AEROTECH

BM/BMS Brushless Motor Hardware Manual

Revision: 2.10.00

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EU Declaration of Conformity

Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238-2811 USA
Product	Standard BM and BMS motors (excluding VAC6 versions)
Model/Types	BM75, BM130, BM200, BM250, BM500, BM800, BM1400, BMS35, BMS60, BMS100, BMS280, BMS465

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

2014/35/EU	Low Voltage Directive
2011/65/EU	RoHS 2 Directive

and has been designed to be in conformity with the applicable requirements of the following Standard(s) when installed and used in accordance with the manufacturer's supplied installation instructions.

IEC 60034-1:2010	Rotating Electrical Machines
IEC 61010-1:2010	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.

Authorized Representative:	Simon Smith, European Director
Address:	Aerotech Ltd The Old Brick Kiln, Ramsdell, Tadley Hampshire RG26 5PR UK
Name	/ Alex Weibel
Position	Engineer Verifying Compliance
Location	Pittsburgh, PA
Date	8/9/2019

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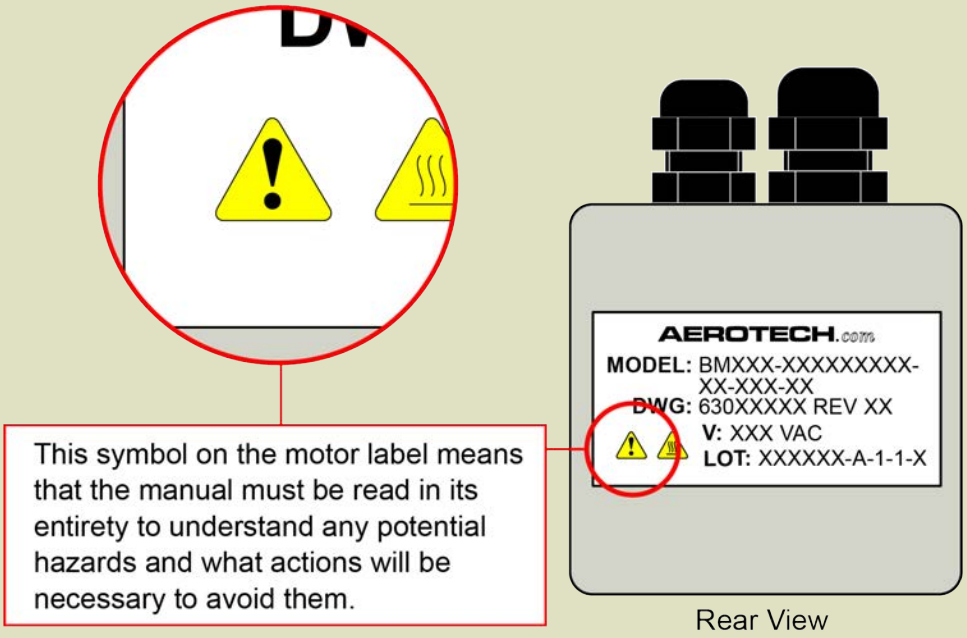
Safety Procedures and Warnings

This manual tells you how to carefully and correctly use and operate the BM/BMS . Read all parts of this manual before you install or operate the BM/BMS or before you do maintenance to your system. To prevent injury to you and damage to the equipment, obey the precautions in this manual. The precautions that follow apply when you see a Danger or Warning symbol in this manual. If you do not obey these precautions, injury to you or damage to the equipment can occur. If you do not understand the information in this manual, contact Aerotech Global Technical Support.

This product has been designed for light industrial manufacturing or laboratory environments. The protection provided by the equipment could be impaired if the product is used in a manner not specified by the manufacturer.

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to www.aerotech.com for the most up-to-date information.

NOTE:



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

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 drive, cabling, etc. are sources of electromagnetic fields. Persons with implanted medical devices need to evaluate the risks associated with these devices before entering an area where they are in use.

WARNING: To minimize the possibility of electrical shock, bodily injury or death the following precautions must be followed.

1. Operators must be trained before operating this equipment.
2. All service and maintenance must be performed by qualified personnel.
3. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
4. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
5. BM/BMS 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.
6. Equipment grounds must be in place and maintained to reduce the risk of potentially fatal or serious injury from electrical shock.
7. Disconnect electrical power to the motor before performing maintenance procedures. In addition, uncouple or otherwise prevent motor-coupled machinery from moving the motor during service.
8. Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
9. Never install or operate equipment that appears to be damaged.
10. If the product is used in a manner not specified by the manufacturer, the protection provided by the product can be impaired and result in damage, shock, injury, or death.

Chapter 1: Overview

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to www.aerotech.com for the most up-to-date information.

Table 1-1: BM Motor Options

Brushless Rotary Servomotors	
BM22	NEMA 17 brushless servomotor; 22.5 oz·in continuous torque
BM75	NEMA 23 brushless servomotor; 72.0 oz·in continuous torque
BM130	NEMA 23 brushless servomotor; 144.0 oz·in continuous torque
BM200	NEMA 23 brushless servomotor; 205.0 oz·in continuous torque
BM250	NEMA 34 brushless servomotor; 322.0 oz·in continuous torque
BM500	NEMA 34 brushless servomotor; 515.0 oz·in continuous torque
BM800	NEMA 42 brushless servomotor; 866.0 oz·in continuous torque
BM1400	NEMA 42 brushless servomotor; 1562.0 oz·in continuous torque
BM2000	NEMA 56 brushless servomotor; 2080.0 oz·in continuous torque
BM3400	NEMA 56 brushless servomotor; 3360.0 oz·in continuous torque
BM4500	NEMA 56 brushless servomotor; 4480.0 oz·in continuous torque
Connectors (Required)	
-MS	Integral cables with military-style feedback and motor connectors; not available for BM22
-D25	Integral cables with D-style 25-pin feedback and D-style 4-pin motor connectors; only available on BM22, BM75, BM130, and BM200
-D25-9D	Integral cables with D-style 25-pin feedback, D-style 4-pin motor, and D-style 9-pin limit connectors; only available on BM75, BM130, and BM200
-D25-FLB	Integral cables with D-style 25-pin feedback connector, flying leads for the motor, and a D-style 9-pin limit connector; only available on BM75, BM130, and BM200
-D25-5DU	Integral cables with D-style 25-pin feedback, D-style 5-pin motor, and D-style 9-pin limit connectors; only available on BM75, BM130, and BM200
-D25-9D-CMS	Integral cables with D-style 25-pin feedback, D-style 4-pin motor, and D-style 9-pin limit connectors and a cable management system; only available on BM75, BM130, and BM200
-D25-4TS	Integral cables with D-style 25-pin feedback, terminal block 4-pin motor, and D-style 9-pin limit connectors; only available on BM75, BM130, and BM200
Feedback (Required)	
-E1000H	1000 lines/rev TTL incremental encoder with Hall tracks; not available for BM22
-E2000H	2000 lines/rev TTL incremental encoder with Hall tracks; not available for BM3400 or BM4500
-E2500H	2500 lines/rev TTL incremental encoder with Hall tracks; not available for BM22
-E5000H	5000 lines/rev TTL incremental encoder with Hall tracks; not available for BM22
-E1000ASH	1000 lines/rev 1 Vpp incremental encoder with Hall tracks; not available for BM22, BM2000, BM3400 or BM4500

Brake (Optional)	
-BK	Brake, holding torque = 0.8 N·m (112 oz·in), 24 VDC, 0.25 A [NEMA 23]
	Brake, holding torque = 1.7 N·m (240 oz·in), 24 VDC, 0.50 A [NEMA 34]
	Brake, holding torque = 5.6 N·m (800 oz·in), 24 VDC, 0.75 A [NEMA 42]
	Brake, holding torque = 40.7 N·m (360 lb·in), 24 VDC, 0.75 A [NEMA 56]
Cable Type (Optional)	
-HF	Hi-Flex life cable; only available on BM75, BM130, and BM200
Cable Length (Optional)	
-xx	Cable length from motor to connectors in decimeters; 3.8 dm is the default with a 50 dm maximum; only available on BM75, BM130, and BM200
Shaft Seal (Optional)	
-NS	Nitrile front shaft seal; only available on BM250, BM500, BM800 and BM1400
Vacuum Preparation (Optional)	
-VAC6	Vacuum preparation to 10^{-6} Torr
Accessories	
MC-HPD25-M	High-power D-style motor mating connector
MC-DB25-F	D-style 25-pin motor and feedback mating connector
MCM1-3	Military style motor power mating connector (BM2000, BM3400, BM4500)
MCM-3	Military style motor power mating connector (BM75, BM130, BM200, BM250, BM500, BM800, BM1400)
MCF-3	Military style feedback mating connector

Table 1-2: 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
-B	Optional motor winding; not available for BMS35.
Connectors	
-MS	Integral cables with military-style feedback and motor connectors; not available for BMS35
-D25	Integral cables with D-style 25-pin feedback and D-style 4-pin motor connectors; not available for BMS280 or BMS465
-D25-9D	Integral cables with D-style 25-pin feedback, D-style 4-pin motor, and D-style 9-pin limit connectors; not available for BMS280 or BMS465
-D25-FLB	Integral cables with D-style 25-pin feedback connector, flying leads for the motor, and a D-style 9-pin limit connector; not available for BMS280 or BMS465
-D25-5DU	Integral cables with D-style 25-pin feedback, D-style 5-pin motor, and D-style 9-pin limit connectors; not available for BMS280 or BMS465
-D25-9D-CMS	Integral cables with D-style 25-pin feedback, D-style 4-pin motor, and D-style 9-pin limit connectors and a cable management system; not available for BMS280 or BMS465
-D25-4TS	Integral cables with D-style 25-pin feedback, terminal block 4-pin motor, and D-style 9-pin limit connectors; not available for BMS280 or BMS465
Feedback Options	
-E1000H	1000 lines/rev TTL incremental encoder w/Hall tracks (-E1000H); not available for BM22
-E2000H	2000 lines/rev TTL incremental encoder w/Hall tracks (-E2000H); not available for BM3400 or BM4500
-E2500H	2500 lines/rev TTL incremental encoder w/Hall tracks (-E2500H); not available for BM22
-E5000H	5000 lines/rev TTL incremental encoder w/Hall tracks (-E5000H); not available for BM22
-E1000ASH	1000 lines/rev 1 Vpp incremental encoder w/Hall tracks (-E1000ASH); not available for BM22, BM2000, BM3400 or BM4500

Brake (Optional)	
-BK	Brake, holding torque: 0.2 N·m [NEMA 17]
	Brake, holding torque: 0.8 N·m (112 oz·in), 24 VDC, 0.25 A [NEMA 23]
	Brake, holding torque: 1.7 N·m (240 oz·in), 24 VDC, 0.50 A [NEMA 34]
Cable Type (Optional)	
-HF	High-flex cable; not available for BMS280 or BMS465
Cable Length (Optional)	
-xx	Cable length from motor to connectors in decimeters; 3.8 dm is the default; not available for BMS280 or BMS465.
Vacuum Preparation (Optional)	
-VAC6	Vacuum preparation to 10^{-6} Torr
Accessories	
MC-HPD25-M	High-power D-style motor mating connector
MC-DB25-F	D-style 25-pin mating connector
MCM-3	Military style motor power mating connector
MCF-3	Military style feedback mating connector

1.1. Motor Specifications

The specifications for the BM series brushless motors are listed in Table 1-3, Table 1-4, Table 1-5, and Table 1-6. The specifications for the BMS series brushless motors are listed in Table 1-7 and Table 1-8.

