

Mounting and Installation Guidelines

Important Note: *The recommendations included in this Kollmorgen Selection Guide are intended to serve as general installation guidelines, and are for reference purposes only. Kollmorgen assumes no responsibility for incorrect implementation of these techniques, which remain the sole responsibility of the user.*

KBM(S) series motors, as well as any other Kollmorgen frameless brushless motors that are supplied as 2-piece rotor/stator kits, should be installed by the user according to the general guidelines below.

User Interface Responsibilities

To assure proper performance and reliability of the motor when installed in the system, the user is responsible for designing the mounting interface in the following manner:

Bearings

The user-supplied bearing system in the motor application must exhibit sufficient stiffness to maintain a rigid, uniform clearance gap between the rotor and the stator under all operating conditions. Concentricity requirements noted on each model-specific Kollmorgen outline drawing should be considered by the user when sizing and selecting bearings for appropriate radial and preload forces to achieve desired motor running gap clearance and total runout. Bearings with the lowest possible friction and high quality lubricant should be chosen to minimize overall system friction, which allows optimal motor operation.

Stator Mounting Materials

A metallic housing/clamp structure is suggested to rigidly mount the stator to assure best conductive heatsinking path and proper structural integrity. Aluminum alloys are preferred due to their superior thermal conductivity and strength-to-weight ratio, although stainless steel alloys (300 series or equivalent) are an acceptable alternative for applications that are less thermally critical. Carbon steel, cast iron, 400 series stainless alloys and other magnetic flux-conducting ferrous metals are the least desirable choices for stator mounting, but can certainly be used in some cases if proper design choices are considered. Consult a Kollmorgen Engineer for assistance if such metals must be used. Plastics or other similar thermally isolating materials are not recommended, since they adversely affect the heatsinking capacity of the system, making it necessary to significantly de-rate the motor's performance.

Rotor Mounting Materials

The magnetized rotor may be mounted to any metallic shaft of the user's choice. Carbon steel and stainless steel are the most commonly used shaft materials, although aluminum alloys are occasionally used if properly designed for the intended torque and thermal operating range. The user's intended method of attaching the rotor to the shaft may influence the optimum material and tolerance choices for the shaft. The user's shaft does not need to carry flux or function as a portion of the magnetic circuit to achieve rated performance when using a Kollmorgen brushless motor.

Grounding

When mounted in the application, the laminated stack (or bare metal outer sleeve) of the stator must be at the same electrical ground potential as the system chassis and the drive amplifier chassis. If this common ground path is not ensured, the application may exhibit electrical noise and also create an electrical shock hazard. The risk of shock is particularly prevalent when using high pole-count motors with large capacitance characteristics. Typically, if the stator is mounted using electrically conductive metallic components, then a robust ground path between stator stack and machine chassis is inherently achieved. Kollmorgen suggests performing a continuity check to confirm proper ground path before enabling the motor system. In some applications, depending on mounting configuration and materials chosen by the user, a separate conductive ground strap may be required. In such cases, the user is responsible for installation of the ground path and electrical verification.

Wiring

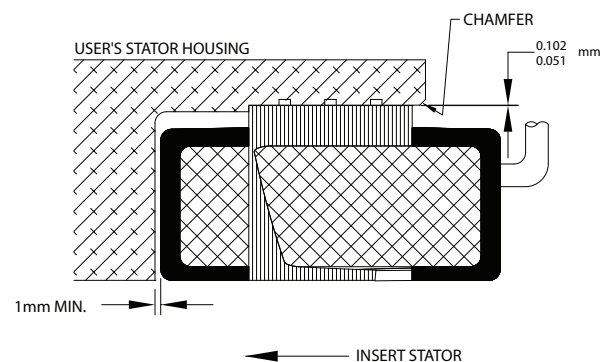
KBM(S) series motors are supplied with UL-compliant unterminated flying leadwires. The user is responsible for proper leadwire routing and connection per the diagrams shown on Kollmorgen drawings. Avoid routing wires across sharp corners, pinch points or edges that may pierce the insulation. Clamp or otherwise secure wire bundle in high vibration applications and avoid wire contact with moving/vibrating surfaces that may abrade the insulation. Provide strain relief for all wire bundles and allow room for a generous bend radius. User assumes responsibility for connector installation, crimping, soldering, shielding, sleeving or any other wire bundling or electrical interface enhancement beyond the configuration shown on the Kollmorgen outline drawing.

Stator Mounting

Kollmorgen suggests the following options for installation of the motor stator depending on torque, vibration and thermal characteristics of the application, as well as cost, ease of assembly and serviceability desired by the user.

