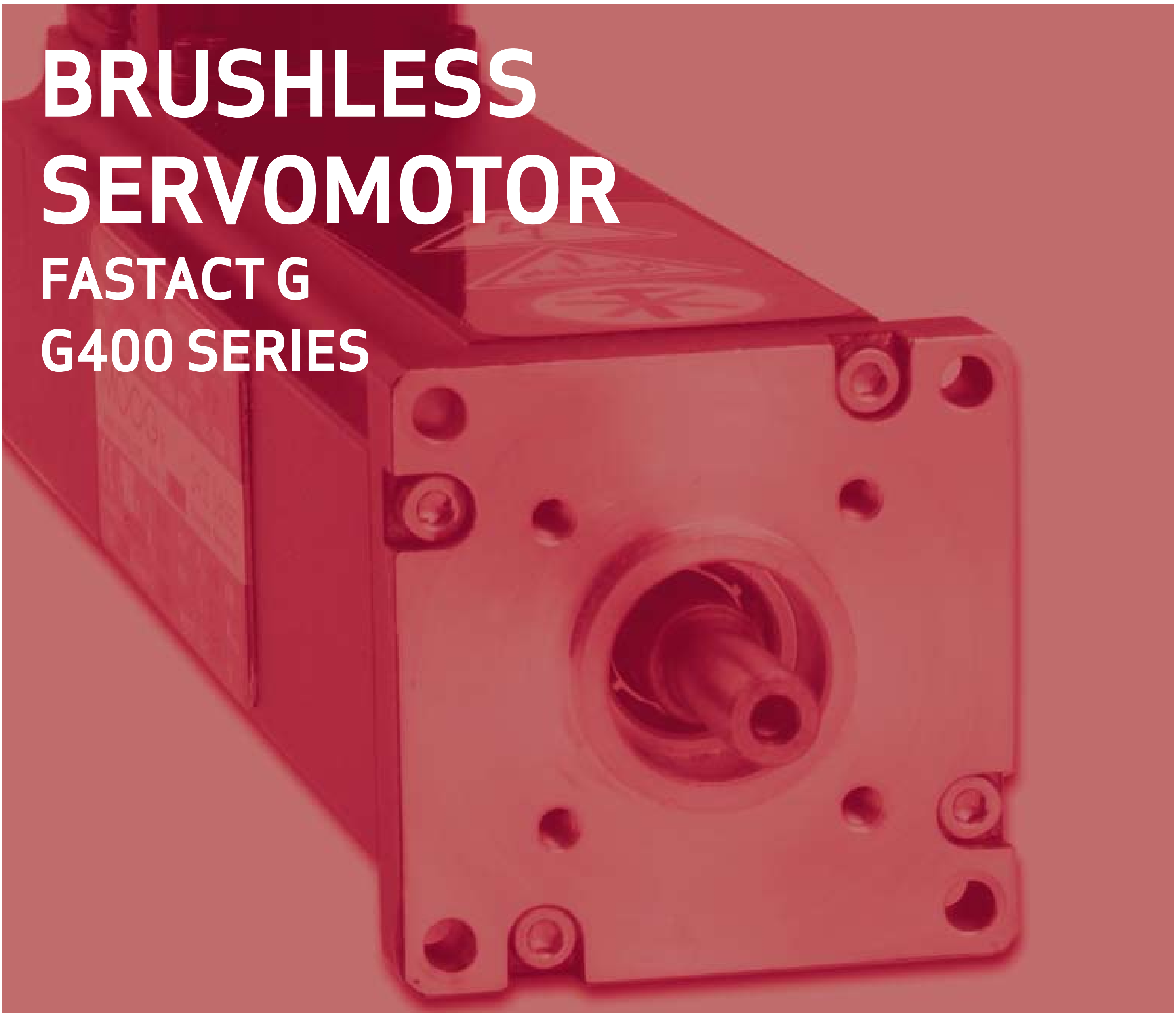
BRUSHLESS SERVOMOTOR

FASTACT G
G400 SERIES



LOW INERTIA, COMPACT LENGTH SERVOMOTORS FOR HIGHLY DYNAMIC APPLICATIONS

VERSION 1.0 | 10/2008

WHAT MOVES YOUR WORLD

MOOG

Whenever the highest levels of motion control performance and design flexibility are required, you'll find Moog expertise at work. Through collaboration, creativity and world-class technological solutions, we help you overcome your toughest engineering obstacles. Enhance your machine performance. And help take your thinking further than you ever thought possible.

This catalog is for users with technical knowledge. To ensure that all necessary characteristics for function and safety of the system are given, the user has to check the suitability of the products described herein. The products described herein are subject to change without notice. In case of doubt, please contact Moog.

For the most current information, visit www.moog.com/servomotorsanddrives

Dimensions in mm

Moog Brushless Technology

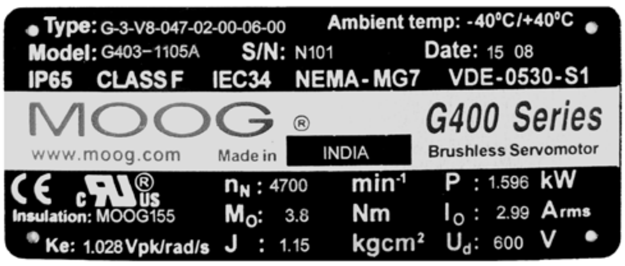
For over two decades, the name Moog has been associated with brushless servo motors and drives offering the highest dynamics, power density and reliability. The servo motors and drives are designed as a system to deliver superior servo performance. Moog offers a broad range of standard servo motors and drives as well as custom solutions to meet your unique application requirements. Moog brushless servo motors and drives are found on a variety of applications; especially where dynamics, compact size and reliability are important.

G400 Series Brushless Servomotors

Moog's G400 Series motors are electronically commutated synchronous AC motors with permanent magnet field excitation.
G400 Series motors are designed for highly dynamic servo applications where positioning times of 30 msec or less are often the norm. The G400 Series offers one of the industry's widest power ranges with standard models available at continuous torque ratings from 0.15 to 76.6 Nm (1.33 to 673 lb-in). The modular design is supported by a variety of options with Moog's application staff capable of supplying fully customized solutions. All Moog servo motors are manufactured in-house and the use of tight machining tolerances, precision balancing and thorough production testing guarantee a long service life.

Ordering information and motor nameplate

To order a motor, choose the various Type options by filling in the boxcar on the inside back page of the catalog. Moog sales department will provide the corresponding Model number suitable for the order. Both model number and boxcar (Model and Type respectively, as in picture) will be present on the motor nameplate. The Type field may vary for motors released prior to June 2008.



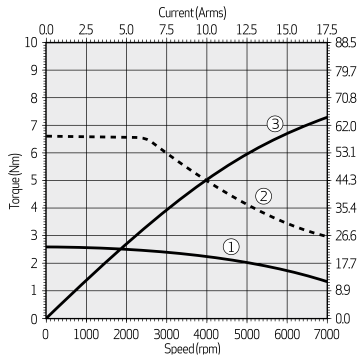
Moog Motor Performance Characteristics

In collaborating with a variety of industrial machine designers, Moog realizes what a critical role the application sizing process plays in overall machine design. With global competition forcing designers to do more with less, there is an ever-increasing need to avoid unnecessary margin and "size" exactly to your application needs. It is for these reasons that Moog specifies motor performance characteristics in a manner that makes them practical for designing your system. Motor characteristics are specified under the same environmental conditions in which they will be used, with notes clearly articulating the operating conditions.

The motor performance characteristic contains three elements.
The first element is the continuous torque curve. This curve illustrates the motor torque available at 100% duty cycle under the following conditions:

- operation in still air with ambient temperatures up to 40°C
- winding temperature at 110°C over ambient for resolver feedback motors
- motor front flange attached to a steel mounting plate measuring 300 x 300 x 12 mm

The second element is the peak torque curve. This curve reflects the motor torque available with a 10% duty cycle (1 out of 10 seconds). It is based on years of practical industry experience and is useful for typical servo applications.
The third element is the motor Kt characteristic. The motor Kt characteristic depicts stator saturation at various operating points and can be used to optimize sizing in low duty cycle applications. G400 motors can deliver a low duty cycle "impulse torque" which is typically 20–30% more than rated peak torque. While motors can be operated reliably at this operating point it is recommended that a member of Moog's application team review the application to ensure thermal restrictions are not violated.



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Superior Motor Dynamics Improves Cycle Time

The G400 Series motor combines a low inertia rotor with an electromagnetic design having exceptional overload capacity. The result is an increase in the effective torque available to accelerate and decelerate the load, enabling higher dynamics and improved cycle times.
G400 Series motors use a fully laminated, weight-optimized, rotor to provide a significant inertia reduction over conventional solid rotor designs. It is able to achieve a high overload capacity through the use of high-energy rare magnets, a high pole count electrical design, and an efficient thermal construction.

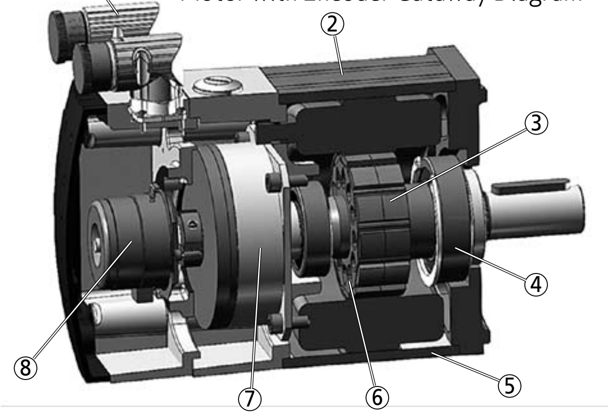
Compact, Lightweight, Construction Simplifies Machine Design

The G400 Series motor provides high torque in a compact, lightweight, package to achieve both high power density and a high torque-to-weight ratio. The compact, lightweight, package provides greater flexibility and often enables new cost-saving approaches to machine construction. In applications where the motor is mounted on a moving axis the high torque to weight ratio allows greater payloads and/or increased acceleration.
G400 Series motors leverage an all aluminum motor housing to achieve a significant weight reduction over low cost
steel housings. A robust thermal design allows more power to be designed into a small, compact, package.

Proprietary, Low-Cogging, Design Delivers Smooth Low Speed Operation

The G400 Series motor includes several design enhancements to deliver smooth slow speed performance. The enhancements include the selection of a high pole count (8 to 12 poles) electromagnetic design, a stator with non-symmetric slot count and other proprietary features to minimize cogging.

Motor with Encoder Cutaway Diagram



Ruggedized, Maintenance-Free, Design to Boost Overall System Availability

The G400 Series motor is designed and manufactured in accordance with strict CE (VDE) standards, using ruggedized components with proven reliability in harsh thermal and shock load environments. These all combine to offer years of reliable, maintenance-free, operation and boost overall system availability.
The use of high reliability feedback devices, sealed lifetime lubricated bearings, precision balanced rotors (Class G 6.3 of ISO 1940), reduced runout machining tolerances (Class R of DIN 42955-R) and IP65 construction combine to extend service life.

Flexible Design Option Ease Integration

The G400 Series motor is available with the following options:

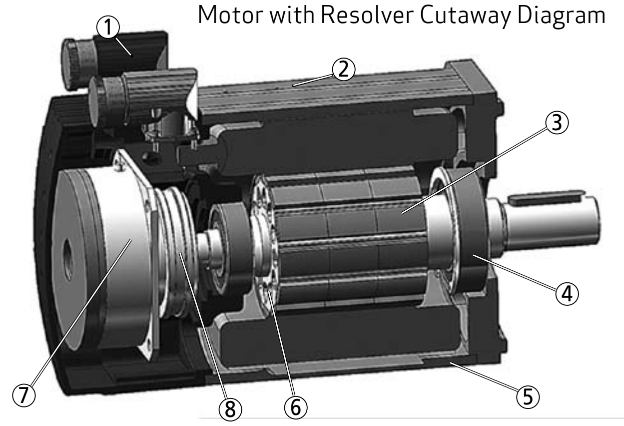
- Integral holding brakes
- Resolver or encoder based feedback
- Plain or slot & key type shafts
- Teflon shaft seal (IP67 sealing)
- Convection (standard) or fan cooling (upon request)

Fully Customized Designs Support Unique Application Requirements

Finally, our G400 Series motors can be customized to meet your unique needs.
The following are typical requests supported by Moog's application staff:

- Custom motor windings
- Custom shafts and flanges
- Custom frameless designs
- Custom connector configurations (including pigtails)
- Custom feedback devices
- Custom designs for unique environments including high temperature, high shock levels, oil and water immersion, areas with explosive gases and areas with elevated radiation levels.

Motor with Resolver Cutaway Diagram



① Metal CE/UL compliant connectors
② Proprietary stator design
③ Rare earth magnets
④ Sealed life-time lubricated bearings
⑤ Lightweight extruded aluminum housing
⑥ Fully laminated low-inertia rotor
⑦ Optional holding brake
⑧ High reliability device feedback

Performance Specifications For Standard Type: G-1-M (Low Voltage)

Characteristics and nominal values with sinusoidal drive

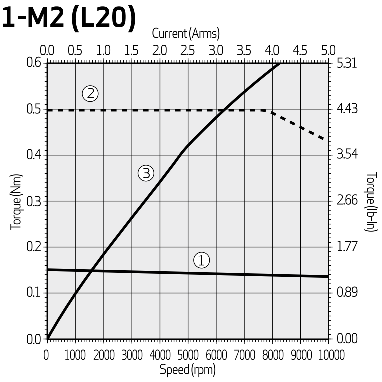
Type		G-1-M2 (L20)	G-1-M4 (L40)	G-1-M6 (L60)	Units
Nominal Torque. continuous duty, locked rotor	M_o	0.15 [1.3]	0.27 [2.4]	0.37 [3.3]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	0.14 [1.2]	0.24 [2.1]	0.30 [2.7]	Nm [lb-in]
Max torque	M_{max}	0.5 [4.4]	1 [8.9]	1.5 [13.3]	Nm [lb-in]
Nominal speed	n_N	9000	6000	6000	rpm
Maximum speed	n_{max}	14000	12000	9000	rpm
Nominal current, locked rotor	I_o	0.87	0.78	0.81	Arms
Peak current	I_p	3.3	3.3	3.7	Arms
Output power, continuous duty, nominal speed	P_N	0.13 [0.18]	0.15 [0.20]	0.19 [0.25]	kW [hp]
Torque constant	k_T	0.17 [1.5]	0.34 [3.0]	0.46 [4.1]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	11	22.1	29.6	Vrms/krpm
Thermal time constant	τ_{Th}	350	500	650	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	23.0	34.8	37.0	Ohm
Winding inductance (phase to phase)	L_{tt}	5.2	10.4	12.4	mH
Rotor inertia with resolver	J	0.027 [0.24]	0.049 [0.43]	0.072 [0.64]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	0.023 [0.2]	0.045 [0.4]	0.068 [0.6]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	0.55 [1.2]	0.68 [1.5]	0.82 [1.8]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	0.4 [3.5]	N/A	Nm [lb-in]
Extra weight	0.06 [0.13]	N/A	kg [lb]
Extra inertia with resolver	0.01 [0.09]	N/A	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	0.01 [0.09]	N/A	kg cm² [lb-insec² x 10^{-4}]
Power requirement	6.0	N/A	Watt
Voltage requirement (+10% -10%)	24	N/A	V_{DC}

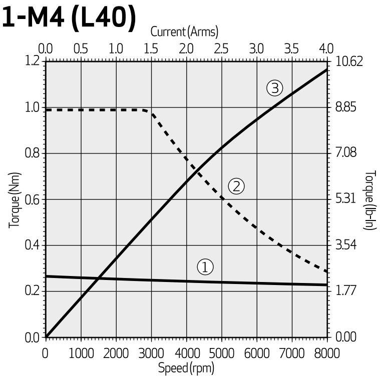
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 8
3. G-X-M: 325 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

G-1-M2 (L20)

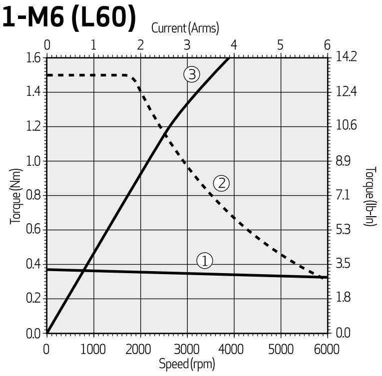


G-1-M4 (L40)



