

MP-Series Medium Inertia Motors



The MP-Series (Bulletin MPM) medium-inertia servo motors offer a compact, power dense, feature-rich solution for applications with heavier loads and greater inertia. Leveraging the proven MP-Series motor technology and quality standards, these new servo motors are ideal for users with print, converting, web handling, automotive, and other applications requiring more power in a smaller package.

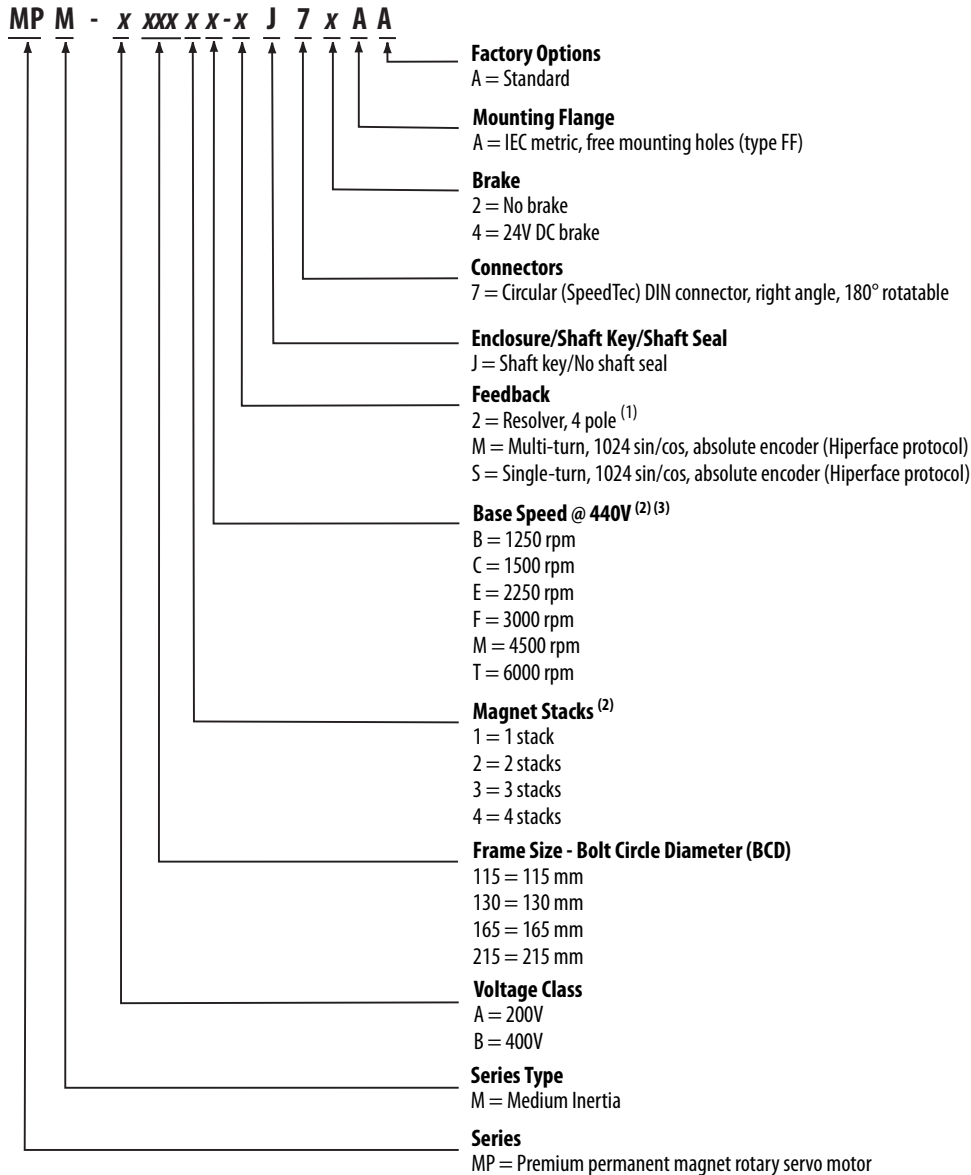
MP-Series Medium Inertia Motor Features

Attribute	Value
Main characteristics	<ul style="list-style-type: none"> • High torque to size ratio • Smart Motor Technology • Medium rotor inertia • Easy migration from 1326AB motors
Features	<ul style="list-style-type: none"> • 200V and 400V-class windings • Multiple winding speed options • High-energy rare-earth magnets • Shaft-end threaded hole • SpeedTec-ready DIN connectors, rotates 180° • Standard IEC 72-1 mounting dimensions
Motor type	Brushless AC synchronous servo motors
Environmental rating	<ul style="list-style-type: none"> • IP50 minimum, without shaft seal (standard). • IP67 with optional shaft seal and use of environmentally sealed cable connectors.
Certifications	Bulletin MPM rotary motors are UL Recognized components to applicable UL and CSA standards. CE marked for all applicable directives. Refer to http://www.ab.com for more information.
Continuous stall torque	2.18...62.8 N·m (19.3...556 lb·in)
Peak stall torque	6.6...154.2 N·m (58...1365 lb·in)
Speed	Up to 7000 rpm
Motor rated output	0.75...7.50 kW
Compatible servo drives	<ul style="list-style-type: none"> • Kinetix 5500⁽¹⁾ • Kinetix 6200/6500 • Kinetix 6000 • Kinetix 300/350 • Kinetix 2000 • Kinetix 7000 • Ultra3000
Typical applications	<ul style="list-style-type: none"> • Printing • Web handling • Converting • Automotive • Metal forming

(1) Requires the 2198-H2DCK Hiperface-to-DSL feedback converter kit. MP-Series (200V-class) medium-inertia motors require the 2198-H2DCK (series B or later) converter kit.

