



# Industrial-Grade NEMA 23 Motors

Brushless, Permanent Magnet, Rotary Motors

Teknic's industrial-grade NEMA 23 servo motors are brushless, rotary motors engineered specifically for OEM manufacturers of automated machinery. They provide excellent value, rugged design, and high power-density.

The combination of fully sintered, rare earth, high temperature Neodymium-Iron-Boron magnets with an optimized stator design results in motors that are more powerful than similarly sized motors. This means that you can match your current performance with smaller (and less expensive) motors or get more power in the same envelope.

In challenging environments (packaging, grinding, routing, plasma cutting, etc.), the industrial-grade motor family is an exceptional value. For example, this motor's windings have been designed to meet class H standards; the bearings are oversized and the entire line has been carefully refined to provide outstanding field reliability.



## PERFORMANCE FEATURES

- A super-hard grade of rare-earth, Neodymium-Iron-Boron magnets provide high power-density and fade-free performance at elevated temperatures, assuring full torque output even when the motor is driven hard.
- Carefully engineered thermal design of both the stator and housing yields high continuous motor torque in a small envelope.
- 180°C rated windings improve thermal overload capability allowing high peak torques to be used for aggressive accelerations and decelerations (thereby decreasing machine index times and increasing throughput).
- Innovative stator design incorporates low-inductance windings with a fast electrical time constant. This provides the OEM with faster motor response and overall higher power (eliminates the torque “droop” at higher speeds commonly found in higher inductance motors).
- Carefully skewed, sinewave stator/rotor design produces a smooth, uniform, sinusoidal torque constant with low harmonic content. This ensures linear, ripple-free torque response and minimum detent torque resulting in smoother motion, faster settling times and reduced motor hunting.
- High torque to rotor inertia enables rapid acceleration.
- Precision, maintenance-free oversized bearings reduce viscous friction and motor noise while smoothing motion and improving motor radial-loading capability.
- Finite element analysis and precision machining yield high-strength shafts to improve load capacity.
- As opposed to many brushless servo motors, that have a separate board for the encoder signals and commutation sensors, Teknic has increased reliability by reducing the internal motor parts count. The fully integrated encoder and commutation sensor design provides accurate and repeatable commutation signals for 6-step drives or the precise start-up position for vector alignment with AC-sinewave servo drives.

## LOW COST OF OWNERSHIP

Although the prices of the industrial-grade motor family are attractive, price is not the only factor that determines true motor cost. These motors are built and engineered to be inexpensive to operate and engineer into automated machinery.

### Supply Chain Advantages

Because of Teknic's highly-tooled JIT production process, these motors (and the OEMs that use them) realize many advantages:

- Shaft sealing and connector options are applied during normal manufacturing processes. In fact, no option requires special builds. So, you can count on reliable lead-times regardless of motor configuration
- These motors are made in the USA, ensuring long-term price stability because production costs are not linked to currency exchange rates.
- Lifelong product tracking via unique product ID.

### Motor Testing

To ensure out-of-the-box reliability, each motor is thoroughly tested before shipment. The tests include:

- 100% HASS testing.
- Mechanical compliance test.
- Encoder integrity test.
- Commutation sensor accuracy test.
- Full electrical compliance test.
- Extended functional test on a vector torque fixture.

### Delivery

The entire family industrial-grade of servo motors is manufactured in high volume using standardized methods. These methods provide repeatable build quality, dependable motor performance and reliable lead-times. These methods also include tight controls over the source of materials and other issues that affect long-term availability. Teknic works exclusively with OEM machine designers, so we understand the value of ensured availability over the entire life of a machine.

**HIGH POWER DENSITY**

Teknic's industrial-grade NEMA 23 motors are more powerful than similarly sized motors because of the combination of fully sintered, high temperature, Neodymium-Iron-Boron magnets and an optimized stator design. This means that you can match existing performance specifications with smaller (and less expensive) motors or get more power without increasing motor size.

