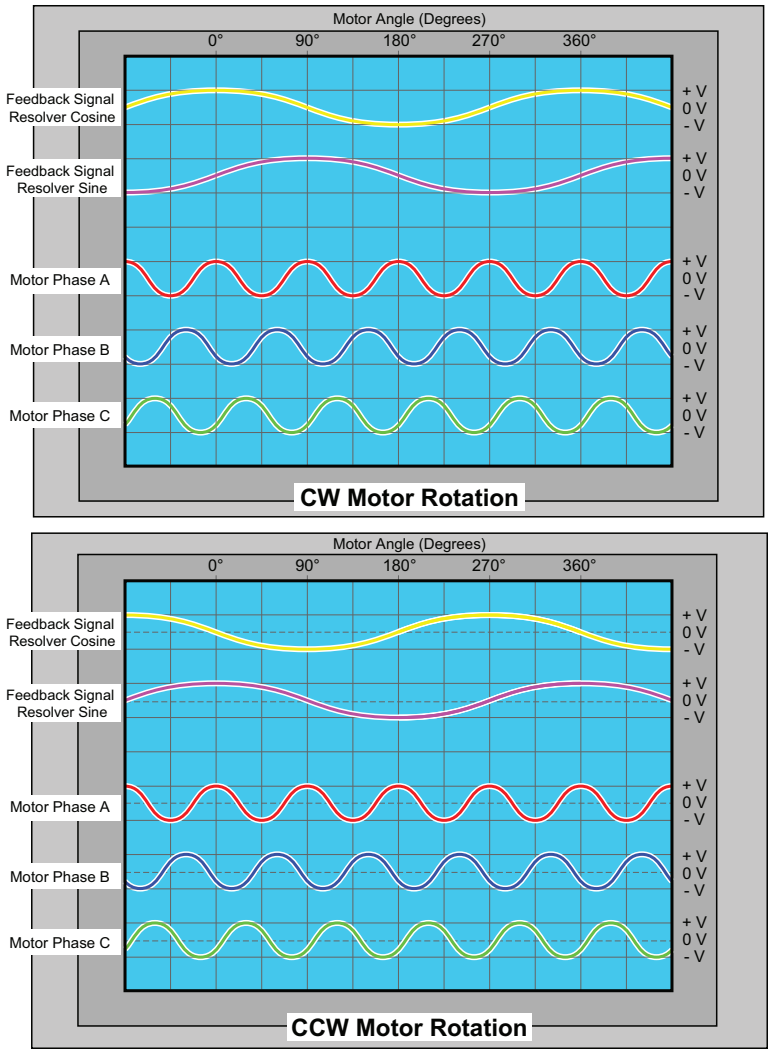


Figure 1-8: Resolver and Motor Phasing

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1.7. Motor Heating

The temperature rise above ambient establishes a limit on the amount of current allowed through the motor winding. The thermal characteristics of the motor, the effectiveness of the surrounding medium to transfer heat away from the motor, and any supplemental cooling determine the operating conditions.

The motor's torque speed curve gives the safe operating region for the motor. The curves are generated under a single set of operating conditions, and the motor's operating specifications are generated under these conditions, see the Motor Specifications section of this manual. If the motor is operated within the safe operating region, that region bounded by the Continuous Operating Curve, then the motor's thermal limit will not be exceeded so long as the minimum environmental and thermal conditions exist. Motor operation in the region bounded by the Peak Operating Curve has to be limited in time or the motor's thermal limit will be exceeded.

Poor heat transfer away from the motor, excessive torque loading, elevated ambient temperatures, etc. are situations that will cause excessive motor heating and failure. The importance of motor overload and thermal protection devices as described in previous sections becomes apparent.

An example torque speed curve is given in Figure 1-9.

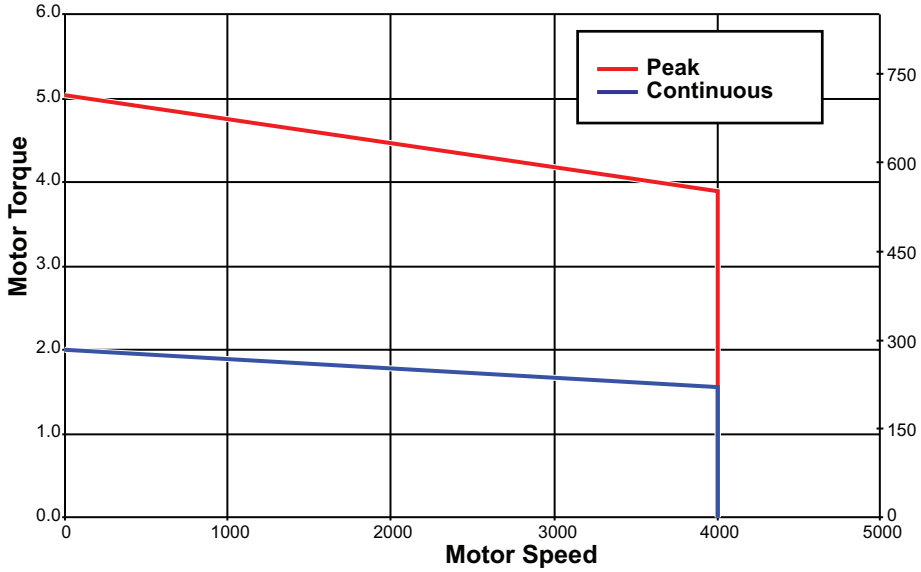


Figure 1-9: Example Torque Speed Curve

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1.8. Maintenance

Installation problems usually reveal themselves early in the installation. Regular preventative maintenance should include but is not limited to the following: make frequent checks for excessive or abnormal motor heating, excessive motor vibrations, loose motor to machine couplers, obstructed air flow to the motor, burning smells, an accumulation of debris on the motor, etc.

Motors should be wiped with a clean dry cloth to remove any grease, dirt, or other material that has accumulated on the motor. Fluids and sprays are not recommended for chance of internal motor contamination. Cleaning the motor labels should be avoided to prevent their removal.

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1.9. Environmental Specifications

The environmental considerations for motor operation are given below. Deviating from these specifications may lead to motor failure or an unsafe operating condition. Contact Aerotech for information concerning motor operations under conditions deviating from these environmental specifications.