① Continuous torque with convection cooling
② Peak torque
③ Motor Kt

G-1-M6 (L60)



Performance Specifications For Standard Type: G-2-M (Low Voltage)

Characteristics and nominal values with sinusoidal drive

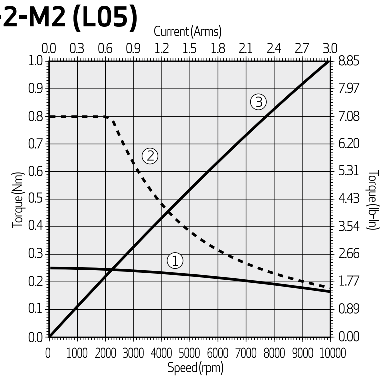
Type		G-2-M2 (L05)	G-2-M4 (L10)	G-2-M6 (L20)	G-2-M8 (L40)	Units
Nominal Torque. continuous duty, locked rotor	M_o	0.25 [2.2]	0.5 [4.4]	0.95 [8.4]	1.7 [15.0]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	0.18 [1.6]	0.42[3.7]	0.74 [6.6]	1.3 [11.2]	Nm [lb-in]
Max torque	M_{max}	0.8 [7.1]	1.6 [14.2]	3.1 [27.4]	6.2 [54.9]	Nm [lb-in]
Nominal speed	n_N	8100	7400	6800	6200	rpm
Maximum speed	n_{max}	11500	10000	9000	7000	rpm
Nominal current, locked rotor	I_o	0.65	1.2	2.15	2.85	Arms
Peak current	I_p	2.4	4.3	7.5	12	Arms
Output power, continuous duty, nominal speed	P_N	0.15 [0.20]	0.33 [0.44]	0.53 [0.71]	0.82 [1.10]	kW [hp]
Torque constant	k_T	0.37 [3.3]	0.42[3.7]	0.46[4.1]	0.60[5.3]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	23.4	26.0	35.6	35.58	Vrms/krpm
Thermal time constant	τ_{Th}	245	415	514	926	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	50.9	20.7	9.9	6.3	Ohm
Winding inductance (phase to phase)	L_{tt}	29.7	15.7	9.1	7.2	mH
Rotor inertia with resolver	J	0.09 [0.8]	0.13 [1.2]	0.22 [1.9]	0.41 [3.6]	kg cm^2 [lb-insec^2 x 10^{-4}]
Rotor inertia with encoder	J	0.07 [0.62]	0.11 [1.0]	0.20 [1.8]	0.39 [3.5]	kg cm^2 [lb-insec^2 x 10^{-4}]
Weight (without brake)	m	1 [2.2]	1.2 [2.6]	1.5 [3.3]	2.3 [5.1]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	1.0 [8.9]	N/A	Nm [lb-in]
Extra weight	0.12 [0.26]	N/A	kg [lb]
Extra inertia with resolver	0.02 [0.18]	N/A	kg cm^2 [lb-insec^2 x 10^{-4}]
Extra inertia with encoder	0.02 [0.18]	N/A	kg cm^2 [lb-insec^2 x 10^{-4}]
Power requirement	10.0	N/A	Watt
Voltage requirement (+6% -10%)	24	N/A	V_{DC}

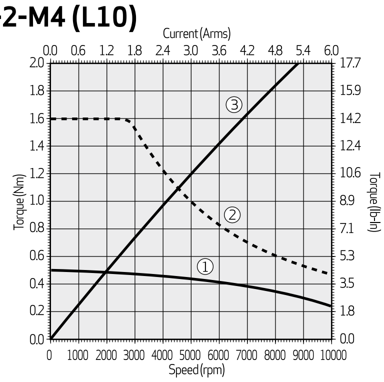
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 8
3. G-X-M: 325 V_{DC} link

For a complete list of options and accessories, see pages 26–27

G-2-M2 (L05)



G-2-M4 (L10)

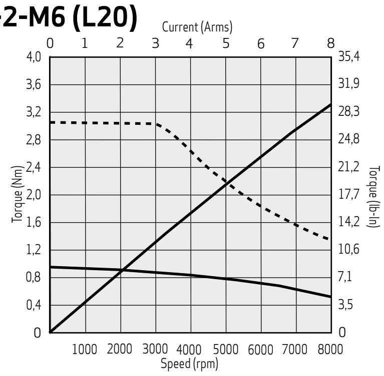


① Continuous torque with convection cooling

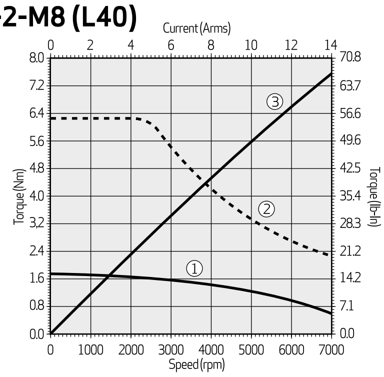
② Peak torque

③ Motor Kt

G-2-M6 (L20)



G-2-M8 (L40)



Performance Specifications For Standard Type: G-2-V (High Voltage)

Characteristics and nominal values with sinusoidal drive

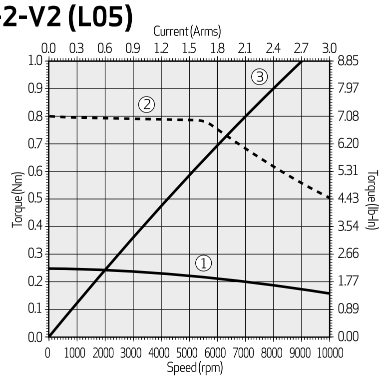
Type		G-2-V2 (L05)	G-2-V4 (L10)	G-2-V6 (L20)	G-2-V8 (L40)	Units
Nominal Torque. continuous duty, locked rotor	M_o	0.25 [2.2]	0.5 [4.4]	1.0 [8.9]	2.0 [17.7]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	0.18 [1.6]	0.29 [2.6]	0.65 [5.7]	1.0 [8.5]	Nm [lb-in]
Max torque	M_{max}	0.8 [7.1]	1.6 [14.2]	3.1 [27.4]	6.2 [54.9]	Nm [lb-in]
Nominal speed	n_N	9000	9000	7500	7500	rpm
Maximum speed	n_{max}	11500	11500	11000	1000	rpm
Nominal current, locked rotor	I_o	0.63	1.26	1.56	2.94	Arms
Peak current	I_p	2.2	4.3	5.3	10.6	Arms
Output power, continuous duty, nominal speed	P_N	0.17 [0.23]	0.27 [0.37]	0.51 [0.68]	0.75 [1.01]	kW [hp]
Torque constant	k_T	0.40 [3.5]	0.40 [3.5]	0.64 [5.7]	0.68 [6.0]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	25.9	25.4	40.0	39.8	Vrms/krpm
Thermal time constant	τ_{Th}	245	415	514	926	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	60.7	20.0	19.2	7.9	Ohm
Winding inductance (phase to phase)	L_{tt}	33.9	15.0	17.9	8.7	mH
Rotor inertia with resolver	J	0.09 [0.80]	0.13 [1.2]	0.22 [1.9]	0.41 [3.6]	kg cm^2 [lb-insec^2 x 10^{-4}]
Rotor inertia with encoder	J	0.07 [0.62]	0.11 [1.0]	0.20 [1.8]	0.39 [3.5]	kg cm^2 [lb-insec^2 x 10^{-4}]
Weight (without brake)	m	1.0 [2.2]	1.2 [2.6]	1.5 [3.3]	2.3 [5.1]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	1.0 [8.9]	N/A	Nm [lb-in]
Extra weight	0.12 [0.26]	N/A	kg [lb]
Extra inertia with resolver	0.02 [0.18]	N/A	kg cm^2 [lb-insec^2 x 10^{-4}]
Extra inertia with encoder	0.02 [0.18]	N/A	kg cm^2 [lb-insec^2 x 10^{-4}]
Power requirement	10.0	N/A	Watt
Voltage requirement (+6% -10%)	24	N/A	V_{DC}

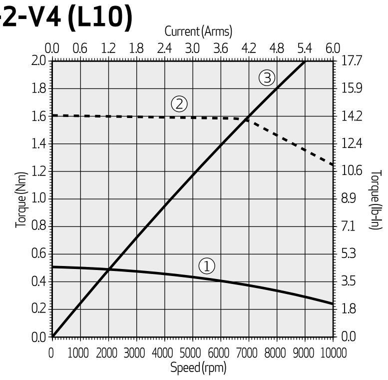
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 8
3. G-X-M: 565 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

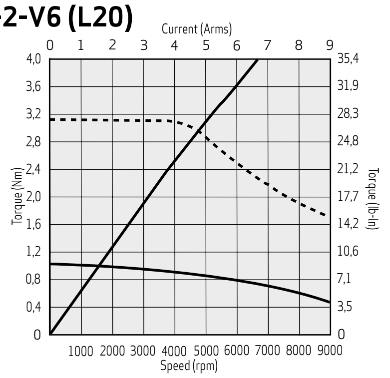
G-2-V2 (L05)



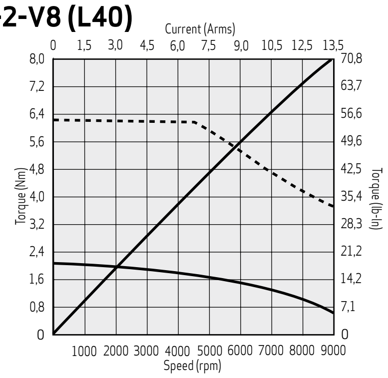
G-2-V4 (L10)



G-2-V6 (L20)



G-2-V8 (L40)



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Performance Specifications For Standard Type: G-3-M (Low Voltage)

Characteristics and nominal values with sinusoidal drive

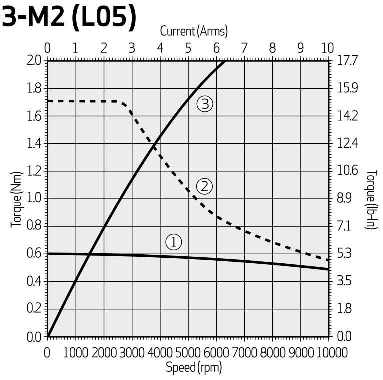
Type		G-3-M2 (L05)	G-3-M4 (L15)	G-3-M6 (L25)	G-3-M8 (L40)	Units
Nominal Torque. continuous duty, locked rotor	M_o	0.6 [5.3]	1.65 [14.6]	2.55 [22.6]	3.7 [32.7]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	0.49 [4.3]	1.4 [12.7]	2.3 [20.3]	3.4 [30.3]	Nm [lb-in]
Max torque	M_{max}	1.7 [15.0]	5.0 [44.3]	8.3 [73.5]	13.1 [115.9]	Nm [lb-in]
Nominal speed	n_N	8800	6300	4800	3900	rpm
Maximum speed	n_{max}	10500	8000	5500	4500	rpm
Nominal current, locked rotor	I_o	1.6	3.2	3.4	4.2	Arms
Peak current	I_p	5	11.5	13	17	Arms
Output power, continuous duty, nominal speed	P_N	0.45 [0.6]	0.95 [1.3]	1.2 [1.5]	1.4 [1.9]	kW [hp]
Torque constant	k_T	0.40 [3.5]	0.53 [4.7]	0.75 [6.6]	0.90 [8.0]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	25	31.6	45.7	55.3	Vrms/krpm
Thermal time constant	τ_{Th}	333	758	967	1345	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	15.2	4.9	5.1	4.1	Ohm
Winding inductance (phase to phase)	L_{tt}	18.8	8.5	10.3	8.9	mH
Rotor inertia with resolver	J	0.16 [1.4]	0.39 [3.5]	0.62 [5.5]	0.97 [8.6]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	0.14 [1.2]	0.37 [3.3]	0.60 [5.3]	0.95 [8.4]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	1.4 [3.1]	2.0 [4.4]	2.6 [5.7]	3.5 [7.7]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	2.0 [17.7]	4.5 [39.8]	Nm [lb-in]
Extra weight	0.20 [0.44]	0.32 [2.8]	kg [lb]
Extra inertia with resolver	0.07 [0.62]	0.18 [1.6]	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	0.07 [0.62]	0.18 [1.6]	kg cm² [lb-insec² x 10^{-4}]
Power requirement	11.0	12.0	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

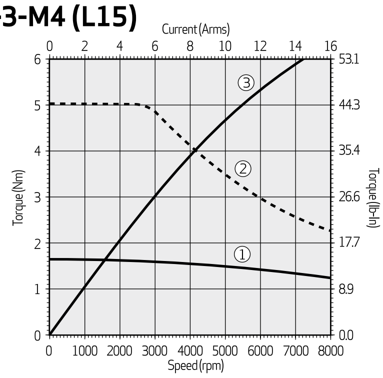
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 8
3. G-X-M: 325 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

G-3-M2 (L05)

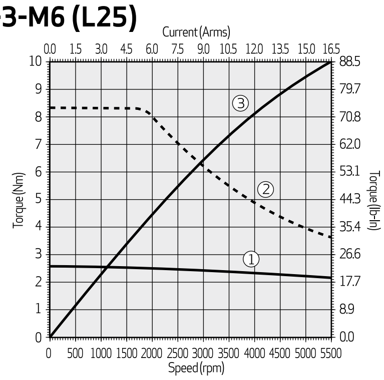


G-3-M4 (L15)

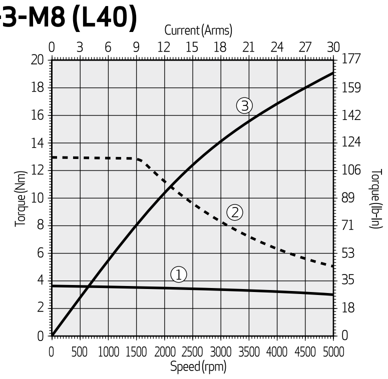


① Continuous torque with convection cooling
② Peak torque
③ Motor Kt

G-3-M6 (L25)



G-3-M8 (L40)



Performance Specifications For Standard Type: G-3-V (High Voltage)

Characteristics and nominal values with sinusoidal drive

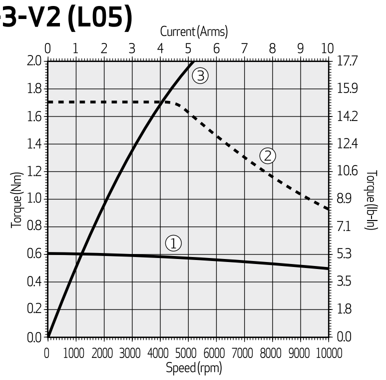
Type		G-3-V2 (L05)	G-3-V4 (L15)	G-3-V6 (L25)	G-3-V8 (L40)	Units
Nominal Torque. continuous duty, locked rotor	M_o	0.6 [5.3]	1.6 [14.2]	2.5 [22.1]	3.8 [33.6]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	0.54 [4.8]	1.4 [12.7]	2.2 [19.5]	3.1 [27.9]	Nm [lb-in]
Max torque	M_{max}	1.7 [15.0]	5 [44.3]	8.3 [73.5]	13.1 [115.9]	Nm [lb-in]
Nominal speed	n_N	8700	6200	4800	4700	rpm
Maximum speed	n_{max}	10500	10000	6000	5600	rpm
Nominal current, locked rotor	I_o	1.3	2.3	2.1	3.0	Arms
Peak current	I_p	4.1	8.3	8.3	12.5	Arms
Output power, continuous duty, nominal speed	P_N	0.49 [0.7]	0.94 [1.3]	1.1 [1.5]	1.6 [2.1]	kW [hp]
Torque constant	k_T	0.48 [4.2]	0.71 [6.3]	1.19 [10.5]	1.27 [11.2]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	30.5	43.4	71.8	76.1	Vrms/krpm
Thermal time constant	τ_{Th}	333	758	967	1345	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	24.6	9.5	13.0	8.1	Ohm
Winding inductance (phase to phase)	L_{tt}	29.0	16.1	25.0	17.0	mH
Rotor inertia with resolver	J	0.16 [1.4]	0.39 [3.5]	0.62 [5.5]	0.97 [8.6]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	0.14 [1.2]	0.37 [3.3]	0.60 [5.3]	0.95 [8.4]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	1.4 [3.1]	2.0 [4.4]	2.6 [5.7]	3.5 [7.7]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	2.0 [17.7]	4.5 [39.8]	Nm [lb-in]
Extra weight	0.20 [0.44]	0.32 [2.8]	kg [lb]
Extra inertia with resolver	0.07 [0.62]	0.18 [1.6]	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	0.07 [0.62]	0.18 [1.6]	kg cm² [lb-insec² x 10^{-4}]
Power requirement	11.0	12.0	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