Table 1-3: BM22, BM75, and BM130 Motor Specifications

		BM22	BM75	BM130
Performance Specifications (1,2)				
Stall Torque, Continuous (3)	N·m (oz·in)	0.16 (22.5)	0.51 (72.0)	1.02 (144.0)
Peak Torque(4)	N·m (oz·in)	0.48 (68.0)	1.30 (181.0)	2.50 (361.0)
Rated Speed	rpm	3000	4000	4000
Rated Power Output, Continuous	W	50	192	333
Electrical Specifications (2)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	3.9	9.0	19.0
Continuous Current, Stall (3)	A_{pk} (A_{rms})	4.9 (3.5)	9.0 (6.4)	6.9 (4.9)
Peak Current, Stall (4)	A_{pk} (A_{rms})	14.7 (10.4)	22.5 (15.9)	17.3 (12.2)
Torque Constant (5)	N·m/A_{pk} (oz·in/A_{pk})	0.032 (4.50)	0.060 (8.00)	0.150 (20.90)
	N·m/A_{rms} (oz·in/A_{rms})	0.045 (6.40)	0.080 (11.40)	0.210 (29.60)
Motor Constant (3,5)	N·m/√W (oz·in/√W)	0.038 (5.41)	0.055 (7.84)	0.101 (14.30)
Resistance, 25°C (Line-Line)	Ω	0.67	1.00	2.00
Inductance (Line-Line)	mH	0.73	1.42	3.52
Maximum Bus Voltage	V_{DC}	80	340	340
Thermal Resistance	°C/W	4.56	1.18	1.04
Number of Poles	--	8	8	8
Mechanical Specifications				
Frame Size	NEMA	17	23	23
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)	$5.20x10^{-6}$ (0.00070)	$9.20x10^{-6}$ (0.00130)
Max Radial Load	N (lb)	78 (18)	89 (20)	89 (20)
Max Axial Load	N (lb)	39 (9)	89 (20)	89 (20)

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. All performance and electrical specifications ±10%
3. Values shown @ 105°C rise above a 25 °C ambient temperature, with housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink
4. Peak torque assumes correct rms current; consult Aerotech
5. Torque constant and motor constant specified at stall
6. Maximum winding temperature is 130 °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

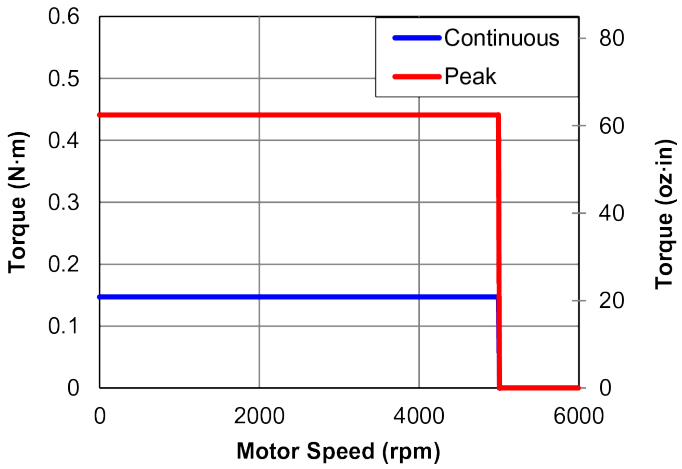


Figure 1-1: BM22 Torque Speed Curves

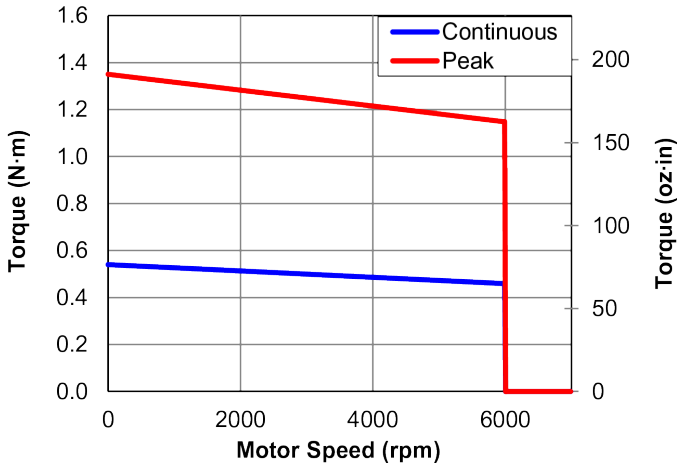


Figure 1-2: BM75 Torque Speed Curves

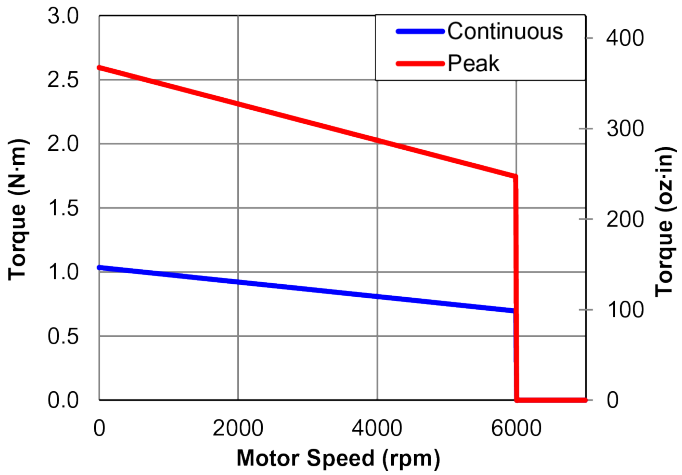


Figure 1-3: BM130 Torque Speed Curves

Table 1-4: BM200, BM250, and BM500 Motor Specifications

		BM200	BM250	BM500
Performance Specifications (1,2)				
Stall Torque, Continuous (3)	N·m (oz·in)	1.45 (205.0)	2.30 (322.0)	3.60 (515.0)
Peak Torque (4)	N·m (oz·in)	3.60 (512.0)	5.70 (805.0)	9.10 (1286.0)
Rated Speed	rpm	4000	4000	4000
Rated Power Output, Continuous	W	455	739	1065
Electrical Specifications (2)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	18.0	28.0	29.0
Continuous Current, Stall (3)	A_{pk} (A_{rms})	10.3 (7.3)	10.3 (7.3)	17.5 (12.4)
Peak Current, Stall (4)	A_{pk} (A_{rms})	25.8 (18.2)	25.6 (18.1)	43.8 (30.9)
Torque Constant (5)	N·m/A_{pk} (oz·in/A_{pk})	0.140 (19.90)	0.220 (31.40)	0.210 (29.40)
	N·m/A_{rms} (oz·in/A_{rms})	0.200 (28.10)	0.310 (44.40)	0.290 (41.60)
Motor Constant (3,5)	N·m/√W (oz·in/√W)	0.131 (18.54)	0.206 (29.22)	0.287 (40.69)
Resistance, 25°C (Line-Line)	Ω	1.10	1.10	0.50
Inductance (Line-Line)	mH	2.18	2.74	1.42
Maximum Bus Voltage	V_{DC}	340	340	340
Thermal Resistance	°C/W	0.81	0.82	0.61
Number of Poles	--	8	8	8
Max Temperature	°C	124	144	123
Mechanical Specifications				
Frame Size	NEMA	23	34	34
Motor Weight	kg (lb)	2.0 (4.40)	3.6 (7.92)	5.0 (11.00)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$1.30x10^{-5}$ (0.00180)	$7.85x10^{-5}$ (0.01110)	$1.39x10^{-4}$ (0.01970)
Max Radial Load	N (lb)	89 (20)	178 (40)	178 (40)
Max Axial Load	N (lb)	89 (20)	89 (20)	89 (20)

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. All performance and electrical specifications ±10%
3. Values shown @ 105°C rise above a 25 °C ambient temperature, with housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink
4. Peak torque assumes correct rms current; consult Aerotech
5. Torque constant and motor constant specified at stall
6. Maximum winding temperature is 130 °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

