

Storage, Handling, Installation & Assembly Guide **FRAMELESS MOTOR**

THIS GUIDE IS VALID FOR MODEL NUMBERS:

HT
MF (Megaflex)
QB (Quantum)
RBE
R-BLDC and L-BLDC
R-BLAC and L-BLAC
RM and LM
STK
MT (MACCON Torque & Kit motors)

-NOTE-

All MACCON frameless electric motors are thoroughly tested before being carefully packaged for shipping. The results of these tests can be read on the Test Report that is supplied with the motor.

When calling MACCON for technical support, please have your Company name, Motor part number, serial number and this Test Report ready for reference.

If it has been misplaced, please advise us and we will send you a copy.

PLEASE, READ THIS GUIDE BEFORE ATTEMPTING MOTOR INSTALLATION

-CAUTION-

VERY STRONG MAGNETIC FIELDS ARE PRESENT IN ALL FRAMELESS MOTORS. STRONG MAGNETIC FIELDS MAY HAVE A DANGEROUS EFFECT ON ELECTRICAL DEVICES. DO NOT STORE MAGNETIC SENSITIVE DEVICES NEAR FRAMELESS MOTORS

Table of Contents

General / Safety

- Unpacking, Storage and Assembly
- Precautions during Operation
- Maintenance

1.0 Design Recommendations for mounting Rotating Motors

- 1.1 Alignment Information
- 1.2 Stator Mounting
- 1.3 Rotor Mounting

2.0 Design Recommendations for mounting Linear Motors

- 2.1 Alignment Information
- 2.2 Magnet Track Mounting
- 2.3 Coil Assembly Mounting

3.0 Assembly

- 3.1 Assembly of rotational motors
- 3.2 Assembly of linear motors
- 3.3 Electrical Connection

4.0 Troubleshooting

- 4.1 Return Motor for Service or Repair

Unpacking, Storage and Assembly

MACCON Motors use powerful permanent magnets which require care during handling.

When handling multiple motors don't allow the magnets snap together. This may damage the magnets and cause injury.

Do not drop the magnets. Do not heat the magnets. This can possibly weaken the magnetic field and thus the torque of the motor.

Persons with pacemakers or Automatic Implantable Cardiac Defibrillators (AICD) should maintain a minimum distance of 30 cms from magnet assemblies. Other devices such as watches, magnetic disks and cards may also be damaged by the magnetic fields from our motors.

Where possible, a minimum distance of 1m should be maintained between magnet assemblies and other magnetic/ferrous composite materials.

Use only non-metallic instrumentation when verifying assembly dimension prior to installation (e.g. calipers, micrometers, laser equipment, etc.).

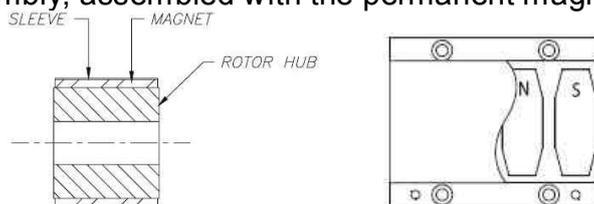


During motor unpacking ESD "Electric Static Discharge" can damage the sensors used in the motor (or external electronics). Follow ESD precaution procedures when handling motor components.

When unpacking, inspect the motor assemblies to ensure that no damage has occurred during shipment. Any damage or suspected damage should be immediately documented and reported to MACCON and your shipping insurance.

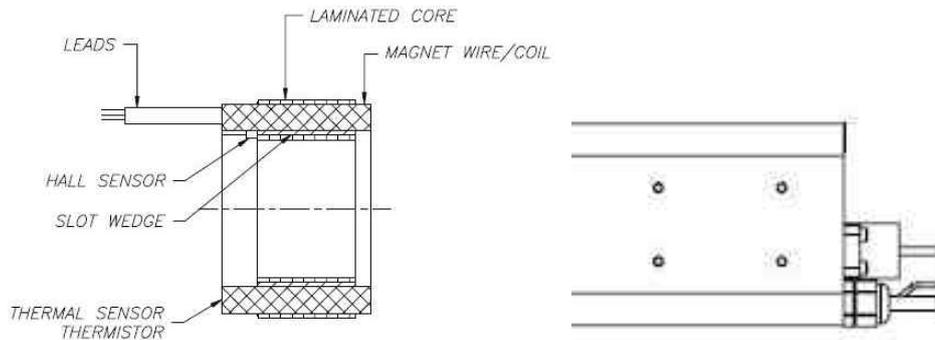
Frameless electric motors are shipped as two separate components in the same container. The contents of the shipping container should be:

- Magnet Assembly, assembled with the permanent magnets; normally the rotor:



Rotational and linear magnet assembly

- Coil Assembly. containing the coils; normally the stator:



Rotational and linear coil assembly

- Copy of Test Report
- Outline drawing and other product support documentation, as needed (may be provided separately)

Optional (If ordered with motor):

- Encoder
- Resolver
- HE-sensors (normally integrated in motor stator)
- thermal protection devices (switch, PT100, PTC)

Both rotor and stator have been carefully packed and secured to prevent damage during shipping and storage. Do not remove the motor component protective wrapping and mounting hardware until time of final motor installation.