**GREATER CONTINUOUS CAPACITY**

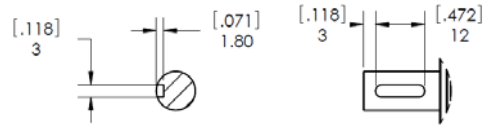
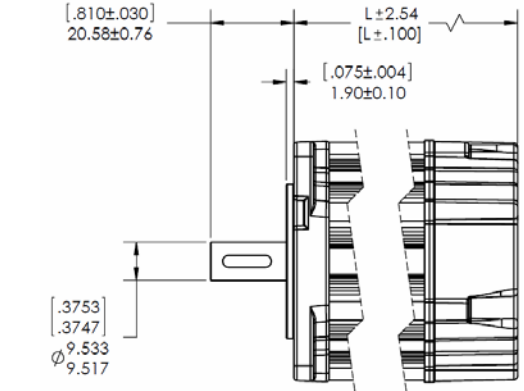
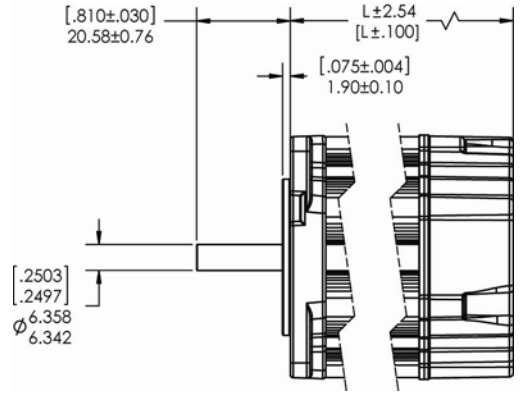
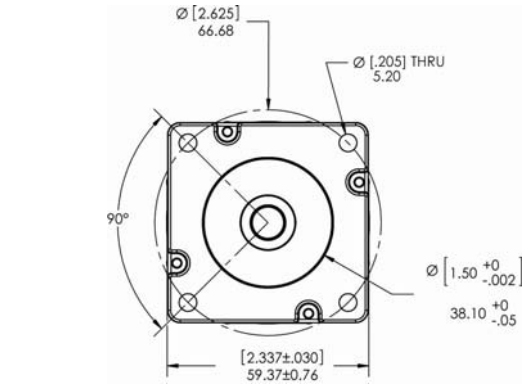
Several innovations combine to provide more continuous motor performance. The ribbed motor housing and internal construction provide a better thermal path from the stator to free-air and the front mounting face, resulting in significantly more thermal conductivity than other motors. Additionally, the FEA-optimized electromagnetic design ensures that this motor is a more efficient converter of electrical to mechanical power (i.e., high motor constant) which means that less motor power is lost to extraneous heating.

**LOW DETENT = SMOOTHER MOTION**

Special attention was paid to the interaction of the rotor's magnetic field with the stator's tooth design with regard to detent (or cogging) torque. Low detent torque enables the smoothest motion possible—which minimizes motor heating and improves the motor's continuous capacity. The magnetic design also assures a sinusoidal torque constant for minimization of torque ripple when using sinusoidal vector drive

**FEA DESIGNED SHAFTS**

Finite element analysis is used to reduce stress concentrations on machined areas of the shaft (such as the fillet where the shaft exits the bearing assembly). This allows the use of oversized bearings without reducing shaft strength. The result is rugged, load-bearing capability.



**“L” Dimension**

M-231x	70.94 mm	2.79 in.
M-232x	89.92 mm	3.54 in.
M-233x	108.97 mm	4.29 in.
M-234x	128.02 mm	5.04 in.