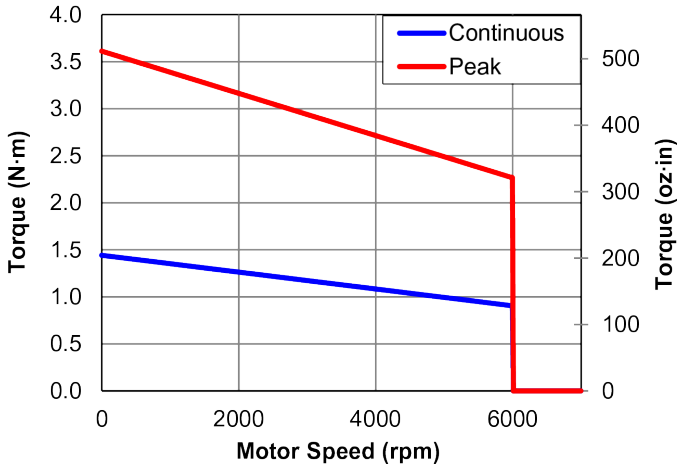


Figure 1-4: BM200 Torque Speed Curves

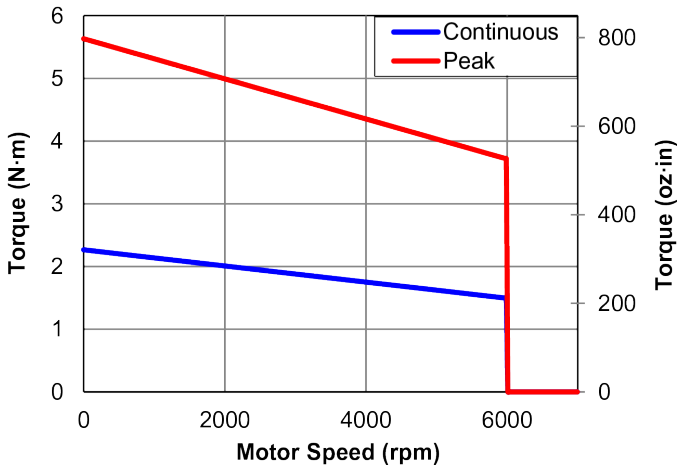


Figure 1-5: BM250 Torque Speed Curves

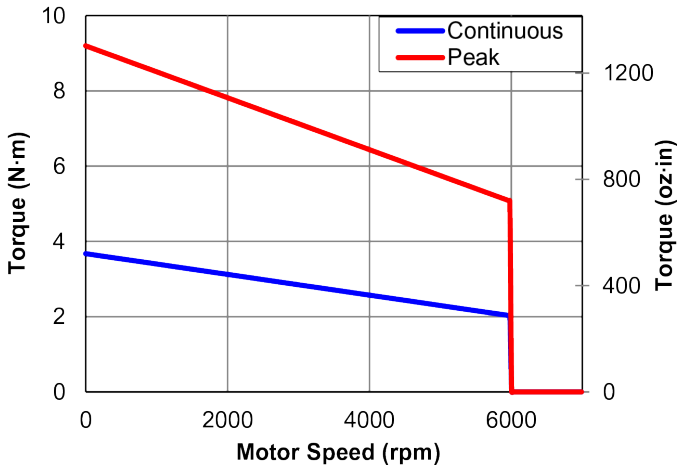


Figure 1-6: BM500 Torque Speed Curves

Table 1-5: BM800 and BM1400 Motor Specifications

Motor Model	Units	BM800	BM1400
Performance Specifications (1,2)			
Stall Torque, Continuous (3)	N·m (oz·in)	6.10 (866.0)	11.00 (1562.0)
Peak Torque (4)	N·m (oz·in)	15.30 (2166.0)	27.60 (3905.0)
Rated Speed	rpm	3000	3000
Rated Power Output, Continuous	W	1446	2529
Electrical Specifications (2)			
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	69.0	69.0
Continuous Current, Stall (3)	A_{pk} (A_{rms})	11.9 (8.4)	20.5 (14.5)
Peak Current, Stall (4)	A_{pk} (A_{rms})	29.8 (21.0)	51.3 (36.2)
Torque Constant (5)	$N·m/A_{pk}$ ($oz·in/A_{pk}$)	0.510 (72.80)	0.540 (76.20)
	$N·m/A_{rms}$ ($oz·in/A_{rms}$)	0.730 (103.00)	0.760 (107.80)
Motor Constant (3,5)	$N·m/\sqrt{W}$ ($oz·in/\sqrt{W}$)	0.451 (63.86)	0.745 (105.47)
Resistance, 25°C (Line-Line)	Ω	1.20	0.50
Inductance (Line-Line)	mH	3.80	1.70
Maximum Bus Voltage	V_{DC}	340	340
Thermal Resistance	°C/W	0.60	0.54
Number of Poles	--	8	8
Mechanical Specifications			
Frame Size	NEMA	42	42
Motor Weight	kg (lb)	6.6 (14.52)	10.7 (23.54)
Rotor Moment of Inertia	$kg·m^2$ ($oz·in·s^2$)	$3.00x10^{-4}$ (0.04250)	$5.60x10^{-4}$ (0.07930)
Max Radial Load	N (lb)	222 (50)	222 (50)
Max Axial Load	N (lb)	89 (20)	89 (20)

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. All performance and electrical specifications ±10%
3. Values shown @ 105°C rise above a 25 °C ambient temperature, with housed motor mounted to a 300 mm x 300 mm x 13 mm aluminum heat sink
4. Peak torque assumes correct rms current; consult Aerotech
5. Torque constant and motor constant specified at stall
6. Maximum winding temperature is 130 °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

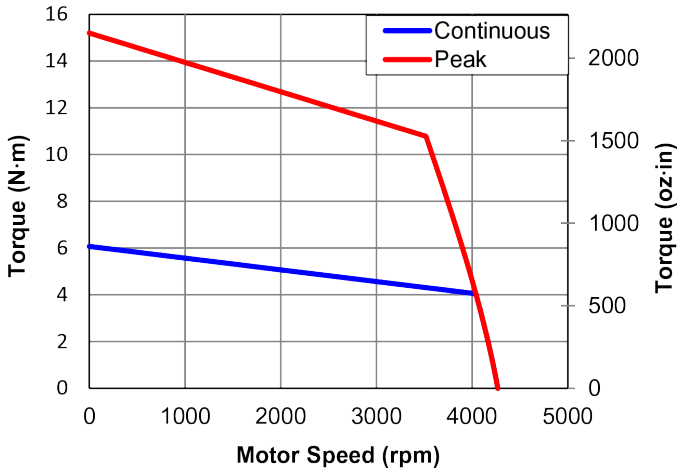


Figure 1-7: BM800 Torque Speed Curves

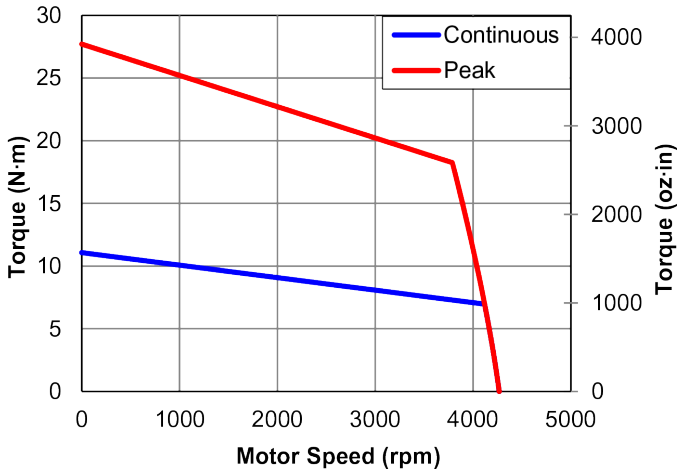


Figure 1-8: BM1400 Torque Speed Curves

Table 1-6: BM2000, BM3400, and BM4500 Motor Specifications

		BM2000	BM3400	BM4500
Performance Specifications (1, 2)				
Stall Torque, Continuous (3)	N·m (oz·in)	14.70 (2080.0)	23.70 (3360.0)	31.60 (4480.0)
Peak Torque (4)	N·m (oz·in)	44.10 (6240.0)	71.20 (10080.0)	94.90 (13440.0)
Rated Speed (6)	rpm	2400	2400	2400
Rated Power Output, Continuous	W	3267	5077	6761
Electrical Specifications (2)				
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	99.0	99.0	99.0
Continuous Current, Stall (3)	A_{pk} (A_{rms})	16.5 (11.7)	26.7 (18.9)	35.4 (25.0)
Peak Current, Stall(4)	A_{pk} (A_{rms})	49.7 (35.1)	80.3 (56.7)	106.1 (75.0)
Torque Constant (5)	N·m/A_{pk} (lb·in/A_{pk})	0.890 (7.90)	0.890 (7.90)	0.890 (7.90)
	N·m/A_{rms} (lb·in/A_{rms})	1.250 (11.10)	1.250 (11.10)	1.270 (11.20)
Motor Constant (3, 5)	N·m/√W (lb·in/√W)	1.030 (9.10)	1.720 (15.20)	2.320 (20.50)
Resistance, 25°C (Line-Line)	Ω	0.66	0.24	0.13
Inductance (Line-Line)	mH	4.70	2.00	1.40
Maximum Bus Voltage	V_{DC}	340	340	340
Thermal Resistance	°C/W	0.64	0.68	0.70
Number of Poles	--	6	6	6
Mechanical Specifications				
Frame Size	NEMA	56	56	56
Motor Weight	kg (lb)	15.0 (33.00)	23.0 (49.90)	30.0 (66.90)
Rotor Moment of Inertia	kg·m^2 (lb·in·s^2)	$1.25x10^{-3}$ (0.01110)	$2.23x10^{-3}$ (0.01970)	$3.24x10^{-3}$ (0.02870)
Max Radial Load	N (lb)	668 (150)	668 (150)	668 (150)
Max Axial Load	N (lb)	223 (50)	223 (50)	223 (50)

1. Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
2. All performance and electrical specifications ±10%
3. Values shown @ 130°C rise above a 25 °C ambient temperature, with housed motor mounted to a 305 mm x 305 mm x 12.7 mm aluminum heat sink
4. Peak torque assumes correct rms current; consult Aerotech
5. Torque constant and motor constant specified at stall
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. All Aerotech amplifiers are rated A_{pk}; use torque constant in N·m/A_{pk} when sizing

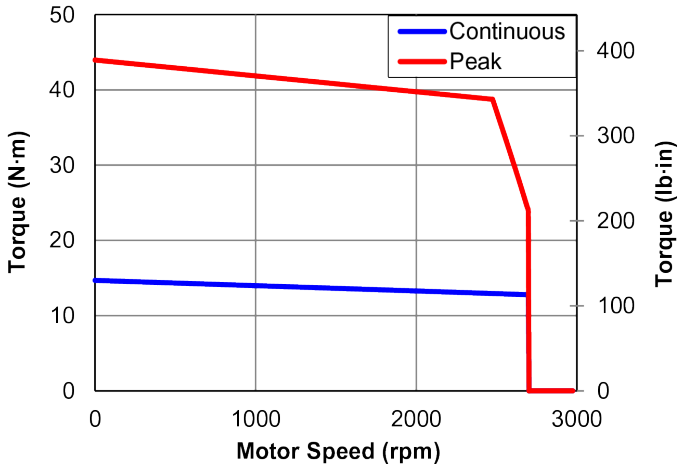


Figure 1-9: BM2000 Torque Speed Curves

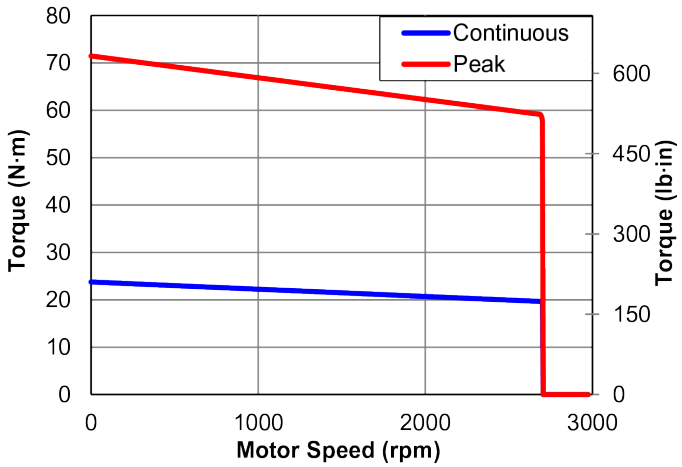


Figure 1-10: BM3400 Torque Speed Curves

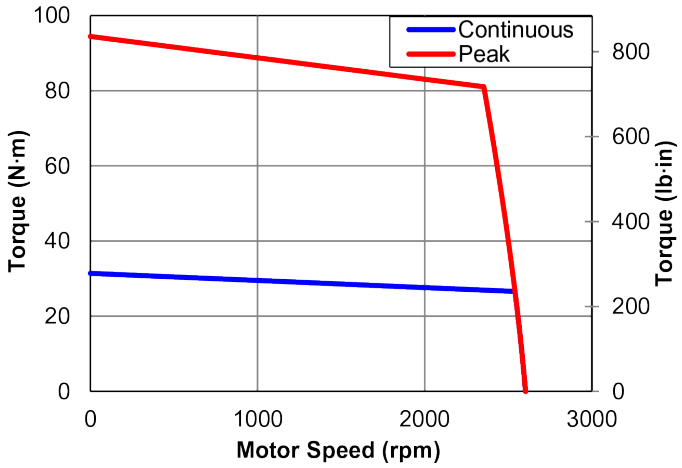


Figure 1-11: BM4500 Torque Speed Curves

Table 1-7: BMS35, BMS60, and BMS100 Motor Specifications

		BMS35	BMS60	BMS100
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	4000	4000	3000
Rated Power Output, Continuous	W	96	116	133
Electrical Specifications (5)				
Winding Designation		-A	-A	-A
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	12.9	19.0	40.0
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})	0.110 (15.50)	0.140 (20.10)	0.270 (38.10)
	N·m/A_{rms} (oz·in/A_{rms})	0.150 (21.90)	0.200 (28.40)	0.380 (53.90)
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	5.80	8.40	12.90
Inductance (Line-Line)	mH	1.70	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				
Frame Size	NEMA	17	23	23
Motor Weight	kg (lb)	0.6 (1.30)	1.1 (2.40)	1.5 (3.30)
Rotor Moment of Inertia	$kg·m^2$ ($oz·in·s^2$)	$1.96x10^{-5}$ (0.00280)	$1.96x10^{-5}$ (0.00280)	$3.71x10^{-5}$ (0.00530)
Max Radial Load	N (lb)	45 (10)	89 (20)	89 (20)
Max Axial Load	N (lb)	45 (10)	89 (20)	89 (20)