- CAUTION-

BECAUSE OF THE WEIGHT OF SOME OF THE LARGER MOTORS, BE CAREFUL TO MOVE MOTOR SHIPPING CONTAINERS WITH A FORKLIFT OR OTHER SUITABLE HOIST

Packaging Materials

After motor installation retain shipping container and all protective wrapping, covering and mounting hardware. The original packaging should be used in case of reshipment. Empty shipping containers should be stored in a dry, cool location (protected from weather and other damaging environmental conditions). See also, 4.1 RETURNING MOTOR FOR SERVICE OR REPAIR, at the end of this guide.

Precautions during Operation

Electrical risks:

Persons who get in contact with the motor or the structure to which the motor is mounted can become injured by electrical shock, when the motor is under power/voltage.

Other equipment in contact with the motor can also experience damage by high voltage.

In case of insulation break-down, double-check the insulation before reapplying power.

Mechanical risks:

Rotating and moving masses can store considerable amounts of energy. In case of mechanical malfunction this energy can be released spontaneously with potentially dangerous effects.

Maintenance

MACCON frameless motors do not require maintenance when operated in a clean environment as they have no wearing parts. For operation in harsh and dirty environments minimal cleaning is recommended every 6 months:

Clean the metallic debris and other contaminants from the air gap. Do not use abrasive cleaners which can destroy the anti-corrosive coating.

Removal of the metal debris may be made by using strips of masking tape. Simply put a strip of tape on the magnet track and then remove it. Another method to pick the metal debris from the track is to use modelling clay. Keeping the magnet track clean will prevent surface scratches. These are caused by metal debris being dragged across the surface of the stainless steel by the magnet field of the moving coil. They should

normally have no effect on the performance of the motor but can lead to abrasion and later to corrosion.

1.0 Design recommendations for mounting rotating motors

This chapter is addressed to persons designing the surrounding construction of the motor. The recommendations should help to integrate the motor and to assure nominal and safe operation.

For assembly instructions see chapter **3.0 Assembly**.

Bearing issue:

This manual does not describe how to support the shaft. Consult bearing catalogue or manufacturer for proper size type and layout.

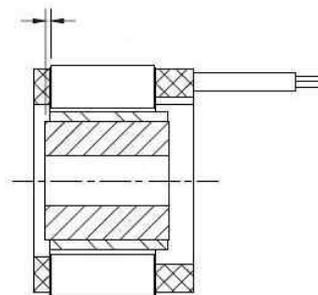
1.1 Alignment of the motor components (stator and rotor)

For a full functional motor assembly it is important to align the stator and rotor components in axial and radial direction. The mechanical tolerances for these alignments are given on the mechanical motor drawing.

Axial alignment:

Axial alignment is important to prevent axial forces on the shaft and to ensure the specified torque. If the magnets of the rotor do not fully cover the stator lamination stack, there may lead to a loss of output torque.

AXIAL PLACEMENT

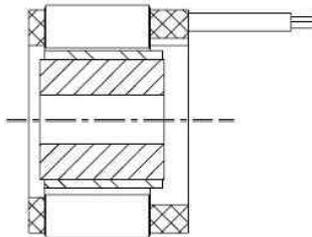


If you use hall-effect sensors proper alignment is important to ensure correct operation. As the motor magnets are also used for the sensors the rotor is wider than the stator lamination stack. The additional length is spent on the cable side of the motor. This is also the side where the hall-effect sensors are normally located. The figure **axial placement** shows such a motor with hall-effect sensors. You can see the intended offset of the rotor.

Radial alignment:

Radial alignment (concentricity) ensures a constant air gap between the stator and the rotor. This air gap must be maintained when the rotor rotates in the stator, in order that there is no mechanical contact between them, even under worst circumstances. The defined manufacturing tolerances in your design should ensure a minimum gap greater than the half nominal air gap.

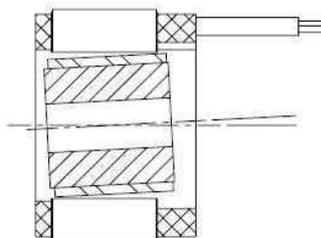
*RADIAL MISALIGNMENT
(CONCENTRICITY)*



Angular alignment:

Angular alignment or minimising tilt is also important in order to maintain a constant air gap.

ROTOR ANGULAR ALIGNMENT



There is normally no figure for the permissible amount of tilt. Over the full length of the rotor this should not exceed the values given for radial alignment.