Temperature:	**Operating:** 0° to 25°C, consult Aerotech for operation outside of this range. **Storage:** -20°C to 85°C
Humidity:	Ambient conditions need to be such that condensation on the motor does not occur. The motors are not to be used in wash-down environments (unless ordering with the IP65 option).
Dust Exposure:	The BM and BMS motors are rated IP40. The BM250, 500, 800, 1400, and 2000 can be ordered, as an option, with IP65 protection.
Altitude:	Up to 2000 m. Consult Aerotech for deration considerations for altitudes above 2000 m
Use:	Indoor use only.
Atmosphere:	Do not use in hydrogen atmospheres

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1.10. Motor Specifications

The specifications for the BM series brushless motors are listed in Table 1-6, Table 1-7, Table 1-8, and Table 1-9. The specifications for the BMS series brushless motors are listed in Table 1-10 and Table 1-11.

Table 1-6: BM22, BM75, BM130, BM200 Motor Specifications

Motor Model	Units	BM22	BM75	BM130
Performance Specifications (1,5)				
Stall Torque, Continuous (2,8)	N·m (oz·in)	0.16 (22.5)	0.55 (78.3)	1.00 (141.5)
Peak Torque(3)	N·m (oz·in)	0.48 (68.0)	1.4 (196)	2.5 (354)
Rated Speed	rpm	3,000	4,000	4,000
Rated Power Output, Continuous	W	50	207	323
Electrical Specifications(5)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	3.9	9	19
Continuous Current, Stall (2,8)	A_{pk} (A_{rms})	4.9 (3.5)	10.0 (7.1)	7.5 (5.3)
Peak Current, Stall (3)	A_{pk} (A_{rms})	14.7 (10.4)	25.0 (17.7)	18.9 (13.3)
Torque Constant (4,9)	N·m/A_{pk} (oz·in/A_{pk})	0.032 (4.5)	0.06 (7.8)	0.13 (18.8)
	N·m/(A_{rms} (oz·in/(A_{rms})	0.045 (6.4)	0.08 (11.1)	0.19 (26.5)
Motor Constant (2,4)	N·m/√W (oz·in/√W)	0.038 (5.37)	0.052 (7.33)	0.088 (12.43)
Resistance, 25°C (Line-Line)	Ω	0.67	1.0	2.0
Inductance (Line-Line)	mH	0.73	0.80	1.80
Maximum Bus Voltage	V_{DC}	80	340	340
Thermal Resistance	°C/W	6.26	1.14	1.00
Number of Poles	--	8	8	8
Mechanical Specifications				
Motor Weight	kg (lb)	0.4 (0.88)	1.1 (2.42)	1.5 (3.30)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$2.00x10^{-6}$ (0.00028)	$5.20x10^{-6}$ (0.0007)	$9.20x10^{-6}$ (0.0013)
Max Radial Load	N (lb)	78 (18)	89 (20)	89 (20)
Max Axial Load	N (lb)	39 (9)	89 (20)	89 (20)
Frame Size	NEMA	17	23	23

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 130°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 155 °C
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) De-rate continuous torque and continuous current by 10 percent when using an encoder(does not apply to BM22)
(9) All Aerotech amplifiers are rated Apk; use torque constant in N·m / Apk when sizing

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Table 1-7: BM250 and BM500 Motor Specifications

Motor Model	Units	BM200	BM250	BM500
Performance Specifications (1,5)				
Stall Torque, Continuous(2,8)	N·m (oz·in)	1.20 (170.0)	2.0 (285)	3.6 (506)
Peak Torque (3)	N·m (oz·in)	3.0 (425)	5.0 (712)	8.9 (1,264)
Rated Speed	rpm	4,000	4,000	4,000
Rated Power Output, Continuous	W	460	671	1029
Electrical Specifications (5)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	18	28	29
Continuous Current, Stall (2,8)	A_{pk} (A_{rms})	10.0 (7.1)	10.5 (7.4)	17.5 (12.4)
Peak Current, Stall (3)	A_{pk} (A_{rms})	25.0 (17.7)	26.3 (18.6)	43.8 (30.9)
Torque Constant (4,9)	N·m/A_{pk} (oz·in/A_{pk})	0.12 (17.0)	0.19 (27.1)	0.20 (28.9)
	N·m/A_{rms} (oz·in/A_{rms})	0.17 (24.0)	0.27 (38.4)	0.29 (40.9)
Motor Constant (2,4)	N·m/√W (oz·in/√W)	0.107 (15.18)	0.171 (24.24)	0.270 (38.28)
Resistance, 25°C (Line-Line)	Ω	1.1	1.1	0.5
Inductance (Line-Line)	mH	1.10	1.30	2.80
Maximum Bus Voltage	V_{DC}	340	340	340
Thermal Resistance	°C/W	1.04	0.94	0.74
Number of Poles	--	8	8	8
Mechanical Specifications				
Motor Weight	kg (lb)	2.0 (4.40)	3.6 (7.92)	5.0 (11.0)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$1.30x10^{-5}$ (0.0018)	$7.85x10^{-5}$ (0.0111)	$1.39x10^{-4}$ (0.0197)
Max Radial Load	N (lb)	89 (20)	178 (40)	178 (40)
Max Axial Load	N (lb)	89 (20)	89 (20)	89 (20)
Frame Size	NEMA	23	34	34

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 130°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 155 °C
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) De-rate continuous torque and continuous current by 10 percent when using an encoder(does not apply to BM22)
(9) All Aerotech amplifiers are rated Apk; use torque constant in N·m / Apk when sizing

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Table 1-8: BM800, BM1400 Motor Specifications

Motor Model	Units	BM800	BM1400
Performance Specifications (1,5)			
Stall Torque, Continuous (2,8)	N·m (oz·in)	5.6 (787)	9.4 (1336)
Peak Torque (3)	N·m (oz·in)	13.9 (1966)	23.6 (3339)
Rated Speed	rpm	3,000	3,000
Rated Power Output, Continuous	W	1400	2330
Electrical Specifications (5)			
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	69	69
Continuous Current, Stall (2,8)	A_{pk} (A_{rms})	10.6 (7.5)	18.0 (12.7)
Peak Current, Stall (3)	A_{pk} (A_{rms})	26.5 (18.7)	45.0 (31.8)
Torque Constant (4,9)	N·m/A_{pk} (oz·in/A_{pk})	0.52 (74.2)	0.52 (74.2)
	N·m/A_{rms} (oz·in/A_{rms})	0.74 (104.9)	0.74 (104.9)
Motor Constant (2,4)	N·m/√W (oz·in/√W)	0.448 (63.44)	0.694 (98.28)
Resistance, 25°C (Line-Line)	Ω	1.2	0.5
Inductance (Line-Line)	mH	3.80	1.70
Maximum Bus Voltage	V_{DC}	340	340
Thermal Resistance	°C/W	0.85	0.70
Number of Poles	--	8	8
Mechanical Specifications			
Motor Weight	kg (lb)	6.6 (14.52)	10.7 (23.54)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$3.00x10^{-4}$ (0.0425)	$5.60x10^{-4}$ (0.0793)
Max Radial Load	N (lb)	222 (50)	222 (50)
Max Axial Load	N (lb)	89 (20)	89 (20)
Frame Size	NEMA	42	42