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 housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink
3. Peak torque 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

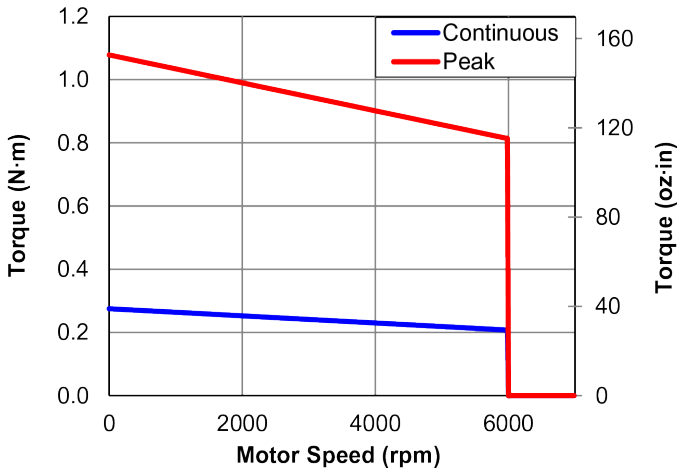


Figure 1-12: BMS35 Torque Speed Curves

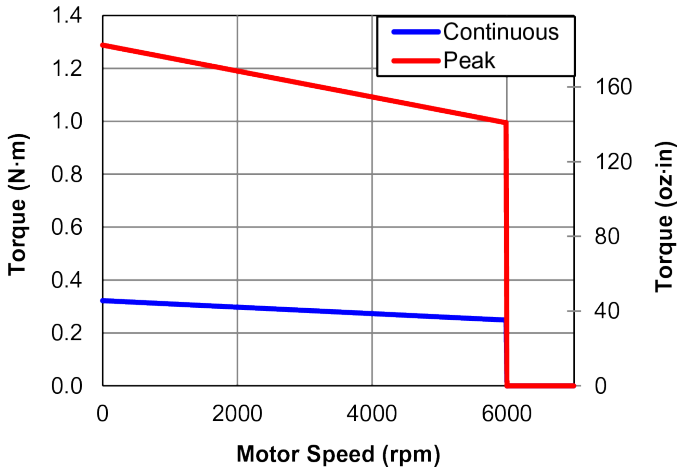


Figure 1-13: BMS60 Torque Speed Curves

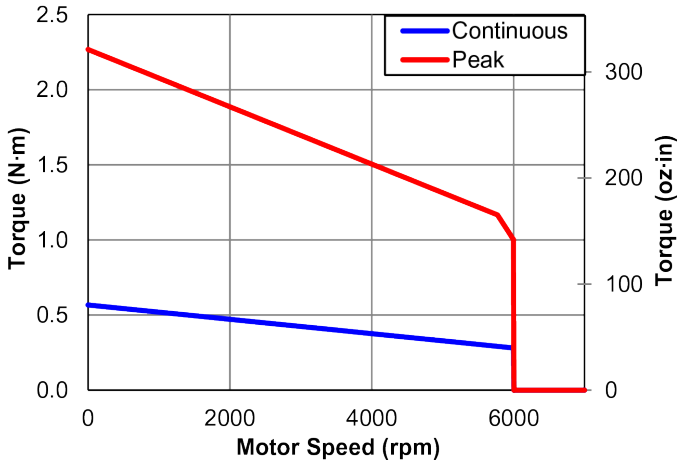


Figure 1-14: BMS100 Torque Speed Curves

Table 1-8: BMS280 and BMS465 Motor Specifications

		BMS280	BMS465
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	3000	2000
Rated Power Output, Continuous	W	381	457
Electrical Specifications (5)			
Winding Designation		-A	-A
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	57.0	79.0
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})	0.420 (59.70)	0.580 (82.60)
	N·m/A_{rms} (oz·in/A_{rms})	0.600 (84.50)	0.820 (116.80)
Motor Constant (2, 4)	N·m/√W (oz·in/√W)	0.179 (25.34)	0.280 (39.70)
Resistance, 25°C (Line-Line)	Ω	5.70	4.40
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			
Frame Size	NEMA	34	34
Motor Weight	kg (lb)	3.6 (7.90)	5.0 (11.00)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$4.66x10^{-4}$ (0.06600)	$9.28x10^{-4}$ (0.13140)
Max Radial Load	N (lb)	178 (40)	178 (40)
Max Axial Load	N (lb)	89 (20)	89 (20)

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 housed motor mounted to a 250 mm x 250 mm x 6 mm aluminum heat sink
3. Peak torque 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

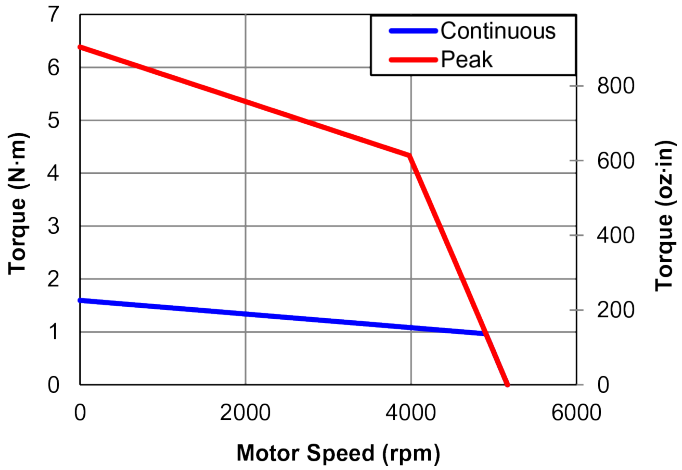


Figure 1-15: BMS280 Torque Speed Curves

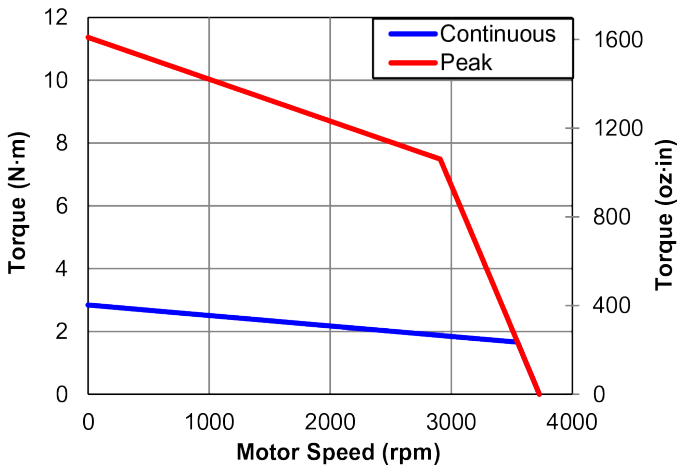


Figure 1-16: BMS465 Torque Speed Curves

1.2. Brushless Motor Dimensions

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

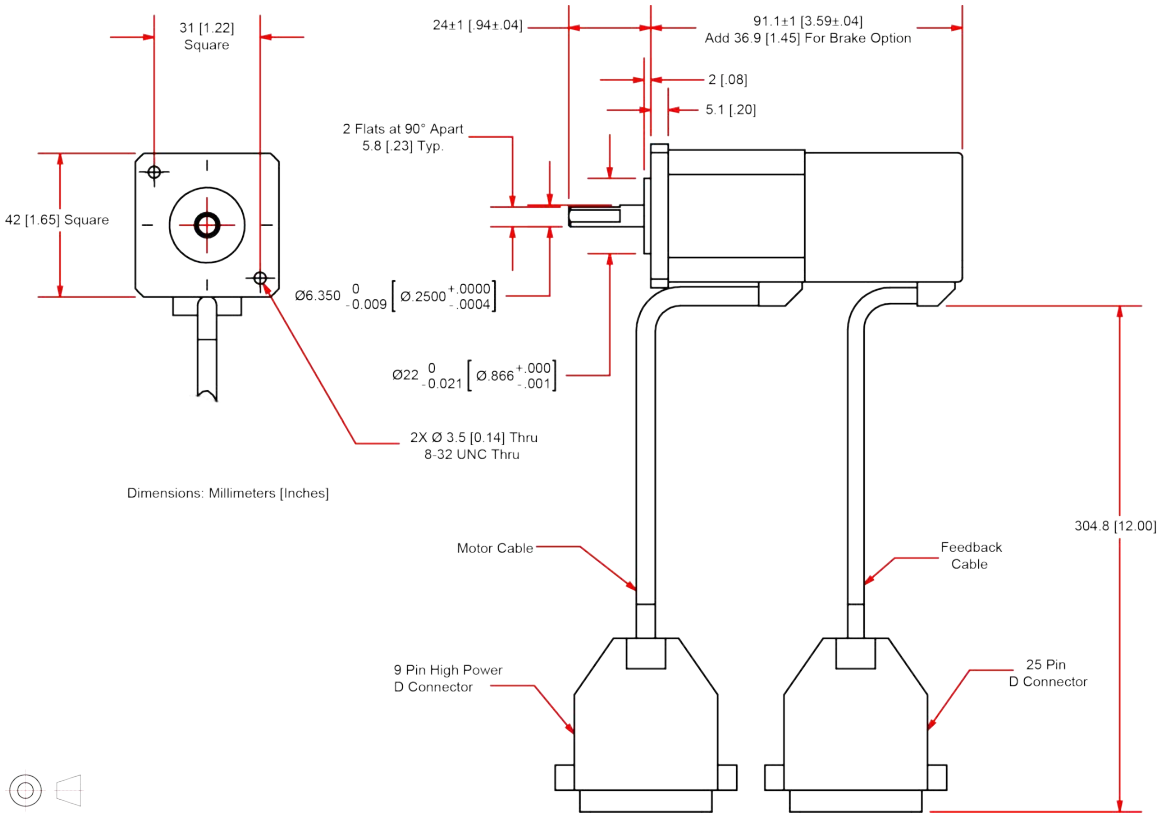
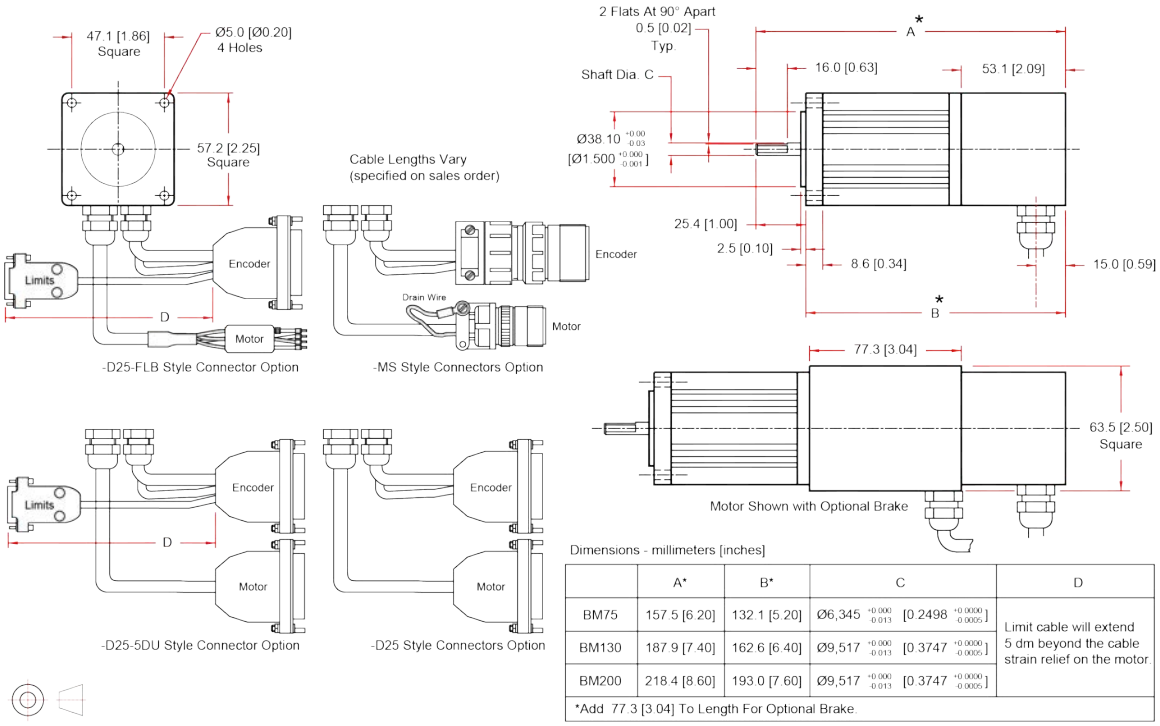