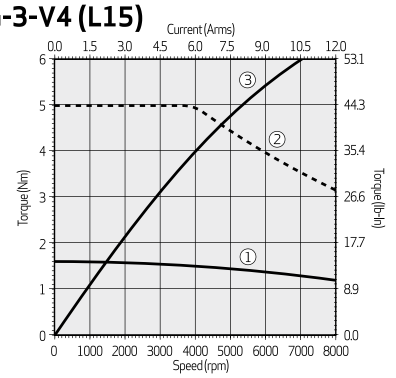
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 8
3. G-X-M: 565 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

G-3-V2 (L05)

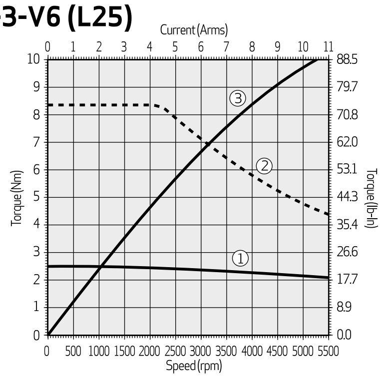


G-3-V4 (L15)

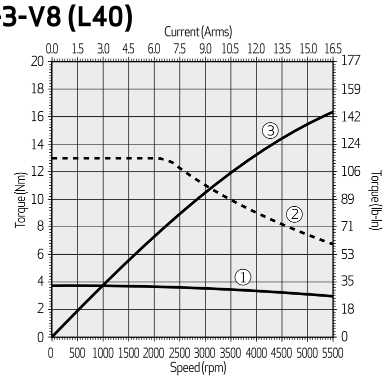


① Continuous torque with convection cooling
② Peak torque
③ Motor Kt

G-3-V6 (L25)



G-3-V8 (L40)



Performance Specifications For Standard Type: G-4-M (Low Voltage)

Characteristics and nominal values with sinusoidal drive

Type		G-4-M2 (L05)	G-4-M4 (L10)	G-4-M6 (L20)	G-4-M8 (L40)	G-4-M9 (L60)	Units
Nominal Torque. continuous duty, locked rotor	M_o	1.3 [11.5]	2.6 [23.0]	4.7 [41.6]	8.2 [72.6]	12.5 [110.6]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	1.0 [8.5]	1.6 [14.6]	4.0 [35.4]	6.3 [55.6]	9.2 [81.5]	Nm [lb-in]
Max torque	M_{max}	3.3 [29.2]	6.6 [58.4]	13.2 [116.8]	26.5 [234.5]	39.8 [352.3]	Nm [lb-in]
Nominal speed	n_N	5800	5500	4300	3500	2800	rpm
Maximum speed	n_{max}	10000	8000	5800	4700	3280	rpm
Nominal current, locked rotor	I_o	3.1	4.8	6.7	9.2	9.6	Arms
Peak current	I_p	9.5	15	23	37.5	42.8	Arms
Output power, continuous duty, nominal speed	P_N	0.58 [0.8]	0.95 [1.3]	1.8 [2.4]	2.3 [3.1]	2.7 [3.6]	kW [hp]
Torque constant	k_T	0.42 [3.7]	0.56 [5.0]	0.70 [6.2]	0.89 [7.9]	1.30 [11.5]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	27.0	34.2	43.1	52.9	69.3	Vrms/krpm
Thermal time constant	τ_{Th}	703	1001	1475	1812	2000	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	5.10	2.70	1.50	0.90	1.00	Ohm
Winding inductance (phase to phase)	L_{tt}	8.5	5.8	4.6	3.5	4.0	mH
Rotor inertia with resolver	J	1.05 [9.3]	1.55 [13.7]	2.6 [23.0]	4.7 [41.6]	6.8 [60.2]	kg cm^2 [lb-insec^2 x 10^{-4}]
Rotor inertia with encoder	J	0.85 [7.5]	1.4 [11.9]	2.4 [21.2]	4.5 [39.8]	6.6 [58.4]	kg cm^2 [lb-insec^2 x 10^{-4}]
Weight (without brake)	m	3.0 [6.6]	3.6 [7.9]	4.7 [10.4]	6.9 [15.2]	9.1 [20.1]	kg [lb]

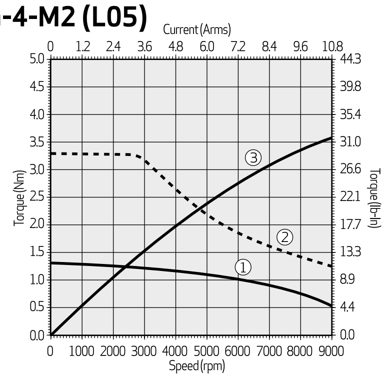
Optional Holding Brake	Option 1	Option 2	Units
Holding torque	9.0 [79.7]	18.0 [159] a)	Nm [lb-in]
Extra weight	0.53 [1.2]	0.75 [6.6]	kg [lb]
Extra inertia with resolver	0.54 [4.8]	1.0 [8.9]	kg cm^2 [lb-insec^2 x 10^{-4}]
Extra inertia with encoder	0.61 [5.4]	1.1 [9.5]	kg cm^2 [lb-insec^2 x 10^{-4}]
Power requirement	18.0	15.6	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 12
3. G-X-M: 325 V_{DC} link

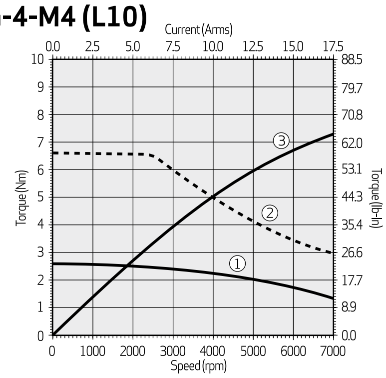
a) with encoder holding torque 14.5 Nm (128.5 lb)

For a complete list of options and accessories, see pages 26–27.

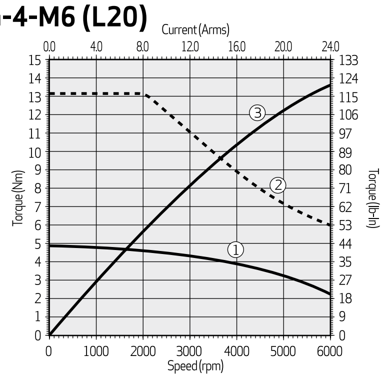
G-4-M2 (L05)



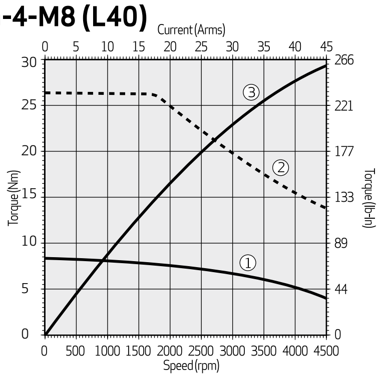
G-4-M4 (L10)



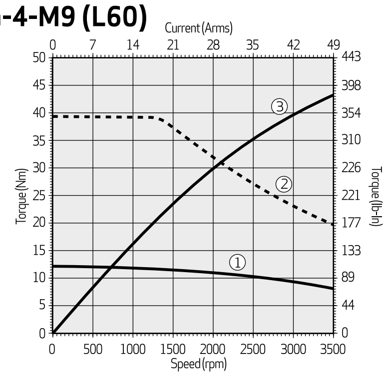
G-4-M6 (L20)



G-4-M8 (L40)



G-4-M9 (L60)



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Performance Specifications For Standard Type: G-4-V (High Voltage)

Characteristics and nominal values with sinusoidal drive

Type		G-4-V2 (L05)	G-4-V4 (L10)	G-4-V6 (L20)	G-4-V8 (L40)	G-4-V9 (L60)	Units
Nominal Torque. continuous duty, locked rotor	M_o	1.5 [13.3]	2.9 [25.7]	5.0 [44.0]	8.3 [73.7]	11.2 [99.1]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	1.1 [9.8]	2.3 [20.0]	3.8 [33.8]	6.3 [55.3]	8.1 [71.9]	Nm [lb-in]
Max torque	M_{max}	3.3 [29.2]	6.6 [58.4]	13.2 [116.8]	26.5 [234.5]	39.8 [352.3]	Nm [lb-in]
Nominal speed	n_N	7800	5500	4200	3300	3000	rpm
Maximum speed	n_{max}	10000	10000	6300	5000	3600	rpm
Nominal current, locked rotor	I_o	3.0	4.9	4.3	5.8	5.6	Arms
Peak current	I_p	8,1	13,6	14,3	23	25	Arms
Output power, continuous duty, nominal speed	P_N	0.90 [1.2]	1.30 [1.7]	1.7 [2.3]	2.2 [2.9]	2.6 [3.4]	kW [hp]
Torque constant	k_T	0.50 [4.4]	0.60 [5.3]	1.15 [10.1]	1.43 [12.7]	1.99 [17.6]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	32,2	37,6	69,7	85,9	118,7	Vrms/krpm
Thermal time constant	τ_{Th}	703	1001	1475	1812	2000	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	6.70	2.83	3.80	2.40	2.84	Ohm
Winding inductance (phase to phase)	L_{tt}	12.0	7.1	11.8	9.4	10.6	mH
Rotor inertia with resolver	J	1.05 [9.3]	1.55 [13.7]	2.6 [23.0]	4.7 [41.6]	6.8 [60.2]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	0.85 [7.5]	1.4 [11.9]	2.4 [21.2]	4.5 [39.8]	6.6 [58.4]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	3.0 [6.6]	3.6 [7.9]	4.7 [10.4]	6.9 [15.2]	9.1 [20.1]	kg [lb]

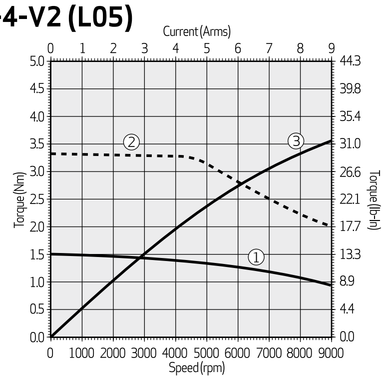
Optional Holding Brake	Option 1	Option 2	Units
Holding torque	9.0 [79.7]	18.0 [159] a)	Nm [lb-in]
Extra weight	0.53 [1.2]	0.75 [6.6]	kg [lb]
Extra inertia with resolver	0.54 [4.8]	1.0 [8.9]	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	0.61 [5.4]	1.1 [9.5]	kg cm² [lb-insec² x 10^{-4}]
Power requirement	18.0	15.6	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 12
3. G-X-M: 565 V_{DC} link

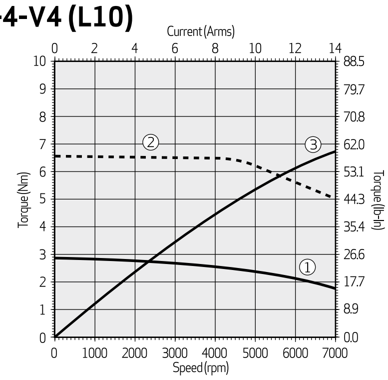
a) with encoder holding torque 14.5 Nm (128.5 lb)

For a complete list of options and accessories, see pages 26–27

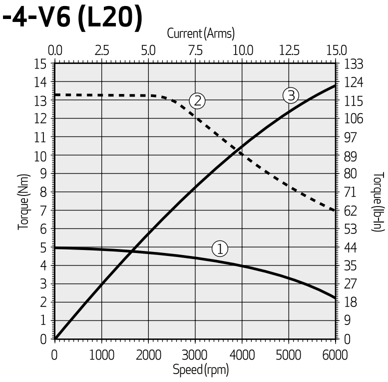
G-4-V2 (L05)



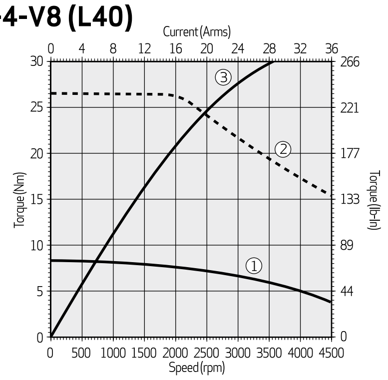
G-4-V4 (L10)



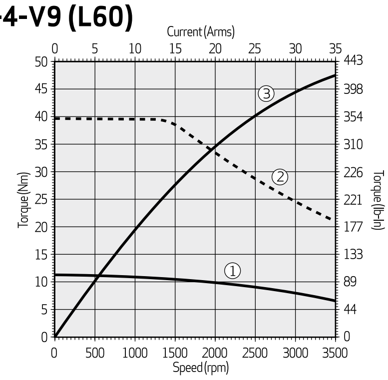
G-4-V6 (L20)



G-4-V8 (L40)



G-4-V9 (L60)



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Performance Specifications For Standard Type: G-5-M (Low Voltage)

Characteristics and nominal values with sinusoidal drive

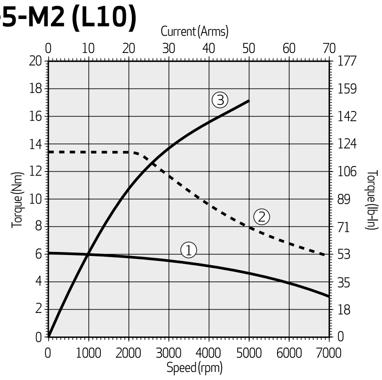
Type		G-5-M2 (L10)	G-5-M4 (L20)	G-5-M6 (L30)	G-5-M8 (L50)	G-5-M9 (L70)	Units
Nominal Torque. continuous duty, locked rotor	M_o	5.8 [51.3]	11.2 [99.1]	16.6 [146.9]	25 [221.3]	36 [318.6]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	4.6 [40.5]	9.3 [82.1]	14.1 [125.2]	20.0 [176.8]	26.8 [237.1]	Nm [lb-in]
Max torque	M_{max}	13.5 [119]	27.0 [239]	40.5 [358]	67.5 [597]	94.5 [836]	Nm [lb-in]
Nominal speed	n_N	4800	3500	2700	2200	2200	rpm
Maximum speed	n_{max}	6800	4200	3300	2400	2500	rpm
Nominal current, locked rotor	I_o	9.5	11.0	12.9	14.8	22.1	Arms
Peak current	I_p	28.8	35.6	42	51.5	77.1	Arms
Output power, continuous duty, nominal speed	P_N	2.3 [3.1]	3.4 [4.6]	4.0 [5.4]	4.6 [6.2]	6.2 [8.3]	kW [hp]
Torque constant	k_T	0.61 [5.4]	1.02 [9.0]	1.29 [11.4]	1.69 [15.0]	1.63 [14.4]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	38.4	60.7	76.8	104.4	97.1	Vrms/krpm
Thermal time constant	τ_{Th}	1587	2196	2539	3292	3700	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	0.86	0.74	0.64	0.56	0.31	Ohm
Winding inductance (phase to phase)	L_{tt}	4.3	4.8	4.8	4.8	3.5	mH
Rotor inertia with resolver	J	4.6 [40.7]	8 [70.8]	11.5 [101.8]	18.4 [162.9]	25.3 [223.9]	kg cm^2 [lb-insec^2 x 10^{-4}]
Rotor inertia with encoder	J	4.4 [38.9]	7.8 [69.0]	11.3 [100]	18.2 [161]	25.1 [222]	kg cm^2 [lb-insec^2 x 10^{-4}]
Weight (without brake)	m	7.7 [17.0]	9.9 [21.8]	12.1 [26.7]	16.6 [36.6]	21 [46.3]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	18.0 [159]]	30.0 [266]	Nm [lb-in]
Extra weight	0.75 [1.7]	1.1 [9.7]	kg [lb]
Extra inertia with resolver	1.0 [8.9]	3.6 [31.9]	kg cm^2 [lb-insec^2 x 10^{-4}]
Extra inertia with encoder	1.2 [10.4]	3.8 [33.4]	kg cm^2 [lb-insec^2 x 10^{-4}]
Power requirement	15.6	17.0	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