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 130°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 155 °C
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) De-rate continuous torque and continuous current by 10 percent when using an encoder(does not apply to BM22)
(9) All Aerotech amplifiers are rated Apk; use torque constant in N·m / Apk when sizing

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Table 1-9: BM2000, BM3400, BM4500 Motor Specifications

Motor Model	Units	BM2000	BM3400	BM4500
Performance Specifications (1, 5)				
Stall Torque, Continuous (2)	N·m (lb·in)	14.7 (130)	23.7 (210)	31.6 (280)
Peak Torque (3)	N·m (lb·in)	44.1 (390)	71.2 (630)	94.9 (840)
Rated Speed (6)	rpm	2,400	2,400	2,400
Rated Power Output, Continuous	W	3282	5073	6789
Electrical Specifications (5)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	99.0	99.0	113.1
Continuous Current, Stall (2)	A_{pk} (A_{rms})	16.5 (11.7)	26.7 (18.9)	31.1 (22.0)
Peak Current, Stall(3)	A_{pk} (A_{rms})	49.7 (35.1)	80.3 (56.7)	93.5 (66.1)
Torque Constant (4, 8)	N·m/A_{pk} (lb·in/A_{pk})	0.89 (7.9)	0.89 (7.9)	1.01 (9.0)
	N·m/A_{rms} (lb·in/A_{rms})	1.25 (11.1)	1.25 (11.1)	1.43 (12.7)
Motor Constant (2, 4)	N·m/√W (lb·in/√W)	1.13 (10.0)	1.86 (16.5)	2.31 (20.5)
Resistance, 25°C (Line-Line)	Ω	0.54	0.20	0.17
Inductance (Line-Line)	mH	3.50	1.60	1.50
Maximum Bus Voltage	V_{DC}	340	340	340
Thermal Resistance	°C/W	0.78	0.80	0.69
Number of Poles	--	6	6	6
Mechanical Specifications				
Motor Weight	kg (lb)	15 (33.0)	23 (49.9)	30 (66.9)
Rotor Moment of Inertia	kg·m^2 (lb·in·s^2)	$1.25x10^{-3}$ (0.0111)	$2.23x10^{-3}$ (0.0197)	$3.24x10^{-3}$ (0.0287)
Max Radial Load	N (lb)	668 (150)	668 (150)	668 (150)
Max Axial Load	N (lb)	223 (50)	223 (50)	223 (50)
Frame Size	IEC	142	142	142

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 130°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 155 °C
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) De-rate continuous torque and continuous current by 10 percent when using an encoder(does not apply to BM22)
(9) All Aerotech amplifiers are rated Apk; use torque constant in N·m / Apk when sizing

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Table 1-10: BMS35, BMS60, BMS100 Motor Specifications

Motor Model	Units	BMS35	BMS60	BMS100
Winding Designation		-A	-A	-A
Performance Specifications (1, 5)				
Stall Torque, Continuous (2)	N·m (oz·in)	0.27 (38.0)	0.33 (46.2)	0.56 (80.0)
Peak Torque (3)	N·m (oz·in)	1.07 (152.0)	1.31 (184.9)	2.26 (320.0)
Rated Speed	rpm	4,000	4,000	3,000
Rated Power Output, Continuous	W	96	112	133
Electrical Specifications (5)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	12.9	19	40
Continuous Current, Stall (2)	A_{pk} (A_{rms})	2.5 (1.7)	2.3 (1.6)	2.1 (1.5)
Peak Current, Stall (3)	A_{pk} (A_{rms})	9.8 (6.9)	9.2 (6.5)	8.4 (5.9)
Torque Constant (4, 8)	N·m/A_{pk} (oz·in/A_{pk})	0.11 (15.5)	0.14 (20.1)	0.27 (38.1)
	N·m/A_{rms} (oz·in/A_{rms})	0.15 (21.9)	0.20 (28.4)	0.38 (53.9)
Motor Constant (2, 4)	N·m/√W (oz·in/√W)	0.046 (6.52)	0.050 (7.02)	0.076 (10.74)
Resistance, 25°C (Line-Line)	Ω	5.8	8.4	12.9
Inductance (Line-Line)	mH	1.7	1.30	2.40
Maximum Bus Voltage	V_{DC}	340	340	340
Thermal Resistance	°C/W	2.21	1.73	1.35
Number of Poles	--	8	8	8
Mechanical Specifications				
Motor Weight	kg (lb)	0.6 (1.3)	1.1 (2.4)	1.5 (3.3)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$1.96x10^{-5}$ (0.0028)	$1.96x10^{-5}$ (0.0028)	$3.71x10^{-5}$ (0.0053)
Max Radial Load	N (lb)	45 (10)	89 (20)	89 (20)
Max Axial Load	N (lb)	45 (10)	89 (20)	89 (20)
Frame Size	NEMA	17	23	23

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 75°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 100 °C (Thermistor trips at 100°C)
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) All Aerotech amplifiers are rated A_{pk}; use torque constant in N·m / A_{pk} when sizing

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Table 1-11: BMS280, BMS465 Motor Specifications

Motor Model	Units	BMS280	BMS465
Winding Designation		-A	-A
Performance Specifications (1, 5)			
Stall Torque, Continuous (2)	N·m (oz·in)	1.60 (227.0)	2.86 (404.8)
Peak Torque (3)	N·m (oz·in)	6.41 (908.0)	11.43 (1619.2)
Rated Speed	rpm	3,000	2,000
Rated Power Output, Continuous	W	381	457
Electrical Specifications (5)			
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	57	79
Continuous Current, Stall (2)	A_{pk} (A_{rms})	3.8 (2.7)	4.9 (3.5)
Peak Current, Stall (3)	A_{pk} (A_{rms})	15.2 (10.7)	19.6 (13.9)
Torque Constant (4, 8)	$N·m/A_{pk}$ ($oz·in/A_{pk}$)	0.42 (59.7)	0.58 (82.6)
	$N·m/A_{rms}$ ($oz·in/A_{rms}$)	0.60 (84.5)	0.82 (116.8)
Motor Constant (2, 4)	$N·m/\sqrt{W}$ ($oz·in/\sqrt{W}$)	0.179 (25.34)	0.280 (39.70)
Resistance, 25°C (Line-Line)	Ω	5.7	4.4
Inductance (Line-Line)	mH	1.10	0.87
Maximum Bus Voltage	V_{DC}	340	340
Thermal Resistance	°C/W	0.93	0.72
Number of Poles	--	14	14
Mechanical Specifications			
Motor Weight	kg (lb)	3.60 (7.9)	5.00 (11.0)
Rotor Moment of Inertia	$kg·m^2$ ($oz·in·s^2$)	$4.66x10^{-4}$ (0.0660)	$9.28x10^{-4}$ (0.1314)
Max Radial Load	N (lb)	178 (40)	178 (40)
Max Axial Load	N (lb)	89 (20)	89 (20)
Frame Size	NEMA	34	34

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 75°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 100 °C (Thermistor trips at 100°C)
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) All Aerotech amplifiers are rated A_{pk}; use torque constant in N·m / A_{pk} when sizing

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1.11. Brushless Motor Dimensions

The following figures show the outline dimensions of each model in BM series brushless motors.