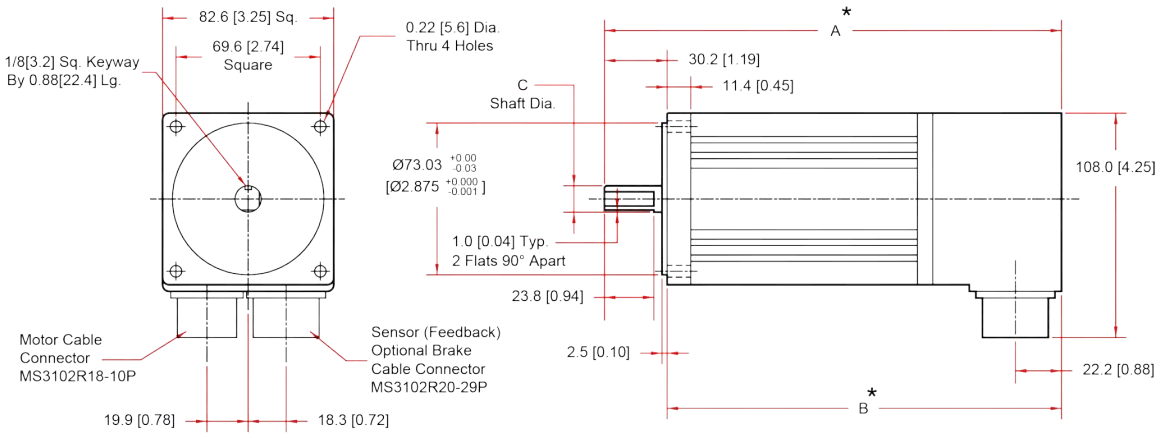
Figure 1-17: BM22 Model Dimensions (NEMA 17)



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.				

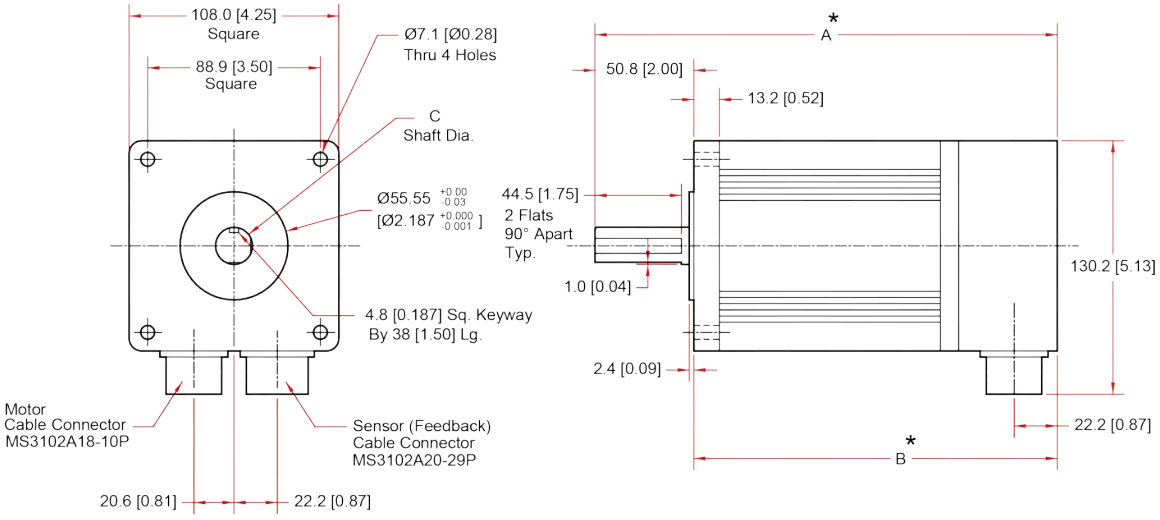
Figure 1-18: BM75, BM130, BM200 Model Dimensions (NEMA 23)



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.			

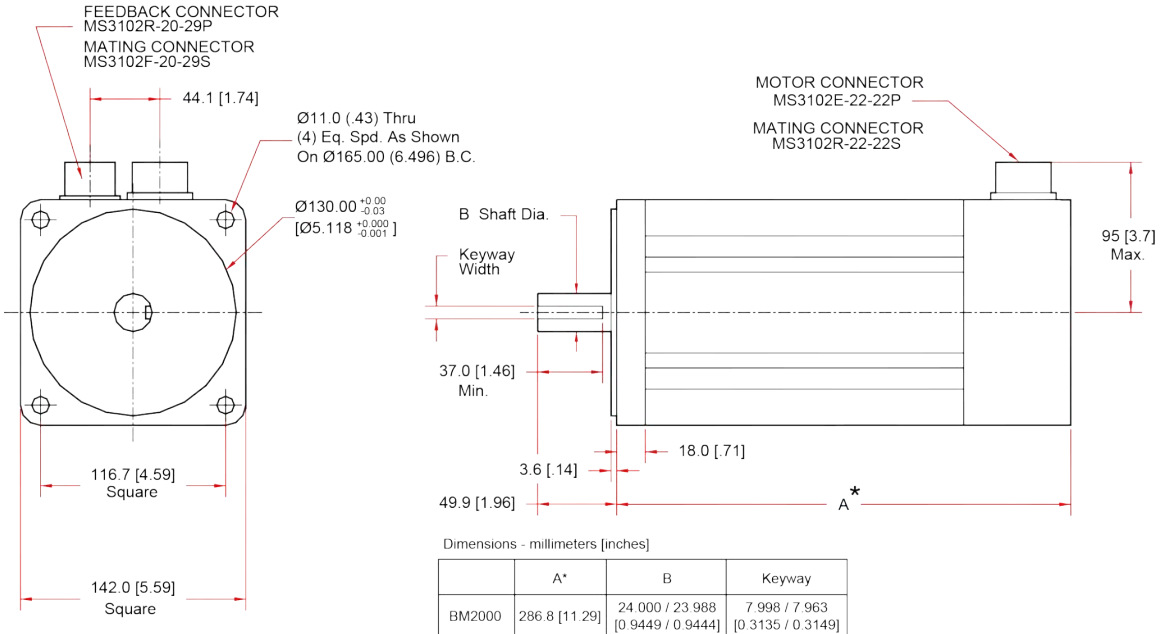
Figure 1-19: BM250, BM500 Model Dimensions (NEMA 34)



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 1-20: 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 1-21: BM2000, BM3400, BM4500 Model Dimensions (NEMA 56)