Adhesive Bond

In most cases, motors in the general peak torque range up to 750 N-m may have the stator bonded in place using a structural epoxy, such as Hysol® EA934NA, 3M™ Scotchweld™ 2214 or other similar adhesives. Bonding is a preferred installation technique for the KBM(S)-10XXX through KBM(S)-57XXX size stators, although shrink fitting as described in the next section is also an acceptable option. Bonding can certainly be used to secure stators larger than the aforementioned size range if desired, but requires additional design and process considerations. To successfully utilize adhesive bonding, the user's stator enclosure should be designed as a cylindrical cup, as shown in the illustration below, with a small shoulder for axial positioning at one end and open at the opposite end. The shoulder serves as a stop point for the stator to bank against when inserted from the open end, and should generally clear the maximum outer diameter of the winding end turn by no less than 1 mm at all circumferential points. A small internal chamfer at the open end of the housing cup simplifies stator insertion. If using a thick structural epoxy, inner diameter of the housing cup should be approximately 0.051 mm - 0.102 mm larger than the maximum outer diameter of the stator. However, the user should consult the adhesive manufacturer for proper bond line thickness, application process and curing instructions. Small grooves shown in the inner diameter of the housing in the illustration below are intended to serve as adhesive reservoirs for



Adhesive Bond Illustration

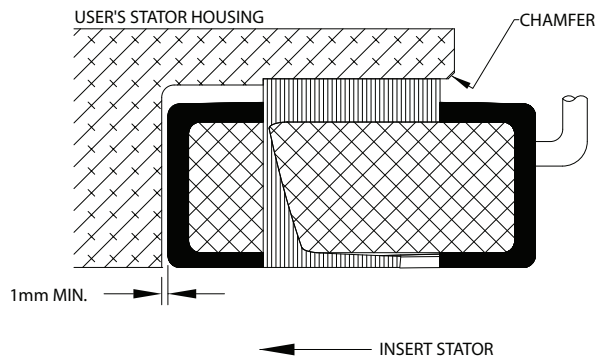
thick structural epoxies, but are considered optional features per the user's discretion. If a retaining compound, such as Loctite® 640™ or other similar adhesive, is preferred instead of a structural epoxy, a much tighter clearance between housing inner diameter and stator outer diameter must be controlled to maintain appropriate bond line thickness. Refer to adhesive manufacturer's guidelines for recommendations. User assumes responsibility for selecting proper adhesive and for designing housing dimensions per expected thermal growth rate at intended temperature extremes of application. Adhesive cure temperatures should not exceed 155°C to avoid damaging the motor stator. Stator and housing surfaces should be cleaned thoroughly prior to bonding to ensure good adhesion.

Mounting and Installation Guidelines

Shrink Fit

The user's housing may be designed with an inner diameter that is slightly smaller than the outer diameter of the motor stator, providing an interference fit when installed. Pressing the stator into the housing at normal room temperature is not recommended because of its laminated construction. Instead, heating the housing to achieve enough thermal growth to freely slide the stator inside is a more common technique that achieves the desired interference fit when the housing cools. Aluminum or steel housings may be used effectively to shrink fit stators across a broad peak torque range, generally from <1 N-m up to thousands of N-m. It is generally not necessary to shrink fit small diameter motors where bonding is a simpler and equally effective option, although it is acceptable to do so at the user's discretion. For KBM(S) series motors, shrink fit is the preferred installation technique for sizes KBM(S)-60XXX through

KBM(S)-118XXX stators. Steel has a lower coefficient of thermal expansion than aluminum, so a steel housing must be heated to a much higher temperature than a comparable aluminum housing to achieve the desired diameter growth and stator installation clearance. In contrast, because aluminum grows much more rapidly than steel at elevated temperatures, the user should take special design precautions regarding size and tolerances to assure that an aluminum housing maintains the required interference fit at the application's extreme high temperature. It is important to design for sufficient dimensional interference fit, which can be influenced greatly by many application variables and design choices, to safely reach the motor's maximum torque while also avoiding crush damage to the stator. The user assumes all responsibility for housing design details, material selection, fit calculations and tolerance analysis for the intended application.

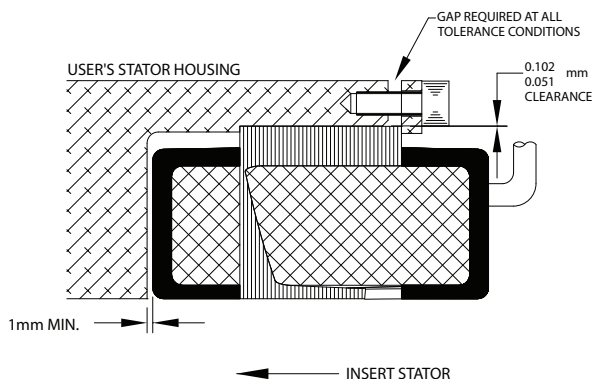


Shrink Fit Illustration

Axial Clamping

For low torque applications, or for applications where the stator may need to be repeatedly installed and removed from the system, axially clamping may be an acceptable option. Kollmorgen does not generally recommend this technique for high shock/vibration applications, extreme temperature applications or for peak torques greater than 50 N-m without special design considerations. The