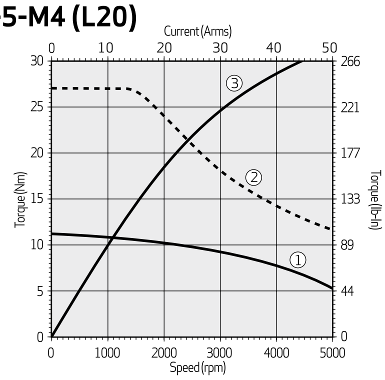
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 12
3. G-X-M: 325 V_{DC} link

For a complete list of options and accessories, see pages 26–27

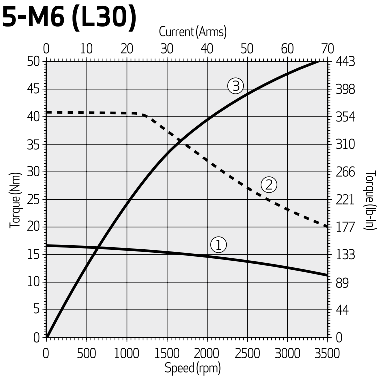
G-5-M2 (L10)



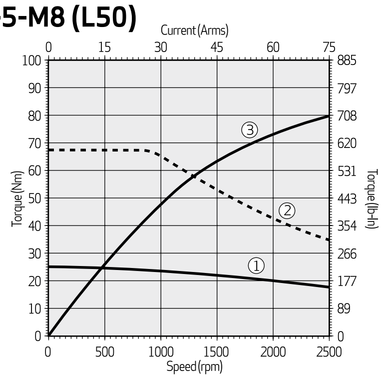
G-5-M4 (L20)



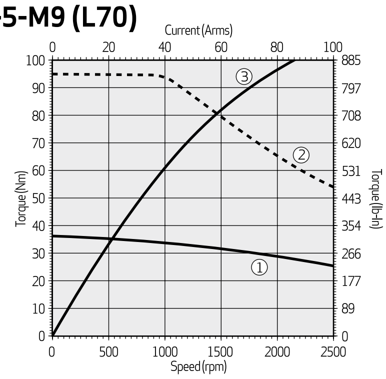
G-5-M6 (L30)



G-5-M8 (L50)



G-5-M9 (L70)



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Performance Specifications For Standard Type: G-5-V (High Voltage)

Characteristics and nominal values with sinusoidal drive

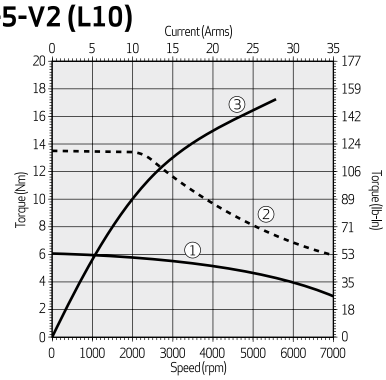
Type		G-5-V2 (L10)	G-5-V4 (L20)	G-5-V6 (L30)	G-5-V8 (L50)	G-5-V9 (L70)	Units
Nominal Torque. continuous duty, locked rotor	M_o	6.1 [54.0]	11.4 [100.9]	16.7 [147.5]	26.3 [232.5]	35.2 [311.5]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	4.7 [41.2]	8.1 [71.9]	11.8 [104.7]	18.8 [166.4]	27.4 [242.1]	Nm [lb-in]
Max torque	M_{max}	13.5 [119.5]	27 [239.0]	40.5 [358.5]	67.5 [597.4]	94.5 [836.4]	Nm [lb-in]
Nominal speed	n_N	4800	4000	3400	2800	2200	rpm
Maximum speed	n_{max}	6500	4900	5200	4000	2900	rpm
Nominal current, locked rotor	I_o	5.5	7.8	12.0	15.0	14.5	Arms
Peak current	I_p	16	24.5	38.5	51.5	51.5	Arms
Output power, continuous duty, nominal speed	P_N	2.3 [3.1]	3.4 [4.6]	4.2 [5.5]	5.5 [7.4]	6.3 [8.4]	kW [hp]
Torque constant	k_T	1.12 [9.9]	1.47 [13.0]	1.39 [12.3]	1.75 [15.5]	2.45 [21.7]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	69.6	88.7	83.7	104.4	145.6	Vrms/krpm
Thermal time constant	τ_{Th}	1587	2196	2539	3292	3700	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	2.90	1.60	0.80	0.60	0.80	Ohm
Winding inductance (phase to phase)	L_{tt}	12.5	10.7	5.8	4.8	6.6	mH
Rotor inertia with resolver	J	4.6 [40.7]	8 [70.8]	11.5 [101.8]	18.4 [162.9]	25.3 [223.9]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	4.4 [38.9]	7.8 [69.0]	11.3 [100]	18.2 [161]	25.1 [222]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	7.7 [17.0]	9.9 [21.8]	12.1 [26.7]	16.6 [36.6]	21 [46.3]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	18.0 [159]]	30.0 [266]	Nm [lb-in]
Extra weight	0.75 [1.7]	1.1 [9.7]	kg [lb]
Extra inertia with resolver	1.0 [8.9]	3.6 [31.9]	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	1.2 [10.4]	3.8 [33.4]	kg cm² [lb-insec² x 10^{-4}]
Power requirement	15.6	17.0	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

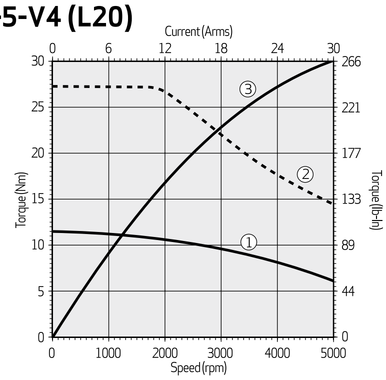
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 12
3. G-X-M: 565 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

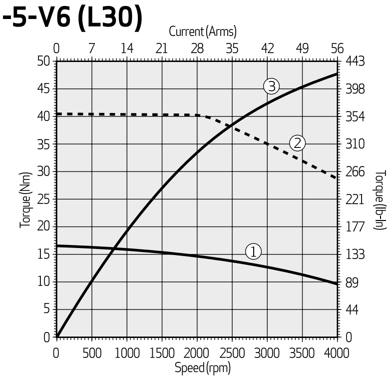
G-5-V2 (L10)



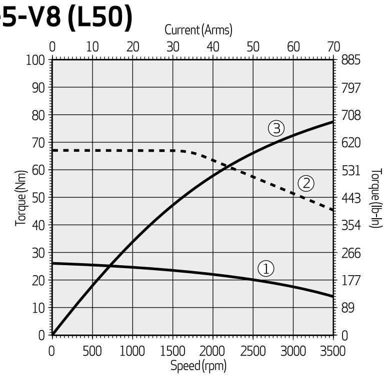
G-5-V4 (L20)



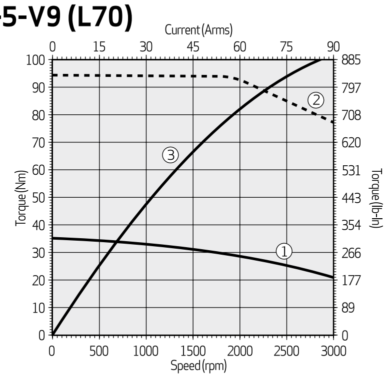
G-5-V6 (L30)



G-5-V8 (L50)



G-5-V9 (L70)



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Performance Specifications For Standard Type: G-6-M (Low Voltage)

Characteristics and nominal values with sinusoidal drive

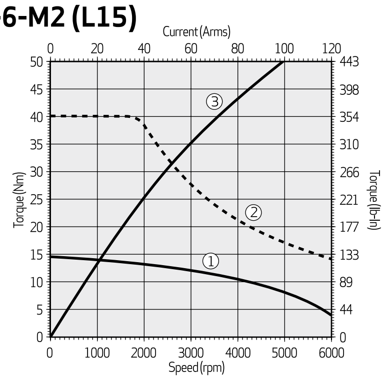
Type		G-6-M2 (L15)	G-6-M4 (L30)	G-6-M6 (L45)	G-6-M8 (L60)	G-6-M9 (L90)	Units
Nominal Torque. continuous duty, locked rotor	M_o	14 [123.9]	27 [239.0]	39 [345.2]	51 [451.4]	75 [663.8]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	9.1 [80.3]	15.6 [138.1]	25.6 [226.6]	33.9 [299.7]	47.8 [422.7]	Nm [lb-in]
Max torque	M_{max}	40 [354.0]	80 [708.1]	120 [1062.1]	160 [1416.1]	240 [2124.2]	Nm [lb-in]
Nominal speed	n_N	4000	3000	2500	2200	2200	rpm
Maximum speed	n_{max}	6300	4700	3900	3300	3000	rpm
Nominal current, locked rotor	I_o	22.0	30.0	38.0	43.0	47.0	Arms
Peak current	I_p	72	108	135	155	180	Arms
Output power, continuous duty, nominal speed	P_N	3.8 [5.1]	4.9 [6.6]	6.7 [9.0]	7.8 [10.5]	11.0 [14.8]	kW [hp]
Torque constant	k_T	0.64 [5.7]	0.90 [8.0]	1.03 [9.1]	1.19 [10.5]	1.57 [13.9]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	41.3	54.4	65.0	75.1	96.9	Vrms/krpm
Thermal time constant	τ_{Th}	2698	3186	3775	3850	4100	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	0.23	0.14	0.11	0.10	0.11	Ohm
Winding inductance (phase to phase)	L_{tt}	1.9	1.5	1.5	1.5	1.7	mH
Rotor inertia with resolver	J	27.2 [240.7]	52.1 [461.1]	77 [681.5]	102 [903]	152 [1354]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	27.0 [239]	51.9 [459]	76.8 [680]	102 [903]	152 [1345]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	15.1 [33.3]	21.1 [46.5]	27.1 [59.7]	33.1 [73.0]	40.0 [88.2]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	30.0 [266]	72.0 [637]	Nm [lb-in]
Extra weight	1.1 [9.7]	2.9 [25.2]	kg [lb]
Extra inertia with resolver	3.6 [31.9]	16.0 [142]	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	3.8 [95.8]	16.1 [143]	kg cm² [lb-insec² x 10^{-4}]
Power requirement	17.0	40.0	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

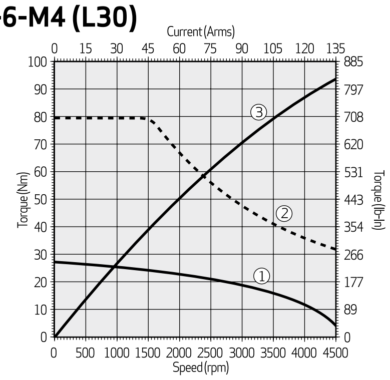
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 12
3. G-X-M: 325 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

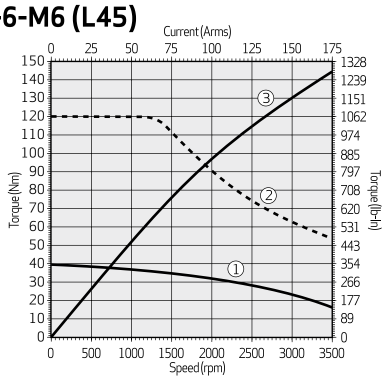
G-6-M2 (L15)



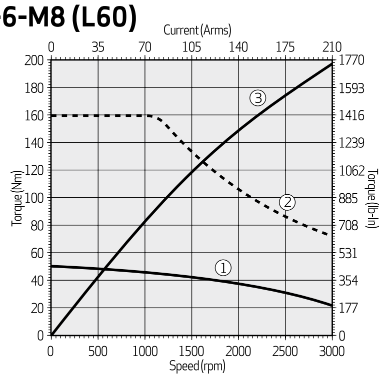
G-6-M4 (L30)



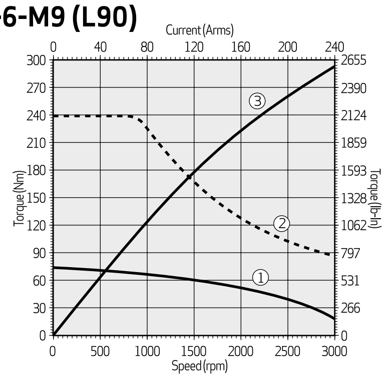
G-6-M6 (L45)



G-6-M8 (L60)



G-6-M9 (L90)



① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

Performance Specifications For Standard Type: G-6-V (High Voltage)

Characteristics and nominal values with sinusoidal drive

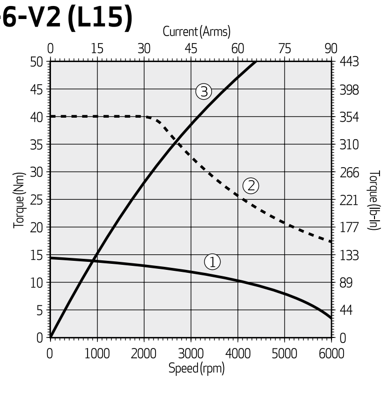
Type		G-6-V2 (L15)	G-6-V4 (L30)	G-6-V6 (L45)	G-6-V8 (L60)	G-6-V9 (L90)	Units
Nominal Torque. continuous duty, locked rotor	M_o	14.4 [127.5]	27.8 [246.1]	40.1 [354.9]	52.4 [463.4]	76.6 [678.3]	Nm [lb-in]
Nominal Torque, continuous duty, nominal speed	M_N	10.5 [92.9]	19.0 [168.4]	25.2 [223.0]	36.1 [319.5]	47.7 [422.3]	Nm [lb-in]
Max torque	M_{max}	40 [354.0]	80 [708.1]	120 [1062.1]	160 [1416.1]	240 [2124.2]	Nm [lb-in]
Nominal speed	n_N	3850	3000	2900	2400	2400	rpm
Maximum speed	n_{max}	6300	5700	4300	3200	3000	rpm
Nominal current, locked rotor	I_o	14.7	23.0	25.3	24.7	33.8	Arms
Peak current	I_p	48	78	89	89	124	Arms
Output power, continuous duty, nominal speed	P_N	4.2 [5.7]	6.0 [8.0]	7.7 [10.3]	9.1 [12.2]	12.0 [16.1]	kW [hp]
Torque constant	k_T	0.98 [8.7]	1.21 [10.7]	1.59 [14.1]	2.12 [18.7]	2.27 [20.1]	Nm/Arms [lb-in/Arms]
Voltage constant	k_e	62	75.4	98.5	131.5	139.8	Vrms/krpm
Thermal time constant	τ_{Th}	2698	3186	3775	3850	4100	sec
Winding resistance at 25°C (phase to phase)	R_{tt}	0.53	0.28	0.27	0.32	0.22	Ohm
Winding inductance (phase to phase)	L_{tt}	4.5	3.2	3.7	4.8	3.5	mH
Rotor inertia with resolver	J	27.2 [240.7]	52.1 [461.1]	77 [681.5]	102 [903]	152 [1354]	kg cm² [lb-insec² x 10^{-4}]
Rotor inertia with encoder	J	27.0 [239]	51.9 [459]	76.8 [680]	102 [903]	152 [1345]	kg cm² [lb-insec² x 10^{-4}]
Weight (without brake)	m	15.1 [33.3]	21.1 [46.5]	27.1 [59.7]	33.1 [73.0]	40.0 [88.2]	kg [lb]

Optional Holding Brake	Option 1	Option 2	Units
Holding torque	30.0 [266]	72.0 [637]	Nm [lb-in]
Extra weight	1.1 [9.7]	2.9 [25.2]	kg [lb]
Extra inertia with resolver	3.6 [31.9]	16.0 [142]	kg cm² [lb-insec² x 10^{-4}]
Extra inertia with encoder	3.8 [95.8]	16.1 [143]	kg cm² [lb-insec² x 10^{-4}]
Power requirement	17.0	40.0	Watt
Voltage requirement (+6% -10%)	24	24	V_{DC}

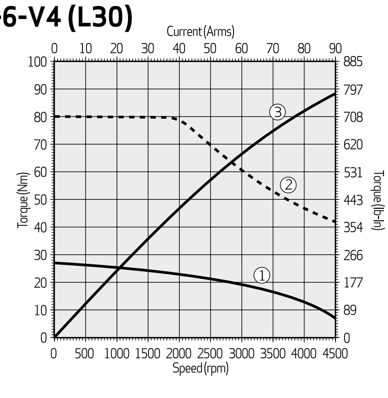
Notes:
1. Motor performances as measured with Moog's servodrive of proper size
2. Motor pole count: 12
3. G-X-M: 565 V_{DC} link

For a complete list of options and accessories, see pages 26–27.