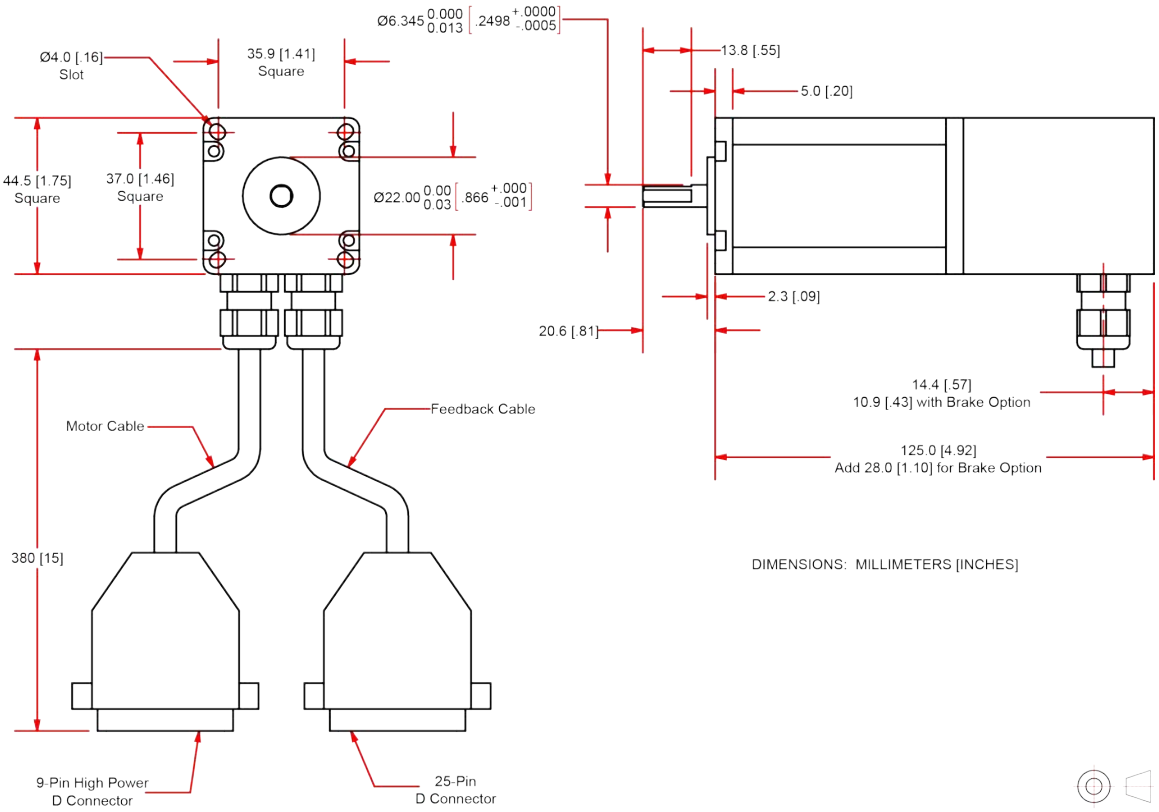
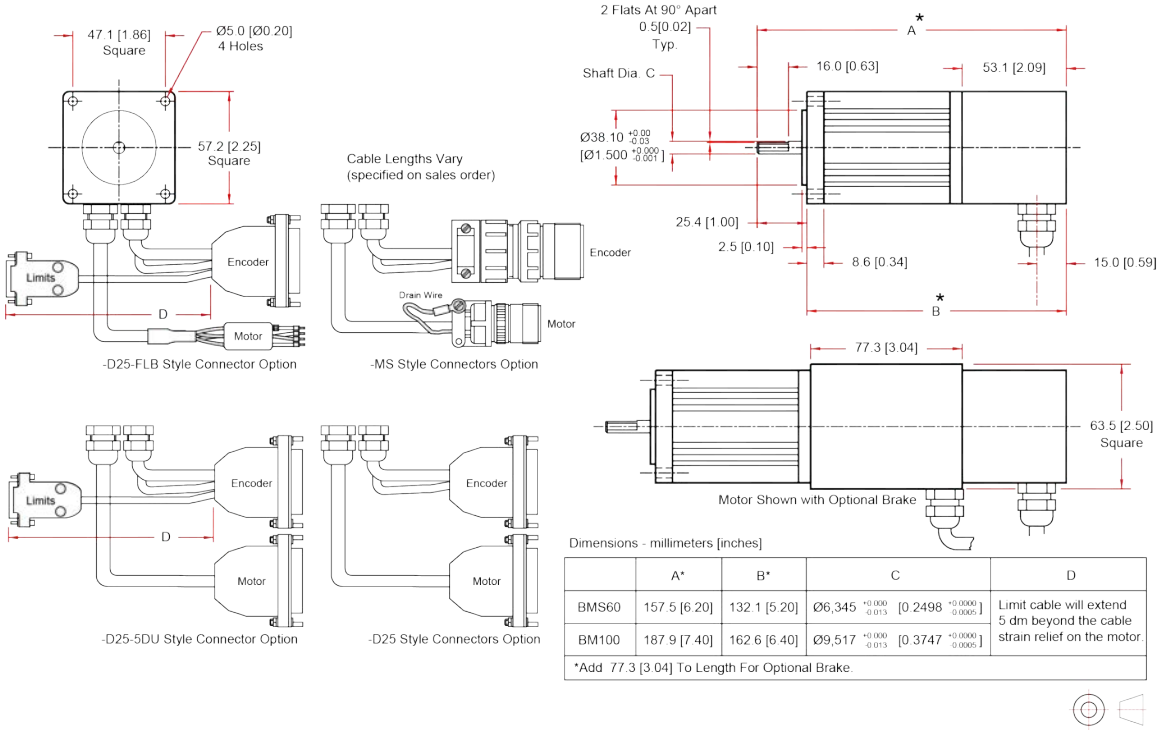


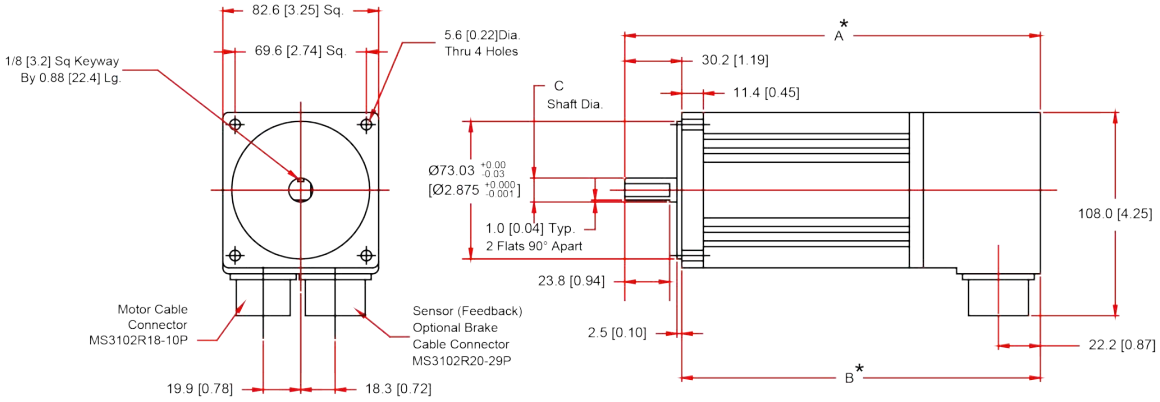
Figure 1-22: BMS35 Model Dimensions (NEMA 17)



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



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 1-24: BMS280 and BMS465 Model Dimensions (NEMA 34)

1.3. Environmental Specifications

The environmental specifications for the BM/BMS motors are listed in the following table.

WARNING: Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.

Table 1-9: 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

1.4. Vacuum Operation

Aerotech can specially prepare the BM/BMS for operation in vacuum environments. Aerotech offers two vacuum preparation options; one for low vacuum (for use in atmospheric pressures to 10^{-3} torr) and one for high vacuum (preparation for environments from 10^{-3} to 10^{-6} torr). As part of this preparation, attention to detail during modification, cleaning, and assembly results in products with optimal performance in vacuum applications.

Special Guidelines

To make sure that the BM/BMS will continue to perform well in the vacuum environment, use the guidelines that follow (in addition to standard handling, installation, and lubrication guidelines outlined in this manual).

1. Do not remove the BM/BMS from its sealed bag until it is ready to use.
2. Always handle the BM/BMS in a clean environment and use powder-free polyethylene gloves to prevent any contaminants from adhering to the surface of the BM/BMS .
3. During installation, use cleaned, vented, stainless steel fasteners when securing the BM/BMS .
4. Reduced air pressure eliminates significant convective heat transfer. This, coupled with the viscous vacuum-compatible lubricants, could result in excessive motor operating temperatures. Because of this, consider all continuous torque ratings to be 40 to 60% lower than the value specified for operation in normal atmospheric environment. Reduce motor usage accordingly.
5. For vacuum applications, the recommended lubricant is a small quantity of Braycote® 602EF grease or a compatible substitute of equal quality.
6. Baking vacuum components between 100 and 125 °C for 24 to 48 hours significantly reduces outgassing at initial pump-down to vacuum pressure and evaporates water vapor that impregnates porous surfaces on the aluminum and Teflon cables. Aerotech recommends that customers bake out vacuum systems when first installing them in the vacuum chamber.

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Chapter 2: Assembly and 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.

2.1. Connector Pinouts

Table 2-1: Motor Connector Options

Option	Connector Description	Pinout Table
-MS	Military style connectors	Table 2-4
-D25	4 pin D-style connector	Table 2-6
-D25-9D		
-D25-9D-CMS		
-D25-FLB	Flying leads	Table 2-8
-D25-4TS	4 pin terminal block connector	Table 2-9
-D25-5D	5 pin D-style connector	Table 2-10

Table 2-2: Feedback Connector Options

Option	Connector Description	Pinout Table
-MS	Military style connectors	Table 2-12
-D25	25 pin D-style connector (no limits)	Table 2-14
-D25-9D	25 pin D-style connector (with limits)	Table 2-16
-D25-9D-CMS		
-D25-5D		
-D25-FLB		
-D25-4TS		

Table 2-3: Limit Connector Options

Option	Connector Description	Pinout Table
-D25-9D	9 pin D-style connector	Table 2-18
-D25-9D-CMS		
-D25-5D		
-D25-FLB		
-D25-4TS		

2.1.1. Motor Connectors

WARNING: Do not allow motor connection cables to contact the motor frame while the motor is in operation.

Table 2-4: Motor Power Connector Pinout (-MS Option)

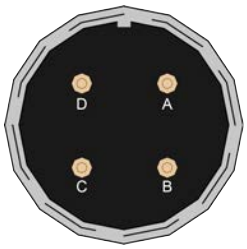
Pin	Function	Connector
A	Motor Phase A	 P/N: MS3101A18-10P
B	Motor Phase B	
C	Motor Phase C	
D	Frame Ground (motor protective ground)	
Backshell	Motor Cable Shield	

Table 2-5: Mating Connector Part Numbers for the Motor Power Connector (-MS Option)

Mating Connector	Aerotech P/N	Third Party P/N
Plug	MCM00475	Amphenol MS3106A18
Insert	MCM00495	Amphenol 9718-10S
Bushing	MCM00481	DDK MS3055-18-10
Clamp	MCM00477	Amphenol MS3057A-10
Note: All parts are nickel-plated		

Table 2-6: Motor Connector Pinout (-D25 Option)

Pin	Description	Connector
Case	Shield Connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase C	
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
A4	Frame Ground (motor protective ground)	

Table 2-7: Mating Connector Part Numbers for the Motor Power Connector (-D25 Option)

Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Sockets [QTY. 4]	ECK00659	ITT Cannon #DM53744-6
Connector	ECK00657	ITT Cannon #DBM9W4SA197

Table 2-8: Motor Power Flying Leads Pinout (-D25-FLB Option)

Wire	Description	Flying Leads
Black	Motor Phase A	
Red	Motor Phase B	
White	Motor Phase C	
Green/ Yellow	Frame Ground and Shield Connection	

Table 2-9: Motor Power Terminal Block Pinout (-D25-4TS Option)

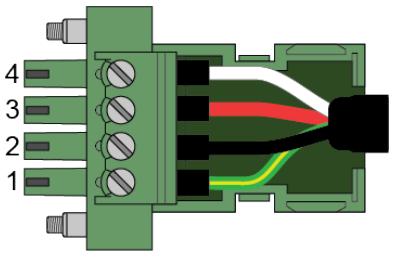
Wire	Description	Terminal Block
White	Motor Phase C	
Red	Motor Phase B	
Black	Motor Phase A	
Green/ Yellow	Frame Ground and Shield Connection	

Table 2-10: Motor Connector Pinout (-D25-5D Option)

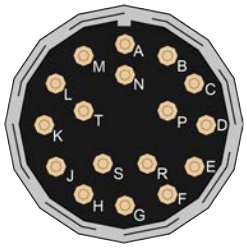
Pin	Description	Connector
Case	Shield Connection	
A1	Motor Phase A	
A2	Motor Phase B	
A3	Motor Phase C	
A4	Reserved	
A5	Frame Ground (motor protective ground)	

Table 2-11: Mating Connector Part Numbers for the -D25-5D Option Motor Power Connector

Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Sockets [QTY. 5]	ECK00659	ITT Cannon #DM53744-6
Connector	ECK01229	ITT Cannon #DBME5W5SA197

2.1.2. Feedback Connectors

Table 2-12: Feedback Connector Pinout (-MS Option)