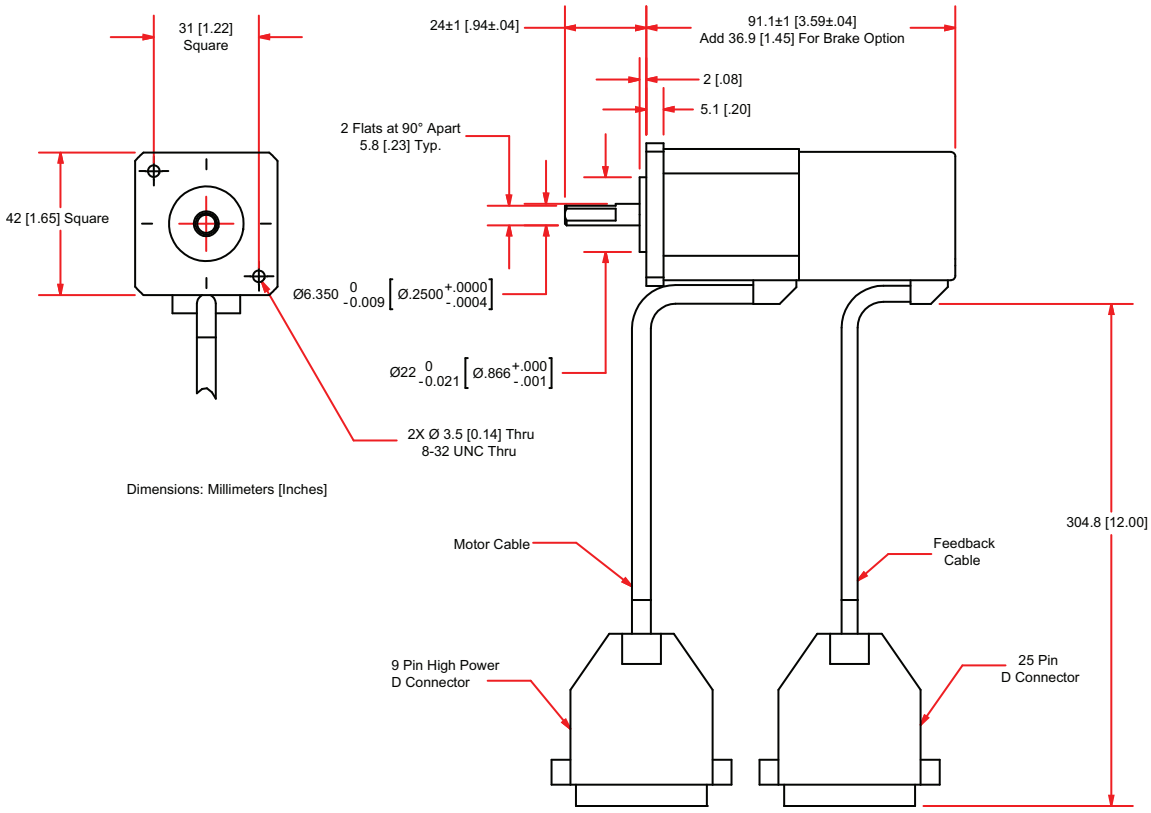
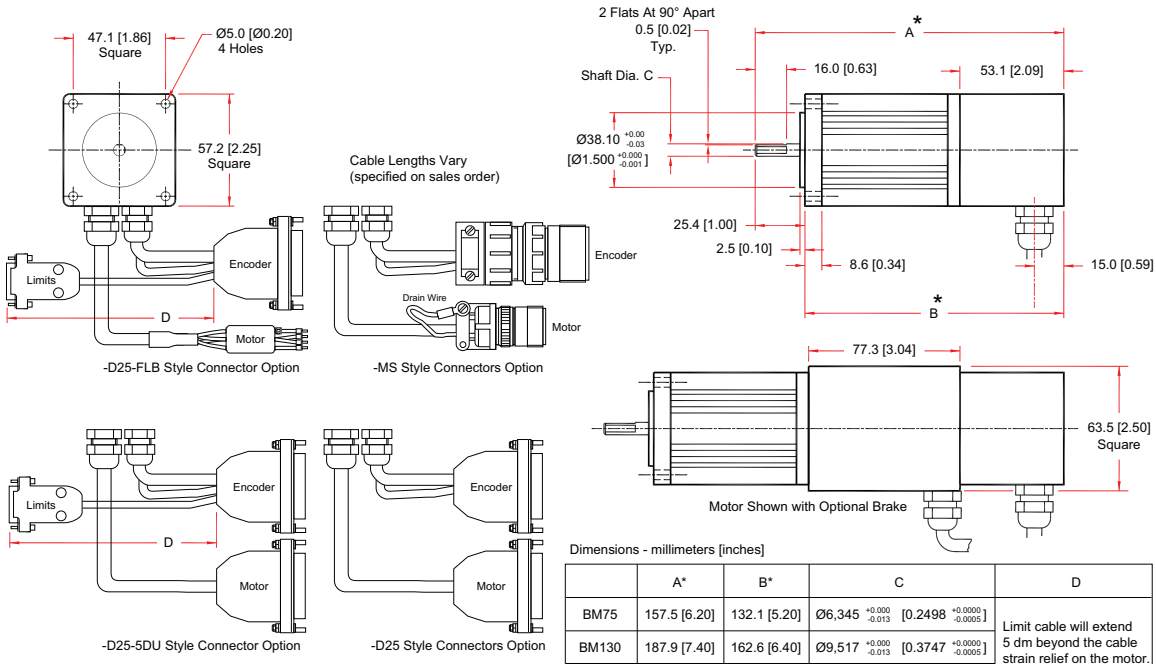


Figure 1-10: BM22 Model Dimensions (NEMA 17)