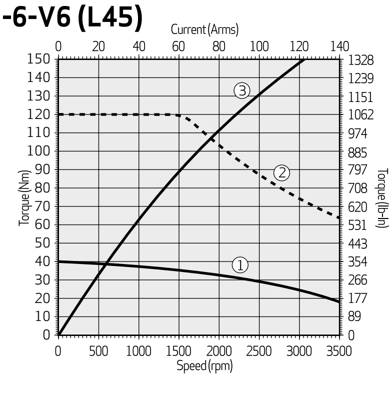
G-6-V2 (L15)



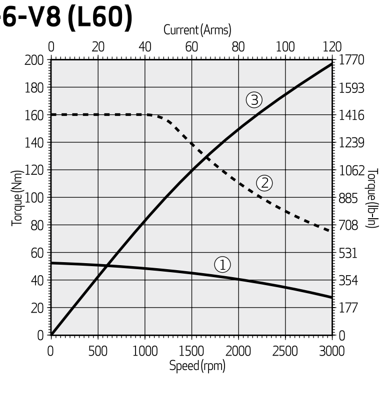
G-6-V4 (L30)



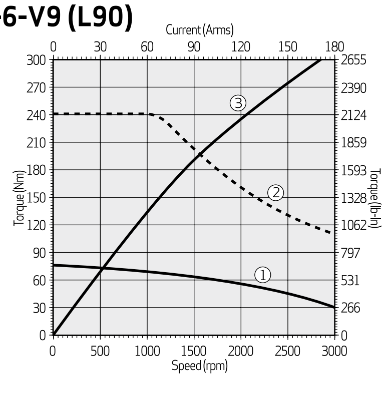
G-6-V6 (L45)



G-6-V8 (L60)



G-6-V9 (L90)



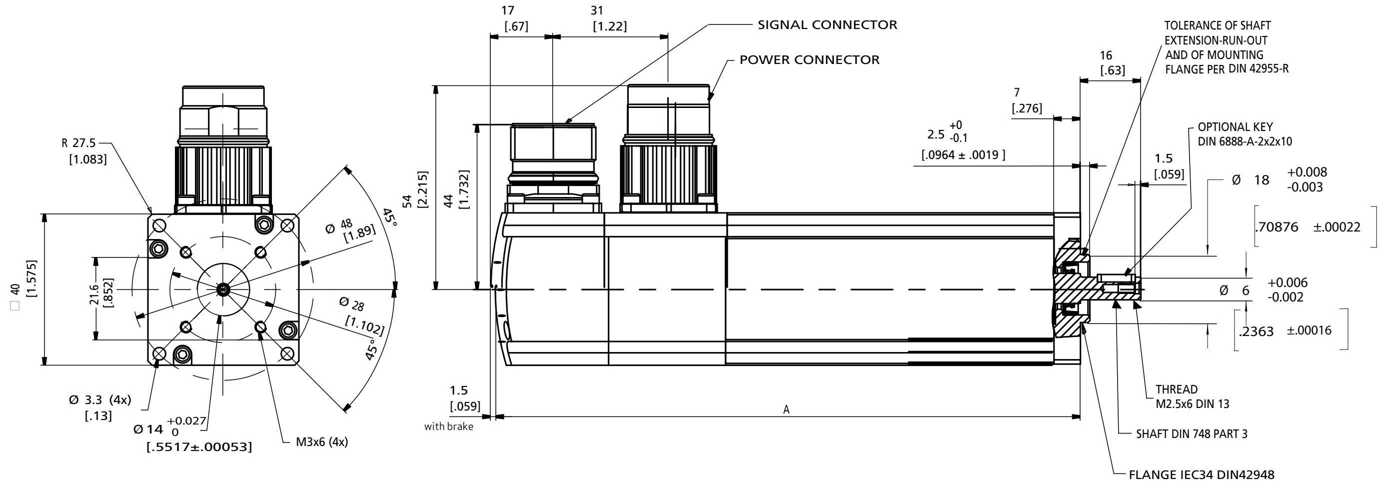
① Continuous torque with convection cooling

② Peak torque

③ Motor Kt

G-1-X with resolver

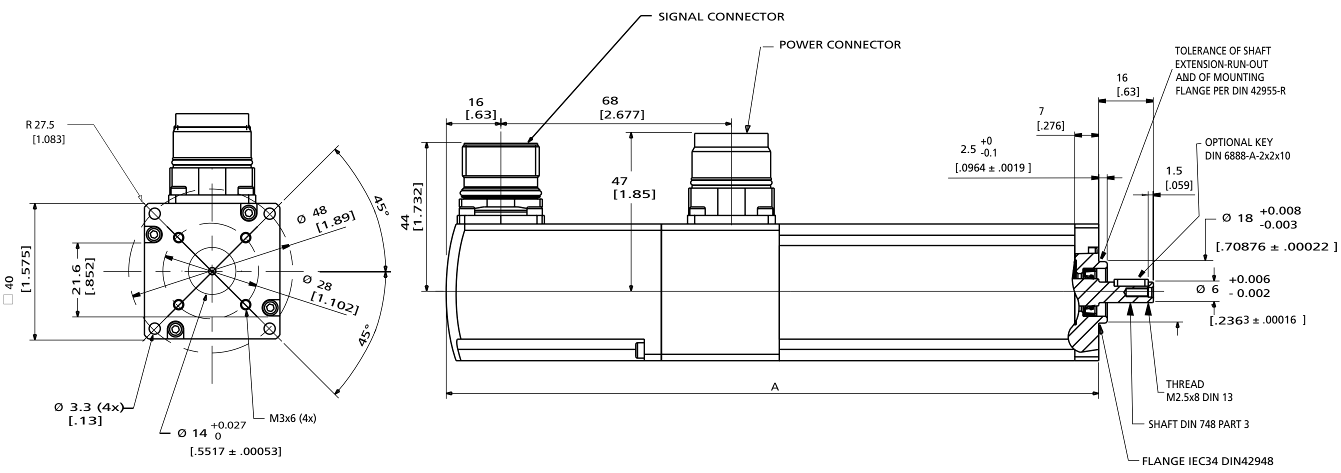
MODEL NO.	Dimension "A" 1)
G-1-X2 (L20)	134 [5.3]
G-1-X4 (L40)	154 [6]
G-1-X6 (L60)	174 [6.8]



Dimensions: mm [in]

G-1-X with encoder

MODEL NO.	Dimension "A"
G-1-X2 (L20)	171 [6.7]
G-1-X4 (L40)	191 [7.5]
G-1-X6 (L60)	211 [8.3]

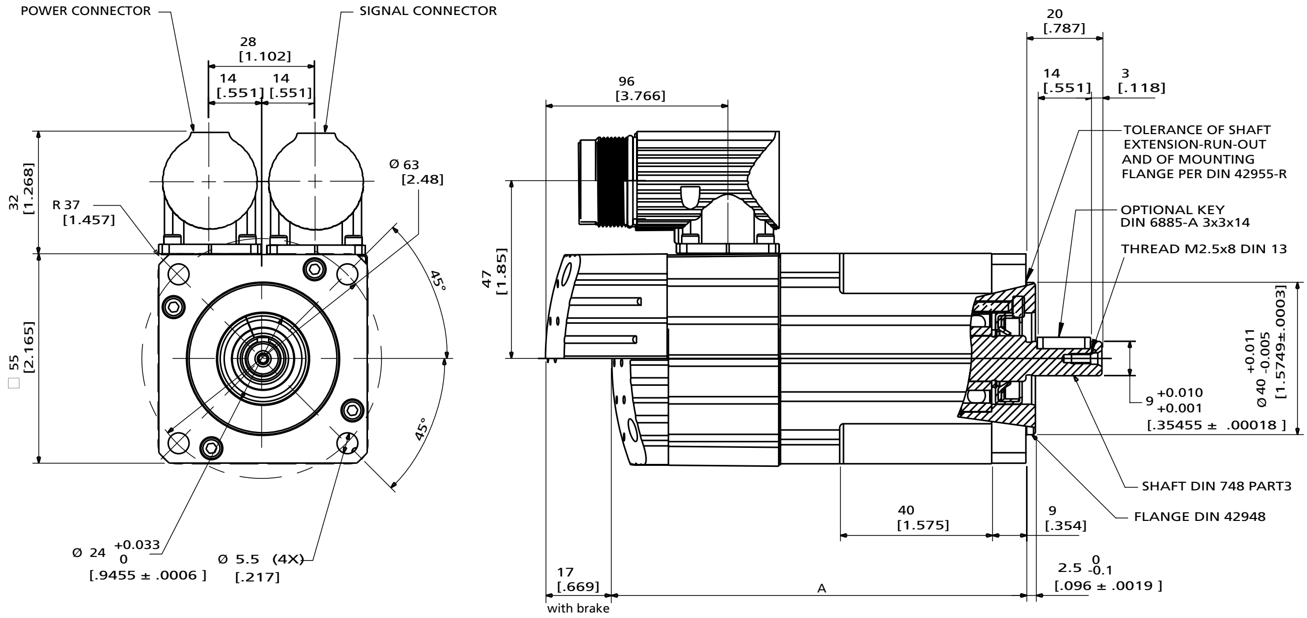


Dimensions: mm [in]

1) without brake

G-2-X with resolver

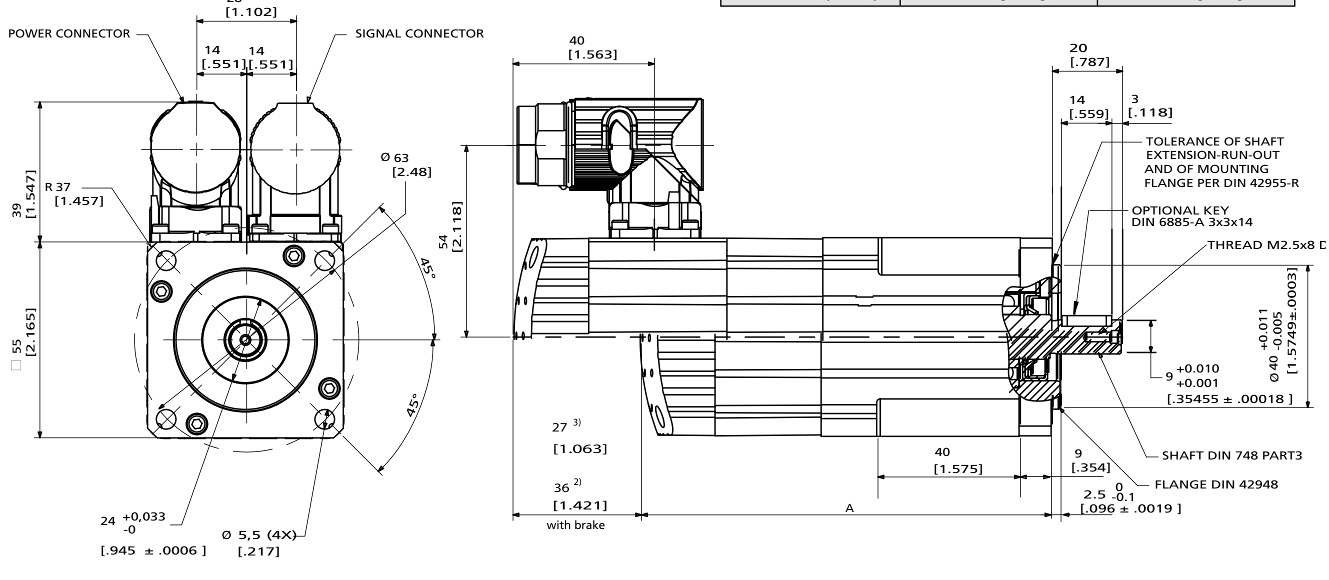
MODEL NO.	Dimension "A" 1)
G-2-X2 (L05)	109 [4.3]
G-2-X4 (L10)	122 [4.8]
G-2-X6 (L20)	147 [5.8]
G-2-X8 (L40)	198 [7.8]



Dimensions: mm [in]

G-2-X with encoder

MODEL NO.	Dimension "A" 1) 2)	Dimension "A" 1) 3)
G-2-X2 (L05)	115 [4.5]	134 [5.3]
G-2-X4 (L10)	128 [5.0]	147 [5.8]
G-2-X6 (L20)	154 [6.0]	173 [6.8]
G-2-X8 (L40)	205 [8.0]	224 [8.8]

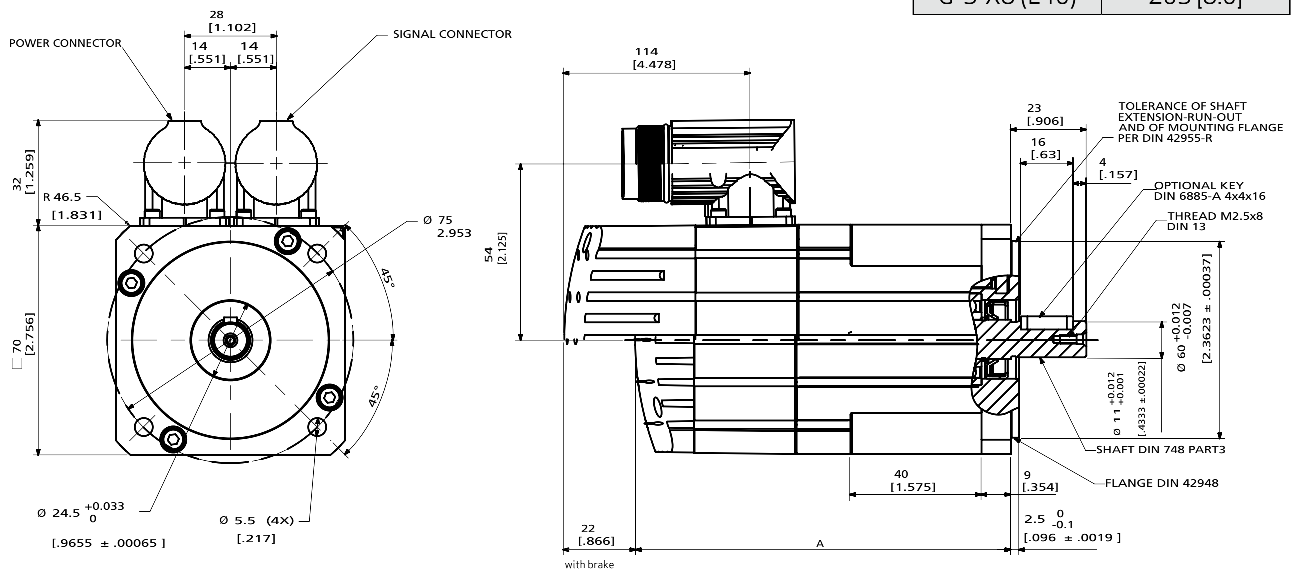


Dimensions: mm [in]

1) without brake 2) Feedback options 02, 03, 04, 06 and 07 3) Feedback option 05

MODEL NO.	Dimension "A" 1)
G-3-X2 (L05)	114 [4.5]
G-3-X4 (L10)	140 [5.5]
G-3-X6 (L20)	165 [6.5]
G-3-X8 (L40)	203 [8.0]

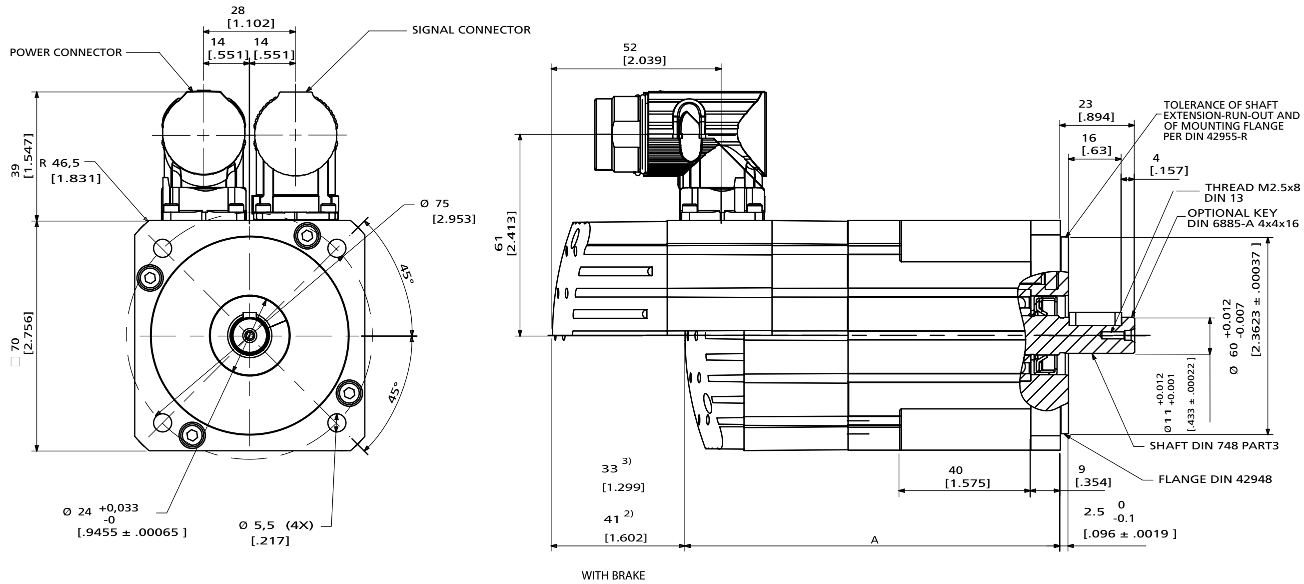
G-3-X with resolver



Dimensions: mm [in]