Catalog Numbers - MP-Series Medium Inertia Motors

Catalog numbers consist of various characters, each of which identifies a specific option for that component. Use the catalog numbering table chart below to understand the configuration of your motor. For questions regarding product availability, contact your Allen-Bradley distributor.



(1) Resolver feedback is not available on all models.

(2) Not all combinations are available. Only the configurations for rated speed and magnet stacks, as listed in MP-Series Medium Inertia Motor (200V-class) Performance Specifications on [page 70](#) and MP-Series Medium Inertia Motor (400V-class) Performance Specifications on [page 71](#), are available. Use Motion Analyzer software to size and select motors for your application.

(3) Maximum speed is servo drive dependant.

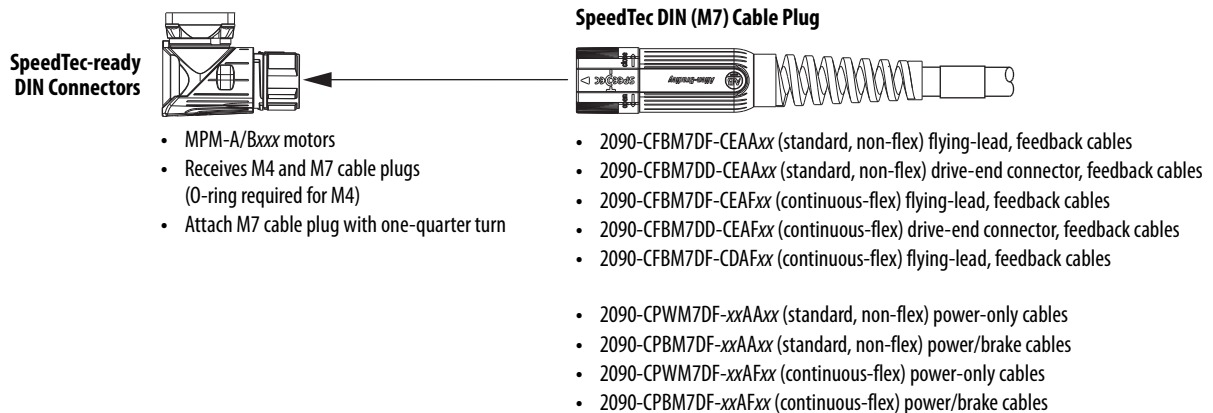
MP-Series Medium Inertia Motor High Resolution Encoders

MP-Series medium-inertia motors are available with high performance encoders with a choice of single-turn (-S) or multi-turn (-M) high-resolution feedback:

- Up to 2 million counts per revolution (-M and -S) for smooth performance.
- Single-turn encoder provides high-resolution absolute position feedback within one turn.
- Multi-turn encoder provides high-resolution absolute position feedback within 4096 turns. The electromechanical design does not require a battery.

Motor Connector/Cable Compatibility

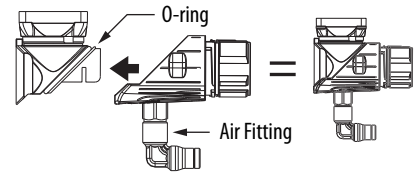
MP-Series (Bulletin MPM) motors are equipped with SpeedTec-ready DIN connectors.



MP-Series Medium Inertia Motor Options

MP-Series medium-inertia motors are available with these options:

- 24V DC brake.
- The positive air-pressure kit (catalog number MPF-7-AIR-PURGE) is mounted on the feedback connector to provide positive air pressure to further reduce the chance of contamination inside the motor.
- Shaft seal kits are available, as are replacement kits for field installation. Shaft seals are made of nitrile and kits include a lubricant to reduce wear.