stator enclosure shown in the illustration below is very similar to the bonding technique example shown in the first section, with approximately $0.051\text{ mm} - 0.102\text{ mm}$ slip fit clearance between the inner diameter of the housing and the outer diameter of the stator. When inserted, the stator banks against a shoulder inside the housing bore that controls axial position and provides a fixed axial clamping surface. The shoulder should clear the maximum outer diameter of the winding end turn by no less than 1 mm at all circumferential points. A separate clamp ring with the same circumferential clearance is placed over the opposite end of the stator and bolted (typically 4 – 12 fasteners, equally spaced) to the housing enclosure.



Axial Clamping Illustration

The user should design the enclosure components to ensure that, with the stator installed, an axial clearance gap exists between the clamp ring and the end of housing at all tolerance conditions. Otherwise, the clamp ring could contact the housing before the fasteners are fully tightened, resulting in insufficient axial clamping force against the stator. If desired, the small radial space between the stator outer diameter and the housing inner diameter may be filled with a thermal compound for more efficient conduction to the heatsink. However, use caution to avoid contaminating the axial clamping surfaces with grease that may reduce clamping force. If the user wishes to evaluate this axial clamping technique for motors with higher peak torque ratings, it may be necessary to increase the total surface area of the clamping regions and increase the number of clamping fasteners.

Bolting

Sizes KBM(S)-163XXX through KBM(S)-260XXX are supplied with the stator installed in an aluminum sleeve with flange and through-holes for bolted mounting. User interfaces for these large motors should be designed per the pilot diameters and hole patterns shown on the Kollmorgen model-specific outline drawings. Several of the smaller sizes within this motor family, such as KBM(S)-10XXX through KBM(S)-45XXX range, are also supplied with the stator installed inside an aluminum sleeve, but do not include a stepped flange and are not intended to be bolted in place. For the latter range of sizes, bonding, shrinking or clamping techniques described in previous sections are appropriate.

Rotor Mounting to Shaft

Kollmorgen's KBM(S) series and other frameless brushless motors utilize high-performance rare earth magnets. Use extreme caution when handling or transporting to avoid injury and product damage. The attractive forces between magnetized rotors and nearby metallic objects can be extremely powerful. Improper handling can result in sudden unexpected impacts. The strong magnetic field can also damage nearby computers, display screens and memory storage devices. Keep the rotor in its shipping container or wrapped protectively until ready to install. This practice will help avoid accidents and prevent contamination such as metallic chips or debris that tend to cling to the magnets.

Axial Alignment Control

Kollmorgen's model-specific outline drawings note axial alignment that must be maintained between rotor and stator when mounted to ensure proper motor performance. The user is responsible for designing the rotor shaft, stator enclosure and bearing system to achieve the specified mounting alignment. Machined shoulders on the shaft or grooves for removable retaining rings are common ways of controlling rotor installation position. Maximum diameter of retaining rings or shaft shoulders should be kept below the rotor diameter where magnets are bonded to the steel hub.

Bonding

Generally, for applications where peak torque does not exceed 750 N-m, rotors can be bonded to carbon steel or stainless steel shafts. Retaining compounds, such as Loctite 640 or other similar adhesives, usually require smooth continuous interface diameters and tight fit tolerances. Structural epoxies generally require slightly larger fit clearance to allow a thicker bond line. Epoxies often benefit from grooves in the shaft/rotor interface that function as adhesive reservoirs and may be enhanced by textured machined surfaces via knurling or grit blasting. Always clean the bond joint surfaces thoroughly to ensure good adhesion. Consult adhesive manufacturer for proper bond line thickness, fit tolerances, process details and curing guidelines. To avoid partial demagnetization of the rotor, do not cure rotor/shaft bond joints at temperatures > 180°F unless rotor is nested inside the matching stator or rotor is completely surrounded by a ferrous metal keeper fixture. Contact a Kollmorgen Engineer if more information is required on this topic. Before bonding rotors to aluminum shafts, consult with adhesive manufacturer for assistance. A highly flexible adhesive with broad thermal properties may be required.

Mounting and Installation Guidelines

Axial Clamping

If the user's shaft is designed with a machined shoulder that the rotor can rigidly bank against, the rotor may be axially clamped in place using a locknut. This technique allows the rotor to be installed and removed from the shaft repeatedly, but requires a portion of the shaft to be threaded. Rotors retained by locknuts may be generally suitable for applications up to 400 N-m peak torque, although this estimate may vary greatly depending upon size and type of nut used.