1.2 Stator mounting:

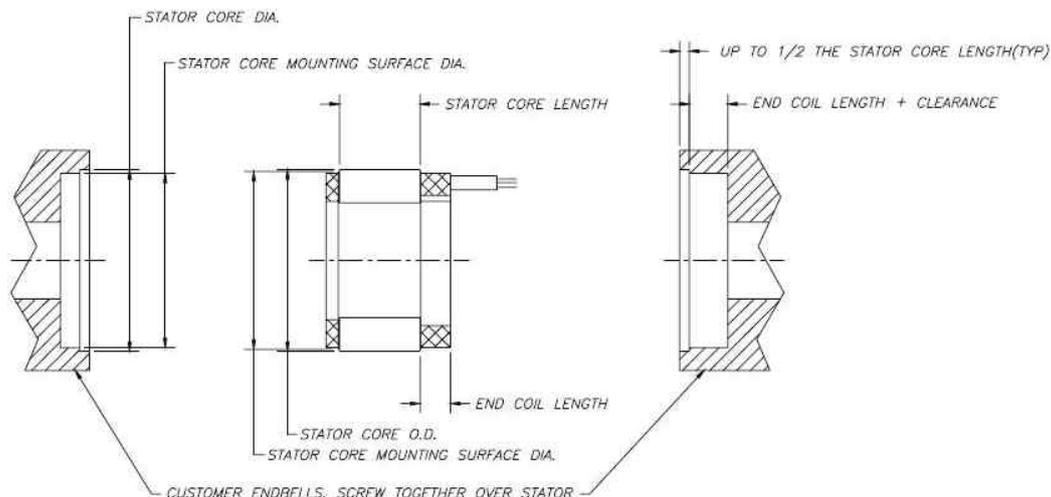
The mounting must ensure proper fixture of the stator under all operating conditions. The stator must not slip tangentially when accelerating or braking.

The stator can be mounted by following methods:

- Stator mounting with end-bells (clamping)
- Stator mounting with screws (only for stators with mounting holes)
- Stator mounting with press seat/heat shrink-fit seat/bond seat

1.2.1 Stator mounting between end-bells (clamping):

This is the standard mounting for frameless motors. The stator core is fixed or clamped between two pieces of metal (called the end-bells). This mounting technique uses friction to moderate the torque between the parts. The axial tension in the motor assembly must therefore always be high enough. This can be achieved by pulling together the two end-bells with screws distributed around the stator core. The end-bells can ideally carry the motor bearings. As the parts are turning workpieces the required alignment of rotor, rotor-shaft, bearing and stator can easily be achieved. The end-bells must allow the connection wires and cables to exit without being damaged or suffering bending under the specified radius. The mechanical design of the end-bells and surrounding housing should allow for good thermal cooling.



Stator with clamping mount

The stator is supplied with a free mounting rim at both sides of the stator (to support mounting within end-bells). The critical dimensions for this mounting rim are the “stator core diameter” and the “stator core mounting surface diameter”. These shoulders allow for direct mechanical interfacing between the stator and the end-bells; the “stator core mounting surface diameter” should allow for a good fit without mechanical collision with the inner diameter of the end-bells! A small air gap should be maintained.

1.2.2 Stator mounting with screws (e.g. MF motors):

This mounting technique is only possible when the stator has mounting holes distributed around the stator core. This assumes that the lamination stack of the stator has a greater diameter than required to conduct the magnetic field. The wider back can also be used to conduct the heat generated by the coils to the mounting structure. This results in better cooling of the motor.

Only one side must be used to fix the stator. It is not necessary to clamp this type of stator between two end-bells (compare 1.2.1 Stator mounting between end-bells (clamping)). The stator outer diameter is normally a precision surface, which can be used for alignment. If this is not the case a thickness gauge may be used during assembly.– See Figure **Stator of MF-motor with axial mounting holes**.



Stator of MF-motor with axial mounting holes

When mounting the stator with screws the motor assembly can kept very short. Please keep the bearing issue in mind.

1.2.3 Stator mounting with press seat/heat shrink-fit seat/bond seat

All these mounting techniques use the outside diameter of the stator lamination stack. For this reason the stator needs to have a machined and precise surface. Refer to the mechanical drawing for tolerances and surface information.

The exact diameter of the counterpart depends on many considerations. If you use an adhesive refer to the data sheet for a correct gap between the parts.

If you want to use a shrink-fit or press-fit assembly it is not easy to choose the right diameter. MACCON cannot give you instructions, which are universally valid. However we suggest you to pay attention to the following aspects:

- Different materials have different thermal expansion coefficients. This means that you are limited in the operating/storage temperature when using different materials for stator and housing.
- The thinner the housing is the smaller the transferred torque. This is the result from deformation of the materials by the forces on it. The housing stretches under the pressure of the stator and vice versa.
- All mechanical parts have tolerances. When you determine the gap you should always calculate the worst case.
- The surface roughness must be suitable.
- Use an adequate calculation method.