IMPORTANT Shaft seals are subject to wear and require periodic inspection and replacement. Replacement is recommended every 3 months, not to exceed 12 months, depending on use.

Shaft Seal Kit Catalog Numbers

Motor Cat. No.	Shaft Seal Kit Cat. No.
MPM-A115xx and MPL-B115xx	MPL-SSN-A4B4
MPM-A130xx and MPL-B130xx	MPL-SSN-A5B5
MPM-A165xx and MPL-B165xx	MPL-SSN-F165
MPM-A215xx and MPL-B215xx	MPL-SSN-A6B6

Refer to the MP-Series Medium Inertia Servo Motor Installation Instructions, publication [MPM-IN001](#), for more information on motor accessories.

Technical Specifications - MP-Series Medium Inertia Motors

MP-Series Medium Inertia Motor (200V-class) Performance Specifications

Motor Cat. No.	Base Speed rpm	Speed, max rpm	Continuous Stall Torque N·m (lb·in)	Peak Stall Torque N·m (lb·in)	Motor Rated Output kW	Speed at Motor Rated Output rpm	Rotor Inertia ⁽¹⁾ kg·m ² (lb·in·s ²)	Motor Weight, ⁽¹⁾ approx kg (lb)
MPM-A1151M	4500	6000	2.18 (19.3)	6.60 (58.0)	0.90	5000	0.00065 (0.00575)	3.45 (7.6)
MPM-A1152F	3000	5000	4.74 (42.0)	13.5 (119)	1.40	4000	0.00077 (0.00682)	5.20 (11.4)
MPM-A1153F	3000	5000	6.55 (58.0)	19.8 (175)	1.45	4000	0.00089 (0.00784)	6.4 (14.0)
MPM-A1302F	3000	4500	5.99 (53.0)	13.5 (119)	1.65	4000	0.000983 (0.00870)	6.8 (15.0)
MPM-A1304F	3000	4000	9.30 (82.0)	19.3 (171)	2.20	3500	0.001223 (0.01082)	9.6 (21.2)
MPM-A1651F	3000	5000	10.7 (95.0)	20.5 (181)	2.50	3000	0.006605 (0.05846)	15.3 (33.8)
MPM-A1652F	3000	4000	13.5 (119)	36.0 (319)	4.03	3500	0.007265 (0.06430)	20.6 (45.4)
MPM-A1653F	3000	4000	18.6 (165)	42.0 (372)	5.10	3000	0.008025 (0.07103)	25.6 (56.4)
MPM-A2152F	3000	4000	27.0 (239)	56.0 (496)	5.20	2000	0.02059 (0.18223)	35.8 (79.0)
MPM-A2153F	3000	3600	34.0 (301)	58.0 (513)	5.80	2000	0.02254 (0.19950)	44.6 (98.3)
MPM-A2154C	1500	2000	55.0 (487)	106 (938)	6.50	1750	0.02449 (0.21675)	53.6 (118)
MPM-A2154E	2250	2650	44.0 (389)	84.0 (743)	7.00	2000		

(1) Refer to MP-Series Medium Inertia Motor Brake Specifications on [page 72](#) for brake rotor inertia and brake motor weight.