Pin	Function	Connector
Case	Shield Connection	 P/N: MS3101A20-29P
A	Cosine	
B	Cosine-N	
C	Sine	
D	Sine-N	
E	Marker	
F	Marker-N	
G	Common ground	
H	+5 V power supply	
J	Reserved	
K	Hall Effect sensor, phase A	
L	**BMS Motor:** Over-Temperature Thermistor sensor	
	BM Motor: Reserved	
M	Hall Effect sensor, phase B	
N	Reserved	
P	Hall Effect sensor, phase C	
R	Reserved	
S	Reserved	
	with -BK Option Only: Brake + (1)	
T	Reserved	
	with -BK Option Only: Brake - (1)	

(1) 24 VDC @ 1 A max

Table 2-13: Mating Connector Part Numbers for the -MS Option Feedback Connector

Mating Connector	Aerotech P/N	Third Party P/N
Plug	MCM00454	Amphenol MS3106A-20
Insert	MCM00464	Amphenol MS20-29S
Clamp	MCM00457	97-3057-1012
Bushing	MCM00493	Amphenol AN3055-22-12

Note: All parts are nickel-plated

Table 2-14: Feedback Connector Pinout (without Limits, -D25 Option)

Pin	Description	Connector
Case	Shield Connection	
1	Reserved	
2	**BMS Motors:** Over-Temperature Thermistor sensor	
	BM Motors: Reserved	
3	+5 V power supply	
4	Reserved	
5	Hall Effect sensor, phase B	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
12	Reserved	
13	Reserved	
	with -BK Option Only: Brake -	
14	Cosine	
15	Cosine-N	
16	Reserved	
17	Sine	
18	Sine-N	
19	Reserved	
20	Common ground	
21	Common ground	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	
	with -BK Option Only: Brake +	

Table 2-15: Mating Connector Part Numbers for the -D25 Option Feedback Connector

Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Connector	ECK00300	FCI DB25S064TLF

Table 2-16: Feedback Connector Pinout (with Limits, -D25-9D, -9D-CMS, -5D, -FLB, -4TS)

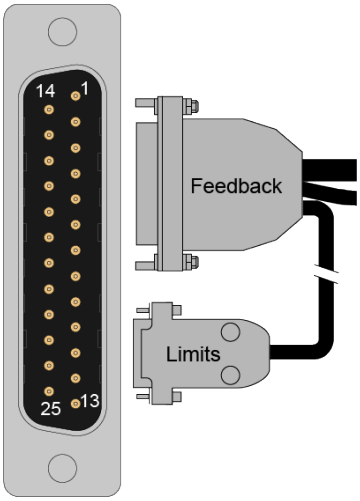
Pin	Description	Feedback Connector
Case	Shield Connection	
1	Reserved	
2	**BMS Motors:** Over-Temperature Thermistor sensor	
	BM Motors: Reserved	
3	+5 V power supply	
4	Reserved	
5	Hall Effect sensor, phase B	
6	Marker-N	
7	Marker	
8	Reserved	
9	Reserved	
10	Hall Effect sensor, phase A	
11	Hall Effect sensor, phase C	
12	Positive hardware limit (Clockwise/CW)	
13	Reserved	
	with -BK Option Only: Brake -	
14	Cosine	
15	Cosine-N	
16	Limit power	
17	Sine	
18	Sine-N	
19	Reserved	
20	Common ground	
21	Common ground	
22	Home limit	
23	Reserved	
24	Negative hardware limit (Counterclockwise/CCW)	
25	Reserved	
	with -BK Option Only: Brake +	

Table 2-17: Mating Connector Part Numbers for the -D25-XX Feedback Connector

Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Connector	ECK00300	FCI DB25S064TLF

Table 2-18: Limit Connector Pinout (-D25-9D,-9D-CMS, -5D, -FLB, -4TS)

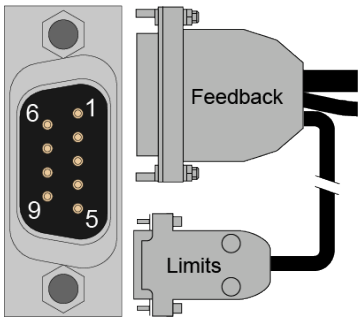
Pin	Description	Limits Connector
Case	Shield Connection	
1	+5 V power supply limit input	
2	Limit Common	
3	Positive hardware limit (Clockwise/CW)	
4	Home limit	
5	Negative hardware limit (Counterclockwise/CCW)	
6	Reserved	
7	Common ground	
8	Reserved	
9	Reserved	

Table 2-19: Mating Connector Part Numbers for the Limit Connector (-D25-xxx)

Mating Connector	Aerotech P/N	Third Party P/N
9-Pin D-Connector	ECK00340	FCI DE09S064TLF
Backshell	ECK01021	Amphenol 17E-1724-2

2.2. 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.

2.2.1. 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.

2.2.2. 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.

2.2.3. 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.

2.2.4. 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.

2.2.5. 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.

2.2.6. Thermal Protective Device (BMS Motors Only)

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 2-1).

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

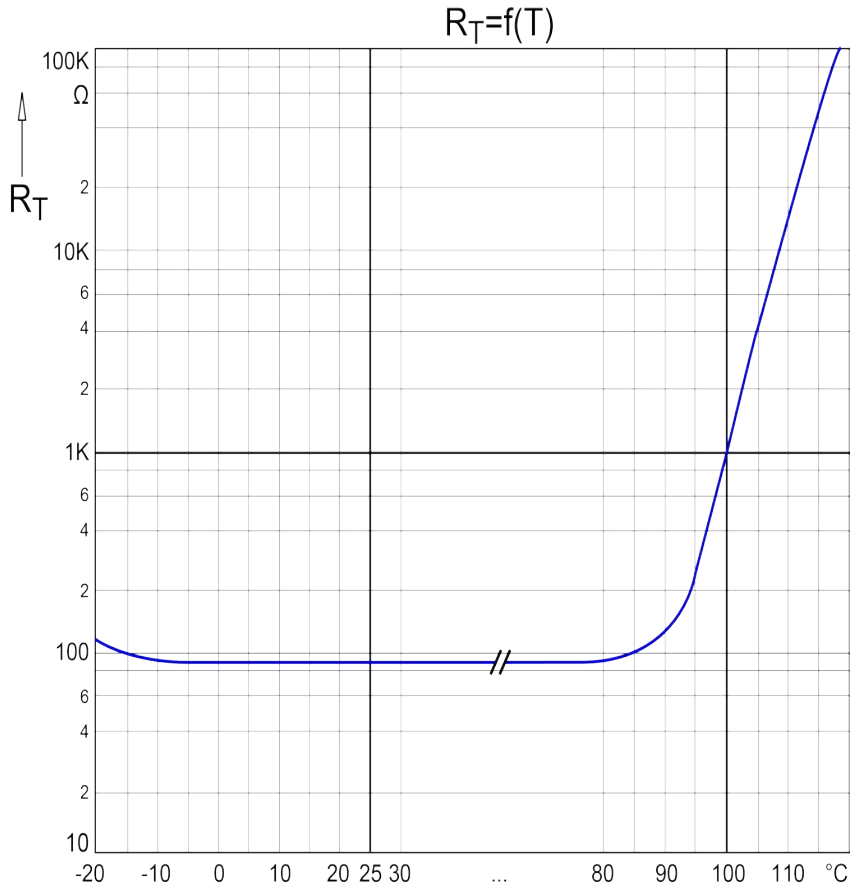


Figure 2-1: Typical Thermal Sensor Resistance as a Function of Temperature

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 2-2 for a typical interface circuit.

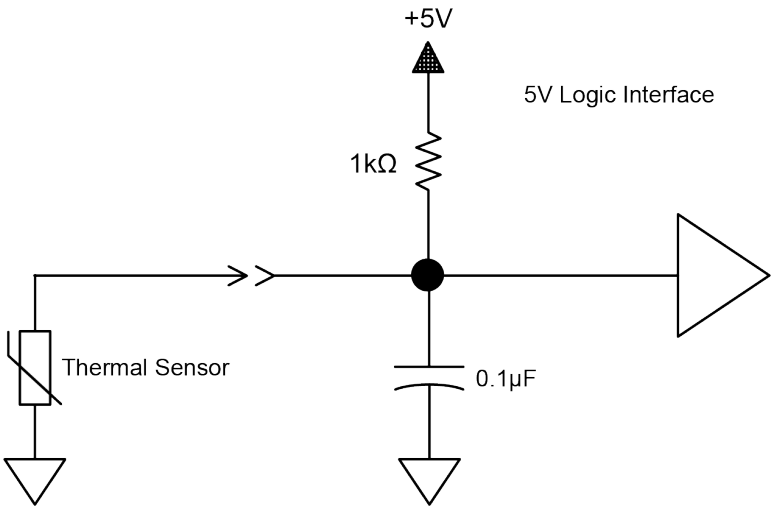
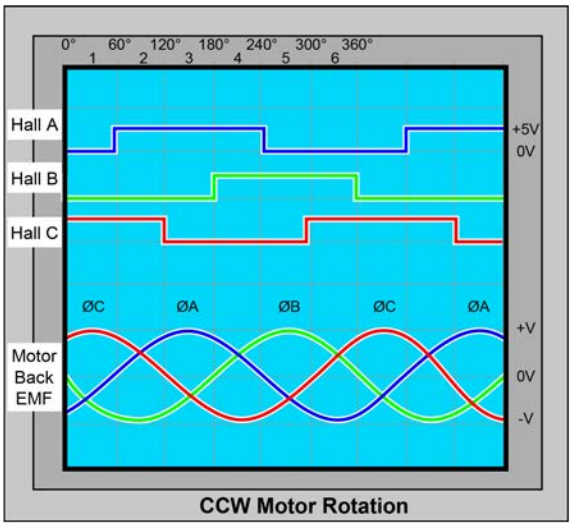


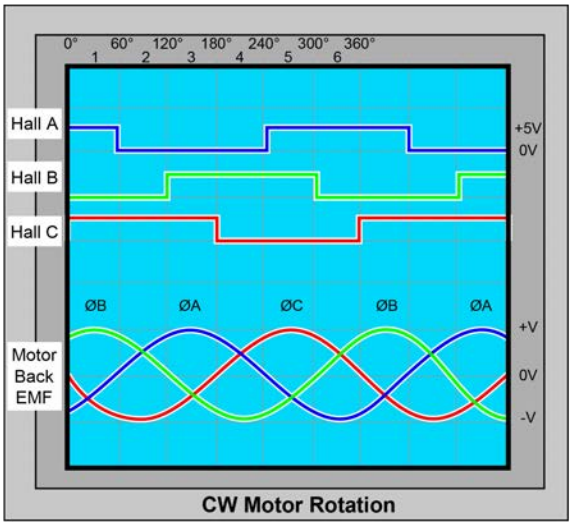
Figure 2-2: Typical Thermistor Interface Circuit

2.3. Hall-Effect Operation and Motor Phasing

Aerotech brushless motors are shipped from the factory with the correct motor phase to Hall effect relationship. Figure 2-3 shows the proper Hall effect to motor phasing for both clockwise (CW) and counterclockwise (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 2-3: 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 2-4. 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.