**CONNECTOR OPTIONS**

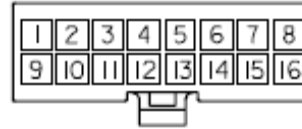
Teknic's industrial-grade NEMA23 motors provide two standard connector options—a Molex Mini-Fit or Souriau Trim-Trio connector. Either option delivers a strong, positively locked connection from the DualShield™ pigtail to the motor cable. The connector, pigtail and pigtail exit from the motor body have been designed as a system so that OEM machine designers have the most mounting, placement and routing flexibility in their designs.

**FLEXIBLE, SINGLE-EXIT PIGTAIL**  
The recessed, tangential exit of the motor's DualShield pigtail provides multiple mounting options and, because of the pigtail's length and flexibility, the absolute minimum installed envelope. The lack of an on-body connector means this motor can be slipped into locations previously unusable due to cabling concerns.

**MINI-FIT CONNECTORS**  
The Molex Mini-Fit connector provides a gas tight link with four points of contact. This low cost and extremely rugged connector system has a current rating of up to 10A per circuit and a 600V rating. The housing features a positive lock and fully isolated, low engagement force terminals.  
Use this connector when a low cost/high reliability option is the critical requirement, and in applications where aesthetics, sealed connections or when more than 10A of continuous current is not required.

**TRIM-TRIO CONNECTORS**  
The Souriau Trim-Trio bayonet-style connector is a keyed, sealed and positively locking unit derived from the MIL-C 26482 specification. Teknic's innovative use of this connector provides a termination system that is unique to the industry for having both logic signals (commutation and encoder) and high current (tested to over 20 amps in this application) phase power in the same connector.  
Normally power and signal contacts are not combined in one connector due to the spacing and clearances required between hazardous and accessible signals. However, Teknic has successfully designed a solution which preserves safety while delivering a high-power, simple solution for cable termination. Use this connection when aesthetics are important, in very dirty environments, or when watertight sealing is necessary. Additionally, this connector supports the greatest current carrying capability.

**Molex® Mini-Fit Jr.™**



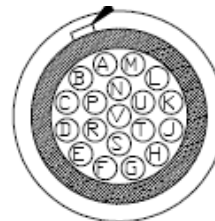
(Wire Entry View)

Mating Housing P/N: 39-01-2161  
Mating (Male) Contact P/N: 39-00-0049 (24 AWG) 39-00-0082 (16 AWG)  
Crimp Tool P/N: 11-01-0198

Pin	Color	Signal	Pin	Color	Signal
1	DRAIN x3	P DRAIN	9	16AWG BLK	PHASE R
2	N/A	N/A	10	16AWG RED	PHASE S
3	GRN	COMM S-T	11	16AWG WHT	PHASE T
4	GRN/WHT	COMM R-S	12	RED	+5VDC IN
5	GRY/WHT	COMM T-R	13	BRN	ENC I
6	DRAIN x1	E DRAIN	14	ORN	ENC B
7	BLK	GND	15	BLU	ENC A
8*	BLU/WHT	ENC A~	16*	ORN/WHT	ENC B~

\* Although all terminals in the connector are populated, this signal complement is available only in motor models configured with a differential encoder

**Souriau™ Trim-Trio®**



(Mating Face Shown)

Mating Housing for Free-Hanging Pigtail P/N: UTG01619S  
Mating Housing for Bulkhead Mount Pigtail P/N: UTG61619S  
Mating (Female) Contact P/N: SC24M1TK6 (24 AWG) RC16M23T (16 AWG)  
Mating Backshell/Clamp P/N: UTG16AC

Pin	Color	Signal	Pin	Color	Signal
R	DRAIN x3	P DRAIN	L	GRY/WHT	COMM T-R
C	16AWG RED	PHASE S	U	BRN	ENC I
D	16AWG WHT	PHASE T	G	GRN	COMM S-T
B	16AWG BLK	PHASE R	T	RED	+5VDC IN
J	BLU	ENC A	F*	ORN/WHT	ENC B~
K*	BLU/WHT	ENC A~	V	ORN	ENC B
H	GRN/WHT	COMM R-S	M	DRAIN x1	E DRAIN
S	BLK	GND			

\* Although all terminals in the connector are populated, this signal complement is available only in motor models configured with a differential encoder

**DURABLE DESIGN**

The combination of high temperature construction, multiple sealing options and oversized bearings results in a motor family suited for a wide variety of environmental conditions.