MODEL NO.	Dimension "A" 1) 2)	Dimension "A" 1) 3)
G-3-X2 (L05)	114 [4.5]	130 [5.1]
G-3-X4 (L10)	140 [5.5]	156 [6.1]
G-3-X6 (L20)	165 [6.5]	181 [7.1]
G-3-X8 (L40)	203 [8.0]	219 [8.6]

G-3-X with encoder

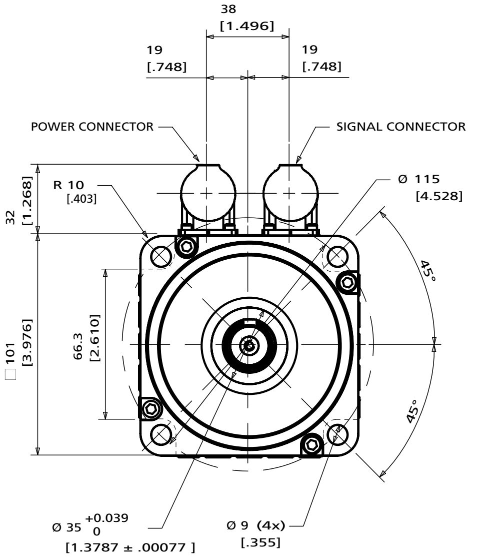


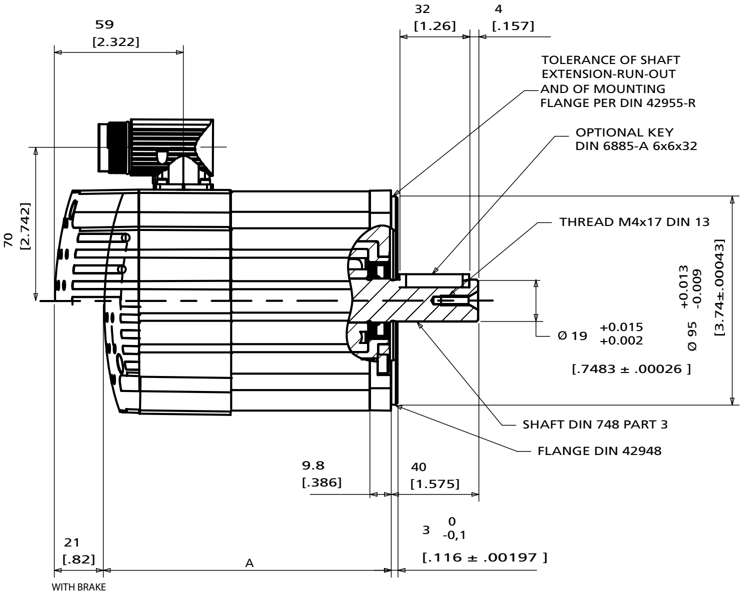
Dimensions: mm [in]

1) without brake 2) Feedback options 01, 02, 03, 04, 06 and 07 3) Feedback option 05

MODEL NO.	Dimension "A" 1)
G-4-X2 (L05)	133 [5.2]
G-4-X4 (L10)	146 [5.8]
G-4-X6 (L20)	171 [6.7]
G-4-X8 (L40)	222 [8.8]
G-4-X9 (L60)	273 [10.8]

G-4-X with resolver

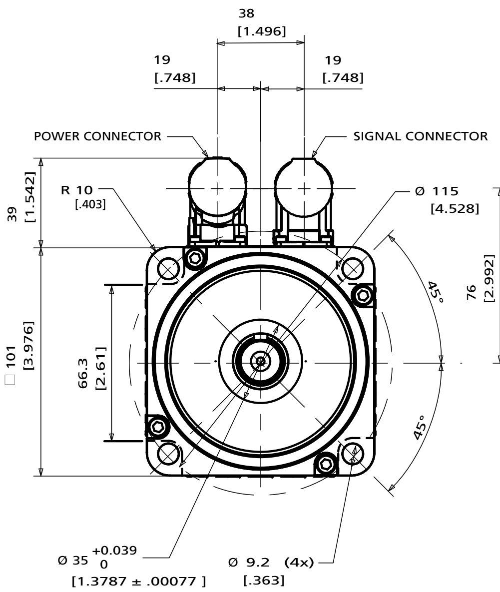


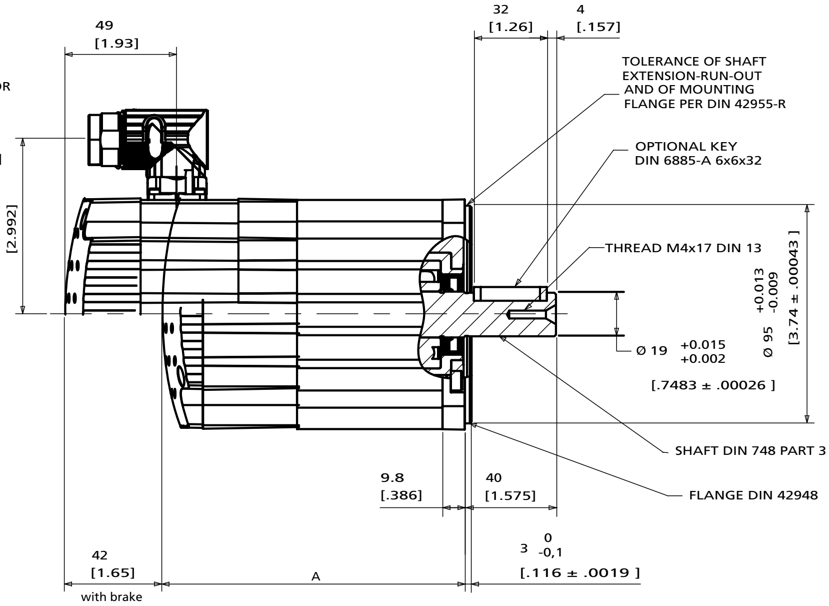


Dimensions: mm [in]

MODEL NO.	Dimension "A" 1)
G-4-X2 (L05)	133 [5.2]
G-4-X4 (L10)	146 [5.8]
G-4-X6 (L20)	171 [6.7]
G-4-X8 (L40)	222 [8.8]
G-4-X9 (L60)	273 [10.8]

G-4-X with encoder



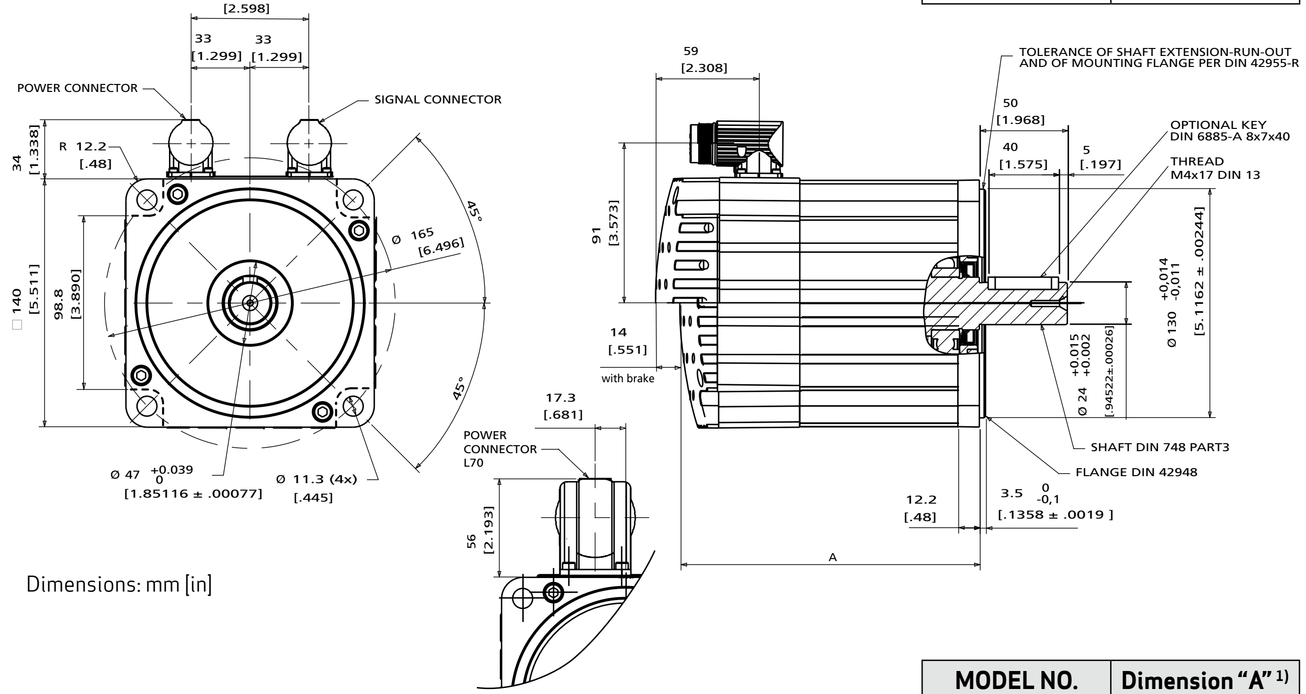


Dimensions: mm [in]

1) without brake

G-5-X with resolver

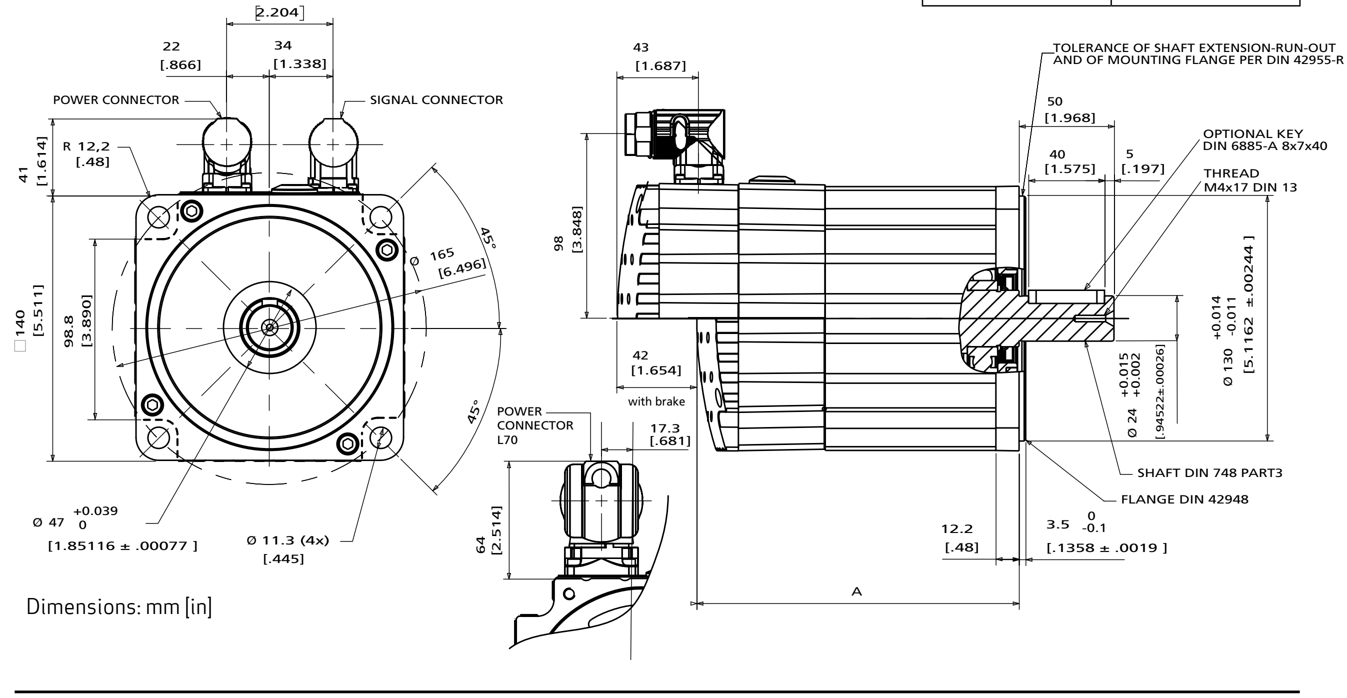
MODEL NO.	Dimension "A" [1]
G-5-X2 (L10)	170 [6.7]
G-5-X4 (L20)	195 [7.7]
G-5-X6 (L30)	220 [8.7]
G-5-X8 (L50)	271 [10.7]
G-5-X9 (L70)	322 [12.7]



Dimensions: mm [in]

G-5-X with encoder

MODEL NO.	Dimension "A" [1]
G-5-X2 (L10)	169 [6.6]
G-5-X4 (L20)	194 [7.6]
G-5-X6 (L30)	220 [8.6]
G-5-X8 (L50)	271 [10.7]
G-5-X9 (L70)	321 [12.7]

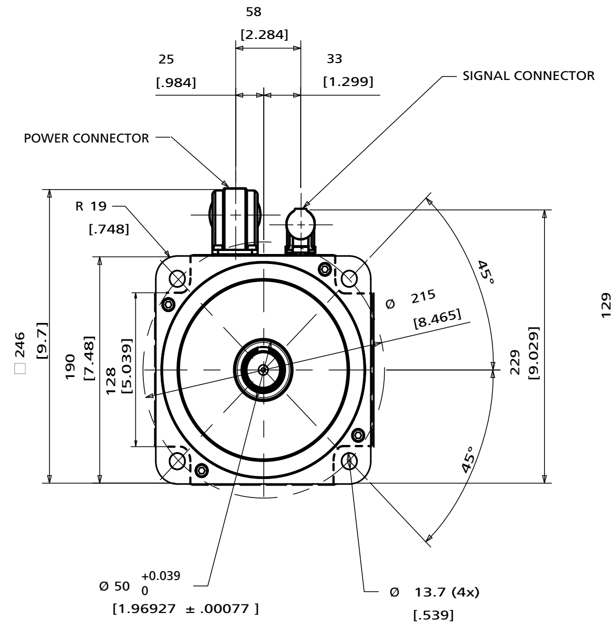


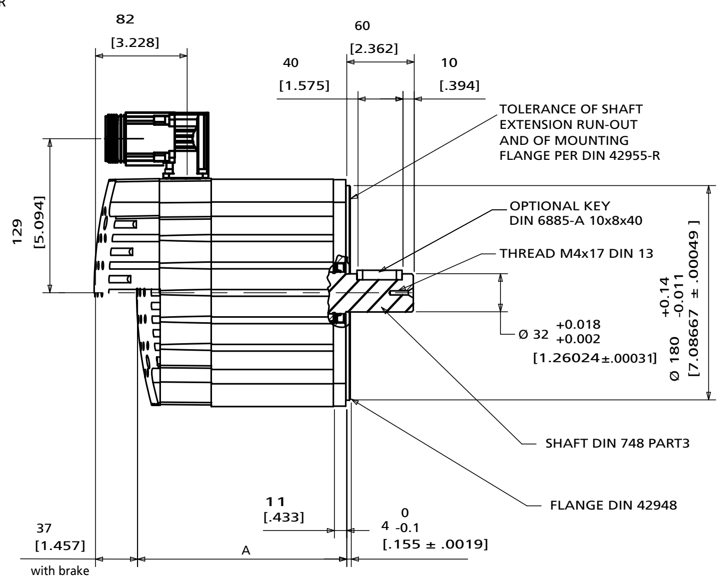
Dimensions: mm [in]