MP-Series Medium Inertia Motor (400V-class) Performance Specifications

Motor Cat. No.	Base Speed rpm	Speed, max rpm	Continuous Stall Torque N·m (lb·in)	Peak Stall Torque N·m (lb·in)	Motor Rated Output kW	Speed at Motor Rated Output rpm	Rotor Inertia ⁽¹⁾ kg·m ² (lb·in·s ²)	Motor Weight, ⁽¹⁾ approx kg (lb)																																																																																																																																																																																			
MPM-B1151F	3000	5000	2.18 (19.3)	6.6 (58.0)	0.75	4000	0.00065 (0.00575)	3.45 (7.6)																																																																																																																																																																																			
MPM-B1151T	6000	7000			0.90	5000			MPM-B1152C	1500	3000	4.74 (42.0)	13.5 (119)	1.20	2500	0.00077 (0.00681)	5.20 (11.4)	MPM-B1152F	3000	5200	1.40	4000	MPM-B1152T	6000	7000			MPM-B1153E	2250	3500	6.55 (58.0)	19.8 (175)	1.40	3000	0.00089 (0.00788)	6.40 (14.0)	MPM-B1153F	3000	5500	1.45	4000	MPM-B1153T	6000	7000			MPM-B1302F	3000	4500	5.99 (53.0)	13.5 (119)	1.65	4000	0.000983 (0.00870)	6.80 (15.0)	MPM-B1302M	4500	6000	MPM-B1302T	6000	7000	MPM-B1304C	1500	2750	10.2 (90.0)	27.1 (240)	2.00	3500	0.001223 (0.01082)	9.60 (21.2)	MPM-B1304E	2250	4000	2.20	MPM-B1304M	4500	6000			MPM-B1651C	1500	3500	10.7 (95.0)	23.2 (205)	2.50	3000	0.006605 (0.05846)	15.3 (33.8)	MPM-B1651F	3000	5000	MPM-B1651M	4500	5000	MPM-B1652C	1500	2500	16.0 (142)	40.0 (354)	3.80	2500	0.007265 (0.06430)	20.6 (45.4)	MPM-B1652E	2250	3500	19.4 (172)	48.0 (425)	4.30	3500	MPM-B1652F	3000	4500	MPM-B1653C	1500	2500	26.8 (237)	67.8 (600)	4.60	2000	0.008025 (0.07103)	25.6 (56.4)	MPM-B1653E	2250	3500	62.0 (549)	5.10	3000	MPM-B1653F	3000	4000	56.0 (496)	MPM-B2152C	1500	2500	36.7 (325)	72.3 (640)	5.60	2000	0.02059 (0.18224)	35.8 (79.0)	MPM-B2152F	3000	4500	33.0 (292)	5.90	2500	MPM-B2152M	4500	5000	30.0 (266)	50.0 (443)	MPM-B2153B	1250	2000	48.0 (425)	101.1 (895)	6.80	1750	0.02254 (0.19949)	44.6 (98.3)	MPM-B2153E	2250	3000	7.20	2000	MPM-B2153F	3000	3800	45.0 (398)	99.0 (876)	MPM-B2154B	1250	2000	62.8 (556)	154.2 (1365)	6.90	1750	0.02449 (0.21675)	53.6 (118.2)	MPM-B2154E	2250	3000	56.0 (496)	112.0 (991)	7.50	2000
MPM-B1152C	1500	3000	4.74 (42.0)	13.5 (119)	1.20	2500	0.00077 (0.00681)	5.20 (11.4)																																																																																																																																																																																			
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MPM-B1153T	6000	7000																																																																																																																																																																																									
MPM-B1302F	3000	4500	5.99 (53.0)	13.5 (119)	1.65	4000	0.000983 (0.00870)	6.80 (15.0)																																																																																																																																																																																			
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MPM-B1304C	1500	2750	10.2 (90.0)	27.1 (240)	2.00	3500	0.001223 (0.01082)	9.60 (21.2)																																																																																																																																																																																			
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MPM-B1651C	1500	3500	10.7 (95.0)	23.2 (205)	2.50	3000	0.006605 (0.05846)	15.3 (33.8)																																																																																																																																																																																			
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MPM-B2152C	1500	2500	36.7 (325)	72.3 (640)	5.60	2000	0.02059 (0.18224)	35.8 (79.0)																																																																																																																																																																																			
MPM-B2152F	3000	4500	33.0 (292)		5.90	2500																																																																																																																																																																																					
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MPM-B2153B	1250	2000	48.0 (425)	101.1 (895)	6.80	1750	0.02254 (0.19949)	44.6 (98.3)																																																																																																																																																																																			
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MPM-B2153F	3000	3800							45.0 (398)	99.0 (876)																																																																																																																																																																																	
MPM-B2154B	1250	2000	62.8 (556)	154.2 (1365)	6.90	1750	0.02449 (0.21675)	53.6 (118.2)																																																																																																																																																																																			
MPM-B2154E	2250	3000	56.0 (496)	112.0 (991)	7.50	2000																																																																																																																																																																																					
MPM-B2154F	3000	3300		88.0 (779)																																																																																																																																																																																							

(1) Refer to MP-Series Medium Inertia Motor Brake Specifications on [page 72](#) for brake rotor inertia and brake motor weight.