1.3 Rotor mounting:

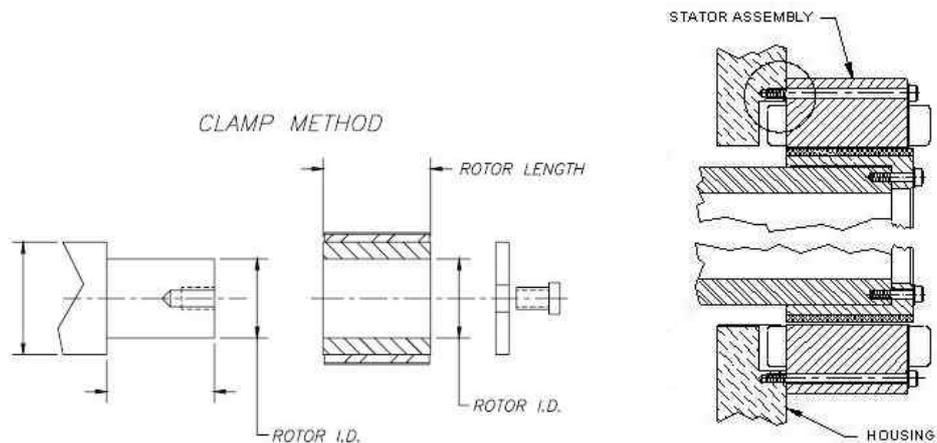
The rotor can be mounted to the shaft by following methods:

- Rotor mounting using screws
- Rotor mounting with bonding
- Rotor mounting with press seat
- Rotor mounting using shaft-hub connection elements

As previously explained the alignment is very important for nominal motor performance. A misalignment of the rotor can also affect in vibrations and damage of the motor assembly (may be dangerous!).

1.3.1 Rotor mounting using screws

This method involves holding the rotor to the shaft with force exerted thru a thrust disc and machine screw. A lock washer or bonding agent can be applied to prevent the screw from becoming loose. The number of screws will depend on the size of the rotor, torque requirements and customer application. Applications involving high torque or sudden start and stop modes may require a woodruff key or square key along with the clamp. Use a transition fit.



Rotor with clamp mounting and rotor with flange mounting

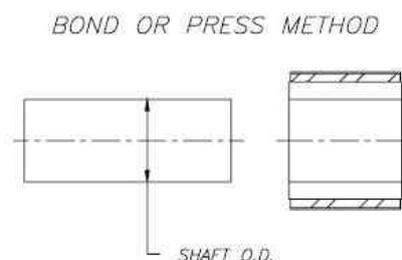
Some larger diameter rotors (e.g. MF motors) have a flange-style mounting option with several holes for fixing directly to a shaft/shaft-end. In this configuration the frontal shaft surface must be in right angle to the shaft axis. Define adequate tolerances in your design

1.3.2 Rotor mounting with bonding:

This method involves holding the rotor to the shaft with a high strength retaining compound. Adhesive manufacturers produce retaining compounds specifically for this design and should be consulted to help select the correct retaining compound for your application. Look in the adhesive data sheet for a correct gap and surface roughness.

1.3.3 Rotor mounting with press seat:

This method involves holding the rotor to the shaft with an interference fit between a set of serrations on the shaft and the rotor ID. A set of 4 serrations equally spaced around the outside diameter of the shaft is required. A tapered serration is acceptable.



If you use the press method without the serrations you have to calculate the right gap to ensure the connection is capable of the required torque. MACCON cannot give you instructions, which are universally valid. We suggest you to use an adequate calculation method. Section **1.2.3 Stator mounting with press seat/heat shrink-fit seat/bond seat** gives you helpful hints for the press-fit.

1.3.4 Rotor mounting using shaft-hub connection elements

Larger rotors can be fixed to the shaft with shaft-hub connection elements (e.g. Tapered shaft lock couplings). Most of these connection elements use friction to transmit the torque. Look at vendor data sheet for detailed mounting instruction.

2.0 Design recommendations for mounting linear motors:

This chapter is addressed to persons designing the surrounding construction of the motor. The recommendations should help to integrate the motor and to assure nominal and safe operation.

For assembly instructions see chapter **3.0 Assembly**.

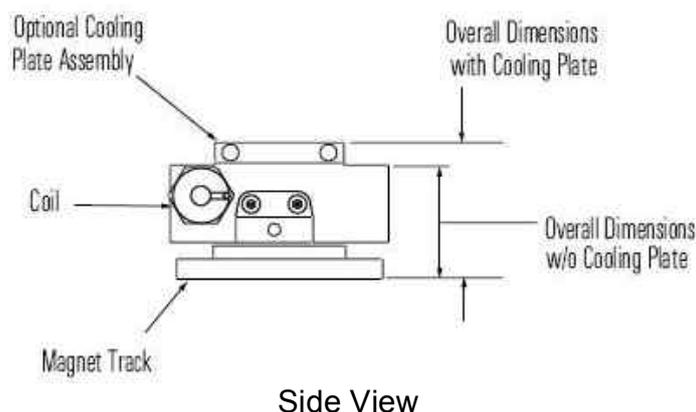
Bearing issue:

This manual does not describe how to support the moving parts. Consult bearing catalogue or manufacturer for proper size type and layout.