In addition to the winding insulation system, other areas of the motor's construction were designed to allow high temperature operation without loss of power:

**MANY ENCODER OPTIONS**

The industrial-grade motor's encoder system provides a multitude of resolution and signaling options. A total of 10 different encoder options are available for motors in the NEMA 23 family. Resolutions as high as 16,000 counts per revolution (post-quadrature) can be selected for applications requiring the highest positioning accuracy. Depending on the application requirements, two signaling options are available; line-driven single-ended or differential quadrature signals.

Use the single-ended encoder option in moderate noise environments when low cost is the most important consideration and where cable runs are shorter.

For a nominal cost increase, the differential encoder signals provide noise immunity and long transmission range. In many cases, it is well worth the incremental cost for the improved engineering margin provided by this option.

**SPECIFICATIONS**

<b>GENERAL</b>		Insulation Rating:	Class H, 180°C
		Motor Poles:	8
		Standard Shaft Diameter:	0.375 in., 9.5 mm
		Motor Pigtail Type:	Space saving, single-exit, DualShield™
		Motor Pigtail Length:	16 in ± 1 in., 406.4 mm ± 25.4 mm.
<b>ENVIRONMENTAL</b>		Shock:	2.0 G
		Vibration:	0.5 G
		Max External Deceleration:	250,000 rad/s <sup>2</sup>
		Max Case Temperature:	85°C
		Max Winding Temperature:	155°C
		Ambient Temperature:	-40°C to +70°C*
		Humidity, non-condensing:	0-95%
		Operating Conditions:	No direct fluid wash-down or submerged use
<b>ENCODER</b>		Type:	Floating optical disk; single-ended or differential signals
		Resolution(s):	2000, 4000, 8000, 16000 counts/rev (post-quad)
		Index Pulse Repeatability:	± 1 count for resolutions ≥ 4,000 counts/rev <sup>3</sup>
		Current Draw, Loaded:	180mA @ 5VDC, all signals loaded with 200Ω load
		Current Draw, Unloaded:	125mA @ 5VDC
<b>COMMUTATION</b>		Commutation Type:	120° spaced, optical commutation sensors
<b>MECHANICAL LOADING</b>		Bearing Type:	Oversized, single-row, deep groove, radial with non-contacting lubrication seals.
		Bearing Life vs. Load:	Depending on the specific motor model, typical bearing life is approximately 3.2 x10 <sup>9</sup> to 5.0 x10 <sup>9</sup> revolutions (based on 5 lb axial and 25 lb radial loads, centered 1.0 inch from front bearing surface). For more detailed loading information, contact Teknic.
<b>WARRANTY</b>			3.5 years

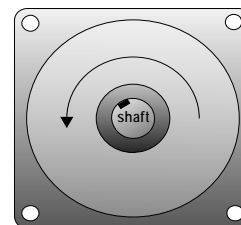
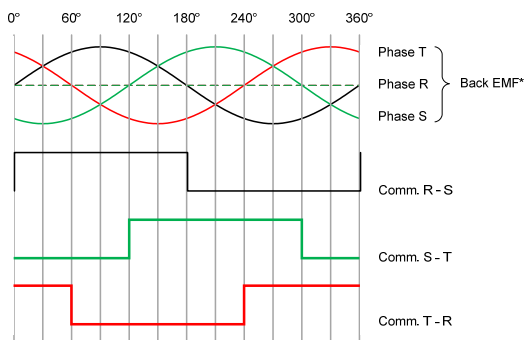
\* The RMS torque limit on certain motors is derated for operation in ambient temperatures above +40°C. Contact Teknic for derating assistance.