Bolting

Motors ranging from size KBM(S)-43XXX and larger are provided with hole patterns in the rotor hub to facilitate bolted mounting. User shaft interface should be designed per the diameter, length, axial position and hole pattern noted on the Kollmorgen model-specific outline drawing.

Installing Rotor Inside Stator

As previously described, magnetic forces can be extremely powerful and surprise the user when handling or installing the rotor. Extreme caution is required when placing the rotor inside the stator.

Secure the Stator

Confirm that the stator is securely mounted per the guidelines previously described before attempting to install the rotor. Kollmorgen recommends taping or tying the wiring bundle aside in a safe position to avoid accidental damage.

Protect the Running Gap Surfaces

If left unprotected, the outer surface of the rotor may stick or "pole" to the nearest point on the inner bore of the stator due to magnetic attractive forces as the user attempts to install it. The resulting friction as the rotor slides along the inside of the stator can potentially damage the rotor band, magnets, coatings or stator bore surfaces. To prevent damage and simplify the rotor installation process, Kollmorgen recommends first installing a thin layer of shim material, such as Mylar® film, in the stator's inner bore. See photos below for examples. Mylar (DuPont® Corp. trade name) is a commonly available polyester film, often used as electrical insulation or in laminating processes, and is available in a variety of thicknesses. The Mylar film can be installed as a single piece that is wrapped entirely around the circumference of the stator bore and slightly overlapped, or multiple pieces may be inserted axially at equally spaced points. Optimum film thickness and number of shim layers required is dependent upon the gap clearance between rotor and stator for the specific motor size the user is attempting to install. Appropriately thick Mylar film shim layer(s) will keep the rotor roughly centered inside the stator bore and provides a slick surface to slide the rotor to its intended mounting position without damage.



Single Mylar Shim



Multiple Mylar Shims

Installing the Rotor

Many of the KBM(S) series rotors are too large to safely lift by hand and the attractive force as the rotor rapidly enters the stator can be too powerful to control by hand. Kollmorgen recommends using a hoist or small overhead crane to lift the rotor into position and stabilize it for safely controlled insertion into the stator. Most large KBM(S) rotors include tapped holes in the steel hub for the user to attach eye bolts to facilitate hoist lifting. Note that swiveled eye bolts, as opposed to fixed ring eye bolts, are recommended for safe lifting with hoist chain and hook interface.

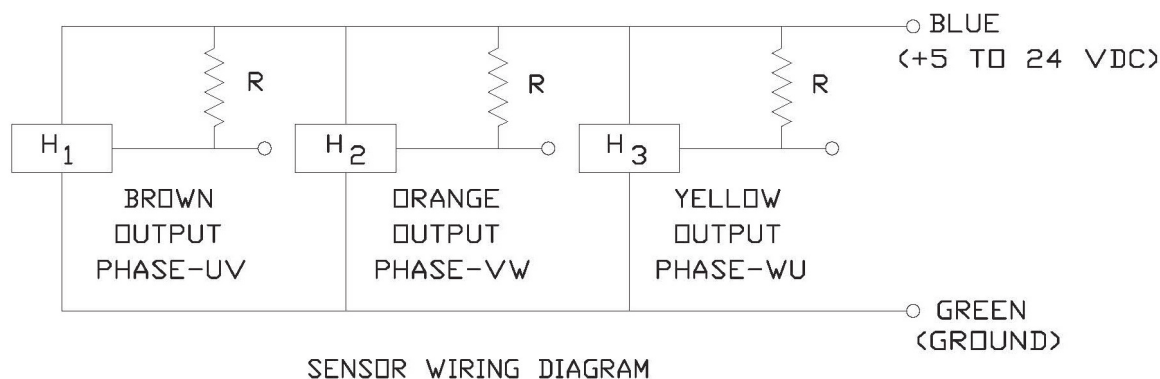
Inspect the Running Gap

After the rotor is properly installed and secured, remove all Mylar shim material. Carefully inspect the running gap for any debris or obstructions. If possible, spin the rotor by hand to confirm that it rotates freely.

Installation Assistance

Customers may contact Kollmorgen for assistance with application or installation problems. See rear cover of this selection guide for contact information. If desired, Kollmorgen can also design and supply custom motor installation fixtures for the user's unique application needs. Fixture solutions are quoted separately on a case-specific basis.

Electrical Wiring Interface



STEP	POWER CONNECTION		
	PHASE "U" BLUE	PHASE "V" BROWN	PHASE "W" VIOLET
1	(+)	(-)	
2	(+)		(-)
3		(+)	(-)
4	(-)	(+)	
5	(-)		(+)
6		(-)	(+)

EXCITATION SEQUENCE TABLE

CCW VIEWED LEAD END