MP-Series Medium Inertia Motor Brake Specifications

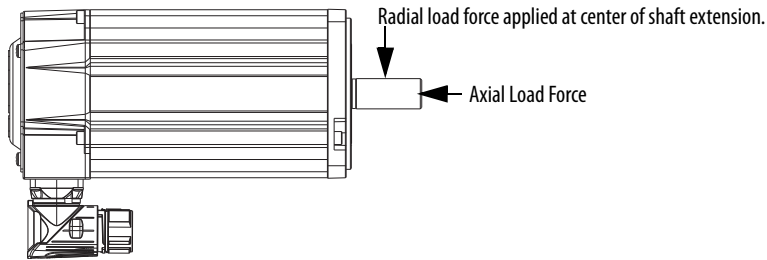
Motor Cat. No.	Backlash, max (brake engaged) arc minutes	Holding Torque N·m (lb·in)	Coil Current at 24V DC A	Brake Response Time			Brake Rotor Inertia kg·m ² (lb·in·s ²)	Brake Motor Weight, approx kg (lb)
				Release ms	Engage (by using external arc suppression device)			
					MOV ms	Diode ms		
MPM-A/B1151	45	4.18 (37)	0.45...0.55	50	20	110	0.00065 (0.00575)	5.2 (11.4)
MPM-A/B1152							0.00077 (0.00681)	6.9 (15.2)
MPM-A/B1153							0.00089 (0.00788)	8.1 (17.8)
MPM-A/B1302	48	10.2 (90)	0.576...0.704	110	25	160	0.000983 (0.00870)	8.6 (19.0)
MPM-A/B1304							0.001223 (0.01082)	11.7 (25.7)
MPM-A/B1651	25	28.3 (250)	1.05...1.28	70	50	250	0.006605 (0.05846)	17.9 (39.5)
MPM-A/B1652							0.007265 (0.06430)	23.2 (51.1)
MPM-A/B1653							0.008025 (0.07103)	28.2 (62.1)
MPM-A/B2152	25	70 (619)	1.84...2.25	200	120	900	0.02059 (0.18224)	43.8 (96.5)
MPM-A/B2153							0.02254 (0.19949)	53.6 (115.8)
MPM-A/B2154							0.02449 (0.21675)	61.6 (135.7)

MP-Series Medium Inertia Motor Load Force Ratings

Bulletin MPM motors are capable of operating with the maximum radial or maximum axial shaft loads listed in the following tables. Radial loads listed are applied in the middle of the shaft extension. The tables starting below represent an L₁₀ bearing fatigue life of 20,000 hours. This 20,000-hour life does not account for possible application-specific life reduction that can occur due to bearing grease contamination from external sources. Maximum operating speed is limited by motor winding.

Radial Load Force Ratings

Motor Cat. No.	1000 rpm kg (lb)	2000 rpm kg (lb)	3000 rpm kg (lb)	5000 rpm kg (lb)	7000 rpm kg (lb)
MPM-A/B1151	77 (170)	61 (134)	54 (119)	45 (99)	40 (88)
MPM-A/B1152	84 (185)	66 (145)	58 (128)	49 (108)	43 (95)
MPM-A/B1153	88 (194)	70 (154)	61 (134)	51 (112)	46 (101)
MPM-A/B1302	105 (231)	83 (183)	72 (159)	61 (134)	54 (119)
MPM-A/B1304	115 (253)	91 (200)	80 (176)	67 (148)	–
MPM-A/B1651	141 (311)	112 (247)	97 (214)	82 (181)	–
MPM-A/B1652	151 (333)	119 (262)	104 (229)	–	–
MPM-A/B1653	156 (344)	123 (271)	107 (236)	–	–
MPM-A/B2152	216 (476)	171 (377)	149 (328)	–	–
MPM-A/B2153	228 (502)	180 (396)	156 (344)	–	–
MPM-A/B2154	235 (518)	185 (407)	161 (355)	–	–