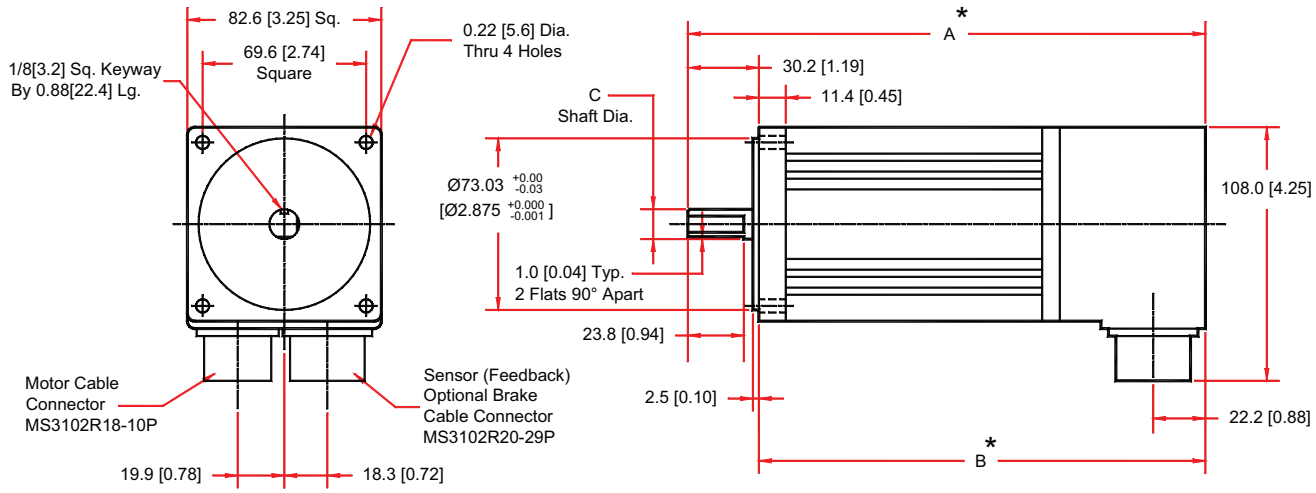
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Dimensions - millimeters [inches]

	A*	B*	C	D
BM75	157.5 [6.20]	132.1 [5.20]	Ø6,345 +0.000 -0.013 [0.2498 +0.0000 -0.0005]	Limit cable will extend 5 dm beyond the cable strain relief on the motor.
BM130	187.9 [7.40]	162.6 [6.40]	Ø9,517 +0.000 -0.013 [0.3747 +0.0000 -0.0005]	
BM200	218.4 [8.60]	193.0 [7.60]	Ø9,517 +0.000 -0.013 [0.3747 +0.0000 -0.0005]	
*Add 77.3 [3.04] To Length For Optional Brake.				

Figure 1-11: BM75, BM130, BM200 Model Dimensions (NEMA 23)

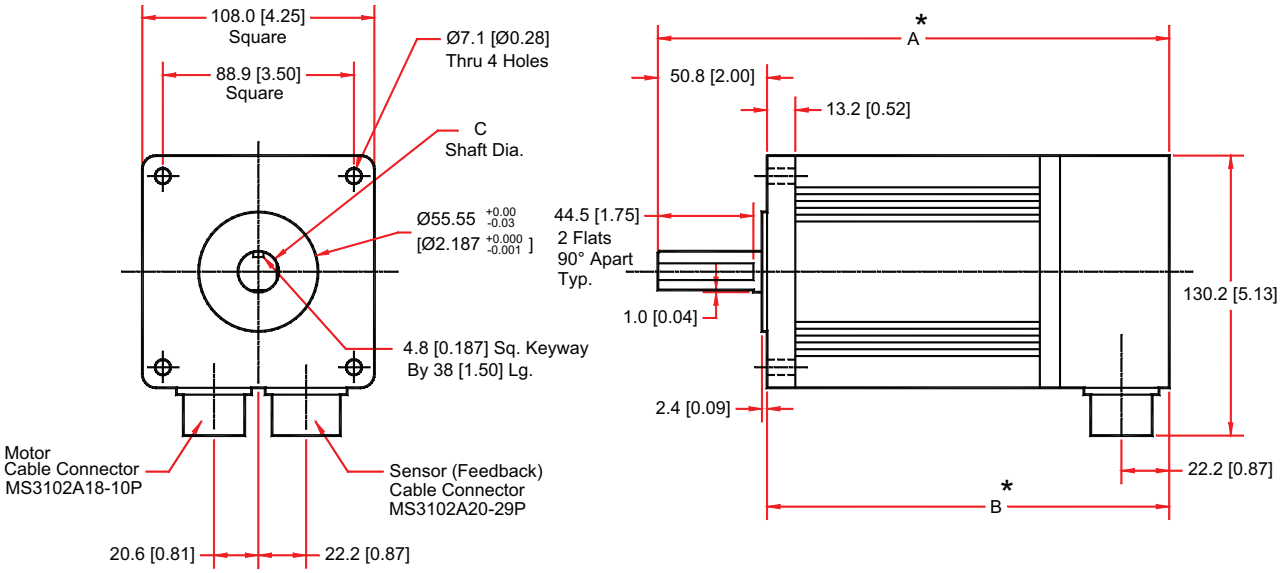


Dimensions - millimeters [inches]

	A*	B*	C
BM250	220.3 [8.67]	190.0 [7.48]	Ø12.69 +0.000 -0.013 [0.4997 +0.0000 -0.0005]
BM500	275.1 [10.83]	244.9 [9.64]	Ø12.69 +0.000 -0.013 [0.4997 +0.0000 -0.0005]
*Add 55.6 [2.19] To Length For Optional Brake.			

Figure 1-12: BM250, BM500 Model Dimensions (NEMA 34)