**INDIVIDUAL SPECIFICATIONS**

Model	2310		2311		2321		2331		2341	
Electrical Interface Option	S/E/W	P/C/Y	S/E/W	P/C/Y	S/E/W	P/C/Y	S/E/W	P/C/Y	S/E/W	P/C/Y
Resistance, phase to phase, [Ω]	2.87	0.72	2.76	0.690	2.46	0.62	2.42	0.61	2.98	0.75
Inductance, phase to phase, [mH]	1.61	0.40	2.93	0.733	3.66	0.92	3.55	0.89	4.59	1.15
Electrical Time Constant, [mS]	0.56	0.56	1.06	1.06	1.49	1.49	1.47	1.47	1.54	1.54
Back EMF (K <sub>e</sub> ), [Vpeak/kRPM]	9.28	4.64	13.27	6.64	23.29	11.65	27.31	13.65	36.40	18.20
Continuous Torque [oz-in] <sup>1,2</sup>	39	39	60	60	116	116	145	145	186	186
Weight [oz, g]	22.1, 626				32.8, 929		44.2, 1252		54.1, 1535	

- 1: Typical, varies by application – contact your sales engineer for application specific rating.
- 2: The G, P or S electrical interface option (Mini-Fit Jr. connectors) limits the continuous current capacity to 10 amps RMS; which, in turn, limits continuous torque capacity. For more continuous torque use the Y, C or E electrical interface option (Trim-Trio connectors).
- 3: ±5 counts for 2,000 counts/rev resolution (unidirectional).

**COMMUTATION SIGNAL TIMING**



\* For counter-clockwise motor rotation as shown

Example:

**M-3411P-LN-08K**

M-□□□□-□□-□□□

**NEMA Frame Size:** 23, 34

**Stack Length:** 1-4

*Indicates the number of magnet sets (stacks) on the motor's rotor*

**Winding/Magnetic Structure:** 1-9; A-Z

*Indicates the winding design. Different designs offer unique torque, speed and power characteristics.*

**Electrical Interface<sup>1</sup>:**

*Indicates the pigtail connector and winding type.*

- P: MiniFit-16 pigtail, free-hanging, winding A
- G: MiniFit-16 pigtail, free-hanging, winding B
- S: MiniFit-16 pigtail, free-hanging, winding C
- C: Sealed Trim-Trio pigtail, free-hanging, winding A
- V: Sealed Trim-Trio pigtail, free-hanging, winding B
- E: Sealed Trim-Trio pigtail, free-hanging, winding C
- Y: Sealed Trim-Trio pigtail, bulkhead mount, winding A
- R: Sealed Trim-Trio pigtail, bulkhead mount, winding B
- W: Sealed Trim-Trio pigtail, bulkhead mount, winding C

**Shaft/End Bell:**

- L: Standard, with parallel keyway (*NEMA 23: 0.375", NEMA 34: 0.500"*)<sup>2</sup>
- Q: 0.250" round shaft, no keyway (*available on M-231x and M-232x motors only*)

**Sealing<sup>3</sup>:**

- N: Dust (standard)
- S: Shaft Seal (in addition to dust sealing)<sup>4</sup>

**Encoder Density:**

*Counts per revolution (post-quadrature)*

- 02: 2,000 counts/revolution
- 04: 4,000 counts/revolution
- 08: 8,000 counts/revolution
- 16: 16,000 counts/revolution

**Encoder Type:**

*All encoders use precision-etched, stainless steel disks.*

- K: Line-driven, single-ended TTL<sup>5</sup>
- D: Differential

1: Contact Teknic for technical information on the different windings  
 2: Dimensions of keyway are 12x3mm (NEMA 23) and 20x5mm (NEMA 34), key not included  
 3: IPC rating depends upon electrical interface option and sealing option together  
 4: Not available with 0.250" shaft  
 5: 667kHz maximum output frequency limit, post-quadrature