MPM-xxxx-xxxxAA Load Forces**Axial Load Force Ratings (maximum radial load)**

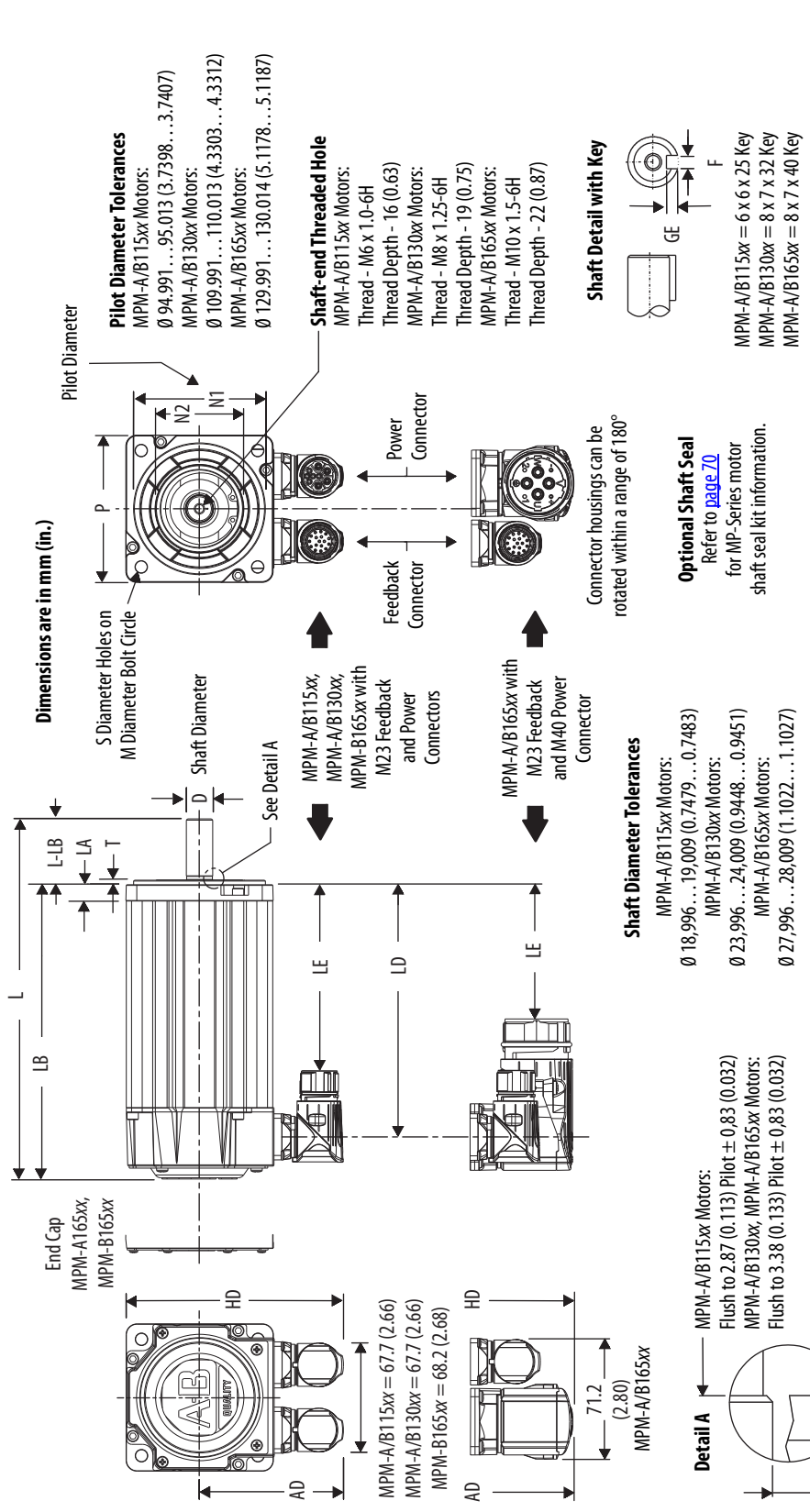
Motor Cat. No.	1000 rpm kg (lb)	2000 rpm kg (lb)	3000 rpm kg (lb)	5000 rpm kg (lb)	7000 rpm kg (lb)
MPM-A/B1151	29 (64)	22 (48)	18 (40)	14 (31)	12 (26)
MPM-A/B1152	31 (68)	23 (51)	19 (42)	15 (33)	13 (29)
MPM-A/B1153	33 (73)	24 (53)	20 (44)	16 (35)	14 (31)
MPM-A/B1302	26 (57)	19 (42)	16 (35)	13 (29)	11 (24)
MPM-A/B1304	30 (66)	22 (48)	18 (40)	15 (33)	–
MPM-A/B1651	37 (81)	28 (62)	23 (51)	18 (40)	–
MPM-A/B1652	41 (90)	30 (66)	25 (55)	–	–
MPM-A/B1653	43 (95)	32 (70)	27 (59)	–	–
MPM-A/B2152	55 (121)	40 (88)	34 (75)	–	–
MPM-A/B2153	60 (132)	44 (97)	36 (79)	–	–
MPM-A/B2154	63 (139)	46 (101)	38 (84)	–	–

Axial Load Force Ratings (zero radial load)

Motor Cat. No.	1000 rpm kg (lb)	2000 rpm kg (lb)	3000 rpm kg (lb)	5000 rpm kg (lb)	7000 rpm kg (lb)
MPM-A/B1151	46 (101)	34 (75)	28 (62)	23 (51)	19 (42)
MPM-A/B1152	46 (101)	34 (75)	28 (62)	23 (51)	19 (42)
MPM-A/B1153	46 (101)	34 (75)	28 (62)	23 (51)	19 (42)
MPM-A/B1302	46 (101)	34 (75)	28 (62)	23 (51)	19 (42)
MPM-A/B1304	46 (101)	34 (75)	28 (62)	23 (51)	–
MPM-A/B1651	61 (134)	44 (97)	38 (84)	30 (66)	–
MPM-A/B1652	61 (134)	44 (97)	38 (84)	–	–
MPM-A/B1653	61 (134)	44 (97)	38 (84)	–	–
MPM-A/B2152	90 (198)	65 (143)	54 (119)	–	–
MPM-A/B2153	90 (198)	65 (143)	54 (119)	–	–
MPM-A/B2154	90 (198)	65 (143)	54 (119)	–	–