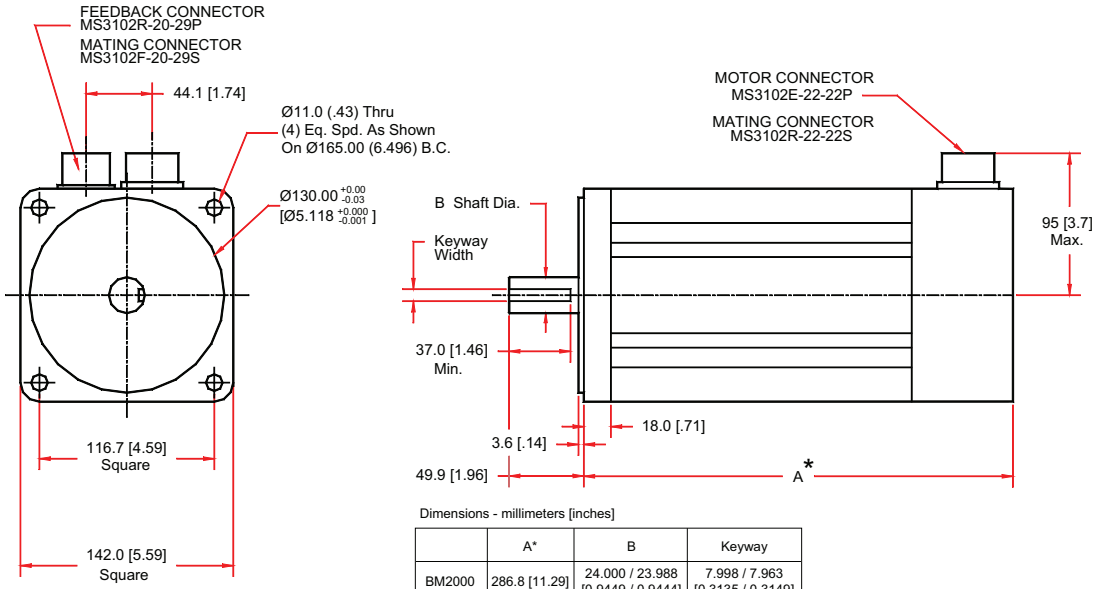
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Dimensions - millimeters [inches]

	A*	B*	C
BM800	238 [9.37]	187 [7.37]	Ø19.04 +0.000 -0.013 [0.7497 +0.0000 -0.0005]
BM1400	318 [12.52]	267.2 [10.52]	Ø19.04 +0.000 -0.013 [0.7497 +0.0000 -0.0005]
*Add 68.9 [2.71] To Length For Optional Brake.			

Figure 1-13: BM800, BM1400 Model Dimensions (NEMA 42)



Dimensions - millimeters [inches]

	A*	B	Keyway
BM2000	286.8 [11.29]	24.000 / 23.988 [0.9449 / 0.9444]	7.998 / 7.963 [0.3135 / 0.3149]
BM3400	355.3 [13.99]	24.000 / 23.988 [0.9449 / 0.9444]	7.998 / 7.963 [0.3135 / 0.3149]
BM4500	423.9 [16.69]	32.000 / 31.984 [1.2598 / 1.2593]	9.975 / 10.000 [0.3927 / 0.3937]
*Add 69.0 [2.7] To Length For Optional Brake.			

Figure 1-14: BM2000, BM3400, BM4500 Model Dimensions (IEC 142)

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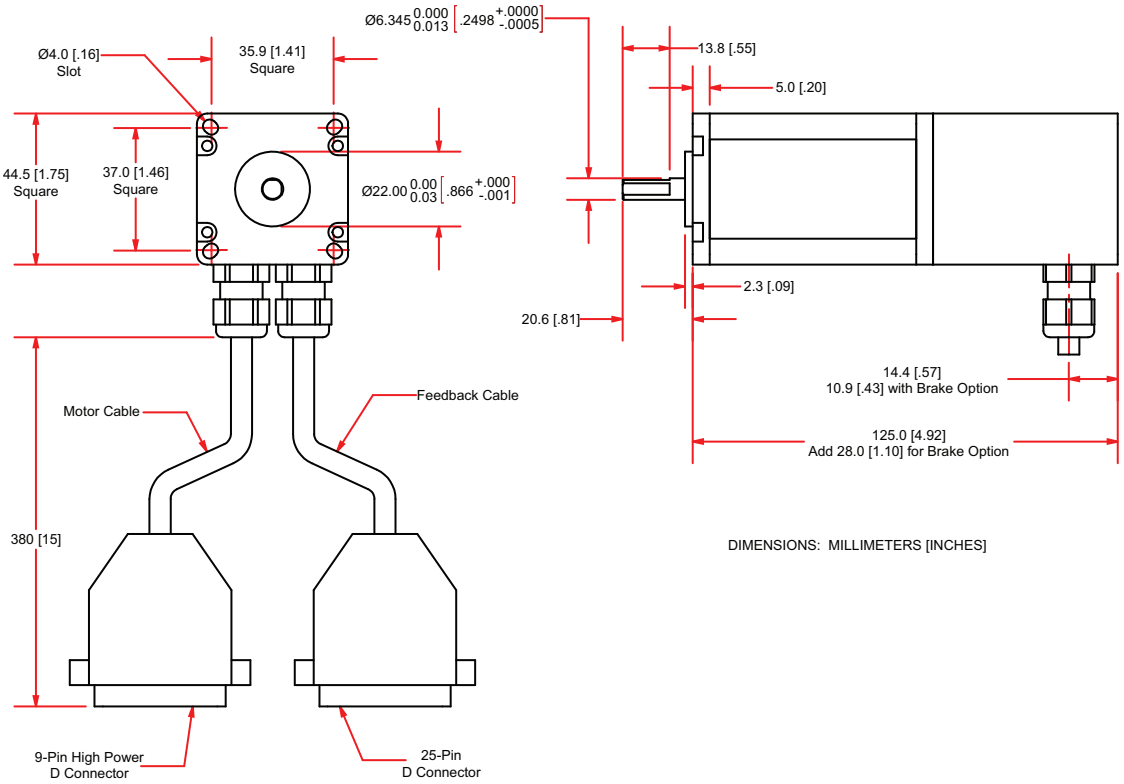
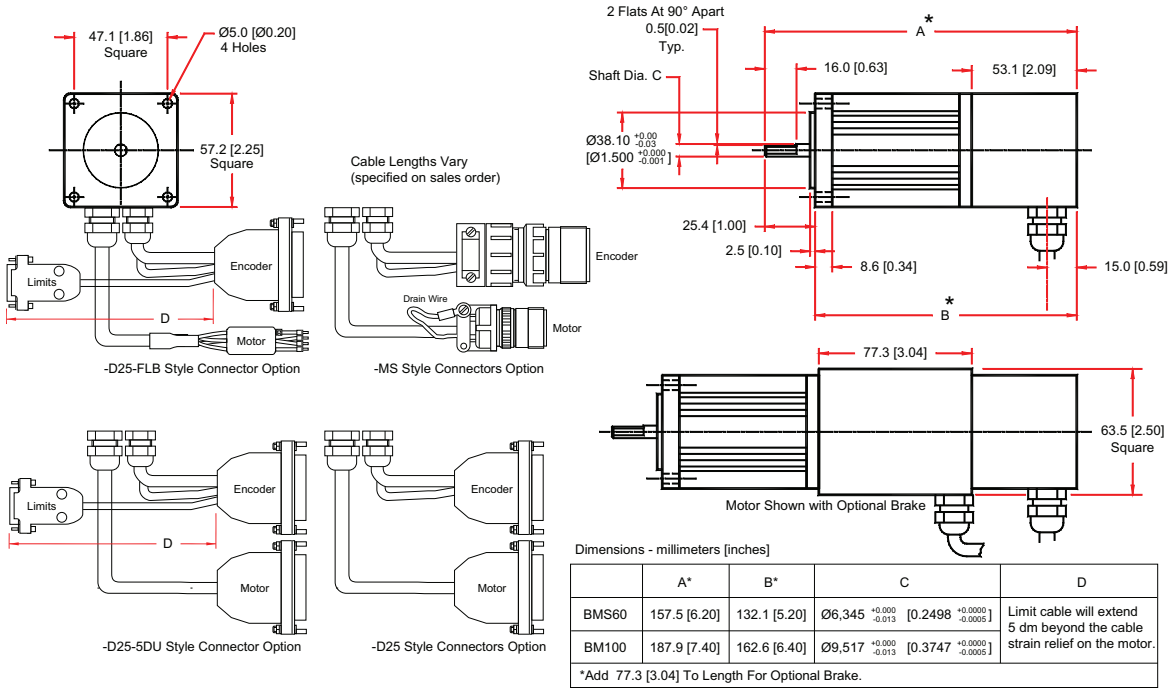