[1] without brake

MODEL NO.	Dimension "A" [1)]
G-6-X2 (L15)	187 [7.3]
G-6-X4 (L30)	225 [8.9]
G-6-X6 (L45)	263 [10.3]
G-6-X8 (L60)	301 [11.9]
G-6-X9 (L90)	377 [14.8]

G-6-X with resolver

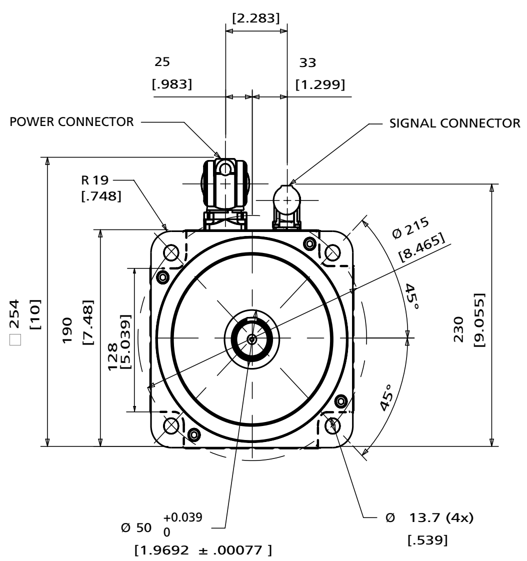


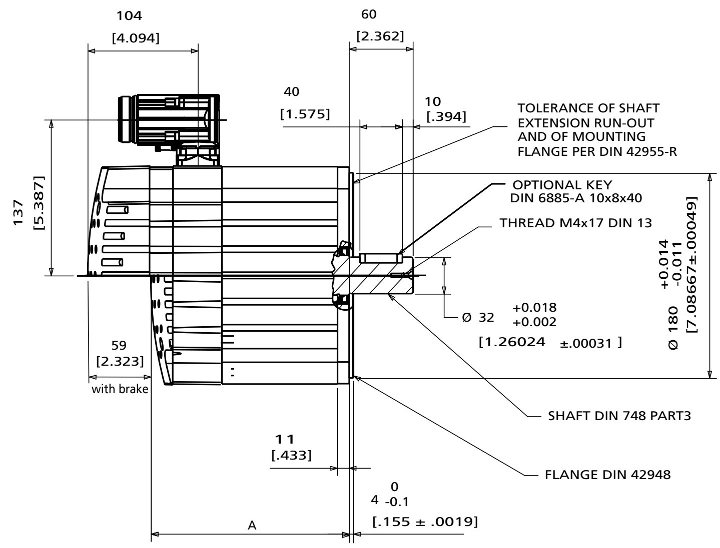


Dimensions: mm [in]

MODEL NO.	Dimension "A" [1)]
G-6-X2 (L15)	186 [7.3]
G-6-X4 (L30)	224 [8.8]
G-6-X6 (L45)	262 [10.3]
G-6-X8 (L60)	301 [11.8]
G-6-X9 (L90)	377 [14.8]

G-6-X with encoder



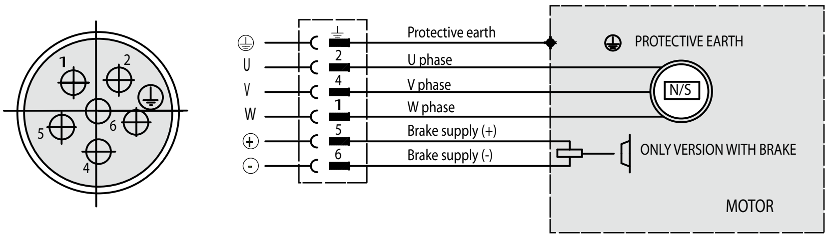


Dimensions: mm [in]

1) without brake

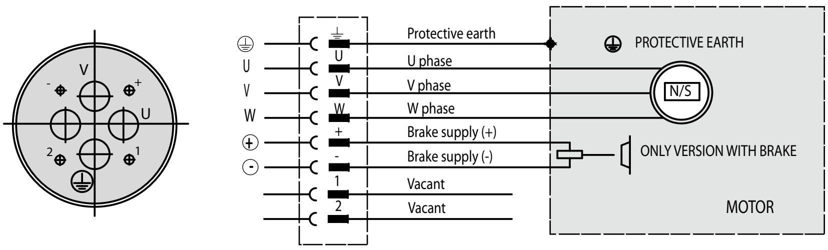
Power connector Size 1

TYPE
G-1
G-2
G-3
G-4
G-5 up to G-5-x8



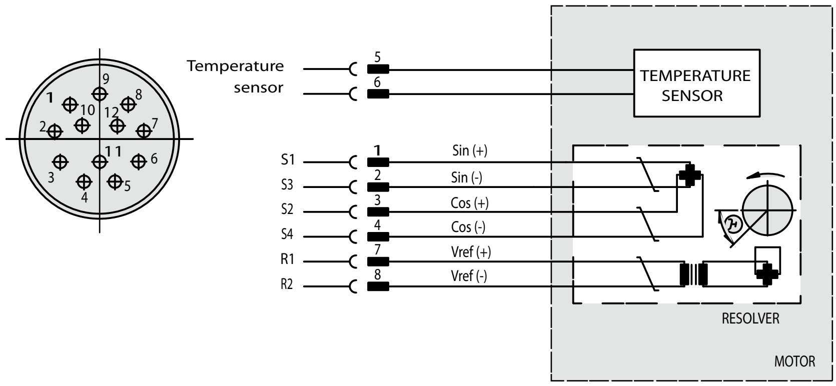
Power connector Size 1.5

TYPE
G-5-x9
G-6



Signal resolver connector [1)]

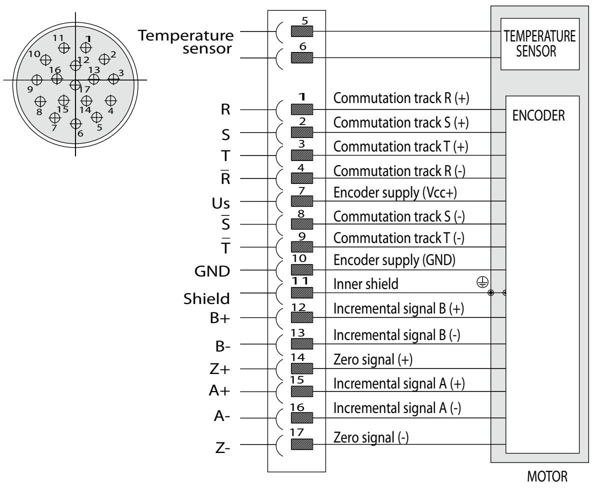
TYPE
G-1
G-2
G-3
G-4
G-5
G-6



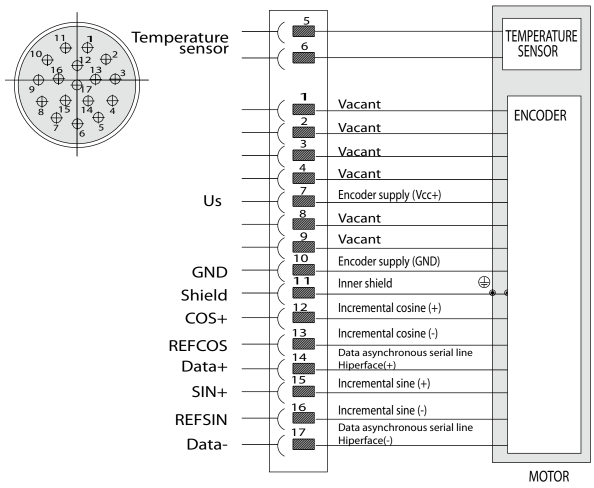
1) See order information; Feedback option: 01

Signal encoder connector

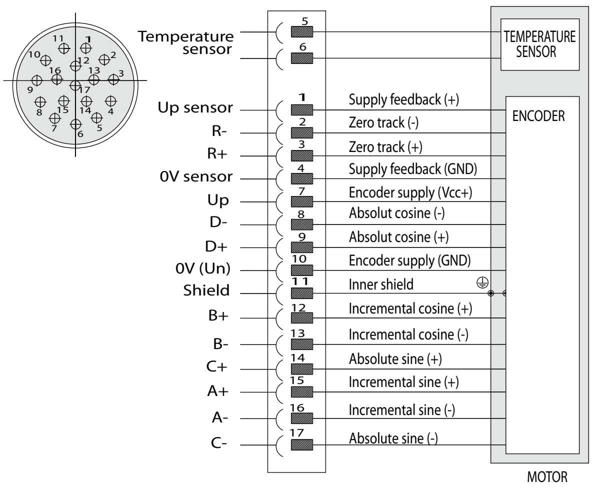
Stegmann Incremental [1]



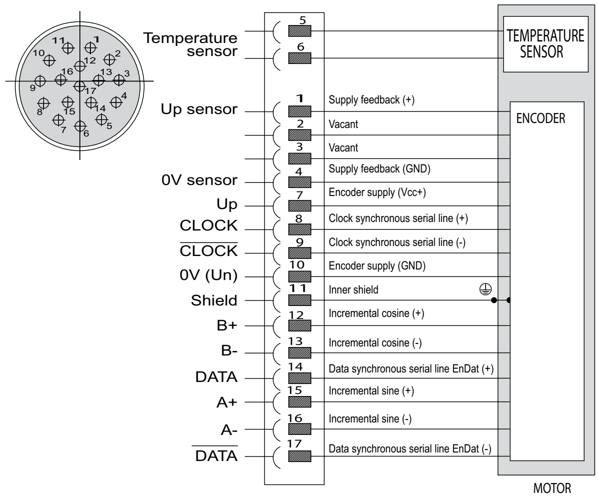
Stegmann Absolute [2]



Heidenhain Incremental [3]



Heidenhain Absolute [4]



[1] See ordering information; Feedback option: 02
[2] See ordering information; Feedback option: 03 and 04
[3] See ordering information; Feedback option: 05
[4] See ordering information; Feedback option: 06 and 07

Bearing Load Diagram

Maximum Permissible Shaft Load
The maximum permissible radial load depends on desired service life.

The bearing load curves display servo motor configurations (motor speed:radial loads) that support an operational life of 20,000 hours (L10h) .

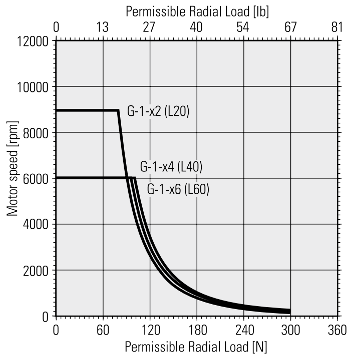
For Maximum axial loads values for individual servo motor models, see the table below . Consult Moog for extended service life requirements or alternate load conditions.

Notes:
1. Load capacity referenced to middle of output shaft.

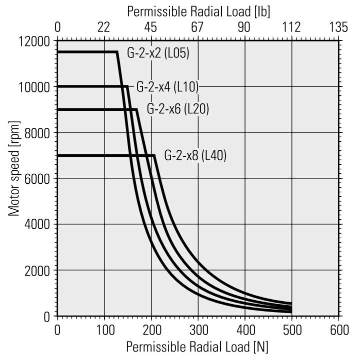
TYPE	Axial load during operation	Axial load during installation
G-1-XX	30N	60N
G-2-XX	75N	150N
G-3-XX	75N	150N
G-4-XX	150N	300N
G-5-XX	200N	400N
G-6-XX	250N	500N

Bearing Load Diagram

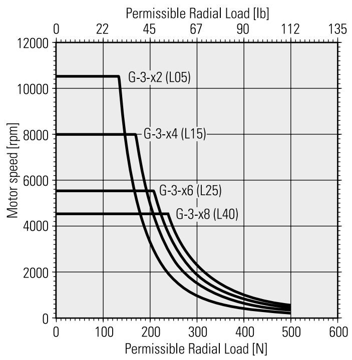
G-1-XX



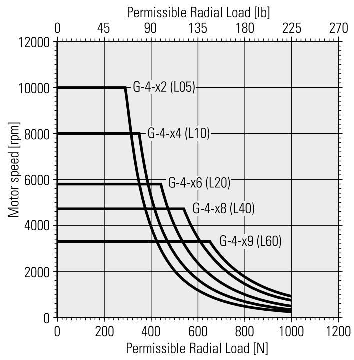
G-2-XX



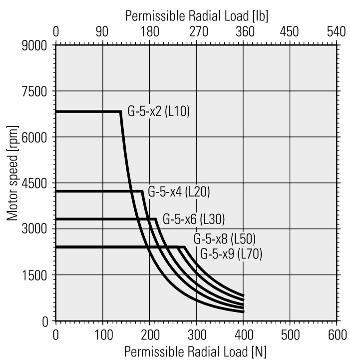
G-3-XX



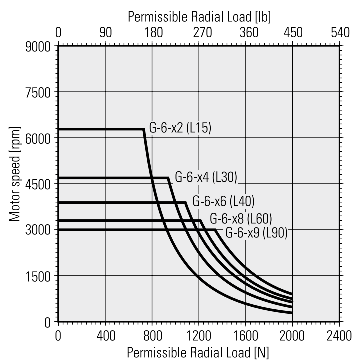
G-4-XX



G-5-XX



G-6-XX



Moog's G400 motors are available with a variety of standard and custom options to address the unique requirements of your application. Moog's motor design and application teams are continually introducing new options to address the changing needs of the market place. As a result, if you need something that's not presently listed, don't hesitate to contact your local sales office – chances are we already have it.

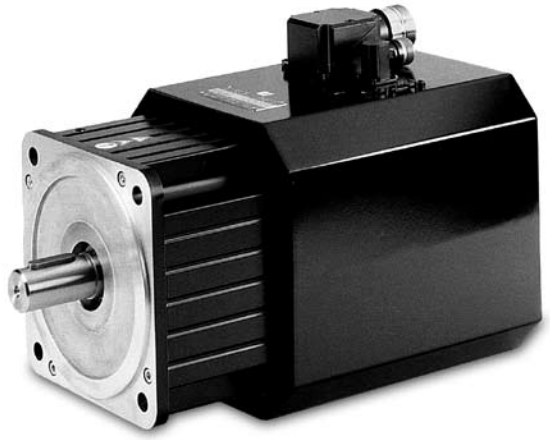
STANDARD OPTIONS

Integral Holding Brake

Holding brakes are available for all standard G400 motors. The brake is a permanent magnet style that is designed to hold the axis in position even with power removed. This is especially useful in applications where the motor is on an axis controlling a weight-induced load (e.g., vertical axis on a gantry robot). Note, the brake is a holding brake and is not designed to stop dynamic loads. The servo drive is required to decelerate the axis and hold position before the brake is engaged.
The integral holding brake requires a regulated 24 VDC supply (see Accessories) for proper operation. Brake power connections are through the standard motor power connector. Refer to motor technical data for brake current requirements.

Fan Cooling

To supply high dynamics in high duty cycle applications, Moog offers optional fan cooling on select G400 motor models. Fan cooling delivers up to 50% greater continuous torque output without increasing motor inertia.
Fans are powered by an unregulated 24 VDC supply (see Motor Accessories) with dedicated power connector. Current requirements are 1 ADC per motor.



Shaft Options

Standard G400 motors are available with plain or slot and key metric shafts. For custom motor shafts such as spline or english dimension shafts see Custom Options.

Shaft Seal

In applications where the shaft/flange mating surface is immersed in fluids, a shaft seal is required to maintain motor integrity. Moog offers PTFE (teflon) type shaft seals which have excellent operating characteristics (resistant to shrinkage and thermal stress).

CUSTOM OPTIONS

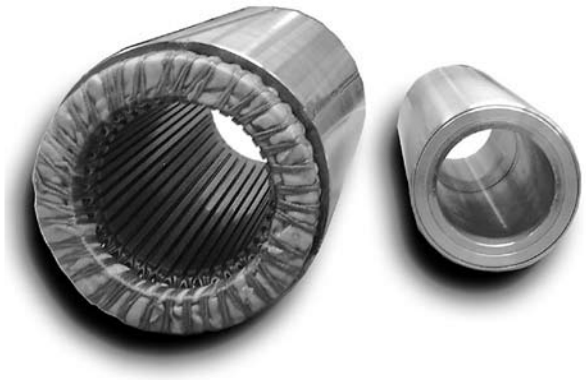
Motor Windings

Moog's standard G400 motors are designed to address the needs of most dynamic motion control applications. However, Moog recognizes that OEMs have unique needs which can not always be addressed by catalog products. This is why Moog offers custom motor windings. Custom motor windings may be used to optimize motor performance in applications with non-standard bus voltages or deliver customized performance characteristics for applications with unique speed or current requirements.