Dimensions - MP-Series Medium Inertia Motors

MPM-A/B115xx, MPM-A/B130xx, MPM-A/B165xx Motor Dimensions



Shaft, Pilot, and Keyway Tolerances	MPM-A/B115xx	MPM-A/B130xx	MPM-A/B165xx
Shaft Runout (T.I.R.)	0.04 (0.0016)	0.04 (0.0016)	0.04 (0.0016)
Pilot Eccentricity (T.I.R.)	0.08 (0.0031)	0.10 (0.0039)	0.10 (0.0039)
Max Face Runout (T.I.R.)	0.08 (0.0031)	0.10 (0.0039)	0.10 (0.0039)
Keyway Depth (GE)	3.50...3.60 (0.138...0.142)	4.00...4.20 (0.158...0.165)	4.00...4.20 (0.158...0.165)
Keyway Width (F)	5.97...6.00 (0.235...0.236)	7.96...8.00 (0.314...0.315)	7.964...8.000 (0.3135...0.3150)

Power Connectors on MPM-A/B165xx Motors	MPM-A165xx Cat. No.	MPM-B165xx Cat. No.
M23 Power Connector	N/A	MPM-B1651F; MPM-B1651C; MPM-B1652C; MPM-B1653C
M40 Power Connector	MPM-A165xx	MPM-B1651M; MPM-B1652E; MPM-B1652F; MPM-B1653E; MPM-B1653F

MPM-A/B115x, MPM-A/B130x, MPM-A/B165x Motor Dimensions

Motor Cat. No.	AD ⁽¹⁾ mm (in.)	HD ⁽¹⁾ mm (in.)	T mm (in.)	LA mm (in.)	LD ⁽²⁾⁽³⁾ mm (in.)	LE ⁽²⁾⁽⁴⁾ mm (in.)	L ⁽²⁾ mm (in.)	LB ⁽²⁾ mm (in.)	L-LB ⁽⁵⁾ mm (in.)	D ⁽⁶⁾ mm (in.)	M mm (in.)	S ⁽⁷⁾ mm (in.)	N1 ⁽⁶⁾ mm (in.)	N2 mm (in.)	P mm (in.)	GE ⁽⁶⁾ mm (in.)	F ⁽⁶⁾ mm (in.)
MPM-A/B1151					124 (4.89)	84.1 (3.31)	190 (7.48)	150 (5.90)									
MPM-A/B1152	90.9 (3.58)	140.1 (5.52)	2.74 (0.108)	10.16 (0.40)	150 (5.89)	110 (4.31)	215 (8.48)	175 (6.90)	40.0 (1.58)	19.0 (0.748)	115.0 (4.528)	10.0 (0.401)	95.0 (3.74)	59.0 (2.32)	98.3 (3.87)	3.5 (0.138)	6.0 (0.236)
MPM-A/B1153					175 (6.89)	135 (5.31)	241 (9.48)	201 (7.90)									
MPM-A/B1302	98.6 (3.88)	155.4 (6.12)	2.74 (0.108)	12.19 (0.48)	153 (6.02)	113 (4.44)	229 (9.0)	179 (7.03)	50.0 (1.97)	24.0 (0.945)	130.0 (5.118)	10.0 (0.401)	110.0 (4.331)	70.3 (2.77)	113.7 (4.48)	4.0 (0.158)	8.0 (0.315)
MPM-A/B1304					204 (8.02)	164 (6.44)	279 (11.0)	229 (9.03)									
MPM-A/B1651					200 (7.88)	160 (6.30)	287 (11.28)	227 (8.92)									
MPM-A/B1652	113.4 (4.47)	185.2 (7.29)	3.12 (0.123)	14.0 (0.55)	251 (9.88)	211 (8.30)	337 (13.28)	277 (10.92)	60.0 (2.36)	28.0 (1.102)	165.0 (6.496)	12.0 (0.481)	130.0 (5.118)	81.0 (3.19)	143.5 (5.65)	4.0 (0.158)	8.0 (0.315)
MPM-A/B1653					302 (11.88)	262 (10.30)	388 (15.28)	328 (12.92)									

(1) This dimension applies to MPM-B165x motors with M23 connectors. For MPM-A/B165x motors with M40 connectors, add 23 mm (0.91 in.).

(2) If ordering an MPM-A/B115x or MPM-A/B130x motor with brake, add 48.5 mm (1.91 in.) to dimensions L, LB, LE, and LD.
If ordering an MPM-A/B165x motor with brake, add 51.5 mm (2.03 in.) to dimensions L, LB, LE, and LD.

(3) This dimension applies to MPM-B165x motors with M23 connectors. For MPM-A/B165x motors with M40 connectors, add 2.0 mm (0.07 in.).

(4) This dimension applies to MPM-B165x motors with M23 connectors. For MPM-A/B165x motors with M40 connectors, subtract 29.0 mm (1.15 in.).

(5) The tolerance for this dimension is ± 0.7 mm (± 0.028 in.).