Figure 1-15: BMS35 Model Dimensions (NEMA 17)

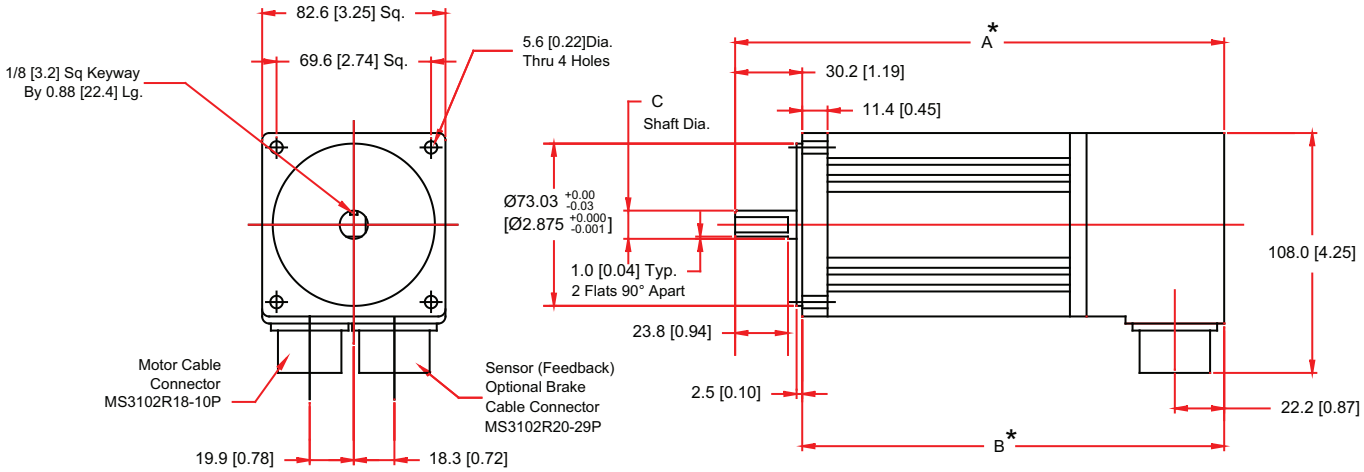


Dimensions - millimeters [inches]

	A*	B*	C	D
BMS60	157.5 [6.20]	132.1 [5.20]	Ø6,345 +0.000 -0.013 [0.2498 +0.0000 -0.0005]	Limit cable will extend 5 dm beyond the cable strain relief on the motor.
BM100	187.9 [7.40]	162.6 [6.40]	Ø9,517 +0.000 -0.013 [0.3747 +0.0000 -0.0005]	
*Add 77.3 [3.04] To Length For Optional Brake.				

Figure 1-16: BMS60 and BMS100 Model Dimensions (NEMA 23)

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Dimensions - millimeters [inches]

	A*	B*	C
BMS280	220.3 [8.67]	190.0 [7.48]	Ø12.69 +0.000 -0.013 [0.4997 +0.0000 -0.0005]
BMS465	275.1 [10.83]	244.9 [9.64]	Ø12.69 +0.000 -0.013 [0.4997 +0.0000 -0.0005]
*Add 55.6 [2.19] To Length For Optional Brake.			

Figure 1-17: BMS280 and BMS465 Model Dimensions (NEMA 34)

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1.12. Part Number and Ordering Information

Order information with part numbers and descriptions are shown in the following tables.

Table 1-12: BM Motor Options

Brushless Rotary Servomotors	
BM22	NEMA 17 brushless servomotor; 22.5 oz·in continuous torque
BM75	NEMA 23 brushless servomotor; 78.3 oz·in continuous torque
BM130	NEMA 23 brushless servomotor; 141.5 oz·in continuous torque
BM200	NEMA 23 brushless servomotor; 170.0 oz·in continuous torque
BM250	NEMA 34 brushless servomotor; 285 oz·in continuous torque
BM500	NEMA 34 brushless servomotor; 506 oz·in continuous torque
BM800	NEMA 42 brushless servomotor; 787 oz·in continuous torque
BM1400	NEMA 42 brushless servomotor; 1,336 oz·in continuous torque
BM2000	IEC 142 brushless servomotor; 130 lb·in continuous torque
BM3400	IEC 142 brushless servomotor; 210 lb·in continuous torque
BM4500	IEC 142 brushless servomotor; 280 lb·in continuous torque
Connectors	
-MS	Military Style connectors for feedback and motor power [standard for all *except* BM22]
-D25	D-shells for feedback and motor power [NEMA 17, NEMA 23]
-D25-FLB	Integral cable to mate to Ndrive/Soloist/Ensemble with ferrules, FBF-1, and limit connector [NEMA 23]
-D25-5DU	Integral cable to mate to Npaq with limit connector [NEMA 23]
Feedback Options	
-E1000H	1000 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output)
-E2000H	2000 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output) [only option for BM22]
-E2500H	2500 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output)
-E5000H	5000 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output)
-E1000ASH	1000 line 1V peak to peak amplified sine encoder
Options	
-BK1	Brake, Holding torque = 0.8 N·m (112 oz·in), 24 VDC, 0.3 A [NEMA 23]
-BK2	Brake, holding torque = 1.7 N·m (240 oz·in), 24 VDC, 0.4 A [NEMA 34]
-BK3	Brake, holding torque = 5.6 N·m (800 oz·in), 24 VDC, 0.7 A [NEMA 42]
-BK5	Brake, holding torque = 40.7 N·m (360 lb·in), 24 VDC, 0.7 A [IEC 142]
-HF	Hi-Flex life cable [NEMA 23]
-xxDM	Cable length from motor to connectors in decimeters (50 dm maximum) [NEMA 23]
-NS	IP65 rated Nitrile front shaft seal [**not** available for NEMA 17, NEMA 23]
-VAC6	Prepared for high-vacuum operation [**not** available for BM22].
Accessories	
MCM1-3	MS Motor Power connector [IEC 142]
MCM-3	MS Motor Power connector [NEMA 23, NEMA 34, NEMA 42]
MCF-3	MS Motor Feedback connector for all BM motors