2.1 Alignment of the motor components (stator and rotor):

Maintaining the air gap is a critical aspect that affects the linear motor installation and operation. You should use a linear guiding with appropriate load rating for the moving part.

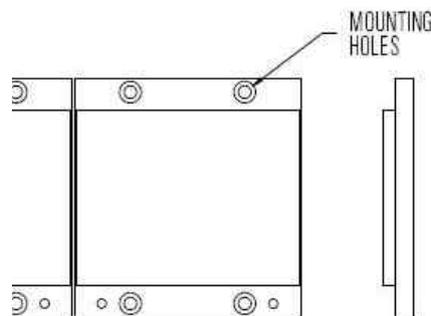
Refer to coil assembly (and cooling plate) drawing for your specific motor. By maintaining installation envelope dimension in your design the required air gap will be met.



2.2 Magnetic Track mounting:

The magnetic track holds the permanent magnets and is mostly mounted to the structure. It is also possible to mount the track to the moving part of the motor.

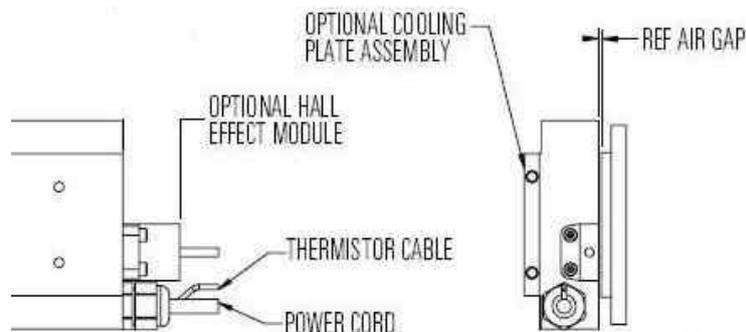
The magnetic track has mounting holes is the back. You should place the track on a flat structure and use all mounting holed to ensure a proper operation of the motor assembly. The structure must be rugged enough to ensure a constant and correct air gap between the moving parts.



The flatness of the surface to which the magnet plate (and the coil plate) is mounted must be within 0,125mm Total Indicator Reading (TIR) per 300mm. This specification correlates to the overall flatness requirement of 0.125mm.

2.3 Coil assembly mounting:

This is the part with the cables. Mostly it is the moving part in a motor assembly. The coils produce (when connected to a current source) the magnetic field which leads to the relative force between the coil part and the magnetic track.



Use all mounting points to avoid twisting of the coil assembly from the magnetic force. As already mentioned in the previous section the mounting surface for the coil assembly must also have an overall flatness of 0,125mm.

3.0 Assembly:

This chapter is addressed to persons assembling or servicing the motor.

This chapter does not discuss stator and rotor issues in different sections. The sections respectively cover a whole motor assembly. For this reason it is not practicable to discuss all variants of stator and rotor combinations. Please regard the sections as examples for commonly used motor configurations.

-NOTE-

CARE SHOULD BE TAKEN IN PREPARATION OF MOUNTING AND
INSTALLATION OF FRAMELESS ELECTRIC MOTORS. ONLY QUALIFIED
TECHNICIANS SHOULD PERFORM THE INSTALLATION AND TESTING.

3.1 Mounting of rotational motors

Small motors (less than 100mm OD) can usually be assembled by hand. Careful attention must be taken while inserting the rotor assembly through the stator. Damage to the stator coil and magnets can occur if the magnet forces suddenly pull the rotor into the stator. The rotor assembly must be securely supported by hand during this process. For large motors, assembly fixtures are recommended to support the stator and rotor during insertion of the rotor assembly.