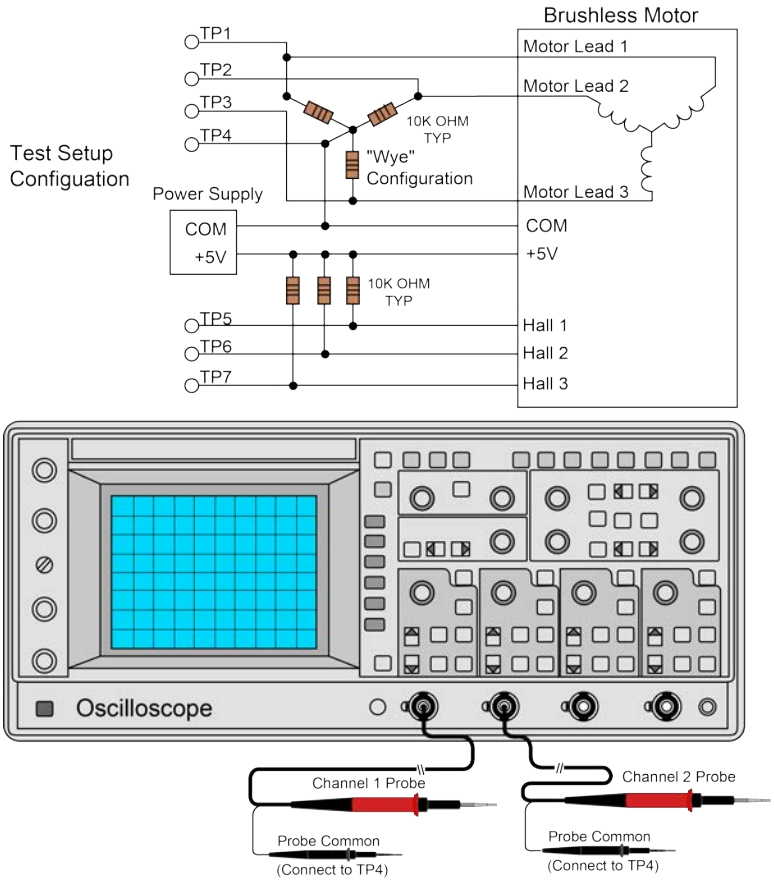


Figure 2-4: Test Setup Configuration

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.

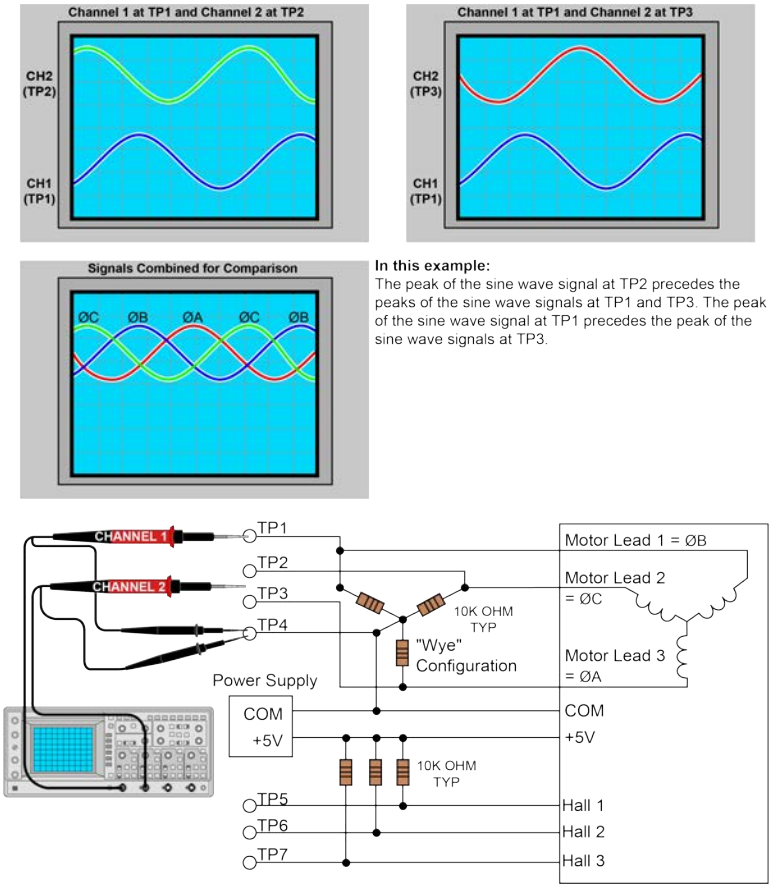
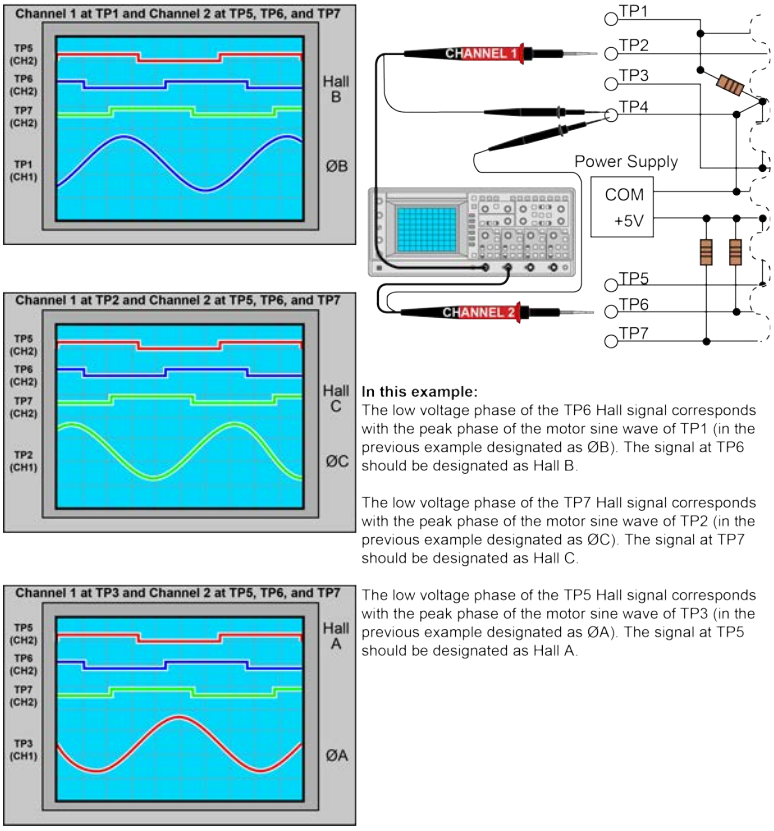


Figure 2-5: Motor Lead Phasing with Oscilloscope

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 2-6.

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.



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 2-6: Hall Phasing with Oscilloscope

2.4. 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 2-7.

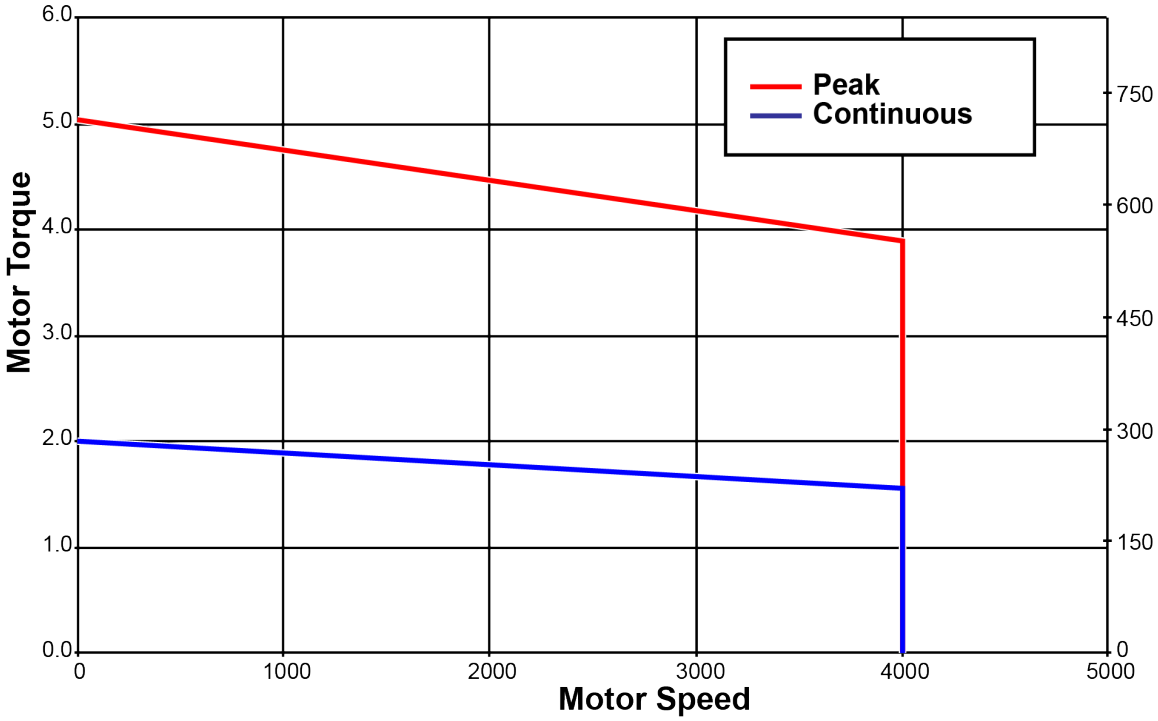


Figure 2-7: Example Torque Speed Curve

2.5. 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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Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from harmful 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, whether 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 on 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.

THE EXPRESS WARRANTY SET FORTH HEREIN IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL AEROTECH BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES.

Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within thirty (30) days of shipment of incorrect material. 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. A "Return Materials Authorization (RMA)" number must accompany any returned product(s). The RMA number may be obtained by calling an Aerotech service center or by submitting the appropriate request available on our website (www.aerotech.com). 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 thirty (30) days after the issuance of a return authorization number will be subject to review.

Visit https://www.aerotech.com/global-technical-support.aspx for the location of your nearest Aerotech Service center.

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 expedited method of return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Fixed Fee Repairs - Products having fixed-fee pricing will require a valid purchase order or credit card particulars before any service work can begin.

All Other Repairs - After Aerotech's evaluation, 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 thirty (30) days of notification will result in the product(s) being returned as is, at the buyer's expense.

Repair work is warranted for ninety (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.

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 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.

Service Locations

http://www.aerotech.com/contact-sales.aspx?mapState=showMap

USA, CANADA, MEXICO	CHINA	GERMANY
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720

TAIWAN	UNITED KINGDOM
Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690	Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649

Have your customer order number ready before calling.

Appendix B: Revision History

Revision	Description
2.10.00	• Updated motor specifications: Section 1.1. • Updated connector pinouts: Section 2.1.
2.09.00	• Updated motor specifications: Table 1-5
2.08.00	• Updated Declaration of Conformity • Updated inductance specifications for BM75, BM130, and BM200: Section 1.1. • Updated connector pinouts: Section 2.1.
2.07.00	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
2.06.00	
2.05.00	
2.04.00	
2.03.00	
2.02.00	
2.01.00	
2.00.00	
1.04	
1.03	
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