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Table 1-13: BMS Motor Options

BMS Series Rotary Servo Motors	
BMS35	NEMA 17 brushless servomotor; 38.0 oz·in continuous torque
BMS60	NEMA 23 brushless servomotor; 46.2 oz·in continuous torque
BMS100	NEMA 23 brushless servomotor; 80.0 oz·in continuous torque
BMS280	NEMA 34 brushless servomotor; 227.0 oz·in continuous torque
BMS465	NEMA 34 brushless servomotor; 404.8 oz·in continuous torque
Winding Options	
-A	Standard winding
Connectors	
-MS	Military Style connectors for feedback and motor power [NEMA 23, NEMA 34]
-D25	25 conductor plastic D-Shell for feedback and motor power (standard) [NEMA 17, NEMA 23]
-FLY-x	Flying leads for feedback and motor power with custom length cable [NEMA 17, NEMA 23]
-D25-FLB	Integral cable to mate to Ndrive/Soloist/Ensemble with ferrules, FBF-1, and limit connector [NEMA 17, NEMA 23]
-D25-5DU	Integral cable to mate to Npaq with limit connector [NEMA 23]
-D25-9D	D-Style and 9-pin and 4DU power D-Style connectors [NEMA 17, NEMA 23]
-D25-4TS	Integral cable to stand-alone drive with limit connector [NEMA 17, NEMA 23]
Feedback Options	
-E1000H	1000 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output) [for all BMS]
-E2000H	2000 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output) [for all BMS]
-E2500H	2500 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output) [NEMA 23, NEMA 34]
-E5000H	5000 line incremental squarewave encoder with marker and Hall-effect tracks (RS-422 line driver output) [for all BMS]
-E1000ASH	1000 line 1V peak to peak amplified sine encoder [for all BMS]
Options	
-HF	Hi-Flex life cable [NEMA 17, NEMA 23]
-BK1	Brake, holding torque: 0.8 N·m (112 oz·in), 24 VDC, 0.3 A [NEMA 23]
-BK2	Brake, holding torque: 1.7 N·m (240 oz·in), 24 VDC, 0.4 A [NEMA 34]
-BK	Brake, holding torque: 0.2 N·m [NEMA 17]
-NS	IP65 rated Nitrile front shaft seal [NEMA 34]
-VAC6	Prepared for high-vacuum operation [for all BMS]
-DM	Cable length specified in decimeters [NEMA 17, NEMA 23]
-DM-HF	High-flex cable length specified in decimeters [NEMA 17, NEMA 23]
Accessories	
MCM-3	Connector; MS Motor Power mate [NEMA 23, NEMA 34]
MCF-3	Connector; MS Motor Feedback mate [NEMA 23, NEMA 34]
MC-HPD25-M	Connector; HPD25 Motor Power mate [NEMA 17, NEMA 23]
MC-DB25-F	Connector; DB25 Motor Feedback mate [NEMA 17, NEMA 23]

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Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, where or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability or any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Laser Products

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

Return Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an airfreight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Returned Product Non-warranty Determination

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time, the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

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On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-site Non-warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Company Address

Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA
15238-2897

Phone: (412) 963-7470

Fax: (412) 963-7459

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Appendix B: Revision History

Revision	Date	General Information
2.06.00	July 25, 2012	Added BMS35, updating: Section 1.10. , Section 1.11. , Section 1.12.
		Updated connector pin tables: Section 1.3.1.
		Updated Thermal Sensor Resistance: Figure 1-2
		Updated BMS35 specification (Rated Power Output, Cont): Table 1-10
		Updated BM Motor Options (Feedback Options): Table 1-12
2.05.00	6/10/11	Clarified IP options: Section 1.9.
2.04.00	6/30/10	Motor dimension drawings updated : Figure 1-11, Figure 1-14, Figure 1-16
2.03.00	4/20/10	Motor dimension drawings updated (pilot tolerances updated): Figure 1-11, Figure 1-12, Figure 1-13, Figure 1-14, Figure 1-16, Figure 1-17
2.02.00	5/28/09	BEMF Constant (Line-Line, Max) (V/krpm) updated (motor specification tables): Table 1-6, Table 1-7 , Table 1-8 , Table 1-10, Table 1-11
		BM20 has been replaced by the BM22: Table 1-6, Figure 1-10
		Obsolete options removed / New options added [-HF, -D25-FLB, -D25-5DU]): Table 1-12, 1.12, Table 1-13, Figure 1-12, Figure 1-17
		Pinout updated: Table 1-2
2.01.00	3/20/09	Rated Power Output updated (motor specification tables): Table 1-6, Table 1-7 , Table 1-8 , Table 1-9, Table 1-10, Table 1-11
2.00.00	10/29/07	Complete manual revision: All
		Motor specification tables updated: Table 1-6, Table 1-7 , Table 1-8 , Table 1-9, Table 1-10, Table 1-11
		Motor dimension drawings updated: Figure 1-11, Figure 1-12, Figure 1-13, Figure 1-14, Figure 1-16, Figure 1-17
		Ordering/part numbers updated: 1.12, Table 1-12, 1.12, 1.12, 1.12, Table 1-13
1.04	10/26/06	Revised, updated with new graphics: All
1.03	5/23/02	Changes not recorded
1.02	4/2/01	Changes not recorded
1.01	2/2000	Changes not recorded
1.00	4/1996	Changes not recorded
* Section, Table, and Figure numbers may no longer be accurate depending on changes made to the latest revision.		

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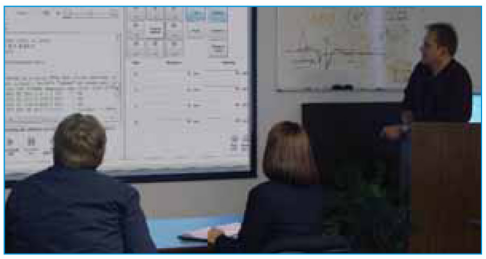
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