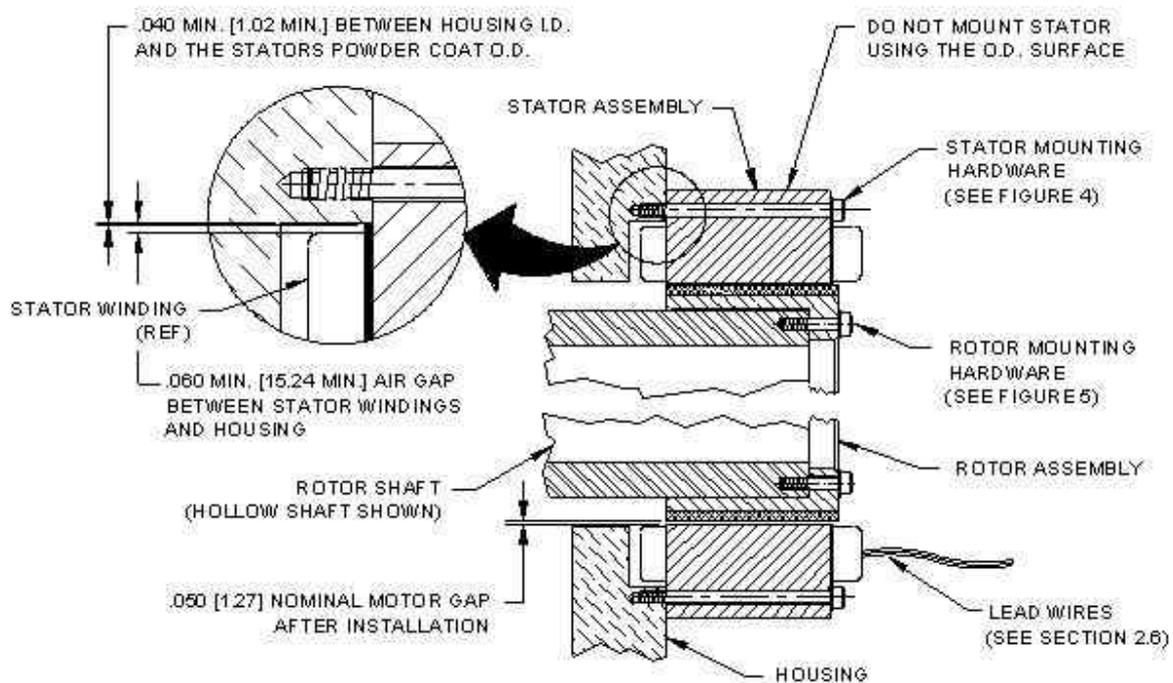
- Under normal operation vibrations produced by the motor can loosen the screws. This results in malfunction or damage of the motor. To avoid this use screw retention for all screws like a liquid thread-locking agent.
- Check the clearance between the winding and the housing. The winding must not touch any other part when assembled. In case of a contact the high operating voltage of the motor can injure persons and destroy electronic equipment.
- Check the air gap between the rotor and the stator after assembly with a non magnetic thickness gauge (e.g. made of brass or plastic). The measured air gap over a full 360° rotation of the rotor should be at least one half of the specified air gap at every position.

3.1.1 Mounting of rotational motors with axial aligned screws and without dedicated radial alignment feature (e.g. some MF motors):

Because of the lack of a dedicated alignment feature for the stator of some motors a special assembling procedure is necessary to archive the required alignment. Please read the following instructions properly before you start with your work.

Compare Section 1.2.2 Stator mounting with screws (e.g. MF motors):

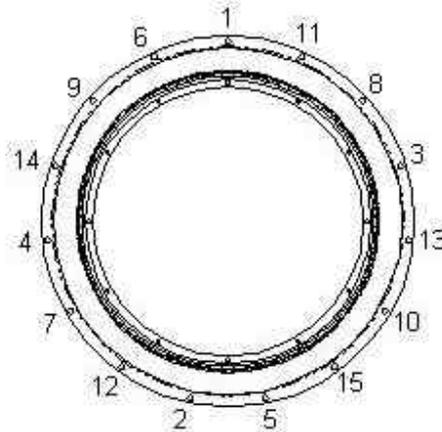
All motor mounting bolt circle patterns should be concentric and should be checked prior to motor installation and rechecked prior to initial testing and operation. Check the clearance between the winding and the housing.



Note : Your motor may look different.
This illustration is for example only.

General Mounting Configuration and Clearances

The use of a high quality liquid thread-locking agent is recommended (follow the manufacturer application instructions). Mounting bolt torque value should be to Industry Standard Specifications and follow a star type tightening sequence pattern. See Figure **General Stator Torque Sequence Pattern**.



Note : Your motor may look different. This illustration is for example only. The number of mounting holes in your motor may be different.

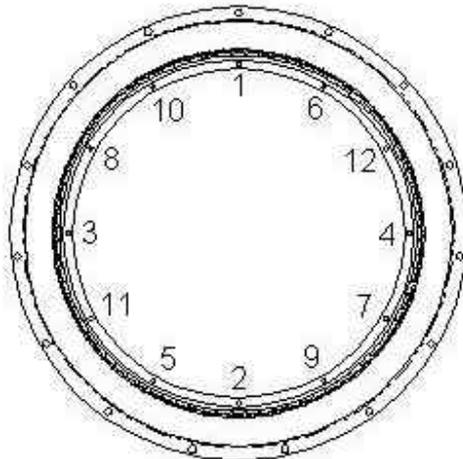
General Stator Torque Sequence Pattern

Apply torque of 1/3 of finished value to each mounting bolt. Repeat torque to all bolts at 2/3 of the finished value. Repeat torque to all bolts until finish torque value is reached.

-CAUTION-

DAMAGE MAY HAPPEN TO ROTOR MAGNETS IF PROTECTIVE
MAGNET SLEEVE IS REMOVED FROM ROTOR O.D.
REMOVE SLEEVE ONLY AFTER ROTOR IS PROPERLY SECURED
ONTO ROTOR SHAFT AND ALIGNED TO STATOR

The same mounting and fixing instructions apply equally for the rotor. See Figure **General Rotor Torque Sequence Pattern**.



Note : Your motor may look different. This illustration is for example only. The number of mounting holes in your motor may be different.