Frameless Options

In addition to offering our compact G400 motors in a frameless package, Moog's motor design and application teams are able to develop specialty motors meeting your unique specifications. Moog's high power density design allows our motor to be packaged in envelopes where other motors simply won't fit. In addition, Moog's design expertise includes motors adapted for operation in extreme environments:

- Elevated Temperatures
- Explosive/Flammable Gases
- Underwater Application
- High Shock Loads
- Radiation Zones



Our G400 frameless motor offering is based on the following standard stator dimensions:

TYPE	Stator Diameter (nominal) mm [in]
G-1	35.0 [1.4]
G-2	48.0 [1.9]
G-3	63.5 [2.5]
G-4	91.9 [3.6]
G-5	130 [5.1]
G-6	178 [7.0]

Custom Shafts and Flanges

To support legacy products or meet unique application needs, Moog's modular G400 motor design is capable of supporting custom shafts (length, diameter or spline fittings) and custom flanges.

Custom Connectors

Moog's standard G400 motors are equipped with quick connect right angle connectors.

Custom Feedback Options

In addition to encoder adapter kits (see Standard Options), Moog can support requests for special feedback devices. Options presently offered include integral encoders (incremental or absolute), tachometers and hall sensors. In addition to standard resolver and encoder options as detailed in the „Ordering Information“, Moog can support requests, where practical, for special feedback devices such as other resolver or encoders types, tachometers and hall effect sensors.

Custom Coatings

Moog's standard G400 motors are rated for spraydown environments. Moog is capable of coating the motors with FDA required coatings for applications in the food processing industry.

ACCESSORIES

To speed your design cycle, Moog offers a variety of accessories which have been specified and tested for compatibility with our motors and drives. These accessories will also minimize assembly activities, allowing you to reduce production time.

- **Recommended Drives: see Moog's drives catalogs**
- **To obtain preassembled motor cables, crimp tools, power supplies, please contact Moog staff.**

This application note aims to provide the user with some tools and guidelines for the correct motor sizing for a new application. When a fully optimized system is required, please contact your local Moog application engineers.

FUNDAMENTAL APPLICATION DATA

A motor is selected to meet four characteristics:
1-RMS Torque
2-Peak Torque
3-Speed
4-Inertia Ratio

Some Useful Pointers

- The continuous stall torque is the torque rating at zero speed. This torque is generally higher than the continuous torque at operating speed. The achievable torque depends on a combination of the motor and the drive used.

- Peak torque is declared for maximum capacity for to a duration of 1 sec. Lower peak torques can tolerate longer durations. For critical applications it is recommended to contact MOOG application support.

- Inertia ratio is generally the most important characteristic when selecting a servo system. It is the ratio reflected total load inertia to the motor shaft inertia. As a general guideline, the more dynamic the system must be, the more important it is to configure these two characteristics with a 1:1 ratio. Higher inertia ratios may not tolerate any significant load change and even become unstable.

- Attention must be paid to applications that place heavy load on the motor (typically vertical load applications when decelerating in the downwards direction). The regeneration capacity must not be overloaded.

- Brushless servomotor based systems are not like a standard asynchronous motors: They are complete control systems. Because there is more freedom of design, there are also more parameters (mechanical, electric, electronics) to be identified in comparison to a conventional motor based system.

- A brushless servomotor has a very short response time and closely tracks changes in the control signals.

- Correctly sized servomotors can run with high case temperature. It is important to ensure that motor heat is properly dissipated.. Dissipation may be through a volume of "still" air, heatsinks, fan cooling or water cooling.

- The speed accuracy depends much more on the quality of the sensor signal (and on the control algorithm of the drive) than on the motor and the load.

- The time lag between a load disturbance and speed adjustment depends on the resolution of the position transducer and on the parameters of the drive.

SELECTION AND OPTIMIZATION OF SYSTEM PARAMETERS

Generally servosystems need to select the following parameters:
- Transmission Ratio
- Mechanical Transmission
- Position Transducer
- Electronic Drive type
- Control Strategy

Transmission Ratio Considerations:

Motors are sized on output torque, so that a high transmission ratio is useful to minimize the motor mass and cost, but it might not be the best choice in terms of overall cost and of dynamic performance. When a motor is applied directly to the load, maximum stiffness and bandwidth (optimal position/following accuracy in the minimum time) is achieved.

Mechanical Transmission Considerations:
The following are the most common mechanical transmissions:
• timing belt
• cycloid and epicycloid reducer
• rack and pinion
• ball screw
• Where n = transmission ratio, the load parameters are transferred to the motor axis according to the following relationships:
-motor speed = load speed x n
-motor torque = load torque / n
-load inertia reflected to the motor axis = load inertia/n^2

In order to identify the optimal mechanical transmission for an application, two main application areas can be identified:

1. Low Dynamic Applications:
   The main objective of the motion is the supply of power, the dynamic performances are not important, involved power is quite large, the motor cost is a significant percentage of the overall system cost.

2. High Dynamic Applications
   The main objective of the motion is mainly positioning with the most of energy used to accelerate, to brake and to position the load in a minimum time with maximum accuracy.

For non dynamic applications, simple speed reducers are acceptable.

For dynamic applications, the required torques are mainly inertial. Moog's general recommendation is to orientate the choice towards inertial matching (transmission ratio which makes the load inertia translated to the motor axis equal to the motor inertia).

When the load inertia transferred to the motor is more than a few times the motor inertia, a high control bandwidth is necessary to electronically compensate for the inertia mismatch and mechanical linkages must be stiff and with no backlash.

Based onto these considerations, it is important to pay attention generating the torque either with a long and narrow motor or with a short and compact motor:
• long motors are optimized for of minimum inertia so that they meet requirement of high accelerations with low inertia loads
• short and compact motors are optimized for torsional stiffness so that they meet the requirements of high inertia loads

In applications with large inertia and short positioning time a check must be made on the torsional resonance frequency to ensure it remains above 1000 Hz assuming that a closed loop bandwidth in the order of 300Hz is achieved thanks to the high dynamic performances of G motors.

The frequency of torsional resonance of a load with inertia Jl connected to an axis with torsional stiffness Sm is:

$$f = ½*\Pi* \sqrt{Sm / Jl}$$

The torsional stiffness of a steel shaft whose diameter is D and whose length is L is:

$$Sm = (\Pi*D^4 * 2.466*10^{-3}) / L$$

Considerations on PT position Transducers
A high performance brushless motor is required to have low inertia, high torque and high torsional stiffness. The next considerations are the mechanics of the feed system and the position transducer.

Most common position tansducers are resolvers and encoders.

Performances can dramatically be improved with encoders as they have:
• 1000 times better resolution than a resolver
• 20 times better accuracy
• 1000 times better Signal/Noise ratio

By using sinusoidal encoders, the rotational uniformity and the velocity dynamics are much higher. In other words, the sinusoidal encoder dramatically improves performance in terms of response time, servo error, overshoot and axis residual vibrations. With a sinusoidal encoder the static positioning accuracy is about 20 arcsec and, more importantly, the accuracy is not affected by the cabling quality. The dynamic error is limited by the Signal/Noise ratio

A limitation to the adoption of encoders is the maximum allowed temperature which is on the order of 110 °C while a revolver is able to tolerate the 155°C of Class F. Encoders are typically more expensive than resolvers.

Considerations on Electronics Drive Type
In order to get the highest rotation uniformity at any speed, torque ripple must be minimized. To achieve this, careful choice of both sinusoidal motor and control system. The motor is matched to a sinusoidal PWM inverter, whose amplitude, frequency and phase are separately controlled. The PWM frequency used should be at least 10KHz. Currently, all Moog drives are fully digital with position, velocity, torque digital loops.
Sampling time should be as short as possible to achieve wide system bandwidth.
Reference signals (position or speed) are provided in analogue or digital form.
Analogue reference is +/- 10V while digital reference can be provided using various protocols.

Considerations on Control Strategy

Control systems can be configured according to three control strategies:

- Torque control: The speed depends on the load
- Velocity control: The torque depends on the load
- Position control: The torque depends on the load

The torque control strategy is used when it is needed to control a force or pull (winders, unwinders, paper processing, textile...). Torque control is intrinsic to brushless motors as they are controlled by electrical current. Hence, torque control does not need accurate transducers.

Velocity control is the most traditional strategy. It uses an integration term so that the speed error is limited to the system offsets.

Position control is carried out only by digital drives, so that the steady state position and speed following error is limited to a few points of the sensor (for an encoder with 4096 pulse/revolutions it means 1/16000 of a revolution). Position loop capability is necessary to synchronize several axes.

MOTOR SELECTION

After the choice of the transmission ratio, based on load, speed and other load data, a first preliminary selection of a motor model can be performed.

The following sequence is suggested:

1. Trace the speed/time diagram of the load cycle
2. Transfer the inertia and the loads of the system to the motor shaft
3. Calculate the cycle of the accelerations and the inertial torques
4. Add the load on the motor axis to the inertial torque
5. Calculate the root mean square value of the torque
6. Calculate the root mean square of the speed
7. Calculate the maximum torque in the cycle
8. Calculate the maximum duration time of the maximum torque in the cycle
9. Calculate the required torque at the maximum speed
10. Calculate the maximum torque

With this data, a preliminary choice of the motor (and the drive) can be performed.

Validation is necessary at this point to ensure the correct thermal and electric sizing of the motor. A motor is considered properly sized when it achieves a maximum temperature of 50°C above room temperature. The following sequence is suggested to verify the selection:

1. Check the peak torque
2. Check the rise in temperature
3. Check that the maximum speed that can be reached

Points 1 and 2 can be solved by the selection of a larger motor, while point 3 can be solved by the selection of a motor with a higher speed winding (also a higher drive current will be necessary).

As a world leader in motion control technologies, Moog offers a full range of service and support designed to ensure maximum productivity on a daily basis.

Moog Authentic Repair® and Aftermarket Services offer the quality, quick turnaround, expertise of trained technicians and global consistency of services you need to keep your equipment operating as it should. Our expert technicians are there to optimize machine performance, minimize downtime and ensure the smooth application of all Moog products.

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- Diagnosing and identifying sources of malfunctions in your motion control system
- Regular maintenance visits, pre-visits prior to scheduled downtime and scheduled repairs
- Machine or system start-up, commissioning and reinstallation services
- Field replacements, retrofits or product repair
- Upgrade recommendations and collaborative engineering to change product parameters
- Access to electronic and print resources, including service manuals, drawings, software and other online resources to solve problems and minimize on-site visits

With facilities in more than 28 countries worldwide, Moog is committed to providing prompt, expert service on a local level.

Visit us today

For more information on Moog Authentic Repair and Aftermarket Services, visit **www.moog.com/industrial**. Use the web site's global locator to find the Moog office nearest you for application engineering, repair or field services.

GENERAL INFORMATION

1. Motors designed to EN 60034 (VDE 0530).
2. Runout class R per DIN 42955-R, IEC 72-1.
3. Rotors balanced to Class G 6.3 per ISO 1940.
4. Sealing to IP65 (excluding shaft) with Moog specified mating connectors.
5. Operating ambient temperature -40 to +40°C (up to 130°C with derated output).
6. Class F winding insulation.
7. Motor flange dimensions per IEC 34, NEMA MG7, DIN 42948, ISO 286.
8. Motor shaft dimensions per DIN 748.
9. Motor shaft keyway per DIN 6885, IEC 72-1.
10. Feedback Sensors
    a. Resolver
      - Type: Transmitter
      - Pole Count: 2
      - Input Voltage: 4 Vrms
      - Carrier Frequency: 3.4 to 8 kHz
      - Input Current: 35 mA max
      - Transformation Ratio: 0.5
    b. Encoder
      - Incremental
      - Absolute Single-turn
      - Absolute Multi-turn
11. G400 servomotors are available in two version:
    G-x-M: designed for the use of 325Vdc link
    G-x-V: designed for the use of 565Vdc link
12. Winding temperature sensors (standard version):
    G-x-M: NTC
    G-x-V: PTC with threshold at 155°C
13. Sealed life-time lubricated bearing

NOTES

1. Continuous ratings based upon:
    a. Operation in still air with ambient temperatures at 25°C.
    b. Winding temperature at 110°C over ambient.
    c. Motor front flange attached to a steel mounting plate measuring 300 x 300 x 12 mm.
2. Peak ratings based on:
    a. Duty cycle of 10% (1 out of 10 seconds).
    b. Iron saturation of 15% or less.
3. Kt-line show non-linearity between current and torque at high end.
4. Nominal speed and power values at maximum continuous output power with conditions per note 1.
5. Resistance and inductance measurement based on “cold” values (i.e., measured at 25°C).
6. Current ratings are Arms per phase.
7. Motor performance as measured with Moog drives at 325 VDC link for the G-X-M motor and 565 VDC link for G-X-V motor. For other drives and voltage levels, please talk to you Moog local application engineers.
8. Specification tolerances are ±10%.
9. For motors with Encoder feedback, please use a lower Nominal Torque, Continuous Duty, Nominal Speed rating (80 C temperature rise above Ambient of 40 C), due to operating temperature limitations (120 C) of encoder devices.
10. The maximum speed, nmax, is the maximum allowable operating speed. This speed is either limited by the voltage limiting Back E.M.F. characteristic or mechanically by centrifugal forces and/or bearing-stressing, whichever value is lower.
11. Resolver feedback motor installation diagrams shown in this catalog assume the use of fixed angled connectors. Encoder feedback motor installation diagrams shown in this catalog assume the use of rotatable angled connectors.

G - □ - □□ - □□□ - □□ - □□ - □□ - □□

Special version	
00	Standard version

Motor size:	
1	40 mm (Flange)
2	55 mm (Flange)
3	70 mm (Flange)
4	100 mm (Flange)
5	140 mm (Flange)
6	190 mm (Flange)

Cooling options:	
-	Natural cooling
F	Fan cooling for size 4/5/6

Winding voltage:	
M	Low voltage: 300 V_{DC} With NTC thermal sensor
V	High Voltage: 565 V_{DC} With PTC thermal sensor

[1] Stack length:	Motor size					
	1	2	3	4	5	6
2	L20	L05	L05	L05	L10	L15
4	L40	L10	L15	L10	L20	L30
6	L60	L20	L25	L20	L30	L45
8	-	L40	L40	L40	L50	L60
9	-	-	-	L60	L70	L90
0	Special					

[2] Nominal speed	
xxx	rpm/100

Feedback option:	Motor size						Resolver / Encoder Type	
	1	2	3	4	5	6		
00	Not allowed							
01	2 poles resolver							
02	-	CKS36		CNS50			Incremental	Stegmann
03	-	SKS36		SRS50			Absolut single turn	Stegmann
04	-	SKM36		SRM50			Absolut multi turn	Stegmann
05	-	ERN1185		ERN1387			Incremental	Heidenhain
06	ECN1113			ECN1313			Absolut single turn	Heidenhain
07	EQN1125			EQN1325			Absolut multi turn	Heidenhain
08	Special							

Mechanical option:	Keyway	Shaft exit seal
00		
01		
02		
03		
04	Special	

[3] Electrical option:	Brake options 1	Brake options 2	Rotable connector	Straight connector	Fixed angled connector
00					
01					
02					
03					
04					
05					
06					
07					
08					
09	Special				

	Motor size 1	2	3	4	5	6
Brake option 1 (Low torque)	0.4 Nm	1 Nm	2 Nm	9 Nm	18 Nm	30 Nm
Brake option 2 (High torque)	-	-	4.5 Nm	18 [4] Nm	30 Nm	72 Nm

1) Active length in 0.1 inch (for G-1 in mm)
2) Example: rpm = 3500 xxx = 035
3) Resolver motors come with fixed angled connectors Encoder motors come with rotatable angled connectors
4) With encoder holding torque 14.5 Nm (128.5 lb)

EXAMPLE:

G - 3 - V8 - 047 - 02 - 00 - 06 - 00

- 00: Standard version
- 06: Encoder Heidenhain ECN1313 abs. sinlge turn
- 00: Plain shaft, no shaft seal
- 02: Standard electrical version (Option 2, brake 4.5 Nm, rotatable connectors)
- 047: Nominal speed: 4700 rpm
- 8: Active length: 40 x 0.1 inch = 4 inches
- V: Winding voltage: 565 V_{DC}
- -: Natural cooling
- 3: Motorsize: Frame size 70 mm
- G: Series: Fastact G

TAKE A CLOSER LOOK

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