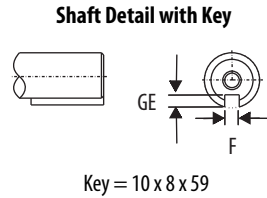
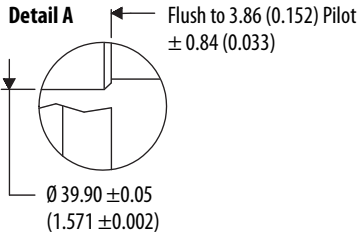
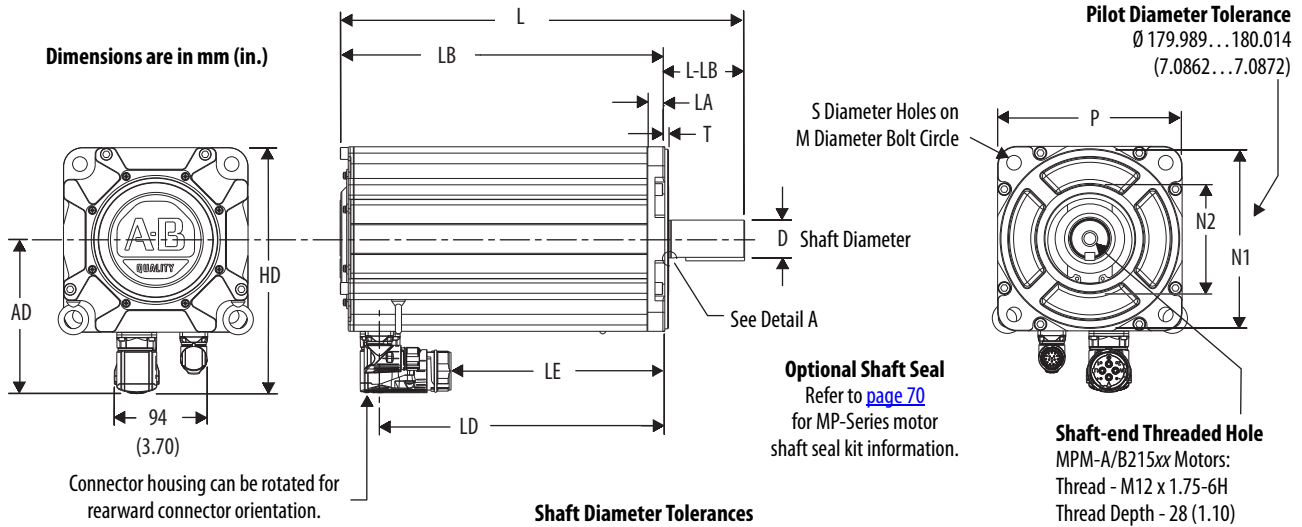
(6) For keyway, shaft diameter, and pilot diameter tolerances, refer to [page Z4](#).

(7) For MPM-A/B115x and MPM-A/B130x motors, the tolerance for this dimension is $+0.36$ mm (± 0.007 in.).

For MPM-A/B165x motors, the tolerance is $+0.43$ mm (± 0.008 in.).

Motors are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPM-A/B215x Motor Dimensions



Shaft, Pilot, and Keyway Tolerances	MPM-A/B215x
Shaft Runout (T.I.R.)	0.05 (0.002)
Pilot Eccentricity (T.I.R.)	0.10 (0.0039)
Max Face Runout (T.I.R.)	0.10 (0.0039)
Keyway Depth (GE)	5.00...5.20 (0.197...0.205)
Keyway Width (F)	9.964...10.000 (0.3923...0.3937)

Motor Cat. No.	AD	HD	T	LA	LD ⁽¹⁾	LE ⁽¹⁾	L ⁽¹⁾	LB ⁽¹⁾	L-LB ⁽²⁾	D	M	S ⁽³⁾	N1	N2	P	GE	F
MPM-	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)
A/B2152					234 (9.23)	163 (6.43)	355 (13.96)	275 (10.81)									
A/B2153	154 (6.06)	247 (9.70)	3.73 (0.147)	17.8 (0.70)	285 (11.23)	214 (8.43)	405 (15.96)	325 (12.81)	80.0 (3.150)	38.0 (1.50)	215 (8.465)	14.50 (0.579)	180 (7.09)	108 (4.25)	185 (7.28)	5.0 (0.197)	10.0 (0.394)
A/B2154					336 (13.23)	265 (10.43)	456 (17.96)	376 (14.81)									

- (1) If ordering an MPM-A/B215x motor with brake, add 88.9 mm (3.5 in.) to dimensions LD, LE, L, and LB.
- (2) Tolerance for this dimension is ±0.7 mm (±0.028 in.).
- (3) Tolerance for this dimension is +0.43 mm (±0.008 in.).

Motors are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.