General Rotor Torque Sequence Pattern

-NOTE-

REMOVE PROTECTIVE SLEEVE FROM ROTOR O.D. AND PLACE IT BACK IN SHIPPING CRATE

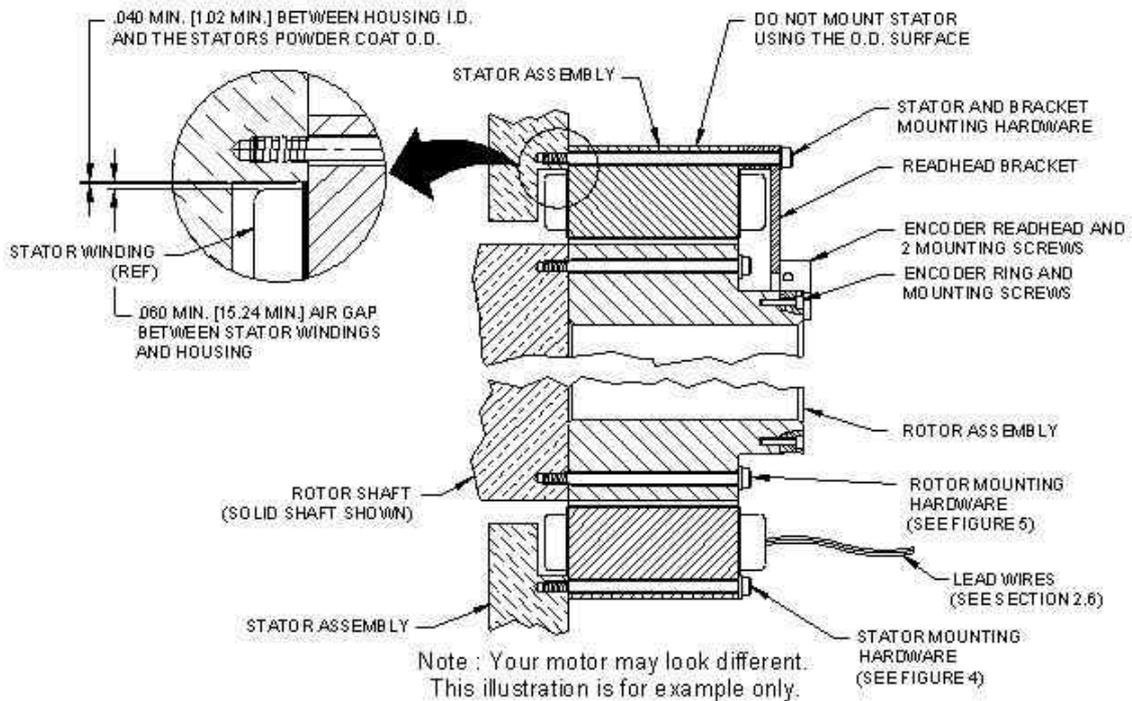
3.1.2 Mounting of a rotational encoder to a motor assembly (e.g. MF motors):

If you ordered the motor with an encoder read-head and ring, special steps are needed to install the stator and rotor. The encoder read-head and ring will not be installed at MACCON and must be installed at time of motor installation:

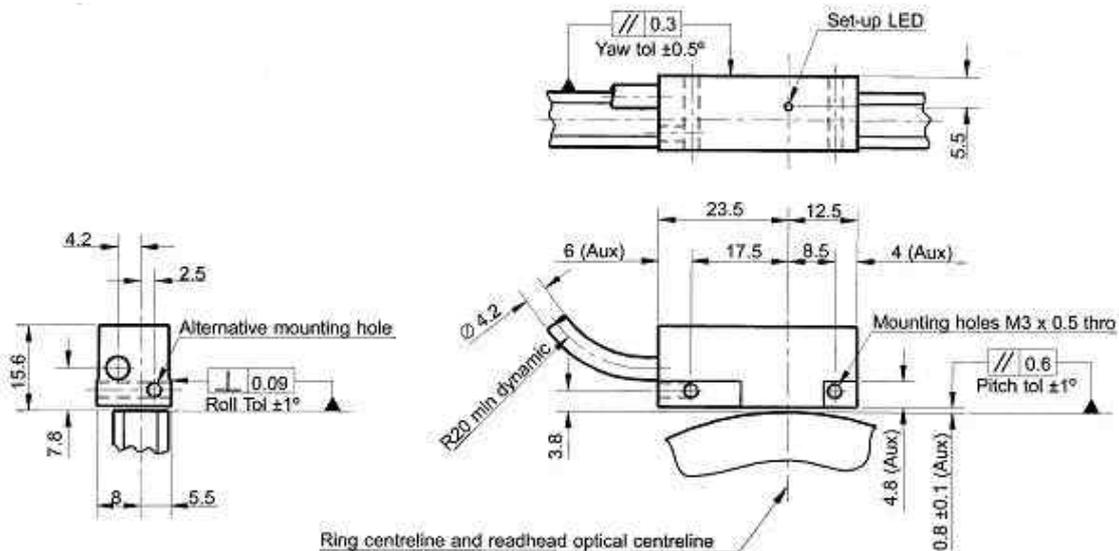
Install read-head onto bracket (bracket not supplied by MACCON). Screws are installed through backside of bracket, be sure that screw heads do not touch stator windings. A counter sinking of read-head mounting screw heads is recommended.

The read-head mounting bracket may be installed using any two-stator mounting holes that work with your motor installation. **The encoder bracket should not be installed until after stator installation and rotor has been mounted on shaft and correctly aligned with stator.**

Carefully install encoder bracket, with read-head, using screws and flat washers. Encoder read-head bracket position must be adjusted to achieve the proper gap, see Figures **Mounting Configuration with Encoder Read-head and Ring** and **Read-head**. If a detail drawing is required to manufacture a read-head bracket for your new motor, contact MACCON for assistance.



Mounting Configuration with Encoder Read-head and Ring



Read-head Installation

The above instructions for mounting read-heads apply for RGH and SR heads (from Renishaw), WMK heads (from AMO) and ERA heads (from Heidenhain).

3.2 Assembly of linear motors

This section describes the assembling of a linear motor with fixed magnet plate and moving coil assembly. The steps are analogue to the opposite case.

The linear motor components come with standard mounting holes according to the data sheet. Use the guidelines found in the following steps to maximize motor performance and minimize the chance of motor damage.

ATTENTION:

To avoid damage due to the magnetic attraction between plates, maintain a minimum distance of five feet between the magnet plates that are being installed and magnet plates awaiting installation. Ensure that the supplied protective devices (i.e. cardboard and metal plate) remain in place until the installation processes is performed.

Ensure the mounting surface to which the magnet plate is to be attached is free of any and all foreign material. If necessary, grind the mounting surface (acetone or methanol may be applied as cleaning agent). Do not clean the surface using abrasives that destroys the anti-corrosive coating!

Verify that the flatness of the surface to which the magnet plate is to be mounted is 0.125mm Total Indicator Reading (TIR) per 300mm. This specification correlates to the overall flatness requirement of 0.125mm.

Prior to any component installation, check the mounting space to ensure a correct air gap of the installed linear motor.

Never try to place the motor coil assembly directly on the magnet plates. Serious damage may result due to magnetic attraction.

Position the moving slide to the end of travel that you wish the cable to exit. Making sure that the mounting face of the motor coil is clean and free of burrs; install the motor under the slide. Select matching screws which do not extend into the air gap. Tighten snugly for now, bolts will be torqued once installation is complete.

On the opposite end of the base, install the first magnet. Non-magnetic tools and hardware (beryllium copper, 300 series stainless steel, etc.) should be use. If not available proceed with care since magnetic items will be attracted to the magnet plates. Do not tighten bolts at this time. Install additional magnet plates by placing them on the base and sliding towards the previous install plate. Orient the plates such that the alignment holes are toward the same side. This will ensure proper magnet polarity.

Move the slide, which you previously mounted motor coil to, over the magnet plate. There may be some resistance while moving onto the plate, this is normal. Measure the gap between the motor and magnet using plastic shim stock. The gap should be 0.79 mm to 1.70 mm. If gap is too large, add appropriate brass or stainless steel shim between motor and slide. If gap is too small, machine the slide or place shims under the bearing pucks.

Once the motor is gapped properly, install the remaining magnet plates.

The final alignment of the magnet plates are done with an aluminium straight edge, and the alignment tool that was supplied with the magnet plates. Slightly loosen the magnet plate mounting bolts, but not the ones that are covered by the motor coil. Place the alignment tool in the holes on each of the plates: This will properly position the pitch of the plates. Align the edges of the plate with the aluminum straight edge and tighten the bolts.

Position the slide over the complete sections and continue aligning the remainder of the plates.

If the area where the magnet plates are to be installed does not allow you to use a straight edge describes above, an alternate method of aligning plates can be done. Space the plate by using a 0.020 plastic shim between the magnet plates, tighten the bolts, and then remove the shim.

Once all the alignment is completed, torque all bolts to values listed in the tables. When considering torque values for mounting hardware, take into account the magnet plate, mounting surface and mounting hardware.

Remove alignment tool and make certain all magnet plate mounting hardware is flush or below magnet surface to prevent damage to the coil.

3.3 Electrical Connection

-CAUTION-

**DO NOT ATTEMPT VOLTAGE OR SIGNAL LEAD WIRE CONNECTION
WITHOUT PROPER CONTROLLER INSTALLATION
DOCUMENTATION AS A GUIDE**

The use of different controller types and motor voltage means that lead wiring between controller and motor may be different for each configuration. Please refer to the MACCON Outline Drawing supplied with your motor and the Data Sheet for detailed information on motor voltage and signal lead wire connection information. If the data sheet was not supplied with your controller or has become misplaced, contact MACCON to secure the lead wire installation information.

Please pay attention for a proper shielding of all cables. This avoids interference effects with other electronic equipment.

Contact MACCON for technical support regarding any special installation questions you may have or technical information you may need.

